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8 Ecological Attributes of Each Area Recommended for the Representative System

8.1 Nuyts Archipelago, St Francis Isles & Coastal Embayments (Murat Bioregion)

Figure 3 shows the location of this area.



Figure 3: Nuyts Archipelago, St Francis Isles & Coastal Embayments

<p>1. Biogeographic Significance</p>	<p>Tourville Bay / Davenport Creek Mangroves at the Tourville Bay / Davenport Creek area are reported to be the largest stand on Eyre Peninsula, and represent the westernmost extent of mangroves in South Australia, and the largest stand of mangroves between Spencer Gulf in South Australia and Exmouth Gulf in Western Australia. Mangroves at Davenport Creek grow on a sandier substrate than is usual for mangroves in South Australia (Morelli and de Jong, 1995; Edyvane, 1995c; Ashman, 1996b; South Australian Coast and Marine Atlas, 2001).</p> <p>Tourville Bay The bay is one of only three estuarine areas in South Australia to be rated as <i>near pristine</i> by participants at a national workshop for the National Land and Water Resources Audit, in 1999. Tourville Bay is therefore listed in the Australian Estuaries database under the category of <i>near pristine</i> (see GeoScience Australia, 2001). Previously Tourville Bay was listed in a national inventory of Australian estuaries (Bucher and Saenger, 1989) as one of the three South Australian estuaries of outstanding conservation significance, due to its undeveloped nature and relatively pristine catchment area.</p> <p>Streaky Bay, Smoky Bay and smaller bays in the region Collectively form the largest area of seagrass on the West Coast of S.A. Seagrass is estimated to cover a total area of approximately 86,160 ha in Streaky and Smoky Bay. Seagrasses of the Far West Coast represent approximately 15% of the total area of seagrasses recorded in South Australia (Edyvane, 1999b).</p> <p>Eastern Great Australian Bight Subject to seasonal warm water masses (see Rochford, 1986 and Herzfeld, 1996,1997), which may influence</p> <ul style="list-style-type: none"> ♦ the “Indo-Pacific” element in the invertebrate fauna (e.g. various species of hydroid, sea cucumber and basket star) (Maxwell and Cresswell, 1981, cited by Edyvane and Baker, 1999b); ♦ part of the fish fauna (species of Western and other warmer region affinity – see section below on Taxonomic Diversity); ♦ the abundance and diversity of some marine macroalgae (e.g. species of <i>Sargassum</i>); and ♦ the seasonal presence of migratory species, such as turtles (Edyvane and Baker, 1999b).
<p>2. Major Physical Influences, and Relative Productivity Level</p>	<p>Major physical influences include variable wave and swell climate (see Hames Sharley Australia, 1989; Shepherd and Womersley, 1976; Edyvane and Baker, 1999b; GeoScience Australia, 2001; Shepherd and Brook, 2003), ranging from:</p> <ul style="list-style-type: none"> ♦ strong south-westerly swell (e.g. St Francis Isles and some of the exposed Far West Coast headlands) and large waves (from strong south-easterly winds) on the exposed outer island areas (e.g. West Island, Hart Island); ♦ moderately wave-exposed headlands (e.g. Point Peter, Point James); ♦ less exposed waters in the more protected lee of the Nuyts Archipelago inner islands, and broad bays of the Far West Coast; and ♦ low wave energy, low swell conditions of the inner bays (Smoky, Tourville, Murat, and others), which are protected by islands and sand spits. Wave exposure is low in the bay areas. For example, mean wave height is around 0.8m in the Blanche Port area, and 0.3m in Smoky Bay. <p>The seasonal warmer water currents, which characterise the Great Australian Bight area, also extend to the islands and bays of the Murat Bioregion (see bioregion description below). Warm water masses in the region are likely to influence the type of macroflora, sessile invertebrates, fish species and migratory taxa (such as marine turtles), that occur in the region (Maxwell and Cresswell, 1981; Edyvane and Baker, 1999b). Warm waters in the eastern Great Australian Bight were previously considered to be due solely to the influence of the Leeuwin current from W.A. (Rochford, 1986). However, more recent oceanographic work (e.g. Herzfeld, 1996,1997; Herzfeld and Tomczak, 1997) has indicated that some of the warm water masses that influence the eastern</p>

	<p>GAB region, may form locally, at the Head of the Bight, and travel eastwards towards Eyre Peninsula.</p> <p>It is evident that the cooler water seasonal upwelling that characterises the lower Eyre Peninsula, is also periodically present along parts of the Far West Coast. For example, Ward <i>et al.</i> (2002, Figure 3) showed that sea surface temperatures are periodically lower in inshore waters of the Far West Coast (e.g. Streaky Bay region), compared with offshore waters. Cooler bottom waters occur during upwelling periods, for example at the St Francis Isles (Shepherd and Brook, 2003).</p> <p>The habitats and biota of the area are influenced by all a combination of the oceanographic features listed above. For example, the St Francis Isles lie in the path of several water masses. In winter, warm waters from the Leeuwin Current and warm Great Australian Bight plumes flow easterly, maintaining mild sea temperatures, whilst during summer to autumn, the same warm plumes, heated on the shallow shelf of the northern GAB, mingle with cooler upwelling water off eastern Eyre peninsula, 2-3°C lower than surface temperatures (Griffin <i>et. al.</i>, 1997; Herzfeld, 1997; Herzfeld and Tomczak, 1997).</p> <p>The large, shallow bays, such as Murat, Denial, Smoky and Streaky have broad depth contours. For example, depths of 20 m or more do not occur until at least 20 km seaward of these bays. Most of the area in these large bays is less than 5m deep. The bays are less wind-exposed than other parts the West Coast that face into the Great Australian Bight, and are protected oceanographically from waves and swell, by islands of the Nuyts group, submerged reefs, sand barriers closer to shore (e.g. near Tourville Bay), and the shallow bay gradients.</p> <p>At St Peter Island, currents from the south-west of the island deposit eroded sands and other sediments on the north-eastern side, and new habitats are being created in this way. Due to variation in erosion and accretion patterns, changes in the coastal strip are noticeable in human time scales (Robinson <i>et al.</i>, 1996).</p> <p>There are relatively steep depth gradients around some of the headlands (e.g. Point Brown) and at the outer island groups. For example, depths may reach 45m to 50m less than 3 km from the coast at the southern side of Franklin Isles and western side of St Francis Isles (South Australian Coast and Marine Atlas, 2001).</p> <p>Fresh groundwater lenses at the base of many sand hills along the West Coast arise as soaks, and “provide refuge for (coastal) plants and animals”. These freshwater groundwater resources have “also been implicated in the upwelling of fresh water in the sheltered (marine) bays, that may be important for several fish and plant species. This relationship however, is uncertain” (Ellis, 1999a).</p> <p>Relative Productivity</p> <ul style="list-style-type: none"> ◆ Periodically, zooplankton biomass is high in the offshore waters of the Far West Coast, for example, near the outer islands (see Figure 16 in Ward <i>et al.</i>, 2000), and this may relate to the periodic influence of cooler water upwelling (see above). ◆ Both the western and eastern sides of the Great Australian Bight are considered to be significant areas for carbonate sediment formation (Gostin <i>et al.</i>, 1988, cited by Edyvane and Baker, 1999b; Bone, 1997, Bone and James, 1998a and 1998b; Bone <i>et al.</i>, 1998). In the eastern part of the Bight, bryozoa dominate sediment production (James <i>et al.</i>, 1994, cited by Edyvane and Baker, 1999b, and references by Bone and James, <i>op. cit.</i>). ◆ Shepherd and Brook (2003) hypothesised that the high abundance of reef fish in the St Francis Isles / Nuyts Archipelago area may in part be due to high local reef productivity and a high carbon subsidy from surrounding seas.
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<p>3. Bioregional Representativeness of Habitats</p>	<p>The area described in this table contains features that are characteristic of the Murat Bioregion (IMCRA Technical Group, 1998). Streaky Bay was not included as part of the Murat Bioregion in version 3.3 of the IMCRA classification (June, 1998). In that version of IMCRA, the eastern boundary of the Murat Bioregion was considered to be the peninsula between Smoky and Streaky Bays (i.e. Point Brown - Cape Missiessy area). However, Streaky Bay is included in the extent of the Murat Bioregion that is now used for classification in South Australia, with Cape Bauer as the eastern boundary of the Murat Bioregion and western boundary of the Eyre Bioregion (see Edyvane, 1999b, and S.A. Coast and Marine Atlas, 2001).</p> <p>Features within the area that are characteristic of the Murat Bioregion (IMCRA Technical Group, 1998), include:</p> <ul style="list-style-type: none"> ♦ mean sea surface temperatures increasing seasonally, under the influence of the warmer water masses from the west; ♦ moderate to low wave energy coastline; ♦ “microtidal” tidal range (1.2 m or less); ♦ rocky crenulate coastline, with a shallow offshore gradient, numerous sheltered, shallow embayments; ♦ coastal geology comprising headlands of Precambrian crystalline rock (i.e. granitic), usually with a dune rock capping, and Pleistocene dune rock cliffs, reefs* (see below) and headlands, interspersed with Holocene beaches, dunes and estuarine deposits, including intertidal and supratidal flats; ♦ numerous offshore islands and sea mounts; ♦ marine flora and fauna typically warm temperate (Flindersian); ♦ shallow embayments dominated by extensive seagrasses meadows, and seagrass also present in the lee of islands; ♦ sandy shores in sheltered areas support the grey mangrove <i>Avicennia marina</i>, the seagrasses <i>Zostera</i> (= <i>Heterozostera</i>) <i>tasmanica</i> and <i>Zostera muelleri</i>, and the brown macroalga <i>Hormosira banksii</i> (on rocky surfaces); ♦ subtidal seagrass communities dominated by <i>Posidonia australis</i> in shallow waters, and <i>P. sinuosa</i>, <i>P. angustifolia</i>, <i>Amphibolis antarctica</i> and <i>A. griffithii</i> in deeper waters; ♦ on rocky shores, exposed calcareous coasts dominated by <i>Ecklonia radiata</i> and <i>Scytothalia dorycarpa</i>; ♦ in calmer areas, macroalgae communities dominated by <i>Sargassum</i> spp. and <i>Osmundaria prolifera</i> on moderate coasts, and <i>Scaberia agardhii</i> in low energy conditions; ♦ Granite boulder reefs dominated by <i>Scytothalia dorycarpa</i> and species of <i>Cystophora</i>; ♦ Distinct tropical element to the flora and fauna of the region (e.g. plankton, fish, echinoderms, hydroids), due to seasonal warm water currents. ♦ Coastal <i>Wetlands of National Importance</i> (e.g. Davenport Creek); ♦ No true rivers, but intermittent streams and tidal mangrove creeks (e.g. Davenport Creek). <p>* (Many of the submerged reefs, island reefs and headland reefs are primarily composed of Precambrian crystalline rocks, particularly granites, and the younger dune rock is a capping, which readily erodes subtidally. Therefore, it is mainly the terrestrial and exposed portions of islands and reefs that are dune rock, and many subtidal reefs are granitic).</p>
<p>4. Habitat Rarity</p>	<p>Rare habitats in the described area are not known for this report.</p>
<p>5. Habitat Diversity</p>	<p>In general, the habitats within this area be summarised as:</p> <ul style="list-style-type: none"> ♦ samphires; ♦ supratidal and intertidal sand and/or mud tidal flats; ♦ mangroves (most westerly extent in S.A.); ♦ intertidal and subtidal seagrasses (both extensive meadows, and patches, of various

densities);

- ♦ sand beaches;
- ♦ benthic sand;
- ♦ reef of various exposures, forms and compositions, (mainly granitic around islands, and at some headlands, but also including calcareous block reefs from eroded material around calcarenite-topped granite islands, calcareous headland reefs in some areas, and subtidal calcareous platform and patch reefs);
- ♦ numerous islands of various sizes, forms, compositions (muddy, sandy, calcareous and granitic) and levels of exposure.

Selected Habitat Notes

Nuyts Archipelago:

A group of 19 main islands, plus a number of emerged rocks and submerged reefs, composed primarily of massive granite bases, capped with calcarenite. Near-shore reef around most of the islands is granite, although calcarenite blocks, eroded from the terrestrial area above, also occur in the shallow subtidal, to around 5m deep. The outermost islands are grouped together as the **St Francis Isles** (Robinson *et al.*, 1996) (see below).

Some of the main islands include the following (descriptions from Robinson *et al.*, 1996, unless otherwise specified):

- ♦ **Purdie Islands:** Exposed granite islands and islets, the largest with a calcarenite cover.
- ♦ **Lounds Islands:** Exposed granite islands, with calcarenite cover.
- ♦ **Franklin Islands:** Two granite islands, with calcarenite capping that drops steeply as scree slopes and cliffs. Calcarenite blocks from the terrestrial erosion occur in some subtidal areas. There is a “massive granite platform” along the coastal rim. A thin sandbar (emerged at low tide) joins the two islands. There are white sand dunes on the north-eastern corner of **West Franklin Island**, near the sand spit (Robinson *et al.*, 1996). On the sheltered northern side of each island, the dissected granite fringe is buried beneath sand beaches, and surfaces only as rocky headlands. There is a long sandy beach on the north-western side of East Franklin Island, backed by sand dunes.
- ♦ **West Franklin Island:** A 1994 benthic survey (Edyvane and Baker, 1999b) recorded that the exposed reef at 15 m was dominated by *Scytothalia dorycarpa*, with *Ecklonia radiata* also in the canopy; and encrusting corallines, the brown turfing macroalga *Homoeostrichus sinclairii*, and mixed red macroalgae (e.g. species of *Laurencia*, *Callophyllis*) and other turfing brown taxa (e.g. *Scoresbyella profunda*) in the understorey.
- ♦ **East Franklin Island:** During a 1994 survey (Edyvane and Baker, 1999b), reef at 7m was dominated by *Sargassum verruculosum* and *S. paradoxum*, and mixed *Cystophora* species (e.g. *C. expansa*, *C. brownii*, *C. siliquosa*, *C. monilifera* and *C. pectinata*), similar to the dominant taxa at reef sites further north, at **Cape D’Estrees** (see below). Other large macroalgae comprised mainly *Ecklonia radiata* and the red *Osmundaria prolifera*, with other *Sargassum* species (*S. lacerifolium*, *S. linearifolium*). Understorey species include the green *Caulerpa flexilis*, and the turfing brown *Zonaria spiralis* (Edyvane and Baker, 1999b and unpublished data).
- ♦ (**St Peter, Goat and Eyre Islands** are discussed below, because they are inner islands in the vicinity of Smoky Bay).

St Francis Isles

A group of eleven islands (the main ones being **St Francis, Smooth, Egg, Dog, Freeling, West, Masillon, Fenelon, Hart, and Lacy Islands**), comprised of granite, with calcarenite and sand overlying most of the larger islands. The total area covered by the group is reported to be 1,312 ha, the largest islands in the group being St Francis Island (809 ha), Masillon Island (202 ha) (Robinson *et al.*, 1996) and Fenelon (approximately 95 ha – estimated from S.A. Coast and Marine Atlas, 2001). Egg and Dog Islands are approximately 60 ha (Robinson *et al.*, 1996; Australian Heritage Commission, undated).

Seagrass meadows and assemblages of macroalgae occur around the islands (Edyvane and Baker, 1996a).

St Francis Island: An island of around 809 ha (Robinson *et al.*, 1996), composed of granite (of a composition not found on the mainland), with calcarenite capping. There are eroded granite boulders and shelves in the intertidal and shallow subtidal zone, and granite fringes the calcarenite cliffs on all sides except the north. Granite blocks occur in a number of subtidal areas (for example, to 12+m, inside North Point and south-west of North Point; and in deeper water, such as 18m and 22m, at the western extremity of the island, according to a survey in 2002 by Shepherd and Brook). **Petrel Cove** is a broad sandy beach bay fringed by dunes, on the north side of the island, and a smaller bay (**East Bay**) is protected behind East Point, on the north-eastern side. Topographically complex calcareous reef to around 5m deep, occurs on the southern shores of **Petrel Bay** (Womersley and Baldock, 2003, cited by Shepherd and Brook, 2003). There are also two sandy coves (e.g. **Trivia Bay** and **"Mast Bay"**) between the points on the south-western side.

A previous survey by Shepherd and Womersley (1976) at **St Francis Island** recorded *E. radiata* and *Scytothalia dorycarpa* on shallow reef (6 m) on the exposed north-western side of the island, with minor amounts of *Cystophora* and *Sargassum* species, and a sparse understorey of species of *Plocamium*. Similar species were recorded at 13 m. On deeper reefs (35 m) *E. radiata* was dominant, with minor cover of *S. dorycarpa* and *Sargassum varians*, and other *Sargassum* species. Numerous red taxa (e.g. species of *Champia*, *Cliftonaea*, *Delisea*, *Plocamium*, amongst others) and turfing brown species (e.g. species of *Dictyota*, *Zonaria*) were recorded in the understorey, on the reef at 35 m. Deeper than 40 m, the dominant cover on reefs on the exposed north-western side comprised mixed species of sponge, hydroid and bryozoa.

On the more sheltered north-eastern side of the island, Shepherd and Womersley (1976) recorded a community of mixed *Sargassum* and *Cystophora* species at 6 m, with the small brown *Lobospira variegata* and the large red *Osmundaria prolifera* dominating the understorey. At 13 m, *E. radiata*, *S. dorycarpa* and *Cystophora pectinata* were dominant, with several species of *Cystophora* and *Sargassum* also in the canopy, and turfing browns (*Zonaria*, *Pachydictyon*) and *O. prolifera* in the understorey. Similar taxa were recorded at 19 m, although *E. radiata* and *S. dorycarpa* were less dominant, and several species of *Sargassum* and *Cystophora* were equally prevalent. The large red *O. prolifera*, turfing browns and small reds (e.g. *Botryocladia sonderi*) dominated the understorey at this depth. Samples taken at 20 m indicated an abrupt decline in brown canopy dominants, and the prevalence of a few understorey taxa that can withstand sedimentation, such as *O. prolifera*, *B. sonderi*, and the small browns *Hydroclathrus clathratus* and *Chlanidophora microphylla* (Shepherd and Womersley, 1976).

At **Petrel Cove / Petrel Bay** at **St Francis Island**, Shepherd and Womersley (1976) recorded the seagrass *Amphibolis antarctica* at the shore fringe, with fairly continuous beds of *Posidonia* below this zone, to around 22 m, beyond which seagrasses became sparser. At 22 m and deeper, the red macroalga *Hennedya crispa* formed a loose-lying community at the time of the survey.

At the time of a 1992 benthic survey (Edyvane and Baker, 1996a, 1999b), shallow reefs (5 m) at the sampled sites at **St Francis Island** were dominated by three species of *Sargassum* (with *Sargassum verruculosum* highly dominant in areas), and two species of *Cystophora*. On reefs at 10 m, *Sargassum verruculosum* and *Cystophora monilifera* and *Ecklonia radiata* were dominant, with *Scytothalia dorycarpa*, mixed species of *Cystophora* and species of *Sargassum* (on different sides of the island) in lesser abundance. The red macroalga *Osmundaria prolifera* was also abundant, with the green *Caulerpa flexilis* and a species of the coralline *Metagoniolithon* in the understorey at some sampled sites. Sandy areas at 15 m were dominated by *Posidonia sinuosa* with *Zostera (Heterozostera) tasmanica*, and *Caulerpa scalpelliformis* was also present. Species of *Sargassum*, and *Ecklonia radiata*, dominated reefs at 15 m, with *O. prolifera*, species of *Cystophora*, *Scaberia agardhii*, and the understorey brown *Homoeostrichus sinclairii* was also present (Edyvane and Baker, 1996a and 1999b).

During a more recent survey of **St Francis Island** in 2002, Shepherd recorded in central **Petrel Bay**, calcareous block reef with crevices at 5m, dominated by fucoid brown macroalgae; and near **East Point**, sloping granite blocks up to 1m high, at 10m depth, also dominated by fucoid macroalgae. Reef between 5m and 10m on the exposed side of **East Point**, was dominated by *Ecklonia radiata* and a community of fucoid species, such as *C. monilifera*, *C. moniliformis* and *C. subfarcinata*. On the south side of **East Bay**, *C. monilifera* and species of *Sargassum* were recorded on reef at 5m, with *Ecklonia* and mixed fucoid macroalgae at 10m (Shepherd and Brook, 2002 survey data). At **North Point**, granite blocks of around 1-2m high were recorded at 8m – 12m depth, covered with a community of fucoid macroalgae. At 18m depth, around 100m off North Point, Shepherd recorded an *Ecklonia* / *Cystophora* community on reef of low to moderate relief, with new seagrass growth of *Amphibolis* and *Posidonia* species, at 20m (Shepherd and Brook, 2002 survey data).

Fenelon Island: Composed of granite (of a composition not found on the mainland), with calcarenite capping. The island coastline is well eroded, and there are few cliffs on the island, apart from those near a small bay on the north-eastern side. The bay is covered by eroded boulders and rubble, but also contains a small sand beach. Apart from the north-east, most sides of the island drop steeply into deep water. The eroded granite around the island has many splits and crevasses in the near-shore area, and has resulted in a number of “blow-holes” (Robinson *et al.*, 1996). A 1992 benthic survey (see Edyvane and Baker, 1996a and 1999b) reported that shallow reefs (5 m) at the time of the survey were dominated by *Cystophora* species (e.g. *C. monilifera* and *C. subfarcinata*) and *Osmundaria prolifera*, with *Sargassum decipiens* and other *Cystophora* species also present. *Caulerpa flexilis* and *Areschougia congesta* were the dominant understory taxa at some sampled sites. *Scytothalia dorycarpa* was highly dominant on reefs at 10 m, with *O. prolifera*, *Sargassum* species, *Cystophora* also present. Major understory species included *C. flexilis* and the coralline *Halimnion roseum*. In deeper (15 m – 20 m) sandy areas, *Posidonia sinuosa* was dominant at the time of a survey in 1994, with lesser cover of *Zostera (Heterozostera) tasmanica* and the red *Plocamium mertensii*. Reefs at 15 m to 20 m were dominated by *Scytothalia dorycarpa*, with *Cystophora monilifera*, *Ecklonia radiata*, and *Cystophora platylobium* also present. Major understory taxa at some of the sampled sites included *Laurencia filiformis* and *L. elata*, *Hymenocladia usnea*, and *Carpopeltis phyllophora* (Edyvane and Baker, 1996a, 1999b, and unpublished data).

Masillon Island: Composed of granite (of a composition not found on the mainland), with calcarenite capping. The island is ringed by cliffs, but contains a number of small bays. The most prominent bay is on the western side; it is deep enough to almost dissect the island, and is surrounded by steep cliffs. The bay at the northern side of the island is the most sheltered. Although most reef in the area are granitic, there are calcarenite blocks and rubble in the intertidal and shallow near-shore subtidal, eroded from the calcarenite capping above (Robinson *et al.*, 1996).

A survey by Shepherd and Womersley (1976) at **Masillon Island** recorded the following dominant taxa at various depths, on near-shore reefs: 1 to 5 m: Dense cover of the coralline *Halimnion roseum* (formerly *Corallina cuvieri*), with sparse coverage of *Cystophora intermedia* and *Sargassum* spp., and species of the turfing brown *Pachydictyon*, and the red *Callophyllis*. At 6 m: Mixed brown canopy macroalgae, such as *Ecklonia radiata*, *Sargassum fallax* (formerly *S. bracteolosum*) and lesser coverage of *S. varians* and other *Sargassum* spp., *Cystophora pectinata* and *C. moniliformis* (with minor amounts of two other species of *Cystophora*), *Myriodesma harveyanum*, and minor coverage of *Scytothalia dorycarpa*. Understorey taxa included species of the reds *Delisea* and *Pterosiphonia*, turfing browns (*Zonaria*, *Pachydictyon*, *Dictyota* species) and minor coverage of *Plocamium* species. At 22 m: *S. dorycarpa* and *E. radiata* dominated, with minor cover of *Sargassum fallax*. Understorey taxa included turfing browns (*Zonaria*, *Chlanidophora*, *Dictyota* and other species), mixed species of the red *Plocamium*, and other reds such as species of *Rhodophyllis* and *Webervanbossaea*. Deeper than 22m: Fewer macroalgae were recorded in deeper water (30+m), however reefs at 32 m were still dominated by *E. radiata* and *S. dorycarpa*, with various red taxa in the understory, such as species of *Ballia* and *Plocamium* (Shepherd and Womersley, 1976).

West Island: The island and its neighbouring reef are remnants of a promontory that once

extended from St Francis Island. West Island is composed of granite (of a composition not found on the mainland), with calcarenite capping. Both West Island and its adjacent reef are highly exposed, particularly on the southern and western sides, and subject to strong swell. There are granite cliffs around the island, and a granite platform covered with boulders, on the western side (Robinson *et al.*, 1996). On the main island, there are steep cliffs dropping into the highly wave-exposed waters of the southern side (Robinson *et al.*, 1996). A survey by Shepherd and Brook (in 2002) recorded steeply sloping granite blocks to around 20m towards the south-western side, dominated by *Ecklonia radiata*, *C. moniliformis* and *C. monilifera*, with *Sargassum* species and *Acrocarpia paniculata* also present. Sand bottom occurred deeper than 20m. On the northern side of West Island, block reef at 4m was dominated by *Sargassum* and *Cystophora* species, and at 11m (the limit depth of the block reef), *E. radiata* and mixed species of *Cystophora* dominated (Shepherd and Brook, 2002 survey data).

Dog, Freeling, Egg and Smooth Islands: Small (approximately 12 ha to 60 ha) exposed islands to the north-west of St Francis, composed of granite with calcarenite capping. **Smooth** and **Egg Islands** have steep granite coastlines, including shelves, rising from deep water, and are subject to strong surge. At **Smooth Island**, a survey by Shepherd and Brook in 2002 recorded mainly *Ecklonia* as the dominant cover on reef at 22m, and a *Cystophora* / *Sargassum* species community on reef at 5m. Shallow reef (e.g. 5m) at **Smooth Island** comprises a steeply sloping granite wall; long sections of smooth sloping granite; caves and tumbled rocks, and abundant crevice habitat (Shepherd and Brook, 2002 survey data). **Dog Island** has a granite coastline, with calcarenite capping beyond the present influence of the sea. There are several coves and points around **Dog Island**, with boulder beaches, and a line of dunes along the eastern side. There are calcarenite blocks in the near-shore area, eroded from the scree slopes. **Freeling Island** has small bays at the south-western end (Robinson *et al.*, 1996). Topographically complex calcareous block reef of high relief occurs on the northern side of **Freeling Island**, to around 5m (Womersley and Baldock, 2003, cited by Shepherd and Brook, 2003). During a survey in 2002, a community of furoid macroalgae was recorded on creviced reef at 6m, at the lagoon area on the north-western side of **Freeling Island**, and *Cystophora monilifera* and various red macroalgae dominated low relief reef at 10m (Shepherd and Brook, 2002 survey data).

Hart Island: One of the most distant islands from the mainland of S.A., and the outermost member of the St Francis group. Composed of granites and volcanic rocks (Robinson *et al.*, 1996).

Lacy Islands: One island and a small islet, with a cluster of emerged and submerged reefs 3.5 km north. The granite fringe has been worn into islets and coves, but calcarenite capping still exists in the intertidal area at some parts of the main island (Robinson *et al.*, 1996).

Evans Island: The calcarenite capping drops steeply at the coast to a broad granite fringe, and boulders and blocks of both types occur in the intertidal area. There are extensive calcareous overhangs and caves around the island, due to sea erosion of the calcarenite layers (Robinson *et al.*, 1996).

Reef in Point Bell area: According to a 1994 benthic survey (Edyvane and Baker, 1999b), granite headland reef was at that time dominated by the *Scytothalia dorycarpa*, with *E. radiata* and *Cystophora racemosa* also occurring in the canopy. Understorey species comprised mainly mixed corallines (species of *Amphiroa*, *Metagoniolithon*, *Haliptilon* and *Rhodopeltis*), with bare sand patches in some sampled areas.

Point Bell Bay: Dominated by a dense cover of the red macroalga *O. prolifera*, with *Sargassum heteromorphum* as sub-dominant on the reef between the sand. In some sandy areas (e.g. western side), the seagrasses *Amphibolis griffithii* and *Posidonia angustifolia* were dominant during a 1994 survey (Edyvane and Baker, 1999b), with lesser cover of *Amphibolis antarctica*. According to mapping by CSIRO (see Edyvane, 1999b), seagrass in the bay mainly occurs on the eastern side, behind Point Bell. Abundant and species-rich red macroalgae were recorded in the bay during a 1994 survey, both free-standing large red taxa, and abundant large red epiphytes. Red taxa recorded as major components of the benthos in sampled areas include species of

Dictyomenia, *Areschougia*, *Phacelocarpus*, *Amansia*, *Micropeuce*, *Delisea*, *Dasya* and *Herposiphonia*, amongst others (Edyvane and Baker, 1999b and unpublished benthic survey data). According to mapping by CSIRO (see Edyvane, 1999b), platform reef (composition unspecified) in the Bell Bay area extends to at least 4 km from shore.

The rocky promontories of **Point Peter**, **Point James**, and points further west contain small land-locked sand beaches backed by cliffs and cliff top dunes (Hames Sharley Australia, 1989). The area is described as a moderate to high energy coastline, dominated by calcarenite (dune-rock), with granitic basement rock outcropping long the coast. There are small sandy beaches east and west of **Rocky Point**, and a long sandy bay between Rocky Point and Point James (Hames Sharley Australia, 1989). In 1994, CSIRO (see map in Edyvane, 1999b) mapped coastal calcarenite reef as outcropping at the coast between the beach areas, with a small bed of dense seagrass (extending at least 200 m from shore) in the more protected area behind **Rocky Point**.

Tourville Bay / Davenport Creek and Denial Bay: The bay is approximately 50 square km (Hames Sharley Australia, 1989), partly enclosed by a Holocene sedimentary barrier that spans between **Point James** and **Point Peter**. A flood tide channel and flood tide delta fill most of the southern half of the bay. There are recurved spits built into the bay on the southern shore, separated by mangrove woodlands in the muddy swales. Tourville Bay acts as a “sink” for sediment transport from higher energy sections of coast (Hames Sharley Australia, 1989). The area has been described as a “diverse sheltered wetland” (Australian Heritage Commission, undated) of samphire flats and mangroves around tidal channels, seagrass, intertidal sand flats and subtidal sand, with small calcareous patch reefs (see Bucher and Saenger, 1989; Morelli and de Jong, 1995; Edyvane, 1999b; S.A. Coast and Marine Atlas, 2001). According to mapping from DEH’s Saltmarsh Mapping Program (in S.A. Coast and Marine Atlas, 2001), an intact samphire area dominates the western and southern sides of **Tourville Bay**, and is up to 2.5 km wide in places. DEH’s saltmarsh mapping program, recorded the northern side of **Tourville Bay** as predominantly bare sand, with intertidal seagrasses as bands (0.6 km - 1 km long), and as small patches. In contrast, CSIRO mapped in 1994 (see Edyvane, 1999b), medium density seagrass throughout the entire northern part of Tourville Bay, extending to around 1.5 km from shore. Seaward of Davenport Creek, subtidal seagrasses occur in patches, surrounded by sand. According to a previous survey, (Bucher and Saenger, 1989), of a total catchment area of 318 km², the intertidal zone of **Tourville Bay** comprises intertidal sand and mudflats (42 km²) and mangroves (13.36 km²).

More recent mapping of the tide-dominated “estuary” of **Tourville Bay**, as part of the National Land and Water Resources Audit, recorded the following statistics (see GeoScience Australia, 2001-2004): Water area (km²)=52.60; Entrance width (km)=6.06; Perimeter (km)=80.32; Maximum length (km)= 10.86; and Maximum width (km)= 6.37.

Davenport Creek: The creek is the most southerly arm of the multi-channel entrance of **Tourville Bay** into **Denial Bay**. The creek is a sheltered, shallow sandy channel, fringed by a narrow band of mangroves on both sides, and has two or three meanders, terminating in the large samphire saltmarsh area in southern and western **Tourville Bay** (Morelli and de Jong, 1995). Samphire also extends for approximately 1 km either side of the creek. The samphire communities on mudflats are mainly *Sarcocornia quinqueflora* and *Halosarcia holocnemiooides*, and the mud flats are subject to tidal flooding (Fotheringham *et al.*, 1983; Fotheringham and Buckley 1987, cited by Morelli and de Jong, 1995). Behind the saltmarsh area lies “a series of playa lakes”. The mangroves are backed on the ocean side (west of the creek) by “large sand dunes” (Morelli and de Jong, 1995). The sandy beach is backed by mangroves, an distinctive feature, because mangroves usually grow in muddier substrate. DEH’s Saltmarsh Mapping Program (S.A. Coast and Marine Atlas, 2001) recorded “tidal stream” seagrass at the head of Davenport Creek, near the samphires, and Morelli and de Jong (1996) described “large areas of seagrass” in the Davenport Creek area. Cockle beds have also been recorded in the vicinity of Davenport Creek. Bare sand and seagrass strips occur seaward of Davenport Creek, in the centre of Tourville Bay (see map by CSIRO, in Edyvane, 1999b). During the 1980s, Hames Sharley Australia

(1989) reported that inland dune transgression towards Davenport Creek was estimated at 3.5 m to 4.5 m per year, burying some parts of the mangrove community at Davenport Creek.

Denial Bay: The western portion of the well-protected, low energy **Murat Bay** (called **Denial Bay**) occurs between **Cape Beaufort** and **Low Point**. Some sand flats have formed from sediments moving around the **Cape Beaufort** area. Most of the coast is bordered by low to moderate energy, high calcarenite cliffs (Hames Sharley Australia, 1989). Samphire fringes the western side (up to 1.3 km wide), northern side (100 m to 200 m) and eastern side (600 m) of the bay. DEH's saltmarsh mapping program (S.A. Coast and Marine Atlas, 2001) mapped bare sand seaward of the samphires, extending 1 km to 1.3 km seaward on the northern and eastern sides, and at least 300 m on the western side. In contrast, CSIRO and SARDI mapped in 1994 (see Edyvane, 1999b), medium density seagrass in the northern and western sides of Denial Bay (i.e. in the area reported by the DEH maps to be bare sand), extending between 0.6 and 1.5 km from shore. The location of bare sand and seagrass in the bay cannot be ascertained for this report, and more recent survey information is required. Patches of calcareous reef also reportedly occur in the bay, covered with brown macroalgae. Further offshore, out of the bays, the near-shore area in the vicinity of Ceduna has been described as supporting "a relatively dense cover of various (macro)algae and a diverse fauna, dominated by feather-worms and sponges" (Bone and James, 1998).

Between **Denial Bay** and **Cape Beaufort** (i.e. south-eastern side of Denial Bay) there is a large area of samphire, approximately 4 km by 2.5 km, according to mapping by DEH's Saltmarsh Mapping Program (S.A. Coast and Marine Atlas, 2001). Tidal channels dissect the samphire, and the channels are fringed by mangroves (around 300 m to 400 m wide, on each side of the channels). Seaward of this intertidal area, towards the Denial Bay mouth, the subtidal comprises bare sand and seagrass stands.

Murat Bay: Little information about the intertidal and subtidal habitats of Murat Bay is available for this report. There are small areas of saltmarsh at the head of Murat Bay. A 1994 benthic survey (Edyvane and Baker, 1999b) recorded *Heterozostera tasmanica* (= *Zostera tasmanica*) at 4m on the northern side of Murat Bay, with minor amounts of the brown macroalgae *Scaberia agardhii* on calcareous reef patches, and areas of bare sand. On the southern side, *Posidonia australis* and bare sand were recorded, and *P. sinuosa* beds were recorded on the eastern side, with minor cover of *P. australis*, and *Pinna bicolor* Razorfish as a dominant invertebrate in the area. In 1994, CSIRO and SARDI (see Edyvane, 1999b) mapped bare sand between 200 m and 1 km from the shore around the bay on the northern and eastern sides, with dense seagrass patches on the eastern side, seaward of the bare sand (and extending 1 - 2 km from the coast). There is reportedly a strip of dense seagrass on the western edge of the bay (extending 100m – 500m from shore), with medium density seagrass throughout the rest of the mapped area of the bay (CSIRO map, in Edyvane, 1999b). Madigan *et al.* (2000) reported that the dominant seagrass in the vicinity of surveyed oyster lease sites was *P. australis*, and that *P. sinuosa* was scarce in the surveyed area.

Bird Rock: Bird Rock is a ring of granite boulders, found north of the main Yatala Channel into **Thevenard**. There is sand on the leeward side (Robinson *et al.*, 1996).

Bosanquet Bay: Low calcarenite cliffs with small sand beaches between, line the **Bosanquet Bay** coast. There is a large sandbar in the centre of the bay, that dissipate the south-westerly swells. Significant sediment build-up has occurred on the southern side of the **Thevenard Peninsula**, leading to the formation of a flat, shallow beach, bordered by mangroves. The northern and north-eastern shores of Bosanquet Bay are bordered by dunes (Hames Sharley Australia, 1989). Little information is available for this report, regarding intertidal and subtidal habitats. *Heterozostera tasmanica* (= *Zostera tasmanica*) was the dominant seagrass at 5 m, according to a 1994 benthic survey (Edyvane and Baker, 1999b), with *Posidonia australis* and *P. sinuosa* and *Halophila australis* also occurring in the area, and the green *Caulerpa cactoides* recorded in minor amounts. *Pinna bicolor*, and species of oyster, dominated the understorey. In 1994, CSIRO (see map in Edyvane, 1999b) mapped bare sand between 200 m to 500 m offshore, and sparse seagrass seaward of the sand.

Decres Bay: Low to moderate energy coastline, protected from south-westerly swells by the position of **St Peter Island**. Low calcarenite cliffs dominate the coastline, and there is a shallow beach backed by dunes, east of **Wittelbee Point** (Hames Sharley Australia, 1989). Little information is available for this report, regarding intertidal and subtidal habitats. *Posidonia sinuosa* beds (Ashman, 1996b) and bare sand (DEH mapping, S.A. Coast and Marine Atlas, 2001) are known to occur in the area. In 1994, CSIRO and SARDI (see Edyvane, 1999b), mapped a seagrass strip to approximately 1 km from shore, with bare sand throughout the rest of the bay.

St Peter Island: St Peter Island is the largest of the Nuyts Archipelago Islands, and the second largest South Australian island after Kangaroo Island, with an area of 3439 ha (Robinson *et al.*, 1996). It has a granite base capped with calcarenite, that forms cliffs along part of the coast. In sheltered areas, the island is covered with beaches (some backed by sand dunes), with silty/muddy tidal flats, and mangroves in the most sheltered areas. The north and north-eastern sides of the island are shallow (less than 5 m). There are small beach areas on the northern side, and a stand of mangroves extending from the north, along the north-eastern sandbar / spit. The longest of the several sandbars on the north-eastern side is 4 km from the shore. The main sandbar is covered with beach ridge vegetation (terrestrial), samphires, and scattered mangroves. Currents from the south-west of the island deposit eroded sands and other sediments on the north-eastern side, and new habitats are being created in this way. Due to changes in erosion and accretion patterns, changes in the coastal strip are noticeable in human time scales (Robinson *et al.*, 1996). On the north-eastern side of **St Peter Island**, there is a dense seagrass bed (around 6 km long and 1 km to 1.5 km wide), on the southern side of the main sandbar, extending into the broad bare sand area of **Decres Bay** (S.A. Coast and Marine Atlas, 2001). Seagrasses also occur on the north-west of the island, but the most extensive stand is west and south-west of the island, between St Peter Island and **Smoky Bay**, and is approximately 15 km wide. Near-shore reef occurs mainly at the steeper southern and south-western sides of the island, similar to the reefs around **Goat Island**.

Goat Island: The island is composed of granite with a calcareous capping, which was previously part of **St Peter Island**. A submerged reef now separates the two islands. There is granite cliff reef on the exposed southern side, and a sandy beach on the north-eastern tip of the island, surrounded by reefs. There is a small emerged section of reef on the south-eastern side (Robinson *et al.*, 1996; S.A. Coast and Marine Atlas, 2001).

Eyre Island: The island is composed mainly of sand, perhaps overlying a well-eroded rock base (Robinson *et al.*, 1996). Most of the island is low-lying, and periodically inundated by sea. According to the Australian Heritage commission (undated) and Robinson *et al.* (1996), three main community types occur on the island, which are dunes on the more exposed southern side, mangroves on the protected north-eastern side, and mudflats, dominated by samphires. The dune barrier has allowed fine silt to build up in deep layers (Robinson *et al.*, 1996). DEH's mapping program recorded the mangrove stand to be approximately 5 km by 1.5 km (and dissected by numerous small channels), backed by a samphire strip that extends up to 6 km across the island (S.A. Coast and Marine Atlas, 2001). The island is ringed by bare sand on all sides, except for a small section on the northern side of the island. Seaward of the sand, seagrass beds extend both north-east (into **Smoky Bay**) and south-west (north-west of **Cape Missiessy**).

Cape D'Estrees: Low calcarenite cliffs and narrow beaches characterise the coastal area between **Cape D'Estrees** and **Laura Bay** (Hames Sharley Australia, 1989). *Posidonia sinuosa* occurs on sandy substrate between reef areas, particularly close to shore (SARDI and CSIRO, unpublished survey data 1994, cited by Ashman, 1996b). At Cape D'Estrees, a 1994 benthic survey (Edyvane and Baker, 1999b) recorded on the near-shore reefs, at a depth of 5 m, *Sargassum* species as dominant flora (particularly *S. lacerifolium*, but also including *S. heteromorphum* and two other species), with other canopy taxa including *Cystophora* spp., *Ecklonia radiata* and *Caulocystis uvifera*. At the time of the 1994 survey, the understory was dominated by mixed sponge and ascidian species, and other sessile invertebrates, as well as the small red

macroalga *Botryocladia sonderi*. A high percentage cover of sessile invertebrates was recorded in the area. A more recent survey in the area by SARDI, has shown that habitat cover in the **Cape D'Estrees** area, comprises, in the nearshore area (e.g. 5m) *Posidonia* seagrass beds with filamentous epiphytic algae, and interspersed with patches of macroalgae such as the brown *Sargassum*. Further offshore, at around 10m, a cover of diverse invertebrates (such as the Razorfish *Pinna*, and various sponges and ascidians) and macroalgae (e.g. *Caulerpa* species) was recorded, in sand and rock habitat. In the most southerly part of the survey area, near the tip of the Cape, the area was dominated by sand, with sparse invertebrates (e.g. solitary ascidians) and red macroalgae was also present (SARDI data, 2002).

Laura Bay: An area of undulating plain stretching to the coast, where sand dunes, sandy beaches and tidal flats occur (Australian Heritage Commission, undated). A series of beach ridges have grown and moved inland during several thousand years, creating the present protected, shallow beach. There is a 1km wide band of supratidal and intertidal flats around the bay, comprising mainly samphire, according to DEH's Saltmarsh Mapping Program (S.A. Coast and Marine Atlas, 2001). Australian Heritage Commission (undated), reported that the tidal flats seaward of the dune areas are "dominated by mangroves" (*Avicennia marina*). The strip of mangroves seaward of the samphire is mapped as a thin band less than 100m wide, mainly on the far western end of the bay, lining **Fox Creek** (S.A. Coast and Marine Atlas, 2001). On the northern and eastern sides of the bay, bare sand extends approximately 600 m into the bay. The southern and south-western sides of the bay support patchy seagrass, approximately 1.5 by 1.5 km (S.A. Coast and Marine Atlas, 2001), which is recorded as covering half of the bay, extending seaward to the bare sand of northern Smoky Bay. Edyvane (1999b) reported "extensive seagrass meadows" as occurring in the small bay. A 1994 benthic survey recorded at a depth of 4 m: seagrass meadows, *Posidonia sinuosa* and *P. australis* as the main seagrasses, with minor coverage of the green macroalga *Caulerpa trifaria* and the succulent red macroalga *Botryocladia sonderi* (Edyvane and Baker, 1999b, and SARDI S.A. Benthic Survey data, unpublished).

Smoky Bay: The size of the estuaries and the extent and diversity of associated wetlands suggest that Smoky Bay contributes significantly to the ecology of the local area (Bucher and Saenger, 1989, cited by Edyvane and Nias, undated). Smoky Bay is a relatively large (approximately 150 km²) shallow bay that has been "extensively filled" with shell detritus and other marine sediments (Hames Sharley Australia, 1989). The coastal area in northern Smoky Bay is dominated by sandy beaches backed by low calcarenite cliffs and fore-dune ridges. North of the rocky promontories near **Saddle Peak**, beaches shelve rapidly into deeper water. A shallow sandy shelf, 300m to 400m wide, lines the coast, created by the sheltering effect of **Eyre Island** and **Cape Missiessy**, which has caused sediment accumulation at the beach areas (Hames Sharley Australia, 1989). Extensive tidal flats surround **Eyre Island** (PIRSA, SARDI and DEH map, in Bryars, 2003). Low calcarenite headlands separate shallow sandy beach areas on the eastern shore of the bay. The southern end of **Smoky Bay** (i.e. behind the headland at Cape Missiessy) contains samphire, mangroves, and numerous tidal creeks (PIRSA, SARDI and DEH map, in Bryars, 2003). There is also a small area of mangroves adjacent to the township. Waters in the bay are generally under two metres deep (Ashman, 1996b). Much of the northern part of the bay is bare sand, according to mapping by CSIRO and SARDI in 1994 (see map in Edyvane, 1999b). Dense seagrasses have been recorded as dominant in the southern part of the bay, east and north-east of **St Peter Island**. Generally, the marine flora is dominated by *Posidonia* species (tape weed) in the subtidal (Bond 1992) and *Zostera* (= *Heterozostera*) *tasmanica* (eelgrass) (Edyvane, pers. comm., cited by Ashman, 1996b), with dense beds of Razorfish (*Pinna bicolor*) on the substrate in some areas (e.g. at some aquaculture lease sites). In the outer part of **Smoky Bay**, the seagrass between **St Peter Island** and **Eyre Island** extends for approximately 15 km between the two islands. There are dense seagrass beds on the eastern side of the southern bay, extending northwards into the main part of the bay, and extensive Razorfish beds also in the southern bay, between the town and the mangrove area. A previous survey of **Smoky Bay** (Bucher and Saenger, 1989, cited by Edyvane and Nias, undated) reported that within a total catchment area of 202 km² (GeoScience Australia, 2001), the supratidal and intertidal parts of the bay consist of intertidal sand/mud flats (10.54 km²) with the fine seagrass *Zostera* (= *Heterozostera*) *tasmanica*; *Avicennia* mangroves (7.62

	<p>km²); sand; samphire, and patches of low <i>Sarcocornia quinqueflora</i>.</p> <p>More recent mapping of the tide-dominated “estuary” of Smoky Bay, as part of the National Land and Water Resources Audit (NLWRA), recorded the following statistics (see GeoScience Australia, 2001 - 2004):</p> <p>Water area (km²) 14.17 Channel (km²) 133.91 Tidal sandbanks (km²) 0.01 Bedrock perimeter (km) 4.33 Flood/ebb delta (km²) 9.82 Intertidal flats (km²) 15.48 Mangrove (km²) 11.34 Saltmarsh / salt flat (km²) 5.19 Seagrass (km²) (not specified) Entrance width (km) 3.32 Perimeter (km) 41.40 Maximum length (km) 3.94</p> <p>Cape Missiessy, Point Collinson, Point Brown: The coast in the area is formed by deposition of multiple spits, and consists of sediments from the south and west (Hames Sharley Australia, 1989). On the seaward side directly south of Cape Missiessy, the coast is dunal. South of Smoky Bay Hill is a high energy stretch of coastline, unprotected from south-westerly swells, in which the coast shelves rapidly to deeper water. Granite cliffs capped with calcarenite enclose the crenulate sandy beaches backed by dunes. There is a steep beach in the lee of Point Brown, composed of weathered granitic material, and of different composition than many of the West Coast beaches (Hames Sharley Australia, 1989). Habitats in the Cape Missiessy area include shallow subtidal sand off the northern tip of the peninsula, dense seagrass south of the sand, extending north-west (i.e. south of Eyre Island), and platform reef south of the seagrass bed, towards Point Brown (CSIRO mapping 1994, in S.A. Coast and Marine Atlas, 2001). There are reefs along the coast between Point Brown and Point Collinson, and small seagrass beds in some of the shallow baylets between headlands. A 1994 benthic survey (see Edyvane and Baker, 1999b) recorded the following taxa on near-shore reef at Point Brown, at a depth of 10m: <i>Ecklonia radiata</i>, with a minor amount of <i>Scytothalia dorycarpa</i>, and an understory comprising mainly encrusting coralline taxa, and other red macroalgae (mainly species of <i>Callophyllis</i> and <i>Phacelocarpus</i>).</p> <p>Point Collinson to Point de Mole: The coastal area is dominated by granite headlands topped with dune calcarenite. Wave energy is generally low (Hames Sharley Australia, 1989). Gascoigne Bay (east of Point Collinson) has sandy beaches on the western side, and is lined with dense seagrass, according to mapping by CSIRO, in 1994 (see map in Edyvane, 1999b).</p> <p>Point de Mole: At the time of a survey in 1994 (Edyvane and Baker, 1999b and unpublished data), reef at 10 m was dominated by <i>Scytothalia dorycarpa</i> and <i>Ecklonia radiata</i>, with <i>Cystophora racemosa</i> and <i>Sargassum paradoxum</i> also present in the canopy, with understory taxa comprising articulated corallines (<i>Amphiroa</i> and <i>Metagoniolithon</i> species) mixed red taxa (species of <i>Plocamium</i>, <i>Trigenia</i> and <i>Rhodymenia</i>), and small mixed brown taxa (<i>Scoresbyella profunda</i>, and species of <i>Dilophus</i> and <i>Homoeostrichus</i>). According to mapping undertaken by CSIRO in 1994 (see map in Edyvane, 1999b), there are dense seagrass beds in the near-shore area at Point de Mole (less than 10 m deep), and in the bay between Point de Mole and Lindsay Point. East of Point de Mole, longshore sedimentation has formed a shallow, protected sandy beach, backed by dunes (Hames Sharley Australia, 1989).</p> <p>Streaky Bay: A large bay, substantially enclosed by the headlands of Cape Bauer to the south and Point Brown to the north west. The granite basement rocks that occur to the north and south of Streaky Bay have been described as “Proterozoic felsic igneous intrusives”, whereas the headlands are Pleistocene Bridgewater Formation aeolianites (Daniel <i>et al.</i>, 1997), with the later formation also being exposed at various places along the shore. The bay is bordered by a shoreline of low cliffs (2m – 3m) of alluvium,</p>
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and sand dunes, and is fronted by sand beaches. Thin deposits of the St Kilda Formation and Semaphore Sand are also present close to shore, as fore-dune and dune sand, supratidal sand flats, supratidal samphire marsh, intertidal mangrove woodland, and intertidal and shallow subtidal sand flats (Geological Survey of South Australia map sheet, Streaky Bay). Subtidally, **Streaky Bay** is a sheltered and relatively shallow expanse of water, less than 10m in most parts, with several channels and two large sand bars. Deeper waters occur in the western portion of the bay (e.g. **Dashwood Rock** area). Morelli and de Jong (1995) described the habitats of Streaky Bay as shallow coastal spit, sandy beaches, mangrove woodland, samphire tidal flats, tidal creeks and exposed mud flats with seagrasses. An example of samphire in the bay is the samphire wetland that covers around 22ha., approximately 1.5 kilometres west of the Streaky Bay township (see Connell Wagner Pty Ltd, 2003).

The sediments of **Streaky Bay** are predominantly biogenic in origin, being a mixture of Holocene biogenic particles (most abundant), unidentifiable abraded bioclastic grains, calcarenite or relict carbonate grains, and Proterozoic rock fragments (Daniel *et al.*, 1997). The major Holocene biogenic components of the sand-sized sediment are, in descending order of abundance, molluscs, bryozoa, foraminifers and calcareous red algae. Minor biogenic components include fragments of echinoderms, brachiopods, crustaceans (ostracodes and barnacles), serpulid worms, corals and sponge spicules. The grain size distribution of the sediments ranges from gravel to mud size. Gravel size sediments occur at the mouth of the bay whereas only minor amounts of gravel occur within the bay. Coarse to very coarse sands are present in high percentages at the mouth, centre and central tidal delta regions of the bay. The grain size of the sediments from the sandbanks and the tidal deltas is predominantly medium to fine sand, with minor areas extending to gravel size. Mud is present, along with medium to very fine sand, in the comparatively deep-water inner marginal basins (Daniel *et al.*, 1997). A recent government and consultants' survey (2002) in the Streaky Bay area between **Haslam** and **Eba Island** recorded a gradation of sediment size, with very fine sediments in the nearshore area, grading to very coarse in deeper waters, north of **Cape Bauer**.

The majority of the marine flora in the **Streaky Bay** area is comprised of seagrass, up to 12 km from the coast, according to CSIRO's 1994 mapping (see Edyvane, 1999b and S.A. Coast and Marine Atlas, 2001). Apart from the sheltered bay, exposed rocky shorelines occur in the Streaky region, and cliffs with frontal shore platforms and reefs typify much of the coastline outside of the bay (Bond, 1994). East of **Point de Mole**, sediment transport into **Streaky Bay** has caused the formation of multiple beach spits, and their migration over time has completely dammed one bay, which now comprises the supratidal flats of **Acraman Creek** (Hames Sharley Australia, 1989). A relatively narrow zone of bare sand fringes the bay. The sheltered north-western corner of the bay (**Acraman Creek** area) supports a stand of the mangrove *Avicennia marina* with an associated samphire community (see below). The relatively shallow (i.e. less than 5 m, according to S.A. Coast and Marine Atlas, 2001), sheltered **Streaky Bay** supports what have been described as "extensive seagrass communities", consisting principally of *Posidonia australis* and *P. sinuosa*, with *Zostera* (= *Heterozostera tasmanica* and *Amphibolis antarctica* also present (Bond, 1994). A 1994 benthic survey (see Edyvane and Baker, 1999b) recorded *Posidonia australis* as the dominant seagrass in shallow waters (e.g. 2m), with *P. angustifolia* and *P. sinuosa* at 6m to 8m. More recent surveys in the area by SARDI, have shown that habitat cover in the area between **Haslam** and **Eba Island** comprises, (i) in the eastern, nearshore area: a sparse but diverse assemblage of invertebrates, seagrasses and macroalgae (such as the turving brown *Hydroclathrus*) on sand; (ii) in the central area, *Posidonia* beds, with some *Amphibolis* seagrass also present, and (iii) a mixture of assemblages towards the west, mostly comprising brown macroalgae (e.g. *Cystophora* and *Sargassum* species, and *Ecklonia*), red macroalgae (e.g. *Osmundaria*) and invertebrates (sponges, and abundant colonial ascidians, in some areas), with little or no seagrass at sampled sites in the west of the survey area. Several stands of the Razorfish *Pinna* were also recorded on the western side. The surveys were undertaken in winter, and it is noted that ephemeral species such as *Halophila* seagrass, may be present at other times of the year, and *Heterozostera* (= *Zostera* – see Soros-Pottruff and Posluszny, 1995, and Kuo, 2004) seagrass may also appear and disappear periodically (SARDI

data, 2002).

Northern Streaky Bay: This part of the coast is exposed to wind-driven waves, but is “reasonably protected” (Bond, 1994), and contains shallow waters. The coastal area of northern Streaky Bay has a relatively narrow beach zone which merges with extensive seagrass communities 100-200 metres off-shore. In 1994, CSIRO mapped dense seagrass beds occurring throughout northern Streaky Bay (see CSIRO mapping in Edyvane, 1999b). According to Bond (1994), the seagrasses are dominated by *Posidonia australis* and *P. sinuosa*, with several other seagrasses including *Heterozostera tasmanica* and *Amphibolis antarctica* “also probably present”. The coastal zone between **Haslam** and **Perlubie Hill** is mainly sandy (Bond, 1994).

Acraman Creek: According to the Australian Heritage Commission (undated), the tidal creek system has been cut off from the sea by a prograding recurved spit. There are sandbars at the mouth of the creek. DEH’s Saltmarsh Mapping Program recorded samphires in the entire western half of the area and a mixed habitat of vegetated dunes, samphire, and mangroves on the eastern side of Acraman Creek, bordering the channels of the creek (S.A. Coast and Marine Atlas, 2001). The **Acraman Creek** samphires are the most extensive in the Streaky Bay region (PIRSA, SARDI and DEH map, in Bryars, 2003). Samphires occur on both regularly- and irregularly-flooded tidal flats, and comprise mainly *Halosarcia* spp. and *Sarcocornia* spp. *Suaeda australis* also occurs in the area (Morelli and de Jong, 1995).

Southern Streaky Bay (Gibson Peninsula / Blanche Port): A 5km stand of mangroves occurs along the edge of **Gibson Peninsula** and extends more than 50 m inland (Fotheringham and Buckley, 1987, cited by Morelli and de Jong, 1995). There are reportedly extensive sand flats about one mile offshore in 4 or 5 metres of water. The long sandbar projects east of **Point Gibson**. Saltmarsh habitat occurs at the southern end of Streaky Bay, along the northern shore of the **Gibson Peninsula**, around **The Spit**, and also in the north-western and south-western corners of **Blanche Port** (Bryars, 2003). Southern Streaky Bay contains dense seagrass throughout the bay, with small sand patches north of Point Gibson (1994 CSIRO map – see Edyvane, 1999b and S.A. Coast and Marine Atlas, 2001). **Blanche Port** is a shallow, sheltered “lagoon” area in **southern Streaky Bay**.

Within the **Blanche Port** area, a previous survey recorded intertidal sand / mud flats (7.19 km²), mangroves (3.42 km²), and scattered areas of the samphire *Sarcocornia* within the mangroves (Butler *et al.*, 1975; Bucher and Saenger, 1989). The large mollusc *Pinna bicolor* (Razorfish) is prolific in the area (Fishnet, 2002). The extensive seagrass coverage in southern Streaky Bay comprises mainly *Posidonia* species, and *Zostera* (= *Heterozostera*) *tasmanica* (GeoScience Australia, 2001). A number of patch reefs also exist in the area, such as **Sponge Rocks South** and **North** and **Fairway Rock**, as well as shallow sand beach areas. The tide-dominated “estuary” of **Blanche Port** was mapped in 2000 as part of the NLWRA, and the following statistics were calculated (GeoScience Australia, 2001 - 2004):

- ♦ Water area (km²) 28.36
- ♦ Central Basin area (km²) 23.76
- ♦ Channel (km²) 0.14
- ♦ Intertidal flats (km²) 12.66
- ♦ Mangrove (km²) 2.50
- ♦ Saltmarsh / salt flat (km²) 1.29
- ♦ Seagrass (km²) 30.82
- ♦ Barrier / Back Barrier (km²) 2.37
- ♦ Entrance width (km) 2.81
- ♦ Perimeter (km) 29.92
- ♦ Maximum length (km) 7.46

Eba Island and Pigface Island: Inner islands in the streaky Bay region. **Eba Island** is a calcareous island of 121 ha, in southern Streaky Bay (Robinson *et al.*, 1996). Eba

	<p>Island is linked to the mainland via a sand bar that dries at very low tides. There may be underlying granite, which is not visible around the island (Robinson <i>et al.</i>, 1996). Shallow waters surrounding the island have been described as supporting “extensive seagrass meadows” and sandflats (Edyvane, 1999b). Pigface Island is a small limestone and sand island of 2 ha (Robinson <i>et al.</i>, 1996), in southern Streaky Bay. Pigface Island may overlie a granite base that is now well eroded (Robinson <i>et al.</i>, 1996). There is a submerged reef around Pigface Island. The south-western sides of both islands are exposed, and meet the sea abruptly, forming reef “walls”. In areas of wave attack, the wall is undercut and eroded, forming “blow holes”, scalloped ridges and jagged reef. The northern coastlines are more protected, especially on Eba Island. There are small sandy coves on the northern side of Eba Island, backed by sand dunes (Robinson <i>et al.</i>, 1996).</p>
<p>6. Taxonomic Diversity</p>	<p>Marine Plants West Coast reefs (e.g. Franklin Islands and Cape D’Estrees): High diversity of large brown macroalgae at some reef sites. For example, 24 species of large brown (i.e. canopy) macroalgae were recorded at headland and island sites during a 1994 benthic survey, including nine species of <i>Sargassum</i> (Edyvane and Baker, 1999b). Point Bell Bay: The area is species-rich in red macroalgae. For example, during a 1994 survey, up to 67 species were recorded as part of the percentage cover in the understory, at surveyed sites within the bay, and an even higher number would be recorded if a full species list was taken in the area. The number of red species forming part of the percentage cover at this site was high when compared with the red flora present at 25 other bay and headland sites sampled along the West Coast (Edyvane and Baker, 1999b, and unpublished benthic survey data).</p> <p>Bony and Cartilaginous Fish Crenulate Bays of the Far West Coast: No figures specific to the area are available, but fish species diversity is expected to be high due to the variety of marine habitat types that exist in the region (see Habitat Diversity section). More than 30 fish species and 7 shark species are commercially and / or recreationally caught in the area, according to fishing records. The number of fish, shark, and ray species recorded in the area would be considerably higher if the variety of seagrass-, sand- and reef-dwelling species that are not caught by fishers were to be included in the list. Some of the reef fish species known from the area, as well as the fish species commonly caught by commercial and recreational fishers, are described in other sections of this table.</p> <p>St Francis Isles: Around 55 species of fish, mostly reef fish, were recorded during a survey of some of the St Francis Islands in 2002, including 7 species of Leatherjacket and 8 species of Wrasse (Shepherd and Brook, 2003; Shepherd and Brook, 2002 survey data). The fish species diversity of the island group is higher than that recorded during the 2002 survey, however the survey provides an indication of the number of easily visible reef fish species in the area.</p> <p>Coastal and Marine Birds Tourville Bay / Davenport Creek: Supports a “wide diversity of waterbirds, probably unequalled on the coastal region of the Eyre Peninsula”, according to Morelli and de Jong (1996). Streaky Bay region: Around 73 coastal, estuarine, and marine birds have been recorded over a 20 year period in the area, including seabirds (such as Petrels, Prions, Shearwaters, Albatross species, Gannets, and cormorants), coastal estuarine birds (species of Oystercatchers, Egrets, Plovers, Dotterels, Sandpipers, Stints and Ducks), and Gull and Tern species, amongst others (Cooper, unpublished information supplied to DEH, for Environment Australia, 2000).</p> <p>Coastal Plants Acraman Creek area has been described as containing “one of the finest examples of diverse samphire vegetation on the Eyre Peninsula” (Morelli and de Jong, 1995).</p>
<p>7. Habitat for Endemic Taxa / Threatened Taxa /</p>	<p>Marine Plants The following macroalgae found in the area and reported to have a limited range (according to Cheshire <i>et al.</i>, 2000 and associated database compiled by Turner,</p>

<p>Rare or Uncommon Taxa</p>	<p>2000; and Womersley, references as specified below):</p> <p>Smoky Bay and Denial Bay regions: Green macroalga <i>Cladophoropsis magna</i> (Womersley 1984);</p> <p>St Francis and Fenelon Islands: coralline red <i>Metagoniolithon chara</i> (Edyvane and Baker, 1996a);</p> <p>St Francis Island: Red macroalga <i>Kallymenia spinosa</i> (Womersley, 1994);</p> <p>Fenelon Island: The uncommon coralline red species <i>Amphiroa gracilis</i> is found in the region (see description by Womersley, 1996).</p> <p>Cannan Reefs (south of St Francis Isles): <i>Cryptonemia kallymenioides</i> (Womersley, 1994).</p> <p>Point de Mole: At sites sampled, local abundance of the unusually structured brown macroalga <i>Scoresbyella profunda</i> (Edyvane and Baker, 1999b), described as <i>rare</i> by Womersley (1987).</p> <p>Bony and Cartilaginous Fish</p> <p>West Coast headland reefs and Nuyts Archipelago: A number of reef fish species known in the area have been recognised during the past two decades as being potentially vulnerable to decline, and therefore of conservation concern (see Section 9.2, and Baker, in press). Examples include Western Blue Groper, Western Blue Devil, Harlequin Fish, Blue-Throated Wrasse (abundant in some island areas), Rosy Wrasse, and other wrasse species, and several others. The islands of the Nuyts Archipelago are relatively lightly fished compared with coastal locations (Shepherd and Brook, 2003), and therefore may constitute an important refuge for some of these species compared with the more heavily fished reefs near the mainland. Notes on the apparent status of some of these reef fish species in S.A. are provided in Section 9.2, and Baker, in press).</p> <p>Nuyts Archipelago (St Francis Isles): Some of the reef fish species recorded at the offshore islands, such as Western Footballer, Western Wirrah, Blue-Tailed Leatherjacket (Shepherd and Brook, 2003, and unpublished survey data), and Red-lipped Morwong are of Western Flindersian affinity, being more common in W.A., and not usually observed in most parts of South Australia (see distribution summaries in Baker, in press). The uncommonly recorded leatherjacket species <i>Cantheschenia longipinnis</i> (Smoothspine Leatherjacket) and <i>Meuschenia venusta</i>, (Stars-and-Stripes Leatherjacket), both known mostly from eastern Australia, also occurs in the area (S.A. Museum records, and survey data by Shepherd and Brook, 2002, cited by Baker, in press).</p> <p>St Francis Island is the type locality for the primitive chordate <i>Epigonichthys australis</i> (the Deepwater Lancelet), a species known from few locations in Australia (Gomon et al., 1994; Australian Government Department of the Environment and Heritage, 2003g).</p> <p>The West Coast provides habitat for Crested Threefin <i>Trinorfolkia cristata</i> (Fricke, 1994), which is uncommonly recorded, and known almost exclusively from South Australia (Kuiter, 1983; Hutchins and Swainston, 1986; Fricke, 1994; Edgar, 2000; Froese and Pauly, 2003; OZCAM database records, cited by Baker, in press).</p> <p>The Ceduna area is one of the few locations in South Australia where the sub-tropical Western Australian goby species <i>Eviota bimaculata</i> (Twospot Fringed-fin Goby) has been recorded (see Baker, in press for summary of distribution).</p> <p>Far West Coast: Regular seasonal sightings of Great White Sharks – e.g. in the Ceduna and Streaky Bay areas, which may be abundant in the western Bight region due to food sources such as pinnipeds (Bruce, 1992). Great White Shark was listed under the IUCN Red List 2003 as <i>vulnerable</i> and <i>conservation dependent</i>, and it is a protected species under the <i>Fisheries Act 1982</i> in South Australia.</p> <p>Inner islands of Nuyts Archipelago: Presence of the uncommon South Australian endemic Coastal Stingaree <i>Urolophus orarius</i> (Last and Gomon, 1987; South Australian Museum record, cited in Baker, in press). This species is of conservation concern due to its limited known depth range, strong habitat association, and viviparous method of reproduction. The species is considered to be threatened (P. Kyne, IUCN Shark Specialist Group, pers. comm., 2004; Baker, in press).</p> <p>Streaky Bay Peninsula: Presence of Leafy and Weedy Seadragons, observed by divers and as beachwashed specimens. Leafy Seadragons have also been recorded from Smoky Bay. Leafy and Weedy Seadragon were listed under the IUCN Red List 2003 as <i>Data Deficient</i>, and the Leafy Seadragon is a protected species under South Australia legislation.</p>
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Streaky Bay: A number of specimens of a new species of pipefish, Venus Pipefish *Stigmatopora venusensis* sp. nov. (Browne et al., in prep.) have been found in the bay. The species has a limited known distribution, having been found to date only along western Eyre Peninsula, from Streaky Bay to Venus Bay. The species is reported to be intolerant of sediment or macroalgae settling over its seagrass habitat through lack of water movement, or due to high input of sediment or nutrients (Browne, 2004).

Eastern Great Australian Bight: Habitat for the uncommon Flimsy Flounder *Arnoglossus* sp. (Gomon et al., 1994), known to date from a limited depth range, in the trawl grounds of the eastern Great Australian Bight (see Baker, in press, for summary).

Invertebrates

St Peter Island (Nuyts Archipelago): "Rare species of shellfish" have purportedly been recorded at **St Peter Island**, according to Morelli (1995, in Morelli and de Jong, 1995) and Edyvane and Nias (undated). Details of the purported "rare species of shellfish" are not available for this report, however, it is possible that the citing is related to the reference by Hames Sharley Australia (1989), who stated that "rare molluscs occur on the northern side of the long spit" (on **St Peter Island**). The citing by Hames Sharley Australia (1989) is likely to relate to a comment received by public submission (Howlett, pers. comm., cited by Hames Sharley Australia, 1989) that two species of opisthobranch molluscs (shell-less marine snails), that were undescribed at the time, have been recorded in the area.

St Francis Isles: There is a published report of a new species of the muricid genus *Dermomurex* (*Viator*) *howletti*, found at "St. Francis Isles and Nuyts Archipelago, South Australia, and Esperance, Western Australia" (Vokes, 1995). The shell is reportedly "the fifth taxon to be described in this exclusively Australian sub-genus and the first living species from the southern part of the continent" (Vokes, 1995).

St Francis Isles: the endemic sponge *Clathria* (*Dendrocia*) *curvichela* has been recorded to date only from south of the St Francis Isles (Hooper, in Australian Government Department for the Environment and Heritage, 2003d).

St Francis Isles: During the 2002 scientific expedition to Nuyts Archipelago, a number of previously unknown and undescribed invertebrate species were collected (S. Shepherd, pers. comm., 2002), including 8 species of jellyfish (Gershwin and Zeidler, 2003).

At the **St Francis Isles**, Verco (1908, cited by Wilson et al., 1993) recorded a species of Egg Cowrie, *Primovula verconis* (Cotton and Godfrey, 1932). This is the only known locality for the species, however it may occur more widely in S.A., and W.A. (Wilson et al., 1993). Egg Cowries are mainly tropical, and few species occur in southern Australia (Wilson et al., 1993).

The cowrie *Zoila friendii thersites* also occurs in the region (e.g. the **St Francis Isles** and the **Franklin Islands**), and the cowrie *Z. marginata orientalis* also occurs at the **St Francis Isles** (Wilson and Clarkson, 2004). *Zoila* cowries have direct development of young, and strong habitat association, and are of conservation concern (see section 9.2).

Smoky Bay: One of two areas in S.A. where the small murex shell *Favartia* (*Murexiella*) *tatei* has been recorded. The species is considered to be rare (Wilson et al., 1994) and appears to be endemic.

Far **West Coast (e.g Point Brown):** The small endemic viviparous starfish *Patiriella parvivipara* (Thomas, 1982) occurs in the area, and is often found associated with shallow pools on granite substrate. The species has a very limited known distribution.

Examples of other species which may be endemic to South Australia, include the following:

Streaky Bay: The marine flatworm *Notoplana longicrumena* has only been recorded from Streaky Bay and Port Noarlunga (Prudhoe, 1982).

St Francis Isles: one of the few localities where the endemic gastropod *Anachis fenestrata* (a small dove shell) has been collected (Wilson et al., 1994).

West Coast (general): Habitat for the endemic nudibranch *Aphelodoris lawsae* and the opisthobranch *Phillinopsis troubridgensis* (Burn, 1989; Rudman, 2000, 2001).

A number of ascidian species that appear to be endemic to South Australia, based upon known records (e.g. Kott, 1997; Australian Government Department of Environment and Heritage, 2004b), have been reported from the Great Australian Bight / West Coast region.

Examples include:

St Francis Island: *Polyandrocarpa simulans*;

Franklin Island: at least three species, such as *Polycitor cerasus*, *Pycnoclavella aurantia* and *Pycnoclavella elongata*. These may be considered uncommon, of limited known distribution, and possibly endemic to S.A.;

Great Australian Bight: two species of *Leptoclinides*; and two species of *Aplidium*.

Marine Mammals

Nuyts Archipelago and St Francis Isles: Significant breeding colonies of Australian Sea Lions are found in the region (Australian Heritage Commission, undated; Gales, 1990; Gales *et al.*, 1994; Dennis and Shaughnessy, 1996, cited by Lewis *et al.*, 1998; Shaughnessy, 2002). The Australian Sea Lion is currently listed as *rare* under the S.A. *National Parks and Wildlife Act 1972*, and has also been considered by some researchers to be endangered (Gales, 1990; Gales *et al.*, 1994; Dennis and Shaughnessy, 1996). Figures for Australian Sea Lion adults and pup numbers are presented below:

Purdie Rocks / Island: a total of 577 Sea Lions was recorded during the mid 1990's; although only 200 were recorded in 1982 (Gales *et al.*, 1994 cited by Robinson *et al.*, 1996), and overall, pups numbers have declined in the area since 1979, up to the present (Rowley, 2001). Despite the reported decline, the area was more recently ranked 5th most important area in South Australia in terms of Australian Sea Lion pup production, with 112 recorded in 1990 (Shaughnessy, 2002). A previous survey estimated around 144 Sea Lions at **West Island**, with 14 pups recorded in 1990. (Gales *et al.*, 1994). At **Fenelon Island**, around 240 Sea Lions were counted, with 24 pups recorded in 1990 (Gales *et al.*, 1994);

Lounds Island (Nuyts Archipelago): around 125 Sea Lions were recorded during the mid 1990s, although only 50 were recorded in 1982 (Gales *et al.*, 1994 cited by Robinson *et al.*, 1996). Around 26 pups were recorded in 1990 (Gales *et al.*, 1994), resulting in the area being ranked more recently as the 10th most important site in South Australia in terms of Australian Sea Lion pup production, in a list of 38 sites at which pups have been recorded (Shaughnessy, 2002).

Small South Franklin Island: a total of 361 with 95 pups recorded in 1990; **Small NE Franklin Island:** a total of 240, with 46 pups recorded in 1990; collectively, the **Franklin Island Rocks** area was recorded as a site at which 121 pups were produced in 1990 (Gales *et al.*, 1994), making this the 4th most important area in South Australia, in terms of Australian Sea Lion pup production (Shaughnessy, 2002).

Haul-out sites for Australian Sea Lions also occur on **Sinclair, Hart, Purdie, Egg, Smooth, Dog, Freeling, Masillon, South Franklin Rocks, Lacy** and **Evans islands**, and the reef off **Point Bell** (Watts and Ling, 1985; Gales, 1990; Edyvane and Nias, undated; Robinson *et al.*, 1996; S.A. Coast and Marine Atlas, 2001).

Nuyts Archipelago and Far West Coast bays: Bottlenose Dolphins are regularly observed around the islands, and in the shallow waters of the **Far West Coast** bays. The species "may breed around the **Davenport Creek** area, although no specific information is available" (Hames Sharley Australia, 1989). Young dolphins have also been sighted around the mouth of **Acraman Creek**. IUCN Red List 2003 classified Bottlenose Dolphin as *Data Deficient* (IUCN, 2003).

Far West Coast bays and islands: Seasonal sightings of migratory Southern Right Whales, particularly during winter, *en route* to the Great Australian Bight. In most years, Southern Right Whales come into **Denial Bay** and the **Davenport Creek** area of **Tourville Bay** during the breeding season, according to Hames Sharley Australia (1989). Occasional strandings of other protected whale species are also observed on the eastern shores of upper West Coast embayments (Hames Sharley Australia, 1989). The warmer waters of the West Coast (influenced by seasonal warm water currents), as well as the oceanographically-protected bay configurations along the upper West Coast, may be important factors in the presence of whales in the region, such as around **Ceduna** and **Streaky Bay** (Kemper and Ling, 1991, cited by Edyvane and Baker, 1999b). Southern Right Whale was listed in the IUCN Red List (2003) as *conservation dependent*; it is a protected species in South Australia (*National Parks and Wildlife Act 1972*); and a listed threatened species under the Commonwealth's *EPBC Act 1999*. Other whale species pass through or strand irregularly in the area. For example, Killer Whales (*Orcinus orca*), listed as *Conservation Dependent* in the IUCN Red List 2003, have been sighted swimming at **Point Brown** (8 whales, in 1990), and **Smoky Bay** (5 whales, in 1988) (Ling, 1991).

	<p>Marine Reptiles Nuyts Archipelago: Migratory Leatherback Turtles are seasonally observed in the area. Internationally, the Leatherback Turtle was listed as <i>critically endangered</i> under the IUCN Red List (2003), and is listed as <i>vulnerable</i> under South Australian legislation. Other turtle species have been irregularly observed in the area, however confirmation of species is not available for this assessment.</p> <p>Coastal and Marine Birds Nuyts Archipelago and St Francis Isles: Coastal bird and sea bird species listed as <i>rare</i> under <i>National Parks and Wildlife Act 1972</i> include Osprey (St Francis Island, West and East Franklin, and nesting area at St Peter Island); Rock Parrot (recorded at most islands in both groups, except Masillon, Hart Islands, Bird Rock), Peregrine Falcon (St Peter Island); Eastern Reef Egret (St Francis, West Franklin, St Peter); Cape Barren Goose (Lounds, St Francis, Dog, Freeling, West, Masillon, West Franklin and East Franklin, and St Peter Island) (Robinson <i>et al.</i>, 1996). Australian Heritage Commission's <i>Register of the National Estate</i> (undated) listed Cape Barren goose as <i>the second rarest goose species in the world</i>. Buff-banded Rail (associated with coastal swamps and samphires) also breeds on the St Francis Isles (also recorded on Evans Island, East Franklin, St Peter, Goat and Eyre Islands), and is considered to be "uncommon or rarely seen" (Australian Heritage Commission, undated; Robinson <i>et al.</i>, 1996, citing previous survey records by National Parks and Wildlife S.A.). The islands provide habitat for the following species listed as <i>vulnerable</i> (<i>National Parks and Wildlife Act 1972</i>): Fairy Tern (e.g. Lounds, Hart, West Franklin and East Franklin, and St Peter Island); Eastern Curlew (St Peter Island); White-bellied Sea Eagle (nesting areas at St Peter Island and the cliffs of St Francis Island, and also recorded at Egg, Dog, Lacy, Evans, West Franklin and East Franklin and Goat Islands), and Hooded Plover (St Francis, West and East Franklin, and St Peter Islands) (Robinson <i>et al.</i>, 1996, citing previous survey records by NPWSA).</p> <p>Gibson Peninsula / Blanche Port / Streaky Bay / Acraman Creek: Coastal bird species listed as <i>rare</i> under <i>National Parks and Wildlife Act 1972</i> include Osprey (breeding area in cliffs), Peregrine Falcon, Cape Barren Goose, Great Crested Grebe, Musk Duck, Flesh-footed Shearwater, Eastern Reef Egret, and Rock Parrot (Morelli and de Jong, 1995; Cooper, unpublished information supplied to DEH, for Environment Australia, 2000). Coastal bird species listed as <i>vulnerable</i> in S.A. include Blue Petrel (also listed nationally, under the <i>EPBC Act 1999</i>), Hooded Plover, White-bellied Sea Eagle (breeding area in cliffs), Eastern Curlew and Fairy Tern (Morelli and de Jong, 1995; Cooper, unpublished information supplied to DEH, for Environment Australia, 2000).</p> <p>Ceduna area: Birds classified as <i>rare</i> that use the area as habitat include Eastern Reef Egret, Musk Duck, and Osprey (Hames Sharley Australia, 1989). <i>Vulnerable</i> birds that use the area as habitat include Hooded Plover, Fairy Tern, White-Bellied Sea Eagle (Hames Sharley Australia, 1989).</p> <p>Tourville Bay / Davenport Creek: Bird species in the area that are listed as <i>vulnerable</i> under S.A. legislation include Hooded Plover and Eastern Curlew (Morelli and de Jong, 1995).</p> <p>Far West Coast: Migratory oceanic birds that breed in more southerly latitudes such as New Zealand and Antarctica (e.g. species of Albatross and Petrel), and migratory prions, also frequent the coastal areas of the Great Australian Bight (Copley, 1985, cited by Edyvane and Baker, 1999b). Many of the species in these groups that occur in Australia are listed under the Commonwealth's <i>EPBC Act 1999</i>, as threatened.</p> <p>Coastal Plants Acraman Creek: In the area, there are records of the samphire <i>Centrolepis cephaliformis</i>, which is listed as <i>rare</i> under South Australian legislation (Morelli and de Jong, 1995), and records of the samphire <i>Halosarcia flabelliformis</i>, listed as <i>vulnerable</i> both nationally and in S.A. (Morelli and de Jong, 1995).</p>
<p>8. Other Important Taxa</p>	<p>Marine Plants Exposed islands (e.g. Franklin Islands) and headlands (e.g. Point Brown) have an abundance of encrusting coralline macroalgae (Edyvane and Baker, 1999b and</p>

	<p>SARDI S.A. Benthic Survey data, unpublished), which is important habitat for some species (e.g. post-larval and juvenile abalone - Shepherd and Daume, 1996; Daume <i>et al.</i>, 1997, and as a cryptic habitat for the protection of other small invertebrates from predators).</p> <p>Point de Mole: Locally abundant red macroalga <i>Trigenia australis</i> (Edyvane and Baker, 1999b, samples verified by HBS Womersley). Except for a few sampled areas along the West Coast, such as Point de Mole, the species was not recorded as common component of the benthic cover in other sampled areas, during State-wide benthic surveys from 1992 to 1997.</p> <p>Bony and Cartilaginous Fish</p> <p>Crenulate Bays (between Point Peter to Point Brown) and Streaky Bay: Abundance of large King George Whiting and large Snapper, and of various ray and stingray species, according to fishing records and anecdotal sources.</p> <p>Shallow water reefs between Point Sinclair and Point Peter; Point Bell; Purdie Islands and at Cape Vivonne; Cape Wittelbee; Cape D’Estrees; Sinclair Island; Lounds Island, south-western end of St Peter Island, Goat Island; and between Point Brown and Point de Mole, are reported to be used by one or more of the life stages of the following commercial fish and shark species: King George Whiting, Snapper, West Australian Salmon, Tommy Ruff (Australian Herring), Yellow-eye Mullet, Southern Sea Garfish, Mulloway, Trevally, Yellow-tail Kingfish, Leatherjacket species, Western Blue Groper and other Wrasse species, Snook, Sea Sweep, Silver Drummer, Gummy Shark and Whaler Shark (Bryars, 2003). All of these species, except Southern Sea Garfish, are also reported to utilise reefs at the Lacy Islands, Franklin Islands, and at Evans, Egg, Smooth, Freeling, Dog, St Francis, West, Masillon, Fenelon, and Hart islands, and Cannan Reefs (Bryars, 2003). Many of the ‘forementioned species are also reported from the reefs in northern Streaky Bay (i.e. between Flagstaff Landing and Haslam) (Bryars, 2003).</p> <p>Tidal creeks such as Davenport Creek, and at St Peter Island (e.g. Bob Creek, and creeks on the eastern side of the island) are reported to provide habitat for one or more of the life stages of King George Whiting, West Australian Salmon, Tommy Ruff (Australian Herring), Southern Sea Garfish, Yellow-eye Mullet, Flathead Species, flounder species, and Whaler sharks (Bryars, 2003). Yellow-eye Mullet also utilise the mangrove forests in the area (e.g. Tourville Bay, Murat Bay, Bosanquet Bay and St Peter Island) (Bryars, 2003).</p> <p>Tidal flats in Tourville Bay, Murat Bay, Bosanquet Bay, Decres Bay, Streaky Bay, and around St Peter Island, and Yatala Bank, are reported to provide habitat for one or more of the life stages of the following: West Australian Salmon, Tommy Ruff, Southern Sea Garfish, Yellow-eye Mullet, flathead species, flounder species and Yellow-tail Kingfish (Bryars, 2003).</p> <p>In the subtidal, the unvegetated soft bottom (sand) habitat between Point Sinclair and Point Peter (including the Purdie Islands area), also between Point Peter and Cape D’Estrees (including Goat Island, Tourville Bay, Denial Bay, Murat Bay, Bosanquet Bay and Decres Bay), and also in Laura Bay, Smoky Bay, and Eyre Island, is reported to be used by one or more of the life stages of the following commercial fish and shark species: King George Whiting, School Whiting, Snapper, West Australian Salmon, Tommy Ruff (Australian Herring), Yellow-eye Mullet, Mulloway, flathead species, flounder species, Trevally, Yellow-tail Kingfish, Snook, Red “Mullet”, School Shark, Gummy Shark and Whaler Shark (Bryars, 2003). King George and School Whiting, Snapper, West Australian Salmon, Tommy Ruff, Yellow-eye Mullet, flathead species, Trevally, Yellow-tail Kingfish, Snook and Whaler Sharks, are also reported to utilise the subtidal sand habitats at the St Francis Islands, Franklin Islands, and Cannan Reefs (Bryars, 2003).</p> <p>Surf beaches between Point Sinclair and Point Peter, and at St Mary Bay (near Point Brown) are reported to be used by one or more of the life stages of the following commercial fish and shark species: School Whiting, West Australian Salmon, Tommy Ruff (Australian Herring), Yellow-eye Mullet, Mulloway, flathead species, School Shark, Gummy Shark and Whaler Shark (Bryars, 2003).</p> <p>Sheltered beach habitat, such as that at the south-western end of St Peter Island, and the north-eastern end of Goat Island, is reported to provide habitat for one or more of the life stages of King George Whiting, School Whiting, West Australian Salmon, Tommy Ruff, Yellow-eye Mullet, flathead species, flounder species, and whalers Sharks (Bryars, 2003).</p>
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Small seagrass stands at **Point le Hunte, Point Bell, Rocky Point** and **Davenport Beach** are reported to be used by one or more of the life stages of the following commercial fish and shark species: King George Whiting, West Australian Salmon, Tommy Ruff (Australian Herring), Southern Sea Garfish, flathead species, Trevally, Leatherjacket species, Snook, and Whaler Sharks (Bryars, 2003). All of these species, as well as Snapper, Red "Mullet" and Yellow-tail Kingfish, are reported to utilise the seagrass meadows in **Tourville Bay, Denial Bay, Murat Bay, Bosanquet Bay, Decres Bay, Laura Bay, Smoky Bay, Streaky Bay** and around **St Peter Island, Goat Island** and **Eyre Island** (Bryars, 2003).

Deeper waters from south of Point Sinclair to **west of Scaele Bay** (including the **Nuyts Archipelago** and **St Francis Isles**): An abundance of some shark species, including species of conservation concern (e.g. Bronze Whaler), according to fishing records and anecdotal sources.

Eastern Great Australian Bight: Juveniles of pelagic fish species such as Pilchards, Jack Mackerel and Blue Mackerel have been recorded in inshore regions (Stevens *et al.*, 1984, cited by Edyvane and Baker, 1999b; Ward *et al.*, 2000).

Invertebrates

Shallow water reefs between Point Sinclair and **Point Peter; Point Bell; Purdie Islands;** and at **Cape Vivonne; Cape Wittelbee; Cape D'Estrees; Sinclair Island; Lounds Island**, south-western end of **St Peter Island; Goat Island;** between **Cape Missiessy** and **Point Brown**, and between **Point Brown** and **Point de Mole**, are reported to be used by one or more of the life stages of the following commercial invertebrate species: Southern Rock Lobster (Point Sinclair to **Point Peter; Point Bell, Purdie Islands, St Peter Island, Goat Island**), Southern Calamari, Giant Cuttlefish, Maori Octopus (Point Sinclair to **Point Peter; Point Bell, Purdie Islands, St Peter Island, Goat Island**), Greenlip and Blacklip Abalone, and Purple Sea Urchin (Bryars, 2003). All of these species, are also reported to utilise reefs at the **Lacy Islands, Franklin Islands**, and at **Evans, Egg, Smooth, Freeling, Dog, St Francis, West, Masillon, Fenelon**, and **Hart** islands, and **Cannan Reefs** (Bryars, 2003). Southern Calamari, Giant Cuttlefish and Purple Sea Urchin are reported from the reefs in **northern Streaky Bay** (i.e. between **Flagstaff Landing** and **Haslam**) (Bryars, 2003).

Tidal flats in **Tourville Bay, Murat Bay, Bosanquet Bay, Decres Bay, Streaky Bay, St Peter Island**, and at **Yatala Bank**, are reported to provide habitat for one or more of the life stages of Blue Swimmer Crab, Western King Prawn, and baitworm species (Bryars, 2003). Tidal flats in **Smoky Bay** are reported to provide habitat for one or more of the life stages of Blue Swimmer Crab, Sand Crab, Western King Prawn, Mud Cockles, Razorfish and baitworm species (Bryars, 2003). Tidal flats in **Streaky Bay** are reported to provide habitat for one or more of the life stages of Blue Swimmer Crab, Western King Prawn, Razorfish and baitworm species (Bryars, 2003).

In the subtidal, unvegetated sand habitat between Point Sinclair and **Point Peter**, including the **Purdie Islands** area, and at the **St Francis Isles** and **Cannan Reefs**, is reported to be used by one or more of the life stages of Sand Crab and Southern Calamari (Bryars, 2003).

Surf beach habitats between Point Sinclair and **Point Peter**, also on the western side of **St Francis Island**, and at **St Mary Bay** (near **Point Brown**) are reported to be used by one or more of the life stages of Sand Crab, and Baitworm species, and these species are also reported to utilise sheltered beach habitat at **St Francis** and **Fenelon** islands, and the **Franklin Islands** (Bryars, 2003).

Small seagrass stands at **Point le Hunte, Point Bell, Rocky Point** and **Davenport Beach** are reported to be used by one or more of the life stages of Southern Calamari (Bryars, 2003). Seagrass meadows in **Tourville Bay, Denial Bay, Murat Bay, Bosanquet Bay, Decres Bay, Laura Bay, Smoky Bay, and Streaky Bay**, and around **St Peter Island, Goat Island** and **Eyre Island**, are reported to provide habitat for Blue Swimmer Crab, Razorfish, Southern Calamari, King Scallops and Queen Scallops, the latter three also at **St Francis Island** and the **Franklin Islands** (Bryars, 2003).

Crenulate Bays region (e.g. **Bosanquet Bay, Murat Bay / Denial Bay** and **Smoky Bay, Streaky Bay**): Important habitats for bivalve molluscs. Native Oysters (*Ostrea angasi* and other species), Razorfish (*Pinna bicolor*) and Scallops (genera in S.A. include *Pecten*, *Equichlamys* and *Mimachlamys*) are all abundant (or previously have been abundant) in the area. Razorfish beds are common in some areas (e.g. **Vinya Corner**;

and “extensive Razorfish beds over most of **Smoky Bay**” have been documented (Hames Sharley Australia, 1989). Razorfish also occur in the **Streaky Bay / Blanche Port** area. Dense beds of Razorfish have ecological importance, being large molluscs that are capable of filtering large volumes of waters (when these molluscs are clustered in abundance), and also provide additional hard substrate “micro-habitat” for the attachment of epibiotic plants and animals. **Bosanquet Bay** reportedly contains areas in which “Scallops thrive” (Hames Sharley Australia, 1989).

Streaky Bay region: Regionally abundant Blue Swimmer Crabs, following irregular periods of oceanographically induced successful recruitment (Grove-Jones, 1987). The crenulate bays region represents the most westerly extent of Blue Swimmer Crab in South Australia.

Nuyts Archipelago, St Francis Isles and some coastal reefs (e.g. **Cape D’Estrees**): There are abundant sponges in some areas, according to benthic survey and divers’ reports, however species diversity is not known for this report.

St Francis Isles: Reportedly an “important breeding area for opisthobranch molluscs (shell-less marine snails), such as **Petrel Bay**, which is “significant for molluscs” between the 10 m and 40 m contours (Howlett, pers. comm., cited by Hames Sharley Australia, 1989).

Marine Mammals

Nuyts Archipelago and St Francis Isles: Haul-out sites for New Zealand Fur Seals at **Fenelon Island** (Shaughnessy, 1990; Edyvane, 1999b; Australian Heritage Commission, undated), and some of the other islands (e.g. **Lacy, Hart**). (Australian Heritage Commission undated; Shaughnessy *et al.*, 1994; Edyvane, 1999b; S.A. Coast and Marine Atlas, 2001).

Estuarine, Coastal and Marine Birds

Streaky Bay region: More than 20 migratory bird species listed under international treaties, have been recorded in the Streaky Bay area, such as Curlew Sandpiper, Sanderling, Red-necked Stint, Sharp-tailed Sandpiper, Great Knot, Red Knot, Bar-tailed Godwit, Grey-tailed Tattler, Banded Stilt, Whimbrel, Red-necked Avocet, Oriental Plover, Pacific Golden Plover, Grey Plover, and Greater Sand Plover, amongst other migratory species (Cooper, unpublished information supplied to DEH, for Environment Australia, 2000).

Ceduna area: Habitat for *migratory* waders such as Sharp-tailed Sandpiper, Common Sandpiper, Curlew Sandpiper, Wood Sandpiper, Terek Sandpiper, Red-necked Stint, Greenshank, Ruddy Turnstone, Grey-tailed Tattler, Grey Plover, Lesser Golden Plover, Great Knot and Red Knot, Sanderling, Whimbrel, Bar-tailed Godwit and Mongolian Plover. Some of these species visit for short periods, arriving around October each year, and others stay over summer, moving on around April / May (Hames Sharley Australia, 1989). *Non-migratory* birds that use the area as habitat include Hooded Plover, Red-capped Dotterel (= Plover) and Red-kneed Dotterel (=Plover), Pied and Sooty Oystercatcher, Masked Plover, Banded Stilt and Black-winged Stilt, Black Swan, White-faced Heron, Chestnut Teal and Grey Teal, Crested Tern, Pacific Gull, Silver Gull, and Australian Pelican, and also habitat for the migratory Caspian Tern (Hames Sharley Australia, 1989).

Tourville Bay / Davenport Creek area: Habitat for migratory birds such as Grey Plover (more than 300 recorded in one survey) and Greenshank (more than 250 recorded), amongst other migratory species listed under international treaties (Morelli and de Jong, 1995).

Nuyts Archipelago and St Francis Isles: Habitat for migratory bird species, such as Greenshank (**West Franklin Island, St Peter Island**); Lesser Golden Plover (**St Peter Island**); Whimbrel (**St Peter Island and Eyre Island**); Eastern Curlew (**St Peter Island**); Bar-tailed Godwit (**St Peter Island**); Caspian Tern (**West Franklin and East Franklin Island and St Peter Island**); Great Knot (**St Peter Island**); Red-necked Stint (**St Francis, Lounds, Purdie, West Franklin, St Peter and Eyre Islands**); Sanderling (**Purdie and Freeling, West Franklin, St Peter**); Sharp-tailed Sandpiper (**West Franklin, St Peter Island**); Ruddy Turnstone (recorded foraging along tide line at **Lounds Island**, and also occurs at **Purdie, St Francis, Dog, Freeling, Hart, West Franklin and East Franklin, St Peter and Eyre Islands**) (Robinson *et al.*, 1996).

Eba Island and Pigface Island: Habit for Crested Tern (**Eba**), Little Black Cormorant and Little Pied Cormorant (**Pigface**), Pied Oystercatcher (**Eba**), Sooty Oystercatcher, White-faced Heron (**Eba**) (Robinson *et al.*, 1996). Little Black Cormorants usually

	<p>prefer inland waters, and their presence on Pigface Island was noted with interest by Robinson <i>et al.</i> (1996).</p> <p>Nuyts Archipelago and St Francis Isles: Habitat for coastal and seabird species such as Crested Tern (important roosting site at Hart Island, and also recorded at 12 other islands in the two island groups, several reefs, such as those off West Island and Point Bell are also resting sites), Pied Cormorant (Sinclair, Lounds, St Francis, West Franklin and East Franklin, St Peter, Goat and Eyre Islands); Great Black Cormorant (West Franklin and St Peter Islands); Black-faced Cormorant (Evans, West Franklin and East Franklin, St Peter Island and Bird Rock); Australian Pelican (West Franklin, St Peter, and Eyre Islands, and Bird Rock near the Smoky Bay coast); White-faced Storm Petrel (Fenelon, Evans, West Franklin and East Franklin) (see also Major Breeding Areas); Australasian Gannet (West Franklin Island); Pacific Gull (13 islands); Silver Gull (9 islands); Masked Plover (15 islands); Pied Oystercatcher (St Peter and Eyre Island); Sooty Oystercatcher (15 islands); Buff-banded Rail (St Francis, Evans, East Franklin, St Peter, Goat and Eyre Islands); Little Penguin (see also Major Breeding Areas) (St Francis, Lounds, Egg, Dog, Freeling, Fenelon, Evans, West Franklin and East Franklin, St Peter, Goat, Eyre Islands); Banded Stilt (St Peter Island); Red-capped Plover (St Francis, West Franklin and East Franklin, St Peter and Eyre Islands); Double-banded Plover (West Franklin); White-faced Heron (in the tidal pools of St Francis, and recorded at 9 other islands); and Great Egret (St Peter Island) (Robinson <i>et al.</i>, 1996).</p> <p>Other</p> <p>St Francis Isles and Eyre Island: Although the Native Bush Rat is a terrestrial species, surveys during the 1980s (see Robinson <i>et al.</i>, 1996) recorded bush rats feeding in the piles of macroalgae on the western beaches of Eyre Island. Robinson <i>et al.</i> (1996) considered that the species may nest in these piles of marine debris. Native Bush Rats also occur on a number of the St Francis Isles (Dog, Masillon, Lacy, Goat Islands), and it is likely that a similar marine association of the Bush Rat's life history exists at such islands.</p>
<p>9. Notable Feeding, Breeding/Spawning and Nursery Areas</p>	<p>Bony and Cartilaginous Fish</p> <p>St Francis Isles: The offshore islands are important habitat for a number of reef fish species, that are less abundant on the mainland coast of South Australia. A survey in 2002 (Shepherd and Brook, 2003) showed that some reef fish species (such as Blue-Throated Wrasse, Black-Spotted Wrasse, Barber Perch, Butterfly Perch, and Zebra Fish, amongst others) were highly or very highly abundant at sampled areas in St Francis Isles. This abundance was termed the "offshore island effect" by Choat <i>et al.</i>, 1988 (cited by Shepherd and Brook, 2003). Shepherd hypothesised that the very high abundance of reef fish at the St Francis Isles may be due to high local reef productivity in the area, a high carbon subsidy from the surrounding waters, and low fishing pressure, and that the fish fauna of the St Francis Isles may represent an example of what reef fish composition may have been like in some other parts of the South Australian coast, prior to heavy fishing pressure during the past decades.</p> <p>Shallow water reefs between Point Sinclair and Point Peter; and at Point Bell, Purdie Islands, south-western end of St Peter Island; Goat Island; between Cape Missiessy and Point Brown, and between Point Brown and Point de Mole, are recorded as a habitat for adult spawners of Sea Sweep (also Cape D'Estrees area) and Western Blue Groper, and a nursery area for juveniles of those species (Bryars, 2003). Shallow water reefs between Point Peter and Cape D'Estrees, including Point Peter, Cape Vivonne, Cape Wittelbee, and Cape D'Estrees, are reported to be used by juvenile King George Whiting, West Australian Salmon, Tommy Ruff, Trevally and Sea Sweep (Bryars, 2003).</p> <p>Sheltered beaches at Point le Hunte and Rocky Point; also on the southern end of Eyre Island; and at Edward Bay, are reported to be nursery areas for juvenile School Whiting, and beach habitats at Eyre Island and in Edward Bay are also reported to be spawning areas for Yellow-eye Mullet (Bryars, 2003). The sheltered beaches at the south-western end of St Peter Island; the north-eastern end of Goat Island; at Sandy Cove near Laura Bay; and in parts of Smoky Bay and Streaky Bay) are reported to be nursery areas for juvenile King George Whiting, School Whiting, West Australian Salmon, Tommy Ruff, Yellow-eye Mullet, flathead species, flounder species, and (in most of these areas) Whaler Sharks (Bryars, 2003). Sheltered beach</p>

	<p>areas at St Francis Island, Fenelon Island, and Franklin Islands, are reported to be a spawning area for Yellow-eye Mullet (Bryars, 2003).</p> <p>Davenport Creek, Tourville Bay and Denial Bay: Mangroves and shallow subtidal seagrasses and sand habitats in the region are important nursery areas for King George Whiting, West Australian Salmon, Tommy Ruff, Southern Sea Garfish and Yellow-eye Mullet, amongst others (Jones <i>et al.</i>, 1990; Jones, SARDI, pers. comm., cited by Edyvane, 1996d; Ashman, 1996b; Edyvane, 1999b; Bryars, 2003). Denial Bay: Ashman (1996b) recognised the existence of “important habitats for commercially valuable fisheries, especially the estuarine areas for King George Whiting.”</p> <p>Smoky Bay: According to Bucher and Saenger (1989, cited by Edyvane and Nias, undated), Smoky Bay estuary “supports substantial areas of wetland that would provide habitat for estuarine and offshore fish stocks”. The southern portion is a “particularly important “ / “significant” nursery area for fish (Edyvane and Nias, undated, and Edyvane, pers. comm., cited by Ashman, 1996b). Edyvane (1999b) described Smoky Bay as a “key nursery area for marine scalefish”.</p> <p>Laura Bay was described by Ashman (1996b) as “having significance, as it’s varied habitats (including dense seagrass beds and sandflats) provide important habitat for a variety of native species”. Edyvane (1999b) described Laura Bay as a “key nursery area for marine scalefish”.</p> <p>Tidal creeks in the west coast area (e.g. Davenport Creek; Bob Creek and other creeks on the eastern side of St Peter Island; creeks around the northern and eastern sides of Eyre Island; creeks in southern Smoky Bay; Acraman Creek, and in southern Streaky Bay) are reported to provide nursery habitat for juvenile King George Whiting, West Australian Salmon, Tommy Ruff (Australian Herring), Southern Sea Garfish, Yellow-eye Mullet, Flathead Species, flounder species (Bryars, 2003). Fox Creek at Laura Bay is reported to provide nursery habitat for juvenile King George Whiting, West Australian Salmon, and Yellow-eye Mullet (Bryars, 2003). Similarly, mangrove forests in Tourville Bay, Murat Bay, Bosanquet Bay, Laura Bay, Smoky Bay and around St Peter Island, provide nursery areas for King George Whiting, West Australian Salmon, Tommy Ruff, Southern Sea Garfish, and Yellow-eye Mullet. Except for King George Whiting, all other of these species are also reported to utilise nursery habitat in the mangroves around Eyre Island (Bryars, 2003).</p> <p>Tidal flats in Tourville Bay, Murat Bay, Bosanquet Bay, Decres Bay, Laura Bay, Smoky Bay, Streaky Bay, Eba Island / Perlubie Beach and around St Peter Island and Eyre Island, are reported to be nursery areas for juveniles of one or more of the following species: King George Whiting, School Whiting, West Australian Salmon, Tommy Ruff, Southern Sea Garfish, Yellow-eye Mullet, flathead species and flounder species (Bryars, 2003) Yatala Bank is reported to provide habitat for juveniles of Flounder and flathead species (Bryars, 2003).</p> <p>In the subtidal, unvegetated soft bottom (sand) habitat between Point Peter and Cape D’Estrees (including Goat Island, Tourville Bay, Denial Bay, Murat Bay, Bosanquet Bay and Decres Bay), and at Streaky Bay, is reported to provide nursery areas for juvenile King George Whiting, West Australian Salmon, Tommy ruff, Red “Mullet”, flathead species and Trevally (Bryars, 2003).</p> <p>Deeper waters seaward of Ceduna and seaward of Streaky Bay, including waters around the Nuyts Archipelago, provide habitat for adult Western King Prawns, although prawn abundance is presumably less than that further south in Anxious Bay (as indicated by commercial catch figures – see Carrick and Williams, 2001, and Svane and Barnett, 2004, for recent data).</p> <p>Seagrass meadows in Tourville Bay, Denial Bay, Murat Bay, Bosanquet Bay, Decres Bay, and around St Peter Island and Goat Island provide nursery areas for King George Whiting, West Australian Salmon, Tommy Ruff, Southern Sea Garfish, Red “Mullet”, Trevally, Snook, flathead species, Yellow-tail Kingfish, leatherjacket species and Whaler Sharks (Bryars, 2003). Juveniles of most of these species are also reported to utilise the seagrass meadows of Streaky Bay (Bryars, 2003).</p> <p>Eyre Island and St Peter Island (Nuyts Archipelago): The mangrove, sandbank and seagrass environments around the island are “important fish nursery areas” (Australian Heritage Commission, undated).</p> <p>Streaky Bay: According to Bucher and Saenger (1989, cited by Edyvane and Nias, undated), Streaky Bay estuary “supports substantial areas of wetland that would provide habitat for estuarine and offshore fish stocks”. Eba Island (Streaky Bay) has been described as a “key nursery area” for marine scalefish (Edyvane, 1999b).</p>
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Invertebrates

Shallow water reefs between **Point Peter** and **Cape D'Estrees**, including **Point Peter**, **Cape Vivonne**, **Cape Wittelbee**, and **Cape D'Estrees**, are reported to be egg laying areas for Southern Calamari and Giant Cuttlefish, and the area also provide habitat for all life stages of the Purple Sea Urchin (Bryars, 2003).

Surf beaches between Point Sinclair and **Point Peter**, and at the south-western side of **St Peter Island** and north-eastern end of **Goat Island**, are reported to provide habitat for juvenile Sand Crabs (Bryars, 2003).

Sheltered beaches (e.g. at **Point le Hunte** and **Rocky Point**; also at the south-western end of **St Peter Island**; the north-eastern end of **Goat Island**; the southern end of **Eyre Island**; at **Sandy Cove** near **Laura Bay**; and throughout **Smoky Bay**) are recorded as habitat for juvenile baitworms, and Sand Crabs (Bryars, 2003).

Davenport Creek, Tourville Bay and Denial Bay, Murat Bay, Smoky Bay, Laura Bay, Franklin Island, Eyre Island and St Peter Island (part of **Nuyts Archipelago**), **Yatala Bank, Streaky Bay, Acraman Creek, Perlubie Beach / Eba Island**: The mangroves, shallow sandbanks and sandflats, and/or seagrass habitats of the upper west coast bays and inner island areas, are important nursery areas for Western King Prawns (Wallner, 1985; Hames Sharley Australia, 1989; Murat Bay Aquaculture Management Plan, 1991; Bond, 1994; Ashman, 1996b; Edyvane, 1999b; Australian Heritage Commission, undated). According to Hames Sharley Australia (1989) and MacDonald (1998), the most important Western King Prawn nursery areas along the upper west coast include **Tourville Bay, Smoky Bay** (especially the eastern side), and **Streaky Bay**. Hames Sharley Australia (1989) reported that "large numbers of prawn larvae" occur in **Tourville Bay** and **Denial Bay**. **Smoky Bay** is considered to be a particularly important nursery area for Western King Prawns, and a previous survey during the 1980s reportedly found that the oyster zone in **Smoky Bay** was "the only area to have abundant juvenile Western King Prawns in Smoky Bay" (Wallner 1985, cited by Edyvane and Nias, undated). **Laura Bay** (north of Smoky Bay) is also reported to be a nursery area for juvenile Western King Prawns (Bryars, 2003). Wallner (1985, cited by Edyvane and Nias, undated) reported that **Denial Bay** is an "important nursery for King Prawns, especially the area from the jetty to **Low Point**" and that "the sandbanks north of **Eyre Island** and east of **Cape Missiessy** are important King Prawn nursery areas". Tidal flats in the aforementioned areas also have a nursery function for Blue Swimmer Crabs, Sand Crabs, and/or Mud Cockles.

Tidal creeks (e.g. **Davenport Creek; Bob Creek** and other creeks on the eastern side of **St Peter Island**; creeks around the northern and eastern sides of **Eyre Island; Fox Creek** in **Laura Bay**; creeks in southern **Smoky Bay; Acraman Creek**, and in **southern Streaky Bay**) are reported to provide nursery habitat for juvenile Blue Swimmer Crabs and/or Sand Crabs, Western King Prawns, and Razorfish, although Fox Creek is not listed as a nursery area for the latter (Bryars, 2003). Similarly, mangrove forests in **Tourville Bay, Murat Bay, Bosanquet Bay, Laura Bay, Smoky Bay** and around **St Peter Island** and **Eyre Island**, provide nursery areas for Blue Swimmer Crabs and Western King Prawns, and both spawning adult and juvenile Mud Cockles and baitworm species are reported to utilise the mangrove forests in **Tourville Bay, Laura Bay** and **Smoky Bay** (Bryars, 2003).

Tidal flats in **Tourville Bay, Murat Bay, Bosanquet Bay, Decres Bay, Smoky Bay, Laura Bay, Smoky Bay, Streaky Bay, Eba Island / Perlubie Beach** and around **St Peter Island** and **Eyre Island**, provide spawning areas and nursery areas for Blue Swimmer crabs (Bryars, 2003).

In the subtidal, unvegetated sand habitats between **Point Peter** and **Cape D'Estrees** (including **Goat Island, Tourville Bay, Denial Bay, Murat Bay, Bosanquet Bay** and **Decres Bay**) and also in **Laura Bay, Smoky Bay**, and **Eyre Island**, are reported to be used by one or more of the life stages of Blue Swimmer Crabs, Sand Crabs (**Laura Bay, Smoky Bay, Eyre Island**), Razorfish, King and Queen Scallops, and nursery areas for juveniles of these species (Bryars, 2003).

Seagrass meadows in **Tourville Bay, Denial Bay, Murat Bay, Bosanquet Bay, Decres Bay, Smoky Bay, Streaky Bay** and around **St Peter Island** and **Goat Island** provide feeding areas and/or spawning areas for Blue Swimmer Crabs, Razorfish, Southern Calamari, and King and Queen Scallops, and nursery areas for juveniles of all of these species, except Southern Calamari (Bryars, 2003).

Denial Bay: Ashman (1996b) recognised the existence of "important habitats for commercially valuable fisheries, especially the sandbanks for Western King Prawns

	<p>(see also Wallner, 1985), and the reef areas for Southern Rock Lobster and Abalone".</p> <p>Southern Streaky Bay – Blanche Port: The sandy protected nature of the bay, fringed with areas of samphire and mangrove, indicate that it may be significant in the ecology of important commercial fish species such as Western King Prawn (Bond, 1994).</p> <p>Marine Mammals</p> <p>Nuyts Archipelago and St Francis Isles and Franklin Islands: Important breeding, feeding and resting habitats for Australian Sea Lion, particularly Purdie Island and the Franklin Island rocks - see previous sections on Habitat for Endemic Taxa / Threatened Taxa / Rare or Uncommon Taxa.</p> <p>Nuyts Archipelago and St Francis Isles: Important feeding and resting habitats for New Zealand Fur Seal, and minor breeding area (on a Statewide scale) (see Robinson <i>et al.</i>, 1996; pinniped references in Lewis <i>et al.</i>, 1998; S.A. Coast and Marine Atlas, 2001, and section on Other Important Taxa).</p> <p>Coastal and Marine Birds</p> <p>Nuyts Archipelago and the St Francis Isles: Most of the islands in the two groups support large breeding colonies of Short-tailed Shearwater colonies during the summer months (Morelli, 1995, in Morelli and de Jong, 1995). St Peter Island contains the largest breeding population in South Australia with a previous survey recording a total of around 334,800 birds on the island (Robinson <i>et al.</i>, 1996). St Francis has the second largest recorded breeding population in South Australia (around 273,000 birds, according to one survey by National Parks and Wildlife S.A.). Previous surveys reported the following: Franklin Islands – approx. 102,080 Shearwaters; Goat Island – approx. 94,800 birds; Evans Island: - approx. 29,472 birds; Lacy Island – approx. 4,780 birds (Robinson <i>et al.</i>, 1996). The island group as a whole provides important breeding, feeding and roosting sites for coastal and seabird species. There are approximately 39,520 Short-tailed Shearwaters on Masillon Island and on Dog Island, more than 10,000 (estimates range between 11,000 and 33,000, according to Robinson <i>et al.</i>, 1996, p. 66, and p.159). Smaller populations exist on some of the smaller islands in both island groups.</p> <p>Hames Sharley Australia (1989) identified the major Far West Coast areas for wading birds as being Laura Bay, St Peter Island, Smoky Bay, Eyre Island, Acraman Creek, Cape Missiessy, Davenport Creek, and the mudflats close to Ceduna. Some of these areas are discussed in more detail below. Such areas were considered to be important for both resident and migratory wading birds and other coastal birds, which use the exposed sand and mud habitats for feeding on small crustaceans, molluscs, and other invertebrates.</p> <p>St Peter Island (part of Nuyts Archipelago): The extensive intertidal sand flats around the island provide habitat for a number of seabirds and wading birds, including migratory waders (Ashman, 1996b). Also a breeding area for Little Penguin. St Peter Island has been described as supporting “a profuse and varied bird population”, and “attracting many waders and other waterbirds”, due to the variety of coastal habitats, particularly the mangroves and samphire swamps, and the extensive sandbanks (Robinson <i>et al.</i>, 1996).</p> <p>St Francis Isles: Significant breeding population (in the thousands) of White-faced Storm Petrel on Fenelon Island, which contains many burrows for this species (Robinson <i>et al.</i>, 1996; S.A. Coast and Marine Atlas, 2001). Small populations of Little Penguins (less than 50 birds) breed on St Francis and Freeling Islands (Robinson <i>et al.</i>, 1996).</p> <p>Eyre Island (Nuyts Archipelago): The tidal mudflats are described as providing “important habitat for migratory wading birds” (Morelli and de Jong, 1995). Robinson <i>et al.</i> (1996) reported that the bird population is boosted by the extensive sandbars that attract waders and other birds that feed at the shoreline.</p> <p>Tourville Bay / Davenport Creek: Breeding, nesting and feeding areas for coastal and seabird species. Breeding birds in the area include Pied Cormorants, Black Cormorants and White-faced Herons, and the area also provides notable habitat for Pied Oystercatchers and Sooty Oystercatchers (Butler <i>et al.</i>, 1975; Bransbury, 1988; Watkins, 1993; Copley, 1995, cited by Morelli and de Jong, 1995). Ashman (1996b) reported that the inter-tidal flats of Tourville Bay are important feeding habitat for birds.</p> <p>Laura Bay: The sandflats are reported as an important feeding area for wading birds (Edyvane and Nias, undated).</p> <p>Gibson Peninsula / Blanche Port / Streaky Bay / Acraman Creek: Described as a</p>
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	<p>“major water-bird feeding and roosting area for the west coast of South Australia” (Morelli, 1995, in Morelli and de Jong, 1995).</p> <p>Pigface Island Conservation Park is considered to be a significant seabird rookery (Bond, 1994), and reportedly contains breeding areas for cormorants (Little Black and/or Little Pied Cormorant, according to Robinson <i>et al.</i>, 1996, or Black-faced Cormorant, according to Australian Heritage Commission) and Silver Gulls (Australian Heritage Commission, undated), and roosting and feeding areas for other seabirds.</p> <p>Bird Island (Bird Rock): Australian Pelicans roost on the rocks and sand. Also a habitat for “large numbers” of Cormorants, Silver Gulls and Crested Terns (Robinson <i>et al.</i>, 1996).</p>
<p>10. Shipwrecks and Artificial Reefs</p>	<p>There is an artificial tyre reef in the Target Point area in southern Streaky Bay, and it is reported to have accumulated “substantial marine growth” since it was laid. The artificial reef is known as an aggregation area for “small to medium sized” Snapper (Fishnet, 2002), however no other details are available for this report regarding the function of the artificial reef as additional habitat for other species in the area.</p> <p>There are at least 50 wrecked vessels in the area (mostly modern fishing boats, although a number of historic wooden and metal vessels exist in the area), however, no specific details are available for this report, regarding the function of these wrecks as additional habitat.</p>
<p>11. Popular Dive Sites</p>	<p>Features promoted as being of interest to divers at the Nuyts Archipelago and St Francis Isles (e.g. Lacy Island, St Francis Island and Masillon Island) include the reef and seagrass habitats, Sea Lions, Dolphins, Rock Lobster, Abalone, reef fish (such as Western Blue Devil, Harlequin Fish, Blue Groper, Blue-throated Wrasse, Footballer Sweep, Barber Perch, Magpie Perch, Leatherjacket species, and numerous others) and abundant sessile invertebrates such as sponges, ascidians and soft corals (DIASA, undated; Fishnet, 2002; Aquanaut, undated; other dive tourism promotion materials, and anecdotal sources).</p> <p>Other than Rock Lobster and abundant fish, specific features of interest to divers at recorded coastal dive sites in the Far West area (e.g. Streaky Bay, Point Brown, Smoky Bay, Decres Bay, Ceduna area, Rocky Point and Point James) are not known for this report.</p>
<p>12. National and/or International Importance</p>	<p>Tourville Bay / Davenport Creek and Streaky Bay / Acraman Creek: Both areas are listed as <i>Wetlands of National Significance</i> (ANCA, 1996). Tourville Bay was described previously (Bucher and Saenger, 1989) as one of the three estuaries in South Australia that is of outstanding conservation significance, due to its undeveloped nature and relatively pristine catchment area.</p> <p>Areas listed as being of international importance for shorebirds (Watkins, 1993) are Gibson Peninsula, Blanche Port, Streaky Bay, Acraman Creek, and Tourville Bay.</p> <p>Tourville Bay: Listed by the Australian Heritage Commission as an <i>Indicative Place</i>, meaning that inclusion on the <i>Register of the National Estate</i> may be forthcoming. The area was nominated due to it being “the most extensive mangrove community between Spencer Gulf in S.A. and Exmouth Gulf in W.A.; the most western extent of mangroves in SA; the largest mangrove woodland on Eyre Peninsula; and one of most important coastal wetlands in S.A.” (Australian Heritage Commission, undated). Additional features included in the nomination were the roles of Tourville Bay as a nursery for fish and prawns, and a feeding area for wading birds.</p> <p>Coastal areas (including the intertidal area, for some parks), listed on the <i>Register of the National Estate</i> (Australian Heritage Commission, undated) include:</p> <p>Laura Bay Conservation Park: Coastal / marine features listed in the <i>Statement of Significance</i> include the mangrove areas, which in S.A. are considered as “markedly depleted”. The park preserves a “diversity of coastal communities ranging from coastal mallee scrub, through to mangrove flats”.</p> <p>Eba Island Conservation Park: Value as a roosting and feeding habitat for seabirds, and</p>

	<p>described as a “notable coastal feature” by Bond (1994). Also habitat for migratory birds listed under treaties (e.g. Ruddy Turnstone).</p> <p>Wittelbee Conservation Park: Contains an area of <i>Sarcocornia quinqueflora</i> samphire swamp that is reportedly not well represented in the National Parks system. Other coastal and/or marine features listed in the <i>Statement of Significance</i> include the dunes and the “fine sandy beaches and low rocky headland”.</p> <p>Pigface Island Conservation Park: Value as a breeding area (without predators) for silver gulls and cormorants, and roosting and feeding habitat for other seabirds.</p> <p>Nuyts Archipelago: Coastal / marine features listed in the <i>Statement of Significance</i> include:</p> <ul style="list-style-type: none"> ♦ the type locality of the Nuyts Volcanics, on southern St Peter Island; ♦ the fore-dune ridge system on Eyre Island, which preserves a history of sea-levels and sedimentation; ♦ the nursery function of the intertidal mangrove and seagrass environments around Eyre Island and St Peter Island, for prawns and fish; ♦ the tidal mudflat habitat for migratory wading birds; ♦ the reportedly “rare” species of shellfish in the vicinity of St Peter Island (<i>but see section above on Habitat for Rare Taxa</i>); ♦ the undisturbed nature of Eyre Island; ♦ the large breeding populations Short-tailed Shearwaters; ♦ the feeding and breeding habitats for rare and threatened seabird and coastal bird species; ♦ the breeding colonies of Australian Sea Lion at Purdie and Lounds Islands, and the islets off Franklin Island; and ♦ the haul-out function of several of the islands in the group, for New Zealand Fur Seals and Australian Sea Lions. <p>Isles of St Francis: Coastal / marine features listed in the <i>Statement of Significance</i> include the existence of <i>rare</i> (e.g. Cape Barren Goose) and uncommon (e.g. Buff-banded Rail) birds; the large breeding population of Short-tailed Shearwaters; the significant breeding colonies of Australian Sea Lion; the breeding sites for New Zealand Fur Seal, and the existence of the type locality for the St Francis granite formation (a “Geological Monument”).</p> <p>Acraman Creek (in Smoky Bay): Listed by the Australian Heritage Commission as an <i>Indicative Place</i>, meaning that inclusion on the <i>Register of the National Estate</i> may be forthcoming. The area was nominated as a “geological monument” due to its geological significance as a well preserved stranded tidal creek in excellent condition, that provides a record of sedimentation over the Holocene period (Australian Heritage Commission, undated). Also described as a “significant tidal inlet” by Bond (1994).</p> <p>St Peter Island (part of Nuyts Archipelago): The extensive intertidal sand flats around the island provide habitat for a number of seabirds and wading birds, including migratory waders formally protected under international treaties (CAMBA and JAMBA) (Ashman, 1996b).</p> <p>Nuyts Archipelago and St Francis Isles: Habitat for at least 11 migratory bird species (see section above, on Other Important Taxa), listed under international JAMBA and CAMBA treaties (Robinson <i>et al.</i>, 1996).</p> <p>Ceduna region: Habitat for at least 17 species of migratory shorebirds (see section above, on Other Important Taxa), listed under international treaties CAMBA and JAMBA (Hames Sharley Australia, 1989).</p> <p>Streaky Bay region: More than 20 migratory bird species listed under international treaties, have been recorded in the Streaky Bay area, such as Curlew Sandpiper, Sanderling, Red-necked Stint, Sharp-tailed Sandpiper, Great Knot, Red Knot, Bar-tailed Godwit, Grey-tailed Tattler, Banded Stilt, Whimbrel, Red-necked Avocet, Oriental Plover, Pacific Golden Plover, Grey Plover, and Greater Sand Plover, amongst other migratory species (Cooper, unpublished information supplied to DEH, for Environment Australia, 2000).</p> <p>In the Gibson Peninsula / Blanche Port / Streaky Bay / Acraman Creek area, 12</p>
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	<p>species of migrant shorebird are regularly recorded, such as Ruddy Turnstone, Red Knot, Curlew Sandpiper, Pacific Golden Plover and Grey Plover, Lesser Sand Plover and Greater Sand Plover. Approximately 3500 to 5000 waders utilise the area (Eckert, 1974; Bransbury, 1988; Fuhlbohm, 1992 unpub. records, cited by Morelli and de Jong, 1995).</p> <p>Tourville Bay / Davenport Creek area: Habitat for migratory birds such as Grey Plover (more than 300 recorded, during one survey) and Greenshank (more than 250 recorded during survey) (Morelli and de Jong, 1995), amongst other migratory species listed under international treaties.</p> <p>Eyre Island and St Peter Island (Nuyts Archipelago): The tidal mudflats and sandflats provide habitat for seabirds and migratory wading birds, some listed under international treaties (CAMBA and JAMBA) (Morelli and de Jong, 1995; Australian Heritage Commission, undated; Ashman, 1996b).</p>
<p>13. Major Commercial and Recreational Fish, Sharks, Molluscs and Crustaceans</p>	<p>Some of the commercially and / or recreationally fished species that occur in parts of the area that collectively encompass the crenulate bays between Point Peter and Point Brown (and including Tourville Bay, Denial Bay, Murat Bay, Bosanquet Bay, Decres Bay, Smoky Bay, and shallow waters less than 10 m, out to the St Peters Island area) include:</p> <p><i>Fish:</i> King George Whiting, Snapper, Snook, Tommy Ruff (Australian Herring), West Australian Salmon, Yellow-eye Mullet, Sea Mullet, Goatfish, Wrasse species, Sea Sweep (in some reef areas), Trevally, Mulloway, Leatherjacket species, Blue Morwong, Garfish, School Whiting, Yellow-fin Whiting, Yellow-tail Kingfish, Weedy Whiting, Southern Sea Garfish, Striped Perch, and species of Flathead and Flounder.</p> <p><i>Sharks and Rays:</i> Gummy Shark, School Shark, Bronze Whaler and/or Black Whaler, Eagle Ray, Smooth Stingray and other species of ray, stingray and stingaree.</p> <p><i>Invertebrates:</i> Southern Calamari, Blue Swimmer Crabs (depending upon irregular recruitment), Sand Crabs, Razorfish, Native Oysters, King and Queen Scallops, Mud Cockles, Western King Prawns (deeper water out of the bays), Abalone (in some reef areas), Purple Sea Urchin (in some reef areas), Giant Cuttlefish and bait worm species.</p> <p>Regionally, some of the commercially and / or recreationally fished species that occur in the Streaky Bay area (including reefs offshore) include:</p> <p><i>Fish:</i> King George Whiting, Australian Salmon, Snapper, Snook, Tommy Ruff, Garfish, Striped Perch, Yellow-eye Mullet, Trevally, reef fish (such as Blue Morwong, Trevally, Sweep, Leatherjacket species, Wrasse species, Boarfish, Red Snapper, Blue Groper and Dusky Morwong), various Whiting species (Yellow-fin, Weedy, and School Whiting), Flounder, Mulloway, Ocean Leatherjackets, various "Rock Cod" species.</p> <p><i>Sharks and Rays:</i> School Shark and Gummy Shark, Bronze Whaler and/or Black Whaler, Wobbegong Shark, other shark species, various species of ray, stingray and stingaree.</p> <p><i>Invertebrates:</i> Southern Calamari, Blue Swimmer Crab, Sand Crab, Razorfish, Scallops, Octopus, Abalone, Rock Lobster.</p> <p>Some of the commercially and / or recreationally fished species that occur in waters from south and east of Point Sinclair to west of Sceale Bay (including the Nuyts Archipelago and St Francis Isles, but excluding all shallow waters landward of a line between Point Peter and Point Brown), include:</p> <p><i>Fish:</i> King George Whiting (particularly the larger individuals), School Whiting, Australian Salmon, Snook, Pilchards, Ocean Leatherjacket, Sea Sweep, Snapper and Blue Morwong. Bluefin Tuna and other pelagic species are caught in deeper Commonwealth waters. Other species that are caught commercially and/or recreationally in the area include various Leatherjacket species, various "Rock Cod" species, Australian Herring, Garfish, Blue Groper and other Wrasse species, Boarfish, Redfish (Red Snapper), Trevally, Yellow-eye Mullet, Yellow-tail Kingfish, Mulloway, Blue Mackerel, and Silver Drummer.</p> <p><i>Sharks and Rays:</i> Gummy Shark and School Shark, Bronze Whaler and/or Black Whaler</p>

	Shark, other shark species (e.g. Saw Shark), Eagle Ray and various other ray species, <u>Invertebrates</u> : Southern Calamari, Western King Prawns, Greenlip and Blacklip Abalone, Rock Lobster, Sand Crab, Purple Sea Urchin, Maori Octopus, Giant Cuttlefish, bait worm species.
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<p>1. Biogeographic Significance</p>	<p>Point Labatt: supports a well-recognised mainland colony of Australian Sea Lion, which is one of the few mainland colonies known in Australia (and the world, because the Australian Sea Lion is an endemic species to Australia). The Australian Sea Lion is currently listed as <i>rare</i> in South Australia (S.A.) under the <i>National Parks and Wildlife Act 1972</i>, and has also been considered by some researchers to be a threatened species (Gales, 1990; Gales <i>et al.</i>, 1994; Dennis and Shaughnessy, 1996, Shaughnessy, 1999).</p> <p>Islands in the area collectively represent a biogeographically significant breeding area for Australian Sea Lion. Counts of pup production have shown that the island off Cape Blanche (Nicholas Baudin Island) is one of the top 7 breeding colonies of Australian Sea Lion in existence, and is one of the few known colonies where pup mortality rates are low (Shaughnessy, CSIRO, pers. comm. to FOSB, 2001-2002). Shaughnessy and Dennis (2002) estimated that around 72 pups occur the island. A recent survey in January 2005 at Olive Island (McIntosh, Shaughnessy and NPWS, unpublished), recorded 140 pups.</p>
<p>2. Major Physical Influences, and Relative Productivity Level</p>	<p>Physical Influences</p> <ul style="list-style-type: none"> ♦ Baird Bay is a shallow, almost land-locked bay of high salinity and low nutrient status, with limited tidal exchange (Bond, 1994), and these physical features are major influences on the marine biota of the area. ♦ The coastal area is within the influence of the warm water masses that extend eastwards from the Great Australian Bight, to western Eyre Peninsula. The Leeuwin current, which is a predominant influence in the western Great Australian Bight, is joined by an easterly-moving warm water mass that is generated in the Bight, and the influence of this warm water mass extends to the Eyre coast (Herzfeld, 1997; Herzfeld and Tomczak, 1997; Herzfeld, 2000). ♦ Rugged coastal cliff areas (e.g. Cape Bauer, Point Westall, Cape Blanche, Cape Radstock) are exposed to strong winds and wave action from the Great Australian Bight, and the entire coastal area (from Cape Bauer to Cape Radstock) is subjected to swell, mainly from the south-west, at all times of the year (Petruševics <i>et al.</i>, 1998). Wave heights along exposed parts of the mid-west coast can be extreme (i.e. several metres or more). ♦ There are steep depth gradients close to the coast along most of the headland sections of coast between Cape Bauer and Cape Radstock. For example, waters 30m deep abut the coast at Point Westall, and waters 50+m deep occur at around 1.5 – 1.6 nautical miles from shore, in a number of areas (e.g. off Cape Radstock and other parts of the Calca Peninsula; off the headland south of Cape Blanche; and off the Westall Way area) (Bond 1994, South Australian Coastal and Marine Atlas, 2001). <p>Relative Productivity:</p> <ul style="list-style-type: none"> ♦ Although warm water masses are a strong physical influence in the area (see above), in some years the nutrient-rich cool water upwelling that is commonly observed along south-western Eyre Peninsula, also occurs along the mid-west coast, from Cape Bauer to Cape Radstock. For example, <i>in situ</i> measurements from SARDI's research vessel in 1999 showed that water temperature in the area was low relative to the surrounding coast, and that chlorophyll levels were high (see Figure 16 in Ward <i>et al.</i>, 2000).

<p>3. Bioregional Representative-ness of Habitats</p>	<p>Cape Bauer is the eastern boundary of the Murat Bioregion and western boundary of the Eyre Bioregion (see Edyvane, 1999b, and South Australian Coastal and Marine Atlas, 2001).</p> <p>The area contains some habitats and features that are representative of part of the Murat Bioregion (IMCRA Technical Group, 1998), namely:</p> <ul style="list-style-type: none"> ♦ Coastal geology comprising headlands of Precambrian crystalline rock (usually with a dune rock capping), and Pleistocene dune rock cliffs, reefs and headlands, interspersed with Holocene beaches, dunes, and estuarine deposits; ♦ Offshore islands and sea mounts; ♦ Marine flora typically Flindersian; ♦ Subtidal seagrass communities dominated by <i>Posidonia</i> species in shallow waters; ♦ On rocky shores, exposed limestone coasts dominated by <i>Ecklonia radiata</i> (in some areas); ♦ The red <i>Osmundaria</i> as one of the dominant macroalgae on moderately exposed coasts; ♦ Granite boulder reefs dominated by species of <i>Cystophora</i>. <p>The area contains some habitats and features that are representative of the western part of the Eyre Bioregion (IMCRA Technical Goup, 1998), namely:</p> <ul style="list-style-type: none"> ♦ Exposed rocky coast (including cliffs, headlands, and shore platforms); ♦ Shallow to moderate offshore gradient; ♦ Pleistocene dune rock cliffs as part of the coastal geology; ♦ Holocene dune barrier beaches and lagoon deposits; ♦ Sheltered, shallow embayment, dominated by seagrasses; ♦ Subtidal assemblages dominated by red macroalgae (e.g. <i>Osmundaria</i>, and species of <i>Plocamium</i>), species of the green <i>Caulerpa</i> (e.g. <i>C. flexilis</i>), and species of the brown canopy macroalgae <i>Cystophora</i>; ♦ Significant colonies of Australian Sea Lion and/or New Zealand Fur Seals; ♦ Coastal <i>Wetlands of National Importance</i> (Baird Bay).
<p>4. Habitat Rarity</p>	<p>Not known for this report.</p>
<p>5. Habitat Diversity</p>	<p>Habitat types include:</p> <ul style="list-style-type: none"> ♦ Supratidal samphire/saltmarsh habitat (Baird Bay area); ♦ Extensive supratidal sand flats and shellgrit beaches (Baird Bay area); ♦ Sheltered sandy bay habitat, with numerous tidal channels (with some seagrass) (Baird Bay area); ♦ Sand island habitat (Baird Bay); ♦ Rugged, wave-exposed calcareous cliff areas; ♦ Wave-exposed beach habitats; ♦ Wave-exposed bays, containing both seagrass beds and macroalgae-dominated calcareous patch reefs; ♦ Granite intertidal headland reefs; ♦ Nearshore reefs (both granite and calcareous), dominated by fucoid brown macroalgae and a variety of large red macroalgae, green macroalgae and turfing brown macroalgae (see descriptions below); ♦ Island reef habitats (both granitic and calcareous); ♦ Offshore calcareous reef and sand habitats. <p>Selected Habitat Notes (Bond, 1994; Robinson <i>et al.</i>, 1996; Edyvane and Baker, 1998b, and unpublished SARDI S.A. Benthic Survey data; J. Baker, pers. obs., 2002; Shepherd and Brook, 2004).</p>

Regionally, the major habitats in the area comprise:

- ♦ Rugged, wave exposed, granite-based calcareous-topped headlands and cliffs, and broad exposed bays, and associated nearshore reefs, with benthic cover that is characteristic of the western part of the Eyre Bioregion e.g. *Cystophora* species and *Ecklonia radiata* as dominant brown macroalgae; diverse mixed red taxa in the understory, dominated by species of *Plocamium* and *Phacelocarpus*, and *Osmundaria prolifera*, and also green macroalgae (e.g. species of *Caulerpa*) and turfing browns (e.g. *Homoeostrichus*) in the understory;
- ♦ Shallow, sandy, seagrass-lined sheltered embayment (the area includes Baird Bay, one of several sheltered embayments along the western Eyre coast). There are also sapphire wetlands associated with the shallow sandy embayment of Baird Bay.

Cape Bauer

The eroded, coarse-grained calcarenite mantle (over granitic basement rock) is evident in this area (Shepherd and Brook, 2004). At **Cape Bauer** there is a small calcarenite headland on the northern, more sheltered side of the Cape, and *Ecklonia*, *Scaberia* and species of *Cystophora* are the dominant macroalgae in the shallow subtidal (Shepherd and Brook, 2004). There are reefs between Olive Island and Cape Bauer, and north of Cape Bauer. The high energy conditions that exist along this coastline support reef communities of mainly red and brown macroalgae, with associated assemblages of reef fauna (Bond, 1994). During a benthic survey in 1994, (Edyvane and Baker, 1998b), reef sampled at 10m was dominated by mixed red taxa (*Phacelocarpus* species, *Plocamium dilatatum*, *Trigenia australis* and *T. umbellata*, species of *Callophyllis*, *Peyssonnelia* and *Sonderopelta coriacea*). The canopy browns *Ecklonia radiata* and *Cystophora moniliformis* were also recorded, with minor cover of species of green *Caulerpa* (mainly *C. obscura*), and an understory of encrusting corallines and bare sand patches.

Olive Island

An exposed granite island with a calcarenite cap, surrounded by numerous smaller reefs of non-foliated and relatively resistant granite (Robinson *et al.*, 1996). Olive Island was previously connected to the mainland, and is now a cluster of the more resistant fragments of a granite rise that previously extended from what is now the closest mainland point, **Cape Bauer**. On the north-eastern side of Olive Island, there is a narrow inlet, and the sheltered granite point supports a small sandy beach. Part of the sandy plateau at the top of the island, supports Marsh Saltbush shrubland (Robinson *et al.*, 1996). There are reefs between **Cape Bauer** and Olive Island.

South of Cape Bauer, to Point Labatt / Cape Radstock area: A rugged, high wave energy coastal area of calcareous cliffs and headlands, overlying basement granite, which extends into the adjacent nearshore marine area, forming a series of reefs and isolated headlands that protect some of the backing cliffs from wave-induced erosion. Along this stretch of coast there are many nearshore reefs and rock outcrops (both calcareous and granite), and granite islands with calcareous capping (Australian Heritage Commission, undated; Morelli and de Jong, 1995). There are relatively exposed bays facing the eastern Great Australian Bight (e.g. **Corvisart Bay**, **Sceale Bay** and **Searcy Bay**), surrounded by headland reefs. **Corvisart Bay (Back Beach)** is a broad exposed bay with a sand beach and reef patches near the shore. Along some sections of coast further south, there are smaller, more sheltered sandy beaches between headland cliffs. In general, the coastal reefs south of **Cape Bauer** support communities of mixed red and brown macroalgae, and associated reef fauna (Bond, 1994), characteristic of exposed conditions. **The Granites** and **The Dreadnoughts** are examples of the granitic basement reefs that are exposed in the coastal area. **The Granites** lagoon is a 350m section of coast north-east of Granite Rock, protected from swell by a low barrier granitic reef about 20m-40 m offshore, partly enclosing a lagoon 1-3 m deep, with several small openings to the open sea throughout its length, as well as at the eastern end (Shepherd and Brook, 2004). The substrate is smooth granite blocks and boulders, with rocky/sandy bottom to 3m deep, and *Ecklonia*, *Scaberia* and species of *Cystophora* are the dominant macroalgae in the shallow subtidal (Shepherd and Brook, 2004). **Smooth Pool** is a broad, eroding granite shelf extending less than 250m along the coast, with numerous intertidal rock pools during low tide, some around 2m deep. The lagoon of **Smooth Pool** is completely separated from the open sea at low tide, by a low granite reef, less than 0.5m above low water, and about 5m-

10m wide, such that at high tide the lagoon is inundated (Shepherd and Brook, 2004). The lagoon is about 20-40m wide and mostly 1m - 2m deep, with granite boulders or blocks, and some patches of bare sand and seagrass (*Posidonia* spp), with *Ecklonia*, *Scaberia* and *Cystophora monilifera* being the dominant macroalgae in the shallow subtidal (Shepherd and Brook, 2004). Rock pool biota includes various crab species, barnacles, seastars, small fish, and various macroalgae. There are exposed coastal reefs in the **High Cliff – Point Westall** area. On the northern shore of the **Westall Peninsula** the calcarenite mantle has been eroded to form broad granitic shore platforms falling away steeply to depths of more than 10m, where rock meets sand (Shepherd and Brook, 2004). **Point Westall** is exposed, but the eastern end of the Peninsula is more sheltered. The shallow subtidal substrate in the area includes calcarenite, as well as granitic boulders and blocks at the eastern end, grading to large blocks with increasing exposure toward the Point. *Ecklonia*, *Cystophora* and *Scytothalia* are the dominant macroalgae in the shallow subtidal (Shepherd and Brook, 2004).

Speeds Point, and a barrier reef extending from it, projects into northern **Sceale Bay**, partly enclosing a small unnamed bay on its northern side, commonly known as **Speeds**. The substrate at Speeds is mostly calcarenite of low to high relief, with some seagrass patches, and the macroalgae *Cystophora* and *Scaberia* on calcarenite (Shepherd and Brook, 2004).

There are exposed coastal reefs also in the **Yanerbie** area (northern end of **Sceale Bay**), as well as a beach at **Yanerbie**, with high dunes in the vicinity. **Sceale Bay** is a relatively deep coastal bay fringed by a sand and rock beach which merges with extensive seagrass communities offshore (mainly *Posidonia* species – Bond, 1994), and there are reefs at both the northern and southern ends of the bay. The northern Sceale Bay coastal reefs are extensive, with emergent reef outcrops and submerged reefs stretching from the point west of **Yanerbie**, to the **Point Westall / High Cliff** area, and further north up the **Westall Way** coast. At the southern end of **Sceale Bay**, the emergent granite outcrop (named **Nicholas Baudin Island** in 2003), occurs close to the cliff at **Cape Blanche**. The coast between southern **Sceale Bay** and **Cape Radstock** comprises steep coastal areas of granitic basement rock and overlying calcareous cliffs, interspersed with sandy beaches and a relatively exposed bay (**Searcy Bay**). Reefs in the area are dominated by mixed assemblages of red and brown macroalgae and associated invertebrate fauna characteristic of wave-exposed conditions. Benthic sampling in 1994 (Edyvane and Baker, 1998b, and unpublished SARDI S.A. Benthic Survey data) showed that in **Searcy Bay**, *Ecklonia radiata* and *Cystophora* species (e.g. *C. pectinata* and *C. monilifera*) dominated the granite reef at 13m at the time of the 1994 survey, with lesser amounts of the large red *Osmundaria prolifera*, and the brown *Acrocarpia paniculata*. Recorded understorey taxa in **Searcy Bay** included a dense coverage of mixed red (mainly *Phacelocarpus* species, but also *Plocamium preissianum* and *P. costatum*, and *Callophyllis* species), brown (mainly *Homoeostrichus*) and green (e.g. *Caulerpa flexilis*) taxa (Edyvane and Baker, 1998b and unpublished SARDI S.A. Benthic Survey data, 1994). Examples of coastal cliff and shore reef areas in the section between south Sceale Bay and Cape Radstock include **Cape Blanche**, **Slade Point**, and the seaward side of the **Calca Peninsula** (e.g. **Point Labatt**, **Cape Radstock**). At the time of the 1994 SARDI survey, calcareous reef area at **Point Labatt** was dominated by green macroalgae (species of *Caulerpa*), the brown macroalga *Ecklonia radiata*, with mixed red taxa in the understorey (*Plocamium* species, *Phacelocarpus* species, and the encrusting red *Sonderopelta coriacea*), mixed smaller brown taxa, and encrusting corallines (Edyvane and Baker, 1998b, and unpublished SARDI S.A. Benthic Survey data, 1994).

Baird Bay: A narrow, shallow (less than 5m deep), and sheltered bay with an entrance that narrows to 300m, opening into Anxious Bay. Baird Bay has an extensive flood tide delta bisected by a main channel, and there are numerous smaller channels within the bay. The bay contains extensive sand flats and supratidal flats, backed by shell grit beach ridges (with intermittent areas of coastal marsh), sand dunes and calcrete plains. Within the beach ridge land unit, supratidal flats have formed in the depressions between the ridges. Samphire shrublands occur at the edge of the tidal flats. Saltmarshes flank the eastern edge of the widest part of the **Calca Peninsula**, and there are other stands of saltmarsh at “Kalka” and “The Washpool Spring”, on the eastern side of **Baird Bay**. In the north-eastern part of the bay, ground water seepages occur, forming brackish soaks/springs, and supporting marsh and sedgeland (Bond, 1988; Morelli and de Jong, 1995; Bryars, 2003).

	<p>A sandy island exists within the bay (Unnamed Island, also known as Section 181), which is connected to the mainland at low tide, and contains a sandy beach and a compacted calcareous "scree" slope that enters the bay waters (Robinson <i>et al.</i>, 1996). Much of the bay is devoid of seagrass, and dominated by bare sandy substrate although species of <i>Posidonia</i> are found growing in the major channels. Baird Bay covers an area of approximately 200-300 ha (Morelli and de Jong, 1995), or approximately 40 km of stable shoreline and 35 km of water area (Bond, 1994).</p> <p>Baird Bay was mapped in 2000 as part of the National Land and Water Resources Audit, and the following statistics were calculated within a total facies area of 45.3km² (see GeoScience Australia, 2001 - 2004):</p> <p>Water area (km²) 43.66 Central Basin area (km²) 36.1 Channel (km²) 3.72 Floodplain (km²) 0.11 Tidal sandbanks (km²) 3.55 Intertidal flats (km²) 3.4 Mangrove (km²) 1.22 Saltmarsh (km²) 1.02 Seagrass (km²) 6.5 Rocky reef (km²) 0.88 Bedrock (km²) 0.30 Bedrock perimeter (km) 1.59 Entrance width (km) 2.26 Entrance length (km) 6.13 Perimeter (km) 59.01 Maximum length (km) 21.32 Maximum width (km) 4.02</p> <p>Jones Island lies at the mouth of Baird Bay. Similar to the emerged coastline in this area, Jones Island is predominantly calcareous, and is exposed to the full force of the ocean. There is reef and unvegetated soft bottom between Jones Island and Baird Bay (PIRSA, SARDI and DEH map, in Bryars, 2003).</p>
<p>6. Taxonomic Diversity</p>	<p>Marine Plants Little information is available for the area. In a 1994 government benthic survey of 26 locations along the west coast, sampled sites at Searcy Bay contained the 5th highest number of species of macroalgae recorded at those locations, collectively forming a significant part of the benthic cover (Edyvane and Baker, 1998b).</p> <p>Bony and Cartilaginous Fish Baird Bay: At least 17 commercially and/or recreationally important scalefish species have been recorded inside the enclosed bay, as well as four shark species (SARDI, unpublished data, and S.A. recreational fishing records). (N.B. the number of small, non-commercial fish species in the bay is not known for this report)</p> <p>Invertebrates <i>Not known for this report.</i></p> <p>Estuarine, Coastal and Marine Birds Baird Bay: Complete list not known for this assessment, but 19 waterbird species regularly recorded (Morelli and de Jong, 1995).</p>
<p>7. Habitat for Endemic Taxa / Threatened Taxa / Rare or Uncommon Taxa</p>	<p>Marine Plants Point Labatt: A rare species of red macroalgae, <i>Gigartina wheliae</i>, has been recorded growing at Point Labatt (Edyvane and Baker, 1998b). The species has rarely been recorded in other parts of S.A. to date, and was previously known only from drift specimens (Womersley, 1994). Point Westall: Brown macroalga <i>Corynophlaea cristata</i> (Womersley, 1987), which is reported to have a limited range.</p> <p>Marine Invertebrates: Point Labatt, Smooth Pools, The Granites: The endemic viviparous starfish <i>Patiriella parvivipara</i>, which has no planktonic larval stage, and narrow habitat limits (Environment Australia, 1998a), is found in the area (G. Hobson, pers. comm., citing research by M. Byrne, University of Sydney). Bony and Cartilaginous Fish: Leafy Seadragons recorded outside Baird Bay, near Jones Island, and at Back Beach</p>

	<p>(Corvisart Bay), Point Westall, and Dreadnoughts; Weedy Seadragons (including mass stranding reports) recorded at Back Beach, and Smooth Pool (Dragon Search Program database reports 1996-2002 – see Baker, 2003a and b). Leafy and Weedy Seadragon were listed by the IUCN Red List (2003) as <i>Data Deficient</i>, and Leafy Seadragon is protected under S.A. Fisheries Act.</p> <p>Baird Bay: A number of specimens of a new species of pipefish, Venus Pipefish <i>Stigmatopora venusensis</i> sp. nov. (Browne et al., in prep.) have been found on shallow sand flats in the bay. The species has a limited known distribution, having been found to date only along western Eyre Peninsula, from Streaky Bay to Venus Bay. The species is reported to be intolerant of sediment or macroalgae settling over its seagrass habitat through lack of water movement, or due to high input of sediment or nutrients (Browne, 2004).</p> <p>The Javelin Pipefish <i>Lissocampus runa</i> also occurs in the Baird Bay / Searcy Bay area (museum records, cited in Baker, in press). Although the species is considered common in some of the shallow sheltered bays within its range (Gomon et al., 1994), there are few specimens from South Australia, and surveys are required to better determine the distribution and status of this species (Browne, 2003).</p> <p>Cape Bauer to Cape Radstock and Olive Island: Habitat for reef fish species of conservation concern, such as Western Blue Groper and other wrasse species; Harlequin Fish; and other strongly site-associated reef fish species. Shepherd and Brook (2004) reported that relatively high densities of Western Blue Groper juveniles and sub-adults were recorded in sheltered pools (such as The Granites, Smooth Pool and Speeds Point), adjacent to exposed rocky coasts. Notes on the conservation status of (and threats to) these reef fish species are provided in Section 9.2, and in Baker (in press).</p> <p>Reef between Jones Island and Baird Bay: Habitat for both adult and juvenile Western Blue Groper (Bryars, 2003). The species is of conservation concern in South Australia (see Baker, in press).</p> <p>The deeper waters seaward of the Sceale Bay area are part of the migratory route of Southern Bluefin Tuna, and the “rise” off Sceale Bay is an area of the West Coast where the species aggregates closest to the coast during its offshore migration along the Eastern Great Australian Bight to the lower Eyre Peninsula area (e.g. see Figure 2 in Klaer <i>et al.</i>, 2002). Southern Bluefin Tuna is recognised internationally (IUCN) and nationally (Commonwealth <i>EPBC Act 1999</i>) as a threatened species, and is a species of conservation concern in southern Australian states (see Pogonoski <i>et al.</i>, 2002; Baker, in press).</p> <p>Open Bays and Headlands of the West Coast: Considered to be an important area for Great White Sharks, which are commonly observed in the region. There is anecdotal evidence of nursery areas for White Sharks along the mid west coast area (FOSB Media Release, 2001). Great White Shark is a protected species in South Australia; is also listed under the Commonwealth’s <i>EPBC Act 1999</i> as a threatened species, and was listed in the IUCN’s Red List 2003 as <i>vulnerable</i> and <i>conservation dependent</i>.</p> <p>Marine Mammals</p> <p>Cape Blanche to Cape Radstock (Searcy Bay): Australian Sea Lions (<i>Neophoca cinerea</i>) regularly haul out on the low reefs scattered along this stretch of coast, particularly reefs near Cape Blanche and Point Labatt (Bond, 1994). A “newly discovered” breeding colony of around 80 - 100 Australian Sea Lions (including mother and juvenile groups) was recorded by CSIRO in the early 2000s, at the small island west of Cape Blanche (Australian Broadcasting Commission, 2001; Shaughnessy, 2001), named Nicholas Baudin Island. Shaughnessy (2001) considered that the recently recorded colony off Cape Blanche may be a “source” area for the Sea Lions that visit the Point Labatt / Jones Island area. The Australian Sea Lion is classified as <i>rare</i> (under S.A. legislation) and considered by some researchers to be endangered (e.g. Gales, 1990; Gales <i>et al.</i>, 1994). A small colony of New Zealand Fur Seals (more than 40 animals) was also recorded at Nicholas Baudin Island by CSIRO (Australian Broadcasting Commission, 2001; Shaughnessy, 2001). The New Zealand Fur Seal was classified by IUCN 2000 as <i>Lower Risk, but Conservation Dependent</i>, but not included in the 2003 list. The New Zealand Fur Seal is listed in the <i>EPBC Act 1999</i>.</p> <p>Point Labatt: The area contains a well-recognised mainland colony of Australian Sea Lion (listed as <i>rare</i> in S.A.), one of the few mainland colonies known in South Australia. A breeding colony of sea lions occur along the shoreline, previously estimated to comprise approximately 46-68 sea lions (Gales, 1990; Gales <i>et al.</i>, 1994, Dennis and</p>
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Shaughnessy, 1996, cited by Lewis *et al.*, 1998).

Point Labatt: New Zealand Fur Seals are recorded in the area (Department of Environment and Land Management 1993; Morelli 1995). The New Zealand Fur Seal was classified by IUCN in the Red List 2000 as *Lower Risk, but Conservation Dependent*, however the species was not included in the IUCN Red List 2003. The species is also listed under the Commonwealth's *EPBC Act 1999*. An Australian Fur Seal has also been recorded using the **Point Labatt** area (Department of Environment and Land Management, 1993; Morelli and de Jong, 1995). Australian Fur Seal is uncommon in South Australia, and the species was classified in the IUCN Red List 2000 as *Lower Risk, but Conservation Dependent*, however it was not included in the 2003 IUCN Red List

Calca Peninsula – Searcy Bay - Sceale Bay – Westall Way: Southern Right Whales (*Eubalaena australis*) pass along the mid west coast during winter and spring (DELM 1993a, FOSB Media Release, 2001). Southern Right Whale was listed in the IUCN Red List (2003) as *conservation dependent*. The species is listed as *vulnerable* under S.A. legislation, and is also listed as a threatened species under the *EPBC Act 1999*.

Jones Island: A colony of Australian Sea Lions occurs in the Jones Island area, at the entrance to **Baird Bay** (Robinson and Heard, 1985; Gales, 1990, Gales *et al.*, 1994, Bond, 1994; Morelli, 1995; Dennis and Shaughnessy, 1996). Recent counts by a local eco-tour operator have suggested that the colony has grown during the past decade, and around 75 individuals have been observed. Shaughnessy and Dennis (2002) recorded 12 Australian Sea Lion pups on **Jones Island**. The Australian Sea Lion is listed as *rare* in South Australia under the *National Parks and Wildlife Act 1972*.

Olive Island: Breeding colony of Australian Sea Lion, a species considered by some researchers to be endangered (Gales, 1990; Gales *et al.*, 1994; Dennis and Shaughnessy, 1996). Numbers are variable. For example, the table in Lewis *et al.* (1998, citing Gales, 1990, Gales *et al.* 1994, and Dennis and Shaughnessy, 1996), reported 240 Sea Lions from the island. Robinson *et al.* (1996) reported 155 animals observed in 1982, and Gales *et al.*'s 1994 survey (cited by Shaughnessy, 2002) recorded around 50 adults and 28 pups. Overall, pups numbers have declined in the area since 1979, up to the early 2000s, according to Rowley (2001). However, a recent survey recorded 140 pups on Olive Island (Macintosh, Shaughnessy and NPWSA, unpublished) pointing out the importance of this area as a breeding habitat.

Olive Island: Haul out site for New Zealand Fur Seals (see status listing above, for Point Labatt).

Coastal and Marine Birds

Point Labatt: Habitat for Osprey, listed as *rare* under the *National Parks and Wildlife Act 1972* and has also been considered as a potentially threatened species, according to listing in the Commonwealth's *Directory of Important Wetlands* (Morelli and de Jong, 1995). Previously, there has been evidence of Osprey breeding on the northernmost headland (DELM, 1993a, cited by Morelli and de Jong, 1995). According to DELM (1993a) and Morelli and de Jong (1996), Point Labatt also provides habitat for a number of other coastal bird species of conservation concern, such as the Eastern Reef Egret (classified *rare* in S.A.). The White-bellied Sea Eagle is also found in the area, and is classified under S.A. legislation as *vulnerable*.

Baird Bay Islands Conservation Park (including Jones Island and Unnamed Island): Baird Bay is an important migration stopover site for migratory birds from the northern hemisphere, and several of these species of migrant shorebird are uncommon in southern Australia. Examples include: Red Knot which is "mostly scarce on southern coasts"; Grey Plover which is described as "not uncommon in some areas, but rather local"; Lesser Sand Plover described as "rare in Tasmania and South Australia"; and Greater Sand Plover, which requires "suitable undisturbed habitats and is less common on east and southern coasts of Australia" (Pizzey, 1988). Baird Bay is an extremely important area for the migratory Grey Plover on the west coast of S.A. (Morelli and de Jong, 1995). Species found in the area that are listed under the *National Parks and Wildlife Act 1972* include the Osprey (Jones Is), White-bellied Sea Eagle and Fairy Tern (*Sterna nereis*), and all three have been listed as potentially threatened in the *Directory of Important Wetlands* listing (Morelli and de Jong, 1995). Researchers consider Fairy Tern populations to be vulnerable, with Fairy Tern breeding success declining markedly in recent years, in some parts of S.A. (NPWS, 1995). The Grey Plover (*Pluvialis squatarola*) and Sooty Oystercatcher (*Haematopus fuliginosus*) also occur in the area, and were considered in the area's listing in *Directory of Important*

	<p><i>Wetlands</i> (Morelli and de Jong, 1995) as potentially threatened. Jones Island: Habitat for the Rock Parrot (Robinson <i>et al.</i>, 1996), and Osprey (T. Dennis and Birds Australia survey data, 2003), both of which have a coastal association and are listed as rare under South Australian legislation. Baird Bay and Unnamed Island (entrance to Baird Bay): Habitat for the Osprey (<i>rare</i> under S.A. legislation), White-bellied Sea Eagle (<i>vulnerable</i> in S.A., and also a migratory species listed under international treaty) and Fairy Tern (<i>vulnerable</i>).</p> <p>Westall Way (e.g. High Cliff area): Habitat for White-Bellied Sea Eagle (vulnerable).</p> <p>Olive Island: Habitat for the coastal Rock Parrot, which is listed as <i>rare</i> under <i>National Parks and Wildlife Act 1972</i>, and habitat for White-bellied Sea Eagle (Robinson <i>et al.</i>, 1996), which is listed as <i>vulnerable</i> under <i>National Parks and Wildlife Act 1972</i>. The rare Osprey Cape (T. Dennis and Birds Australia survey data, 2003), the Cape Barren Goose (classified under S.A. legislation as <i>rare</i>), and a Fairy Tern population have also been recorded on the on the island (Robinson <i>et al.</i>, 1996, T. Dennis and Birds Australia survey data, 2003).</p> <p>Calca Peninsula to Cape Bauer: Nesting areas along the cliffs for White-Bellied Sea Eagle (<i>vulnerable</i>) and Osprey (<i>rare</i>). Searcy Bay/Cape Blanche area has greater density of Osprey than anywhere else in SA (T Dennis, unpublished). Migratory oceanic birds that breed in moresoutherly latitudes such as New Zealand and Antarctica (e.g. species of Albatross and Petrel), and migratory prions, also frequent the coastal areas of the Great Australian Bight (Copley, 1985, cited by Edyvane and Baker, 1999b). Many of the species in these groups that occur in Australia are listed under the Commonwealth's EPBC Act.</p>
<p>8. Other Important Taxa</p>	<p>Marine Plants</p> <p>Cape Bauer: High percentage cover of large red macroalgae of mixed species, at sites sampled on near-shore reefs, compared with 25 other coastal headland and bay sites along the west Coast, sampled during 1994 (Edyvane and Baker, 1998b). Large red taxa were more abundant than brown macroalgae at a number of the sites sampled. Dense and abundant red macroalgae provide a specific habitat due to their physical and chemical properties. For example, <i>Plocamium</i> plants are a food supply for the sea hare mollusc <i>Aplysia parvula</i>, which lives on them (Burn 1989). <i>Plocamium</i> plants are also one of the foods eaten by Greenlip Abalone <i>Haliotis laevis</i> (Shepherd, 1973; Shepherd and Cannon, 1988), and <i>Plocamium</i> plants also house a number of epifaunal amphipod and isopod species, found in the branches (J. Baker, pers. obs.). Species of <i>Plocamium</i> are also one of several macroalgal food sources for some chiton species (Putman, 1990). Other "bushy" reds may share similar physical and chemical properties, and thus serve some similar ecological functions. Reef fish (including cryptically-coloured juveniles), also use dense red macroalgae (e.g. for shelter, and protection from predators etc).</p> <p>Dense green macroalgae (species of <i>Caulerpa</i>) dominate the reefs in some headland areas (Edyvane and Baker, 1998b). This is an uncommon feature on many reefs along most parts of the West Coast. Dense stands of green macroalgae would provide specific ecological functions for taxa that are dependent up them; for example, various diatoms and dinoflagellates (Samann <i>et al.</i>, 1988); tube-dwelling, nestling and other types of amphipods (Fenwick, 1976), and opisthobranch molluscs, many of which feed on green macroalgae such as species of <i>Caulerpa</i> (Jensen, 1979, 1980 and 1994; Gavagnin <i>et al.</i>, 1994; Burn, 1989).</p> <p>Exposed headland area (e.g. Cape Bauer) have an abundance of encrusting coralline macroalgae (Edyvane and Baker, 1998b and SARDI S.A. Benthic Survey data, unpublished), which provides an important habitat for some taxa, such as molluscs, including juvenile abalone (see Shepherd and Daume, 1996; Daume <i>et al.</i>, 1997) .</p> <p>Bony and Cartilaginous Fish Reefs between Cape Bauer and Cape Radstock; Olive Islands; and reef between Jones Island and Baird Bay are reported to be used by one or more of the life stages of the following commercially and/or recreationally significant fish: KGWhiting, Snapper, West Australian Salmon, Tommy Ruff, Yellow-eye Mullet, Trevally, Leatherjacket species, Snook, Western Blue Groper and other Wrasse species, Sea Sweep, Silver Drummer; Gummy Shark and Whaler Sharks (Bryars, 2003). Unvegetated soft bottom (sand) habitats in the area between Cape Bauer and Cape Radstock; and around the Olive Islands, are reported to support King George</p>

	<p>Whiting, School Whiting, Snapper, West Australian Salmon, Tommy Ruff, Yellow-eye Mullet, Mulloway, flathead species, Trevally, Snook, Yellow-tail Kingfish (Olive Islands) and Whaler Sharks (Bryars, 2003). All of these species, as well as School Sharks and Gummy Sharks, are reported to utilise the subtidal sand habitat along Anxious Bay (Bryars, 2003)</p> <p>Surf beaches at Corvisart Bay, Sceale Bay and Searcy Bay, northern Anxious Bay (e.g. Silica Beach, Tyinga Beach), eastern Anxious Bay (e.g. Rincon Beach, Mount Camel Beach) and southern Anxious Bay (e.g. Talia Beach) are reported to be used by one or more of the life stages of the following commercially and/or recreationally significant fish species: School Whiting, West Australian Salmon, Tommy Ruff, Yellow-eye Mullet, Mulloway (Corvisart Bay), flathead species, School Shark and Gummy Shark (Corvisart Bay) and Whaler Sharks (Bryars, 2003).</p> <p>Sheltered beaches at The Dreadnoughts, Speeds Point, Yanerbie, Cape Blanche / Slades Point, and Horseshoe Bay in northern Anxious Bay, are reported to be used by one or more of the life stages of the following commercially and/or recreationally significant fish species: King George Whiting, School Whiting, West Australian Salmon, Tommy Ruff, Yellow-eye Mullet, flathead species, and Whaler Sharks (Bryars, 2003).</p> <p>Seagrass meadows in Sceale Bay are reported to be used by one or more of the life stages of the following commercially and recreationally significant fish species: King George Whiting, West Australian Salmon; Tommy Ruff, flathead species, Trevally, Leatherjacket species, Snook, and Whaler Sharks (Bryars, 2003). Seagrass meadows in Baird Bay: are reported to be used by one or more of the life stages of the following commercially and recreationally significant fish species: King George Whiting, West Australian Salmon, Tommy Ruff, Southern Sea Garfish, Red "Mullet" (Blue-spotted Goatfish), flathead species, Trevally, Leatherjacket species, Snook, and Whaler Sharks (Bryars, 2003).</p> <p>Unvegetated soft bottom (sand) habitats in Baird Bay are reported to be used by one or more of the life stages of the following commercially and recreationally significant fish species: King George Whiting, School Whiting, West Australian Salmon; Tommy Ruff, Southern Sea Garfish, Yellow-eye Mullet, Red "Mullet" (Blue-spotted Goatfish), Trevally, Snook, flathead species, flounder species and Whaler sharks (Bryars, 2003).</p> <p>Marine Mammals</p> <p>Baird Bay and the waters seaward of Calca Peninsula to Cape Bauer / Olive Island: Pods of Bottlenose Dolphins are regularly observed in these areas. IUCN Red List 2003 (IUCN, 2003) classified the Bottlenose Dolphin as <i>Data Deficient</i>.</p> <p>Invertebrates</p> <p>The coastal reef areas described in this table are important for Greenlip and Blacklip Abalone, which were previously abundant in the area prior to over-exploitation. Some reefs in the area are also important habitat for gastropod molluscs (including those used as specimen shells) (e.g. Speeds Point and other reefs along the coast between Cape Bauer and Cape Radstock).</p> <p>Reefs between Cape Bauer and Cape Radstock; also Olive Islands; and reef between Jones Island and Baird Bay, are reported to be used by one or more of the life stages of the following commercially and/or recreationally significant invertebrate species: Southern Rock Lobster, Southern Calamari, Giant Cuttlefish, Maori Octopus, Greenlip and Blacklip Abalone, and Purple Sea Urchin (Bryars, 2003). Unvegetated soft bottom habitats in this area also provide habitat for Sand Crabs and Southern Calamari (Bryars, 2003).</p> <p>Surf beaches at Corvisart Bay, Sceale Bay, Searcy Bay, northern Anxious Bay (e.g. Silica Beach and Tyinga Beach), eastern Anxious Bay (e.g. Rincon Beach, Mount Camel Beach) and southern Anxious Bay (e.g. Talia Beach), and sheltered beaches at The Dreadnoughts, Speeds Point, Yanerbie, and Cape Blanche / Slades Point, and Horseshoe Bay in northern Anxious Bay, are reported to be used by one or more of the life stages of the following commercially are reported to be used by adult and juvenile Sand Crabs and bait worm species (Bryars, 2003).</p> <p>Unvegetated soft bottom (sand) habitats in Baird Bay are reported to be used by one or more of the life stages of Sand Crab, Western King Prawn, and Southern Calamari, the later of which also utilises seagrass habitat in Baird Bay (Bryars, 2003). Sand Crabs and Southern Calamari also utilise the subtidal sand habitat along the Anxious Bay coast (Bryars, 2003).</p>
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	<p>Coastal and Marine Birds</p> <p>Point Labatt: Species of cormorant (e.g. Black Cormorant and Black-faced Cormorant), Gull and Tern use the Point Labatt area (Morelli and de Jong, 1995, and bird observers' reports).</p> <p>Jones Island: Other coastal bird species recorded using the island area include: White-faced Heron, Masked Plover, Silver Gull, Black-faced Cormorant, Black Cormorant, Caspian Tern and Crested Tern and oyster catchers (Robinson <i>et al.</i>, 1996, and bird observers reports).</p> <p>Baird Bay and Unnamed Island (entrance to Baird Bay): In addition to the species listed as rare or vulnerable in S.A. (see section above), other coastal bird species recorded using the area include: Little Egret, Double-banded Plover, Red-capped Plover, Sooty Oystercatcher, Pied Oystercatcher, Swamp Harrier, Australian Pelican, Pied Cormorant, Fairy Tern and Silver Gull (Robinson <i>et al.</i>, 1996).</p>
<p>9. Notable Feeding, Breeding / Spawning and Nursery Areas</p>	<p>Bony and Cartilaginous Fish</p> <p>Baird Bay: Recognised as a nursery area for scalefish, such as King George Whiting (see Jones, 1980 and Jones <i>et al.</i>, 1990, Figure 3.2). Tagging studies by Jones (1980) showed that most juvenile King George Whiting remained in Baird Bay for up to 18 months to two years, but that after one year, some fish move out of the bay to deeper areas (e.g. fish from Baird Bay were recaptured at Waldegrave Island, 67km southwards). Considering the very high abundance of King George Whiting in Baird Bay, and the significance of commercial and recreational fishing for King George Whiting in this bay, Baird Bay could be considered an important area for this species on the west coast. According to Morelli and de Jong (1995), Baird Bay is "renowned for its King George Whiting grounds".</p> <p>Baird Bay: is one of several sheltered bays / nurseries on the west coast utilised by young West Australian Salmon (Salmon Trout) (Jones, 1999).</p> <p>Tidal flats and unvegetated soft bottom habitats in Baird Bay: In addition to King George Whiting and West Australian Salmon (see paragraphs above), these habitats are also reported to be nursery areas for juvenile Tommy Ruff, Yellow-eye Mullet, Red "Mullet" (Blue-spotted Goatfish), Southern Sea Garfish, Trevally, flathead species, and flounder species (Bryars, 2003). Seagrass habitat in Baird Bay supports juveniles of King George Whiting, West Australian Salmon, Tommy Ruff, Southern Sea Garfish, flathead species, Trevally, and Leatherjacket species (the latter in the southern part of the bay) (Bryars, 2003).</p> <p>Surf beaches at Corvisart Bay, Sceale Bay, Searcy Bay, northern Anxious Bay (e.g. Silica Beach and Tyringa Beach), eastern Anxious Bay (e.g. Rincon Beach, Mount Camel Beach) and southern Anxious Bay (e.g. Talia Beach), and sheltered beaches at The Dreadnoughts, Speeds Point, Yanerbie, and Cape Blanche / Slades Point, are reported to be used by juvenile School Whiting (Bryars, 2003).</p> <p>Invertebrates</p> <p>Baird Bay: Recognised as one of the six important nursery areas for Western King Prawns on the West Coast of S.A. (MacDonald, 1998). Older prawns move out of the bay into deeper waters, and one of the key fishing areas for King Prawn on the West Coast occurs in the deeper waters south and south-west of Baird Bay, Venus Bay and Anxious Bay (MacDonald, 1998).</p> <p>Tidal flats and unvegetated soft bottom habitats in Baird Bay: In addition to Western King Prawn (see paragraph above) these habitats are reported to be nursery areas for juvenile Sand Crabs and Southern Calamari (Bryars, 2003).</p> <p>Seagrass meadows in Baird Bay are reported to be a spawning and egg deposition area for Southern Calamari (Bryars, 2003).</p> <p>Marine Mammals (see also Section 7 of this table)</p> <p>Point Labatt: A breeding colony of Australian Sea Lion occur along the shoreline (Gales, 1990; Gales <i>et al.</i>, 1994, Dennis and Shaughnessy, 1996, cited by Lewis <i>et al.</i>, 1998). The area is considered important because it is one of the few mainland breeding colonies for this species in Australia (DELM, 1993a; Morelli and de Jong, 1995).</p> <p>Cape Blanche: A breeding colony of Australian Sea Lion (including mother and juvenile groups) has been recorded by CSIRO, at the small island west of Cape Blanche</p>

	<p>(Australian Broadcasting Commission 2001), recently named Nicholas Baudin Island. Ongoing studies of the colony by CSIRO suggest that the Cape Blanche colony is the breeding area that sustains both Point Labatt and Jones Island (Baird Bay) (Shaughnessy, CSIRO, pers. comm. cited by FOSB Media Release, 2001). Shaughnessy (2002) reported that the pup production at Cape Blanche was the 7th highest of all colonies / groups of Australian Sea Lions in South Australia.</p> <p>Coastal and Marine Birds</p> <p>Baird Bay: The area is an important “migration stopover” site for migratory birds. Nine species of migrant shorebird have been recorded, which include: the Red Knot, Pacific Golden Plover, Grey Plover, Lesser Sand Plover and Greater Sand Plover. Baird Bay supports the largest concentration of migratory Grey Plovers on the west coast. The total number of waders that use Baird Bay have been estimated during the 1990s to be approximately 1500-3500. Up to 1000 Grey Plovers are regularly recorded feeding in summer (Eckert, 1974; Fuhlbohm, 1992; Robinson <i>et al.</i>, 1996). According to the Australian Heritage Commission’s (2001) Register of the National Estate listing, Baird Bay is recognised as a significant habitat for sea birds such as Ospreys, Pelicans, and Sooty Oystercatchers, with breeding populations of some of these species in the area. According to DELM (1993a) and Morelli and de Jong (1995), Baird Bay provides a drought refuge and habitat for a wide variety of water birds on the west coast of South Australia. The islands in Baird Bay provide a roosting place for “a large number of seabirds” (Morelli and de Jong, 1995). The freshwater soaks of Baird Bay attract “many waterbirds”, and are “one of the few places on the west coast where ducks reliably congregate”. “Significant numbers” of Chestnut Teal, Grey Plover (see point above, on migratory birds), Fairy Tern and Crested Tern use the area. Other bird species that occur in the area include Musk Duck, Black Swan, and Hoary-headed Grebe (District Council of Streaky Bay, 2003).</p> <p>Jones Island: Contains a small breeding colony of Pelicans, and Sooty Oystercatchers. Pelicans are extremely sensitive to disturbance when rearing chicks, and therefore nesting sites are restricted to only a few locations in South Australia (particularly isolated but sheltered islands) (Robinson <i>et al.</i>, 1996).</p>
<p>10. Shipwrecks and Artificial Reefs</p>	<p>There are two protected shipwrecks from the 19th century, and three unprotected shipwrecks from the 20th century known in the area, but most of the wreck remains have not been found, and the contribution of these wrecks in the creation of artificial reef habitat is not known for this report.</p>
<p>11. Popular Dive Sites</p>	<p>A pool formed in the surf zone south of Streaky Bay (i.e. Smooth Pool) is recognised for the presence of sweep and schools of small fish of various species (DIASA, undated), and Sceale Bay has been described as having “good fish life” (Aquanaut, undated). Other areas recognised for diving include Slade Point and High Cliffs (Aquanaut, undated), however details of the ecological and biological features of these areas are not available for this report. Many coastal areas are inaccessible due to exposed conditions and deep water, however reef fish (such as Blue Groper, red fish, Blue Morwong, wrasse species, and others) are known to be common in the area, as are Rock Lobsters and abalone, which are also of importance to divers.</p> <p>Biota of importance to snorkellers and swimmers in the area include Australian Sea Lions and Bottlenose Dolphins (see Part 2 of this table).</p>
<p>12. National and/or International Importance</p>	<p>Olive Island Conservation Park is one the <i>Register of the National Estate</i> due to its role in providing a nesting area for a large rookery of Cormorants; a habitat for other seabirds, and a habitat for the rare Australian Sea Lion. The isolation of the Island, minimal human disturbance and lack of introduced species are also considered to be of importance in the listing (Australian Heritage Commission, undated).</p> <p>Olive Island: In addition to the above, the island provides habitat for a number of coastal bird species listed under international treaties, such as the Sharp-tailed Sandpiper and Ruddy Turnstone (Robinson <i>et al.</i>, 1996);</p> <p>Point Labatt Conservation Park is on the <i>Register of the National Estate</i>, due to its</p>

	<p>significance as one of the few mainland breeding colonies of the Australian Sea Lion. The shoreline limestone cliffs above the granite slabs are included in the park. The Marine Area adjacent to the Point Labatt Conservation Park was previously listed as an <i>Indicative Place</i> on the Register of the National Estate (i.e. inclusion in the Register is pending, following assessment). The marine area was nominated due to its role in “providing resources for the survival of the mainland colony of Australian Sea Lion”, and also for its “spectacular coastal scenery”. The Register listing does not mention the current Aquatic Reserve at Point Labatt, which was declared under the <i>Fisheries Act 1982</i> in South Australia in 1986.</p> <p>Although Point Labatt is an exposed coastal location and not a wetland, it is listed in <i>Environment Australia’s Directory of Important Wetlands</i>, due to the significance of the mainland colony of Australian Sea Lion.</p> <p>Baird Bay Islands Conservation Park (24ha) is on the <i>Register of the National Estate</i>, designated in recognition of: the breeding habitat of sea birds, including Osprey, Pelican, Sooty Oystercatcher and Crested Terns; and the colony of Australian Sea Lions that utilise Jones Island (Australian Heritage Commission, undated). Caspian Terns (a listed migratory species), have also been observed in the area.</p> <p>Baird Bay and its islands are also included in the <i>Directory of Important Wetlands</i> (Morelli and de Jong, 1995).</p> <p>Baird Bay: Ten bird species found in the area are listed under international treaties for migratory birds. Watkins (1993, cited by Morelli and de Jong, 1995) identified the area as of international importance for shorebirds.</p>
<p>Major Commercial and Recreational Fish, Sharks, Molluscs and Crustaceans</p>	<p>Some of the fish and shark species that are commercially (and in some cases only recreationally) significant, in the exposed mid-west coast region (which includes the area between Cape Bauer and Calca Peninsula), include:</p> <p><u>Fish</u>: West Australian Salmon, King George Whiting, Snapper, Snook, Tommy Ruff (Australian Herring), Southern Sea Garfish, Redfish (“Red Snapper”) Yellow-eye Mullet, Red “Mullet” (Blue-spotted Goatfish), Trevally, reef fish (such as Blue Morwong, Trevally, Sea Sweep, Silver Drummer, Leatherjacket species, Western Blue Groper and other wrasse species), Boarfish, Dusky Morwong, various Whiting species, Rock Ling, flathead species, flounder species, Mulloway, Ocean Leatherjackets, Southern Bluefin Tuna.</p> <p><u>Sharks and Rays</u>: School Shark and Gummy Shark, Bronze Whaler and/or Black Whaler Shark and other pelagic shark species, Wobbegong sharks, and various ray species.</p> <p><u>Invertebrates</u>: Greenlip and Blacklip Abalone, Rock Lobster, Maori Octopus, Giant Crab and Velvet Crab, Purple Sea Urchin, Southern Calamari, Giant Cuttlefish, specimen shells.</p> <p>Some of the fish and shark species that are commercially and/or recreationally significant, in and around Baird Bay include:</p> <p><u>Fish</u>: King George Whiting (the major species caught commercially and recreationally in Baird Bay), Southern Sea Garfish, Yellow-eye Mullet, Snapper, Redfish (Red “Snapper”), West Australian Salmon, various wrasse species, Tommy Ruff (Australian Herring), Blue Morwong, Red “mullet” (Blue Goatfish), Trevally, other whiting species, Weedy Whiting, Snook, Leatherjacket species, flathead species and flounder species.</p> <p><u>Sharks</u>: School Shark; Whaler sharks, and other shark species.</p> <p><u>Invertebrates</u>: Greenlip and Blacklip Abalone, Southern Calamari, Sand Crabs, Western King Prawns, baitworm species.</p>

8.3 Venus Bay and Surrounds (Eyre Bioregion)

Figure 5 shows the location of this area.



Figure 5: Venus Bay and surrounds

1. Biogeographic Significance	(See section 12 of this table, on the biogeographic significance of Lake Newland , according to the Commonwealth's ANZECC criteria – Seaman 2002)
2. Major Physical Influences and Relative Productivity Level	<p>Physical Influences</p> <ul style="list-style-type: none"> ♦ Venus Bay: Highly saline, shallow bay with high summer temperatures, containing both estuarine habitat and freshwater soaks. Summer water temperature is markedly higher inside Venus Bay (e.g. 24°C and higher), compared with the waters of Anxious Bay (e.g. around 18°C) (e.g. see CSIRO sea surface temperature maps from NOAA satellite). ♦ Mid Western Eyre Peninsula: The coastal marine area is within the influence of the warm water masses that extend eastwards from the Great Australian Bight, to western Eyre Peninsula. The Leeuwin current, which is a predominant influence in the western Great Australian Bight, is joined by an easterly-moving warm water mass that is generated in the Bight, and the influence of this warm water mass extends to the Eyre coast (Herzfeld, 1997; Herzfeld and Tomczak, 1997; Herzfeld, 2000). ♦ Anxious Bay coast: The coast faces into the eastern Great Australian Bight, and experiences high swells, and high wave exposure, with wave heights at times reaching several metres or more (up to 7m, according to GeoScience Australia, 2001). The beach along the 38km Newland Barrier is a dynamic high-energy surf zone, with high sand deposition and loss (DEH, 2001a). ♦ Steep depth gradients down to 50m exist close to shore, in part of the mid-west coast region (S.A. Coast and Marine Atlas, 2001). ♦ In general, Anxious Bay coastline is subjected to swell from the south-west, at all times of the year (Petruševics <i>et al.</i>, 1998). ♦ The Holocene dune barrier of the Newland area is responsible for maintaining the Lake Newland wetland area behind the dunes, in the “back barrier depression” (Short <i>et al.</i>, 1986). The Newland beach strip, in southern Anxious Bay, is backed by Holocene dune transgression. The main barrier, extending from Walkers Rocks to the Talia Monument, spans around 38km of coast. Breaches of the fore-dunes in the past have transgressed into the Lake Newland depression, breaking the otherwise contiguous nature of the lagoon area (see Short <i>et al.</i>, 1986; DEH, 2001a). <p>Relative Productivity</p> <ul style="list-style-type: none"> ♦ Although the main area of nutrient-rich upwelling close to the coast is concentrated further south than the Anxious Bay area, upwelling does occur in the vicinity of Anxious Bay, as evidenced by measurements of sea surface temperature and chlorophyll concentrations, taken in the area (e.g. see Ward <i>et al.</i>, 2002). ♦ The coastal waters of Anxious Bay coastal waters are renowned for the high productivity of prawns (see references in sections below). <p><i>No other specific details on relative productivity are available for this area, for this report.</i></p>

<p>3. Bioregional Representativeness of Habitats</p>	<p>The area described in this table contains some habitats and features that are representative of the western part of the Eyre Bioregion (see IMCRA Technical Group, 1998), namely:</p> <ul style="list-style-type: none"> ♦ Moderate to high deep water wave energy coastline; ♦ Exposed rocky coast comprising Precambrian meta-sedimentary cliffs and Pleistocene dune rock cliffs, headlands and platforms; ♦ Rocky headland areas interspersed with Holocene dune barrier beaches and lagoon deposits in sheltered areas; ♦ Benthic cover that is characteristic of the western part of the Eyre Bioregion e.g. <i>Ecklonia radiata</i> and species of <i>Cystophora</i>, along with red macroalgae as the dominant understorey taxa, with reds including species of <i>Plocamium</i> and <i>Phacelocarpus</i>, and <i>Osmundaria prolifera</i> (amongst other red macroalgae); ♦ Shallow, sandy, seagrass-lined sheltered embayment (Venus Bay region includes one of several along the western Eyre coast); ♦ <i>Coastal Wetland of National Importance</i> (Lake Newland). ♦ Coastal salt lake (Lake Newland).
<p>4. Habitat Rarity</p>	<p>Lake Newland: is considered unique in the Eyre region, because wetland habitats are not well represented along the Eyre Peninsula (DEH, 2001a). The wetland is one of the few permanent salt lakes located near the coast on the Eyre Peninsula; it is the largest salt lake in the region; has freshwater springs and seepages of high significance to wetland biota (particularly local and migratory birds), and contains coastal and lake vegetation that is now rare along most of Eyre Peninsula (Morelli and de Jong, 1995; DEH, 2001a).</p> <p><i>Other information on habitat rarity is not known for this area, for this report.</i></p>
<p>5. Habitat Diversity</p>	<p>Habitat types include:</p> <ul style="list-style-type: none"> ♦ small areas of supratidal and intertidal samphire / saltmarsh habitat; ♦ supratidal and intertidal sand and mud flats; ♦ small area of intertidal mangroves; ♦ calcareous islands and sand islands (within Venus Bay); ♦ sheltered “bare” subtidal sandy habitat, with sandy tidal channels and sandbars, within the bay; ♦ intertidal and shallow subtidal seagrasses (within Venus Bay); ♦ small areas of calcareous patch reef (in Venus Bay); ♦ rugged, wave-exposed near-shore calcareous cliff and platform reef areas; ♦ wave-exposed, high energy sandy beaches (e.g. fronting the Newland Barrier); ♦ wave-exposed coastal waters containing both subtidal seagrass beds in some areas, and macroalgae-dominated calcareous reefs (nearshore calcareous reefs dominated by various brown macroalgae, and a variety of large red macroalgae, and attached invertebrates (see descriptions below); ♦ coastal salt lake, separated by a dune barrier system from the exposed coast; ♦ Offshore sand and patch reef habitats (e.g. Anxious Bay). <p>Habitat Notes</p> <p>Venus Bay: A shallow and sheltered tide-dominated bay that opens into Anxious Bay. The bay was mapped in 2000 as part of the National Land and Water Resources Audit, and the following statistics were calculated (see GeoScience Australia, 2001 - 2004): Central Basin area (km²) 47.15 Flood/ebb delta (km²) 18.30 Channel (km²) 3.05 Floodplain (km²) 0.49 Intertidal flats (km²) 3.53 Tidal sandbanks (km²) 5.88</p>

	<p>Saltmarsh / salt flat (km²) 1.78 Mangrove (km²) 0.95 Seagrass (km²) 90 Rocky reef (km²) 0.33 Bedrock (km²) 0.43 Bedrock perimeter (km) 6.38 Water area (km²) 70.64 Entrance width (km) 0.47 Perimeter (km) 67.08 Entrance length (km) 3.55 Maximum length (km) 17.26 Maximum width (km) 6.55</p> <p>In contrast to the several of the figures above, Bucher and Saenger (1989, cited by Edyvane, 1995a), reported that Venus Bay comprises 0.40 square km of samphire swamps and mangroves, and 14.74 square km of intertidal sand/mud flats.</p> <p>There are cliffs at the turbulent entrance to Venus Bay, but the waters inside are placid, and the bay comprises a mosaic of seagrass meadows, limestone reefs, mudflats, sandbars and entwining channels (Robinson <i>et al.</i>, 1996). A narrow band of calcarenite reef occurs on both sides of the entrance to Venus Bay, at South Head (PIRSA, SARDI and DEH map, in Bryars, 2003), with <i>Ecklonia</i> and <i>Cystophora</i> species being the dominant macroalgae in the shallow subtidal (Shepherd and Brook, 2004). There are two groups of islands within the Bay: Islands A, B, and C, of the same calcarenite geology as the surrounding land, and created by rising water levels); and the "sand islands" (Germein Island, Garden Island, Tank Island and Unnamed Island), created by the action of the tides (Robinson <i>et al.</i>, 1996). The small calcareous islands A, B, and C, are surrounded by submerged sandbars. Island A is 20ha., with a worn, undercut shoreline that rises as a ledge, and there is a sand beach at the tip, which trails into a long, submerged bank (Robinson <i>et al.</i>, 1996). Island B is 12 ha., and has a sandier coastline than A, with a transition from the shore to low calcarenite platforms. Island C is 6ha., and shares many (morphological and geological) features with Island B (Robinson <i>et al.</i>, 1996).</p> <p>Within Venus Bay, Germein Island, the largest island in the bay (202ha.), is a mangrove and samphire swamp island built by the tidal currents in Venus Bay, and is subject to regular inundation. Butler (1975) recorded the mangrove <i>Avicennia marina</i> mainly on the eastern side of Germein Island, and there are fine silty muds and meandering channels in the area, supporting this vegetation (Robinson <i>et al.</i>, 1996). More recently, DEH's State-wide Saltmarsh Mapping program mapped mangrove as occurring over much of Germein Island, and also at the western side of the entrance to Venus Bay project (S.A. Coast and Marine Atlas, 2001). Mangroves in fine silty mud also occurs on the Unnamed Islands (Robinson <i>et al.</i>, 1996). Both supratidal and intertidal samphire saltmarsh stands have been recorded in the bay (e.g. Germein Island, Unnamed Island, also at the western side of the bay entrance, and south-eastern corner of the bay), which are interspersed with intertidal algal mats / muddy substrates in the latter area (S.A. Coast and Marine Atlas, 2001). There are small areas of sand dunes on Germein Island (e.g. southern side).</p> <p>Venus Bay has extensive and uniform (dense) areas of seagrass (including in the shallows, species of <i>Zostera</i>, and <i>Heterozostera tasmanica</i>, the latter now reinstated into the <i>Zostera</i> genus - see Soros-Pottruff and Posluszny, 1995 and Kuo, 2004), particularly in the north-western part of the bay. The intertidal and shallow subtidal seagrass beds are patchier on the north-eastern and eastern sides of the bay. The freshwater and estuarine seagrass <i>Ruppia</i> also occurs at the northern end of the bay. There are several sandy channels, and flat "bare" sandy bottom on the southern side of the bay, the eastern side of the entrance, and around Germein Island (e.g. eastern side). Harder patches of calcareous substrate in the bay support the brown macroalgae <i>Scaberia agardhii</i> and species of <i>Cystophora</i>, with minor amounts of various red macroalgae.</p> <p>Northern end of Anxious Bay coast: Comprises rugged, high wave energy bay, with wave-exposed beach areas, and calcareous cliffs and shore platforms, in some areas</p>
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overlying harder granitic substrate, which also extends into the adjacent marine area. There are many nearshore reefs in the area. The coastal region supports mainly reef communities dominated by red and brown macroalgae, and associated reef fauna (Thompson, 1988; Bond, 1994). There is limited benthic information available for the upper Anxious Bay coast. There are extensive areas of benthic sand throughout **Anxious Bay**, interspersed with calcareous reefs. In 1994, sampling during SARDI's S.A. Benthic Survey program showed that the calcareous reef area at **Point Weyland** was dominated by the brown macroalgae *Ecklonia radiata* and *Acrocarpia paniculata*, with *Cystophora* spp. as subdominants. The understory consists mainly of mixed red macroalgae species (e.g. species of *Phacelocarpus*, *Callophyllis*, *Craspedocarpus* and a *Myriogramme*-like species). Encrusting coralline species and bare sand patches also occur in the exposed coastal reef areas. Coastal reefs further south in the mid coast section of **Anxious Bay** are dominated by *Ecklonia radiata* and the red *Osmundaria prolifera*, with a number of *Cystophora* species in low density. At the time of the survey, the understory consisted of encrusting corallines, mixed red species (mainly species of *Plocamium* and *Phacelocarpus*), and attached invertebrates (various soft coral and sponge species) (Edyvane and Baker, 1998b, 1999b).

Lake Newland: Description from Morelli and de Jong (1995) and Prescott (2001):

Relatively permanent series of shallow saline lakes with freshwater springs, soaks and seepages, overlying calcrete. The lake area is fed seasonally by freshwater surface and groundwater sources, marine seepages and by occasional direct marine incursion. Groundwater from the Bridgewater Formation aquifer flows into the wetland through a series of fresh water springs, soaks and seepages (Shepherd, 1985). The integrity and flow of the fresh water sources is considered essential for the park's biota. Over half of the lake system dries up over summer. **Lake Newland** is 20 km in length with an extensive dune system isolating the lake from the sea. The Lake Newland area consists of coastal sand dunes (see section below), freshwater springs, and samphire flats. In the area, Holocene evaporitic sediments overlie Pleistocene calcarenite dune material. The wetland includes extensive samphire flats, fringed with paperbark shrublands. The majority of vegetation in the park is coastal heath and low scrubby woodland. Remnants of coastal sheoak (*Allocasuarina verticillata*) woodland, which was once widespread on Eyre Peninsula, occur on the western verges of the lakes. Prominent vegetation around the lakes includes Swamp Paperbark *Melaleuca halmaturorum* tall shrubland / scrub with semi-succulent shrubs; sedges (e.g. *Juncus* and *Isolepis* sp.), samphire shrubland with *Halosarcia* sp., *Sclerostegia arbuscula*, *Suaeda australis* sp., and a tussock grassland. These communities form a natural undisturbed band of marginal vegetation covering most of the lake's perimeter. Aquatic vegetation consists of *Chara*, *Ruppia* and filamentous algae (Lloyd and Balla, 1986; Morelli and de Jong, 1995; DEH, 2001a). Common fauna in the lake include foraminifera (e.g. *Eliphidium* sp. and *Trochammina inflata*); the isopod *Haloniscus searlei*, and the amphipod *Afrochiltonia australis*, and the fish Small-mouthed Hardyhead *Atherinosoma microstoma* (Williams, 1984, 1985, and Glover and Olsen, 1985, cited by Morelli and de Jong, 1995). The diversity of habitats in the park supports a wide range of birds and other fauna of conservation significance (see sections below).

Southern end of Anxious Bay coast: The extensive Holocene dune barrier of the **Newland** area is responsible for maintaining the Lake Newland wetland area behind the beach and dunes (see above). The Newland Barrier is described as a continuous smoothly curved Holocene dune barrier and beach, bounded by calcarenite at each end, with calcarenite reefs exposed at intervals along the beach (Short *et al.*, 1986). The beach strip, in southern **Anxious Bay**, is backed by the Holocene dune transgression, comprising both vegetated and mobile dunes of calcareous composition (DEH, 2001a). The main barrier, extending from **Walkers Rocks** to the **Talia Monument**, spans 38km of coast (Short *et al.*, 1986). There are outcrops of the Bridgewater Formation along the coast, undulating limestone formed by the calcereing of a series of sand dunes adjacent to the coast. Calcrete and carbonate-cemented aeolianites form the headlands at **Talia Caves** and **Cape Finnis** near Elliston, between which the sands of the Lake Newland Conservation Park have been deposited during the Holocene period. Nearshore calcarenite reefs outcrop along part of the 38km stretch of the Newland Barrier (e.g. the coast between **South Head** of Venus Bay and the **Talia Caves** area; and **Lovers Rocks** and **Walkers Rocks** further south), and there are also reefs running parallel to the coast, approximately 1km

	<p>offshore (Short <i>et al.</i>, 1986; SARDI abalone fishing block maps, undated; DEH, 2001a). In the shallow subtidal, the southern end of Anxious Bay has patchy calcarenite rock of low to high relief (with <i>Cystophora</i>), among extensive <i>Posidonia</i> and <i>Amphibolis</i> beds (Shepherd and Brook, 2004).</p>
<p>6. Taxonomic Diversity</p>	<p>Coastal and Marine Birds At least 34 water bird species have been recorded from Lake Newland Conservation Park (Morelli and de Jong, 1995). The wetlands of the Lake Newland area have been rated by Lloyd and Balla (1986) as equal first (along with Big Swamp between Port Lincoln and Coffin Bay) of all wetlands on Eyre Peninsula, by virtue of the area being a natural coastal salina with numerous freshwater soaks, supporting an exceptionally high diversity of birds for a saline ecosystem.</p> <p><i>No other information on biodiversity is available for the area, for this report.</i></p>
<p>7. Habitat for Endemic Taxa / Rare or Uncommon Taxa / Threatened Taxa</p>	<p>Marine Plants Venus Bay: Presence of the estuarine and freshwater seagrass <i>Ruppia</i> (Edyvane, 1995a) at the northern end of the bay. Although species of <i>Ruppia</i> are not rare in S.A., the genus is not regularly recorded in many estuarine areas, at a State-wide scale. <i>Ruppia</i> species are an important food source for a number of coastal waterbird species (see Location 15 in this report for details).</p> <p>Bony and Cartilaginous Fish Leafy seadragons, including aggregations, have been recorded in the beachwash on Mount Camel Beach. Weedy Seadragons have also been recorded washing up on beaches in the area, such as Venus Bay (ocean side); also between Talia Caves and Lovers Rocks, and Mount Camel Beach, including a large number (reportedly more than 200 animals) of dead seadragons recorded along one beach of the Anxious Bay coast during late 1999 (Dragon Search Project database records, 1996 – 2002). Both species are likely to occur in the vicinity of the area described in this table. Leafy Seadragon is a protected species in South Australia, and both Leafy and Weedy Seadragon are listed by the IUCN Red List 2003 as <i>Data Deficient</i>.</p> <p>Venus Bay: A new species of pipefish, Venus Pipefish <i>Stigmatopora venusensis</i> sp. nov. (Browne <i>et al.</i>, in prep.) has been found at very high densities, in the dense <i>Posidonia</i> seagrass that lines the channels of Venus Bay. The species has a limited known distribution, having been found to date only along western Eyre Peninsula, from Streaky Bay to Venus Bay. The species is reported to be intolerant of sediment or macroalgae settling over its seagrass habitat through lack of water movement, or due to high input of sediment or nutrients (Browne, 2004).</p> <p>The Sculptured Seamothe <i>Pegasus lancifer</i>; the Robust Pipehorse <i>Solegnathus robustus</i>; the Javelin Pipefish <i>Lissocampus runa</i>, the Knife-snout Pipefish <i>Hypselognathus rostratus</i>, and the rarely recorded Prickly Pipefish <i>Hypselognathus horridus</i>, all have been reported from the Venus Bay / Anxious Bay area (see records in Baker, in press). Seamoths, as well as some of the pipefish species, and pipehorse species are considered to be potentially threatened species due to their population characteristics (see Pogonoski <i>et al.</i>, 2002; Baker, in press).</p> <p>Eastern Great Australian Bight: Habitat for the uncommon Flimsy Flounder <i>Arnoglossus</i> sp. (Gomon <i>et al.</i>, 1994), known to date from a limited depth range, in the trawl grounds of the eastern Great Australian Bight (see Baker, in press, for summary).</p> <p>Venus Bay: Purported nursery area for Gummy Sharks, due to high numbers of juveniles regularly observed there (D. Mackie, PISA, pers. comm., cited by Edyvane, 1995a). Gummy Shark is a shark species of conservation concern (see AFMA, 2000d, 2002a and 2003a, and Section 9.2 of this report).</p> <p>Anxious Bay: the reportedly rare (Gomon <i>et al.</i>, 1994) anglerfish species <i>Echinophryne mitchellii</i> (= <i>Trichophryne mitchelli</i>) has been recorded in Anxious Bay, and few other locations in South Australia (see Baker, in press, for summary of distribution and habitat information).</p> <p>The deeper waters off Anxious Bay are one of the very few sites where the Striped Trawl Wrasse <i>Suezichthys bifurcatus</i> has ever been recorded (CSIRO Marine Research record, cited in Baker, in press). The species is known from very few specimens, trawled in southern W.A. and western S.A., over a very limited depth range (e.g. see Gomon <i>et al.</i>, 1994; Baker, in press).</p>

Marine Mammals

Venus Bay coast: Studies on dolphin skulls collected from a beach near **Venus Bay** (C. Kemper, SA Museum, pers. comm., cited by Ashman, 1996), suggest that the region may support what has been variously described as a separate species (or sub-species) of the Bottlenose Dolphin, known as *Tursiops aduncus* or *Tursiops truncatus aduncus*, the Inshore or Long-Nosed Bottlenose Dolphin. *Tursiops aduncus* (or *T. truncatus aduncus* - see Bannister *et al.*, 1996) is less commonly recorded in South Australia, compared with *T. truncatus*. The IUCN Red List (IUCN, 2003) listed *T. aduncus* as Data Deficient.

Anxious Bay coast: Southern Right Whales (*Eubalaena australis*) pass along the west coast during winter and spring (DELM, 1993), and are observed close to the Venus Bay coastal area during their migration to the Great Australian Bight (Venus Bay SA web site, 2002). Southern Right Whale was listed in the IUCN Red List 2003 as *conservation dependent*; is listed under S.A. legislation as *vulnerable*, and is recognised under the Commonwealth's *EPBC Act 1999*, as a threatened species.

Venus Bay: Pinnipeds are reported to be regularly observed feeding and swimming in Venus Bay (Venus Bay SA web site, 2002).

Coastal and Marine Birds

Venus Bay (oceanic coast): Cliff habitat for Osprey, listed as *rare* under the *National Parks and Wildlife Act 1972*.

Venus Bay (internal): Venus Bay oceanic coast, and Island A (inside the bay): Cliff habitat and island habitat for White-bellied Sea Eagle, which is listed as *vulnerable* under the *National Parks and Wildlife Act 1972*.

Venus Bay (inside bay) and internal islands: Habitat for Fairy Tern, which is listed under S.A. legislation as *vulnerable*. Fairy Tern breeding success has declined markedly in some parts of S.A. in recent years (NPWS, 1995). Sooty Oystercatcher also recorded at Venus Bay (Robinson *et al.*, 1996), and has previously been described (see Morelli and de Jong, 1995) as potentially threatened. Rock Parrots are found in the area, and the species is listed as *rare* under S.A. legislation.

Lake Newland Conservation Park: Habitat for Hooded Plover *Thinornis rubricollis* (*vulnerable* under SA legislation and considered to be nationally *vulnerable*, according to DEH, 2001) – Hooded Plovers nest and live on the beach just above high water mark; Cape Barren Goose *Cereopsis novaehollandiae* (*rare* under S.A. legislation; *vulnerable* under Commonwealth *EPBC Act 1999*); Fairy Tern *Sterna nereis* (*vulnerable* in S.A.) and Eastern Reef Egret *Egretta sacra* (*rare* in S.A.) (Morelli 1995). According to DEH, the presence, distribution and status of the following species should also be monitored in the area: Musk Duck *Biziura lobata* and Great Crested Grebe *Podiceps cristatus* (both *rare* in S.A.);

Anxious Bay coast: Albatross and Petrel species have been observed along the coastal area, which are wide-ranging oceanic species that breed mostly in the sub-Antarctic islands (and some Albatross species breed in New Zealand), with limited site association to the coast in S.A.. A number of Albatross and Petrel species are listed as *vulnerable* under the Commonwealth's *EPBC Act 1999* (and 3 Albatross species are listed as *endangered*). Most are also listed in the IUCN Red List 2003 (see species Appendix, this report). According to DEH (2001a), the distribution and status of the vulnerable Blue Petrel *Halobaena caerulea* along the **Newland Barrier (Anxious Bay coast)** area should be monitored.

Invertebrates

Both pale and dark forms of the cowrie *Zoila friendii thersites* occur in the **Anxious Bay** area (Wilson and Clarkson, 2004). *Zoila* cowries, which have direct development of young and strong habitat association, are of conservation concern (see section 9.2).

An unknown number of invertebrates, fish species and marine plants in the area may be endemic to South Australia, but quantification is not possible for this report. Two examples include: the endemic gastropod *Anachis fenestrata* (a small dove shell), with **Venus Bay** being one of the few localities where the species has been collected (Wilson *et al.*, 1994); and *Aplidium gastrolineatum*, a colonial ascidian found to date only in S.A., and for which southern **Anxious Bay** is the type locality (Kott, 1997; Australian Government Department for the Environment and Heritage, 2004b).

<p>8. Other Important Taxa</p>	<p>Mammals Pods of Bottlenose Dolphins are regularly observed feeding and swimming in Venus Bay (Venus Bay SA web site, 2002). Bottlenose Dolphin was listed in the IUCN Red List 2003 as <i>Data Deficient</i>.</p> <p>Bony and Cartilaginous Fish Reef at the entrance to Venus Bay is reported to provide habitat for one or more life stages of the following fish species: King George Whiting, Snapper, West Australian Salmon, Tommy Ruff, Yellow-eye Mullet, Trevally, Yellow-tail Kingfish, Leatherjacket species, Wrasse species, Snook, Sea Sweep, Silver Drummer, Gummy Shark and Whaler sharks (Bryars, 2003). All of these species, in addition to Western Blue Groper, are also reported to utilise reef habitats south of Venus Bay, towards Cape Radstock (Bryars, 2003). Seagrass meadows and unvegetated soft bottom (sand) habitats in Venus Bay are reported to provide habitat for one or more life stages of the following fish species: King George Whiting, School Whiting, Snapper (on unvegetated bottom), West Australian Salmon, Tommy Ruff, Southern Sea Garfish, Yellow-eye Mullet (on unvegetated bottom, and also in the Mangrove areas) and Red "Mullet" (on unvegetated bottom), Trevally, flathead species, flounder species, Leatherjacket species, Snook, and Whaler sharks (Bryars, 2003). Tidal Flats around Venus Bay: Habitat for one or more life stages of the following fish species: School Whiting, West Australian Salmon, Tommy Ruff, Southern Sea Garfish, Yellow-eye Mullet, flathead species, flounder species (Bryars, 2003).</p> <p>Invertebrates Venus Bay (Oceanic Coast side): Surveys of 18 west coast locations between Elliston and Cape Adieu showed that reefs on the Venus Bay coast provided habitat for a large number and density of Roe's Abalone, more than were recorded in any of the other survey areas (Branden and Shepherd, 1984). This was also verified by Mackie (PISA, pers. comm., cited by Edyvane, 1995a). Reef at the entrance to Venus Bay is reported to provide habitat for one or more life stages of the following invertebrate species: Southern Rock Lobster, Southern Calamari, Giant Cuttlefish, Maori Octopus, Greenlip and Blacklip Abalone, and Purple Sea Urchin (Bryars, 2003). Southern Rock Lobster, Maori Octopus, Greenlip and Blacklip Abalone, and Purple Sea Urchin are also reported to utilise the reefs south of Venus Bay, along the Anxious Bay coast (Bryars, 2003). Venus Bay: Habitat for Sand Crabs (<i>Ovalipes australiensis</i>), on the tidal flats, and in the subtidal areas of unvegetated soft bottom (PIRSA, 2000; Bryars, 2003). Although Sand Crabs are widely distributed, Venus Bay is one of the major habitats in S.A. for Sand Crabs (PIRSA, 2000), and they are highly abundant in the area. Unvegetated sandy bottom habitat in Venus Bay provides habitat for one or more life stages of the following invertebrate species: Southern Calamari, King Scallop, and Queen Scallop (Bryars, 2003). Tidal Flats around Venus Bay provide habitat for one or more life stages of Mud Cockle, and baitworm species (Bryars, 2003). Port Kenny: Razorfish beds have been recorded near the Port Kenny jetty (Mackie, PISA pers. comm. cited by Edyvane, 1995a). Razorfish are ecologically important, being large filter feeders, and provide additional hard substrate for attachment of epibiota, in sandy and muddy areas.</p> <p>Coastal and Marine Birds Venus Bay and internal islands: Habitat for flocks of Roosting Cormorants (e.g. Black faced Cormorant), Gulls, and two species of Oystercatcher (see also previous section). Nesting sites for Pacific Gull, and minor breeding sites for Caspian Tern and Silver Gull (Copley, 1996; Robinson <i>et al.</i>, 1996; S.A. Coast and Marine Atlas, 2001). Also provides habitat for Chestnut Teal (mainly in the freshwater areas), Masked Plover, White-faced Heron, Greenshank, Pied Oystercatcher, Banded Stilt, Red-neck Stint, and Sharp-tailed Sandpiper (Copley, 1996; Robinson <i>et al.</i>, 1996). Anxious Bay coast: Non-breeding migratory sea birds such as Albatrosses, Petrels and Prions area known to frequent the coastal regions of the great Australian Bight (Copley, 1996, cited by Edyvane, 1999b).</p> <p>Lake Newland Conservation Park: Apart from the rare and/or vulnerable species listed</p>
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	<p>above, the area is a migration stop-over for 7 species of shorebird (5 of which are under international treaty – see section 12 below, for examples of population numbers), and a habitat for several other water bird species. Most common migrant species are reported to be the Red-necked Stint <i>Calidris ruficollis</i>, Curlew Sandpiper <i>C. ferruginea</i> and Sharp-tailed Sandpiper <i>C. acuminata</i> (Morelli and de Jong, 1995).</p>
<p>9. Notable Feeding, Breeding / Spawning and Nursery Areas</p>	<p>Bony and Cartilaginous Fish</p> <p>Venus Bay: Robinson <i>et al.</i> (1996) described Venus Bay as “a haven in which many life forms can reproduce, and a nursery protecting vulnerable larvae and fry from the nearby ocean”. According to Edyvane (1995a), Bucher and Saenger (1989, cited by Edyvane, 1995a) considered that the area supported “substantial and diverse areas of wetland that would provide habitat for estuarine and offshore fish stocks”. Venus Bay is considered to be an important nursery area for King George Whiting, due to the close association of juvenile whiting with <i>Zostera</i> and <i>Posidonia</i> seagrass beds and tidal creeks (Jones, 1980, cited by Edyvane, 1995a). Juvenile Whiting may reside in the bay for around two years, and then move out to more exposed areas (e.g. West coast reefs and offshore islands). Venus Bay Whiting have been recorded at Waldegrave Island (41km from Venus), and as far north as St Peter Island (153km from Venus) (Jones, 1980).</p> <p>Venus Bay is also a significant nursery area for West Australian Salmon (Cappo, 1987). “Salmon Trout”, the smaller sizes classes of Australian Salmon, occur in west coast bays such as Venus Bay, where they feed on small crustaceans, worms, and small fish (Jones, 1999, and references cited therein).</p> <p>Other species for which Venus Bay is reported to be a nursery area, include Tommy Ruff, Southern Sea Garfish (in the seagrass meadows), Yellow-eye Mullet, Red “Mullet” (Blue-spotted Goatfish), Trevally, leatherjacket species (in the seagrass), and species of Flounder and Flathead (in unvegetated areas) (Bryars, 2003).</p> <p>The sand habitats of Anxious Bay provide important habitat for adult Western King Prawns (as indicated by commercial catch figures - see Carrick and Williams, 2001, and Svane and Barnett, 2004, for recent data).</p> <p>Reef areas out of Venus Bay, and south along the Anxious Bay coast, are reported to provide spawning and nursery areas for Sea Sweep and Western Blue Groper (Bryars, 2003).</p> <p>Invertebrates</p> <p>Venus Bay: The area is recognised as one of the six important nursery areas for Western King Prawns on the West Coast of S.A. (MacDonald, 1998b; Boxshall, 2001). Older prawns move out of the bay into deeper waters, and one of the key fishing areas for prawns on the West Coast occurs in the deeper waters outside of Venus Bay (the Anxious Bay trawl grounds) (MacDonald, 1998b). Bond (1994) also mentioned Western King Prawns as a feature of West Coast bays. Carrick (1997) described Venus Bay as a type of “secondary nursery”, because emigration out of the nursery and into the fishery occurs at relatively large sizes (e.g. more than 28 - 32mm). Previous research has shown that larval prawns move into Venus Bay, grow in the nursery, then move out in a southerly direction into Anxious Bay along the 30m contour, from the entrance of Venus Bay, and disperse into the deeper waters of the Anxious Bay trawl grounds (Wallner, 1985). Both juvenile prawns (mainly in the intertidal sandy areas) and sub-adult prawns (mainly in the subtidal areas) use Venus Bay. According to Edyvane (1995a, citing King, 1977, Wallner, 1985, and Carrick, 1993), Venus Bay is the most significant nursery area for Western King Prawns on the west coast, supplying the adjacent deeper water trawl grounds, which have contributed 70% - 80% of the West Coast prawn catch per annum in some years. It is noted that prawns from further north-west (i.e. Ceduna area) also migrate southwards into the Anxious Bay prawn grounds, as evidenced by a recent tagging study (reported in Svane and Barnett, 2004).</p> <p>In addition to providing a nursery area for Western King Prawn (see above), the unvegetated soft bottom habitat and/or the tidal flats in Venus Bay also provide habitat for juvenile Sand Crabs, King and Queen Scallops, Mud Cockles, and baitworm species (Bryars, 2003).</p> <p>Anxious Bay is a spawning area for Giant Cuttlefish (S. Shepherd, SARDI, pers. comm., 2004).</p> <p>Coastal and Marine Birds</p>

	<p>Venus Bay: Considered to have some significance as a coastal bird breeding habitat due to the presence of freshwater soaks interspersed with the estuarine habitats (Copley 1996, cited by Edyvane, 1999b). Recorded breeding habitat for Buff-banded Rail (Robinson <i>et al.</i>, 1996), and several other species documented in other sections of this table.</p> <p>Venus Bay (inside): The area also contains nesting sites for Rock Parrots (e.g. Island B) (Robinson <i>et al.</i>, 1996), which have a coastal association and are listed as <i>rare</i> under the <i>National Parks and Wildlife Act 1972</i>.</p> <p>Venus Bay - Island C: Small breeding colony of Australian pelican (approximately 30 pairs) (Robinson <i>et al.</i>, 1996; Copley, 1996, cited by Edyvane, 1999b).</p> <p>The Lake Newland wetland provides essential habitat for a wide range of waders and other water birds (DEH, 2001). Lake Newland is considered to be a significant feeding habitat in late spring - summer for Hooded Plover, and a significant “summering area” and spring to autumn feeding habitat for Cape Barren Goose, which travel from their winter breeding area on Waldegrave Island to Lake Newland, where they disperses to the swamps and lake edges of the mainland in summer (Robinson <i>et al.</i>, 1982, cited by Morelli 1995 and DEH, 2001). The Lake Newland area is considered important habitat on an international scale, for the Australian endemic Banded Stilt. Lake Newland also serves as a drought refuge for numerous water birds of various other species (Morelli and de Jong, 1995).</p> <p>Examples of population numbers of some water bird species in the Lake Newland area, from surveys during the early 1990s, are listed as follows: Chestnut Teal <i>Anas castanea</i> (populations fluctuate between 150-2000), Black Swan <i>Cygnus atratus</i> (regularly between 50-250), Red-capped Plover <i>Charadrius ruficapillus</i> (flocks of up to 270 individuals), Masked Lapwing <i>Vanellus miles</i> (50 recorded), the Australian endemic Banded Stilt <i>Cladorhynchus leucocephalus</i> (2400 recorded), Red-necked Stint <i>Calidris ruficollis</i> (regular records of 1000-2000), Sharp-tailed Sandpiper <i>C. acuminata</i> (300 recorded), Curlew Sandpiper <i>C. ferruginea</i> (up to 150 recorded) and Common Greenshank <i>Tringa nebularia</i> (common in small numbers, e.g. 20) (Fuhlbohm, 1991 unpublished records and Watkins, 1993, cited by Morelli and de Jong, 1995 and DEH, 2001).</p>
<p>10. Shipwrecks and Artificial Reefs</p>	<p>One unprotected shipwreck from the late 20th century has been found in the area, but its contribution as artificial reef habitat is not known for this report.</p>
<p>11. Popular Dive Sites</p>	<p>Specific details of dive sites with ecological features of interest are not known for this area, for this report (see also Notes on Social and Economic Values and Uses section of this report).</p>
<p>12. National and/or International Importance</p>	<ul style="list-style-type: none"> ♦ Venus Bay Conservation Park is on the <i>Register of the National Estate</i>, due to its significance as a breeding and nesting area for several coastal and sea bird species (Pacific Gull, Caspian Tern, Eastern Reef Heron, Sooty Oystercatcher, Australian Pelican and Rock Parrot). The park includes the western rocky peninsula (e.g. Point Weyland area) and the internal islands. ♦ Venus Bay: Habitat for several migratory birds listed under international treaties. Examples include: Greenshank, Sharp-tailed Sandpiper, Banded Stilt, Buff-banded Rail and Red-necked Stint (Copley, cited by Edyvane, 1995a; Robinson <i>et al.</i>, 1996). ♦ Lake Newland: Listed in the Commonwealth’s <i>Directory of Important Wetlands in Australia</i> (1996 and 2001b). ♦ Lake Newland: Identified as an area of international importance for shorebirds by Watkins (1993); ♦ Lake Newland: The area is a migration stop-over for at least 7 species of migrant shorebird, 5 species of which are listed under international treaties. The most common migrant species in the area are the Red-necked Stint <i>Calidris ruficollis</i>, Curlew Sandpiper <i>C. ferruginea</i> and Sharp-tailed Sandpiper <i>C. acuminata</i> (Morelli and de Jong, 1995). ♦ Lake Newland: Considered important at a national level, due to the area meeting

	<p>ANZECC criteria as a good example of a wetland type in a biogeographic region of Australia (Seaman, 2002).</p> <ul style="list-style-type: none"> ♦ Lake Newland Conservation Park: DEH (2001a) reported that the range of wetlands, fresh water springs, soaks and seepages and the associated wildlife dependent on this system, have international, national and state significance. The park protects what are considered to be very significant wetlands, of international importance for Banded Stilts, and of national importance as summer feeding habitat for the vulnerable Hooded Plover. The Lake Newland area shares the distinction, along with Big Swamp between Port Lincoln and Coffin Bay, of being one of the most important wetlands on Eyre Peninsula for the presence of bird species considered vulnerable at the State level, and also by virtue of being a natural coastal salina with numerous freshwater soaks (rare on Eyre Peninsula), supporting a high diversity of birds (Lloyd and Balla 1986; Morelli and de Jong, 1995; DEH, 2001a). Apart from the provision of habitat for bird species of conservation concern, Morelli and de Jong (1995) and DEH (2001a) considered that the area is important due to (i) the range of waders, shorebirds and other waterbirds; (ii) the role of the area as a drought refuge; (iii) the extent and integrity of the coastal dune system and its vegetation, particularly the remnant she-oak woodlands, which are now uncommon on Eyre Peninsula.
<p>Major Commercial and Recreational Fish, Sharks, Molluscs and Crustaceans</p>	<p>Some of the fish and shark species that are commercially (and in some cases only recreationally) significant, in the Venus Bay area, include:</p> <p><u>Fish:</u> King George Whiting, Australian Salmon, School Whiting, Snook, Tommy Ruff (Australian Herring), Southern Sea Garfish, Snapper, Yellow-eye Mullet, Red "Mullet", Trevally, Leatherjacket species, flathead species, flounder species.</p> <p><u>Sharks and Rays:</u> Whaler shark species, ray and skate species.</p> <p><u>Invertebrates:</u> Sand Crab, Western King Prawn, King Scallop, Queen Scallop, Mud Cockles, baitworm species.</p>

8.4 Investigator Group of Islands (Eyre Bioregion)

Figure 6 depicts the location of this area.

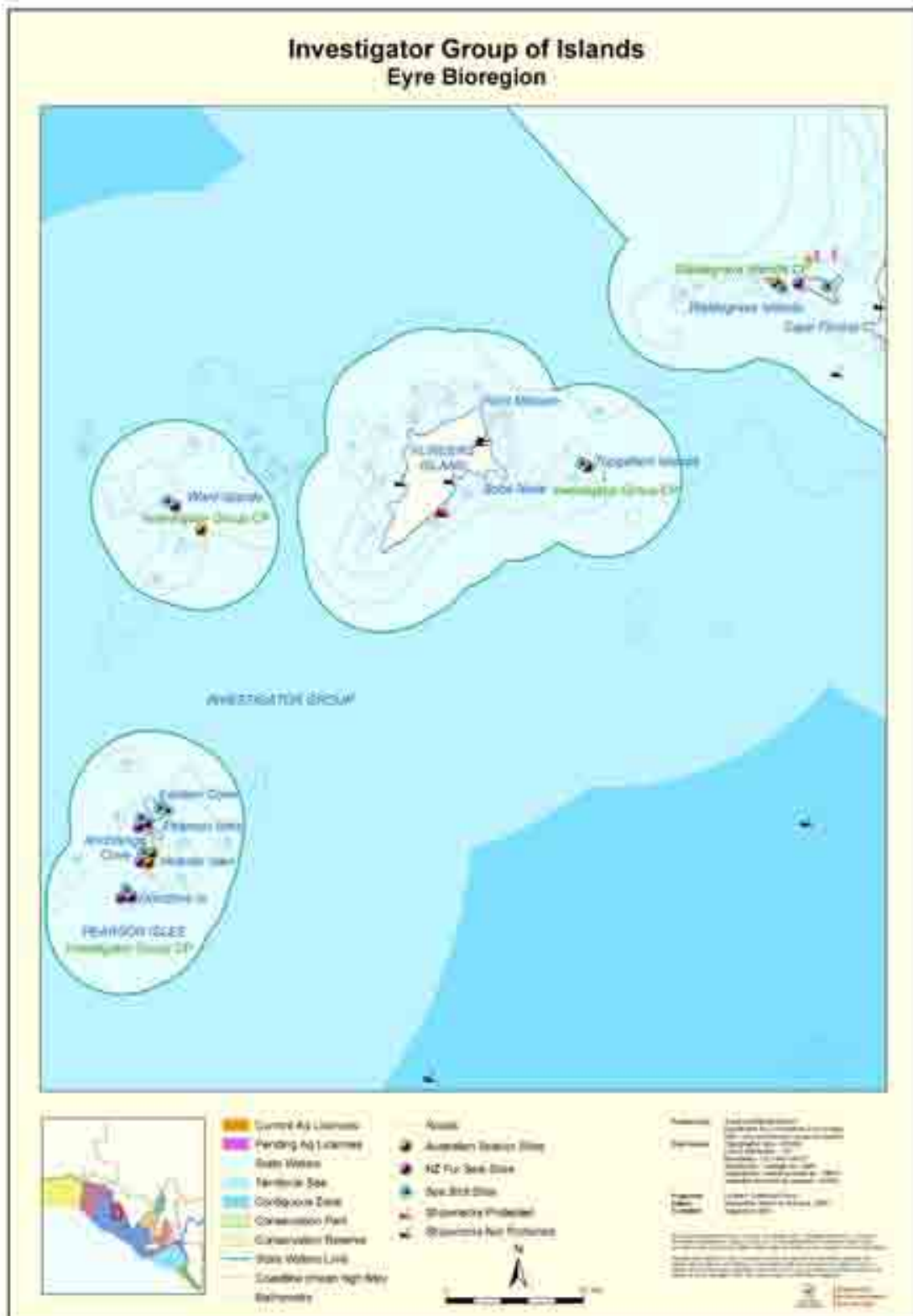


Figure 6: Investigator Group of Islands

1. Biogeographic Significance	See Habitat Rarity for indication of the possible biogeographic significance of the islands in the Investigator Group.
2. Major Physical Influences, and Relative Productivity Level	<p>Major Physical Influences</p> <ul style="list-style-type: none"> ◆ Steep depth gradients occur close to the island coasts in some area: e.g. waters are 50m+ deep less than 500m from the coast of northern Pearson Island, and southern and western sides of Dorothee Island, according to interpolated depth contours in the SA Coastal and Marine Atlas (DTUP, 2001). ◆ There are strong, deep water swells in some areas (e.g. Topgallant Islands) (Robinson <i>et al.</i>, 1996). ◆ Another physical factor that may influence the biota of the area is the clear water and high light penetration, which extends for considerable depths (see Shepherd and Womersley, 1971). ◆ The area may also be influenced by warmer water currents moving eastwards from the Bight region (Rochford, 1986; Herzfeld, 1997), as evidenced by the presence in eastern GAB waters of some species of macroalgae, invertebrates and fish that are usually associated with warmer biogeographical regions (Maxwell and Cresswell, 1981) (see examples below, in other sections). ◆ The influence of seasonal coastal upwellings along western Eyre Peninsula may periodically extend seawards to the Investigator Group region. <p>Relative Productivity</p> <ul style="list-style-type: none"> ◆ The area supports high biomass, abundance and species richness of macroalgae (Shepherd and Womersley, 1971; Edyvane and Baker, 1996a; Baker and Edyvane 2003). ◆ Periodically, high concentrations of zooplankton biomass are recorded in mid-western Eyre Peninsula waters (e.g. see Ward <i>et al.</i>, 2000, Figure 16). <p><i>No other information on relative productivity level is available for this report.</i></p>
3. Bioregional Representativeness of Habitats	<p>The Investigator Group islands have few features that could be considered representative of the Eyre Bioregion as described by IMCRA Technical Group (1998). However, the group of islands have a number of features of high conservation importance. It is considered for the purposes of this assessment that the habitats of the Investigator Group Islands could be classified as “uncommon” or “atypical” habitat types on a bioregional scale, at least within the Eyre Bioregion.</p> <p>The few features of the area that are representative of the Eyre Bioregion (see IMCRA Technical Group, 1998) include:</p> <ul style="list-style-type: none"> ◆ offshore islands; ◆ species of <i>Cystophora</i>, <i>Caulerpa</i>, <i>Plocamium</i> and the large red <i>Osmundaria prolifera</i> as dominant or sub-dominant components of the reef benthos in some areas; ◆ presence of the “S.A. endemic” fish Crested Threefin (<i>Trinorfolkia cristata</i>); and ◆ breeding colonies of New Zealand Fur Seal and Australian Sea Lion.
4. Habitat Rarity	<p>The offshore granite islands that comprise some of the Investigator Group (Pearson, Veteran, and Dorothee) are recognised for their unique geology, being true “island mountains” (inselbergs) composed of granite (Twidale, 1971).</p> <p>The latitudinal position, degree of isolation, geological composition, and oceanographic conditions (e.g. relatively warm, clear water and large swell) of some of the islands in the area, result in habitats and biotic compositions that are unique to the Eyre bioregion. Apart from the inselbergs, other islands in the group share many of these characteristics.</p> <p>The Investigator Group Islands are recognised for their high species diversity and abundance of macroalgae and some invertebrate groups (see below). A number of</p>

	<p>shallow water macroalgae have been found to grow to depths of 50m in the area, which is an unusual feature in South Australian waters – see notes in following section, and Shepherd and Womersley, 1971).</p> <p>The island group is also recognised for a high number of species in many major marine taxa that are uncommon, and/or of limited known distribution; these species are rarely recorded, or not recorded, from other parts of South Australia.</p>
<p>5. Habitat Diversity</p>	<p>Habitats in the area include:</p> <ul style="list-style-type: none"> ◆ granite islands (inselbergs) and associated diversity of near-shore granite reef forms and orientations (large granite boulder and block reefs, platforms, ledges, overhangs, caves, caverns, crevices, vertical underwater “cliffs” to depths of 40m, gravel/rubble reef), dominated by mixed macroalgae on light-exposed reef, and mixed sessile invertebrates in shaded areas such as crevices and under ledges, and in deeper waters; ◆ near-shore calcareous block and rubble reef (macroalgae-dominated) around some islands (e.g. Topgallant). Much of the near-shore calcareous rubble is the product of erosion from the land above tide level; ◆ small sandy beaches; ◆ seagrass beds to depths of 25m – 30m in some areas; ◆ extensive benthic sand habitat, particularly in deeper waters; ◆ mixed sand/granite block/gravel habitat; ◆ Deeper water calcareous (“travertine limestone”) reefs (e.g. at depths of 50m or more, in some areas near Pearson Island – see Habitat Notes). <p>Habitat Notes</p> <p>The Pearson Islands are high granite islands rising abruptly from the eastern section of the Great Australian Bight, with the highest peak being 238m. The large northern land mass (213ha) is joined to smaller rises of the southern island by spits of rock (Robinson <i>et al.</i>, 1996). The islands take the form of wedges and domes, with boulders on the upper slopes, and massive jointed plates on the lower levels (Twidale 1971; Robinson <i>et al.</i>, 1996). The western, exposed shores have tall cliffs, and there are deep bays, chasms and crevasses resulting from the erosion of fractures and joints in the granite. The more sheltered eastern sides are less steep.</p> <p>Shepherd and Womersley (1971) recorded distinct zonation patterns to the macroalgae from the near-shore to at least 50m depth, and growth of macroalgae extends to at least this depth, due to high light penetration and clear waters. Shepherd and Womersley (1971) provided a detailed assessment of Pearson Island’s marine flora during the late 1960’s. The authors reported that on the rocky rough water coast, the upper sublittoral zone (0-8m) was dominated by a species of the barnacle <i>Balanus</i>, and coralline algal mats of <i>Haliptilon roseum</i> (formerly called <i>Corallina cuvieri</i>) and other coralline algae. The 1969 survey, and a more recent survey of islands in the area (see Edyvane and Baker, 1996c and 1999a), have shown that the shallower reefs (to 20m depth) during the early 1990s were dominated by <i>Ecklonia radiata</i>, <i>Acrocarpia paniculata</i>, mixed <i>Cystophora</i> spp., mixed <i>Sargassum</i> spp., with an understory of turfing brown algae (e.g. <i>Homoeostrichus sinclairii</i>, <i>Pachydictyon paniculatum</i>), mixed <i>Caulerpa</i> spp., and mixed red algal species. Some of the red species recorded during the 1969 and/or 1993 surveys included various <i>Plocamium</i> spp., <i>Delisea hypneoides</i>, <i>Austrophyllis alcornis</i>, <i>Delisea pulchra</i>, <i>Osmundaria prolifera</i>, mixed <i>Laurencia</i> species, <i>Asparagopsis armata</i>, <i>Thamnoclonium dichotomum</i>, and mixed corallines such as <i>Haliptilon roseum</i> and species of <i>Metagoniolithon</i> and <i>Amphiroa</i>, amongst others. Shepherd and Womersley (1971) noted that at wave-exposed sites, green macroalgae were sparse at depths less than about 20m except for <i>Caulerpa scalpelliformis</i>. However, at the time of the 1993 survey, <i>Caulerpa</i> species, (particularly <i>C. obscura</i>) were common in the understory assemblage, between 10m and 20m on the exposed north-western side, forming at least 20% (and up to 90%, in some samples) of the surface cover in some quadrat samples (Edyvane and Baker, 1996a and 1999c).</p> <p>Seagrasses (mainly <i>Amphibolis antarctica</i>, and <i>Posidonia</i> spp., such as <i>P. angustifolia</i>), with lesser amounts of <i>Halophila</i> and <i>Zostera</i> (= <i>Heterozostera</i>) <i>tasmanica</i>, occur on sand in the more sheltered areas around some of the islands (e.g. Pearson and</p>

	<p>Ward Islands).</p> <p>Below 20m depth, Shepherd and Womersley (1971) recorded a spiny form of <i>Ecklonia radiata</i> as dominant, with a sparse understorey of red macroalgae such as <i>Plocamium</i> species, and the prostrate reds <i>Peyssonnelia novae-hollandiae</i> and <i>Sonderopelta coriacea</i> (formerly <i>Sonderphyucus australis</i>) covering much of the reef surface. Below 20m, green macroalgae such as <i>Caulerpa flexilis</i>, <i>C. longifolia</i>, and <i>C. cliftonii</i> were common.</p> <p>During the 1969 survey, a shade community of red macroalgae occurred only at depths below about 20m on cave walls and vertical faces, comprising similar species to those on horizontal surfaces in deeper water to 36m, under the <i>Ecklonia</i> canopy. The conspicuous red macroalga <i>Sarcomenia delesserioides</i> was present at 30-36m. An abundant growth of brown and red species (e.g. <i>Scytothalia dorycarpa</i>, <i>Myriodesma quercifolium</i>, <i>Cystophora platylobium</i>, <i>Plocamium preissianum</i>, <i>Pterocladia lucida</i>, <i>Dasyclonium incisum</i> and <i>Metamastophora flabellata</i>) occurred as deep as 50m, on calcareous (travertine limestone) substrate, and some of those species recorded are normally found at shallower depths. A total of 25 species of red algae were recorded at 50m (Shepherd and Womersley, 1971).</p> <p>On the sheltered northern coast (Eastern Cove), Shepherd and Womersley (1971) reported that the upper sublittoral (to 3m) was dominated by turfing macroalgae, comprising <i>Homoeostrichus sinclairii</i> (formerly <i>Zonaria sinclairii</i>), <i>Caulerpa brownii</i> and <i>Pterocladia capillacea</i>. Furoid macroalgae such as <i>Acrocarpia paniculata</i> and <i>Cystophora moniliformis</i> dominated the mid sublittoral, to around 12m, with patches of <i>C. subfarcinata</i> and <i>C. brownii</i>. Understorey species included turfing brown macroalgae such as <i>Pachydictyon paniculatum</i>, <i>Zonaria spiralis</i>, and <i>Homoeostrichus sinclairii</i>, and the red <i>Austrophyllis alvicornis</i>. From around 10m to 18m, <i>C. monilifera</i> and <i>Sargassum verruculosum</i> were dominant, with a mixed understorey including species such as <i>Codium duthiae</i>, <i>Glossophora nigricans</i>, <i>Dilophus fastigiatus</i>, and <i>Bellotia eriophorum</i>. <i>Caulerpa</i> species (<i>C. geminata</i> and <i>C. vesiculifera</i>) also occurred at between 10m to 18m. Reef between 18 to around 29m, on the sheltered coast was dominated by <i>Ecklonia</i>, with other common species including <i>Sargassum varians</i>, <i>Bellotia eriophorum</i>; the red macroalgae <i>Plocamium mertensii</i>, <i>Thamnoclonium dichotomum</i> and <i>Delisea hypneoides</i>; and <i>Plocamium angustum</i> and <i>Kallymenia cribrosa</i> on steep faces (Shepherd and Womersley, 1971). Species recorded on sediment-covered reef patches near the sandy bottom at 38m included <i>Sargassum spinuligerum</i>, <i>Osmundaria prolifera</i>, <i>Lobophora variegata</i> and <i>Caulerpa geminata</i>. Shepherd and Womersley (1971) recorded deeper-water calcareous ("travertine limestone") reefs, at depths of 50m or more, in some areas near Pearson Island. Sediment overlay the reef at around 30m, and the seagrasses <i>Posidonia australis</i> and <i>Zostera</i> (= <i>Heterozostera tasmanica</i>) were recorded on sand.</p> <p>During the 1993 survey, on the south-south-eastern side of Pearson Island, <i>Ecklonia radiata</i>, <i>Cystophora monilifera</i> and <i>Sargassum verruculosum</i> were the dominant species in this zone, to 10m, with other <i>Cystophora</i> species recorded in lesser amounts. The major understorey species recorded during the 1993 survey were similar to those described above for the rough water coast of the north-eastern side. Between 10 – 16m deep, <i>E. radiata</i>, <i>C. monilifera</i> and <i>S. verruculosum</i> were dominant canopy species, and the large red <i>Osmundaria prolifera</i> was also abundant. <i>Caulerpa flexilis</i>, <i>Laurencia</i> species (such as <i>L. filliformis</i>), and <i>Lobospira bicuspidata</i> were major components of the understorey. Other common understorey species recorded at 15m during the 1993 survey included <i>Plocamium mertensii</i>, <i>Thamnoclonium dichotomum</i>, and <i>Delisea hypneoides</i>. Sandy substrates, dominated by seagrasses, were recorded on the sheltered sites of Pearson Island, at 20m depth. The seagrass community was dominated by <i>Amphibolis antarctica</i> and <i>Posidonia angustifolia</i>, which comprised approximately 70% of the visual cover of the habitat, with the fine epiphytic coralline alga <i>Metagoniolithon stelliferum</i> also locally abundant.</p> <p>During SARDI's 1993 benthic survey, the sessile reef fauna of Pearson Island was characterised by the presence of a various common reef invertebrates, including hard coral (<i>Plesiastrea</i> sp.), soft corals (e.g. <i>Capnella</i> sp.), gorgonian corals, hydroids (e.g. <i>Solanderia fusca</i>, <i>Stereothea elongata</i>) sea tulips (ie. <i>Pyura</i> sp.), ascidians (e.g. <i>Herdmania momus</i>), holothurians (e.g. <i>Pentacta</i> sp.) and sponges (e.g. <i>Sycon</i> sp.)</p>
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(Edyvane and Baker, 1999c).

North of the Pearson Islands, **Ward** and **South Ward** Islands are smaller granite islands, with most of the calcarenite cover eroded away. The main dome of Ward is approximately 20 ha (Robinson *et al.*, 1996), descending to rock piles and submerged shelves at sea level. A steep talus, and sheer undercut cliffs, have formed from the remaining calcarenite cap. The surge is channelled through granite crevasses into walls of water that have eroded the calcarenite into overhangs and sea caves.

On both the wave exposed and more sheltered sides of **Ward Island**, SARDI's benthic survey in 1993 (Edyvane and Baker, 1996a and 1999c) reported that reef at 5m was dominated by species of the fucoid *Cystophora* (with different species dominating the northern compared with the southern side of the island), although *Ecklonia* was co-dominant on the more exposed side, and *Caulerpa* species (*C. flexilis*, *C. obscura*) formed a major part of the percentage cover at sampled sites on less wave-exposed south-south-eastern side. The articulated corallines *Metagoniolithon radiatum* and *Amphiroa gracilis* were abundant in the understorey on reef at 5m, on both sampled sides of the island. Between 10m and 15m, the composition of macroalgae at sampled sites on the northern and southern sides of the island was very similar in the dominance of *Ecklonia radiata* and various *Cystophora* species. Moderately wave-exposed areas and were typically dominated by species of *Caulerpa* between 5-15m. Various *Plocamium* species, particularly *P. costatum*, formed a major part of the understorey at sites on the northern and southern side of the island. *Homoeostrichus sinclairii*, was also recorded as a major component of the understorey. Bare rocky substrate was common at the 5m, 15m and 20m exposed sites of Ward Island.

Mixed patch reef and sand habitat was recorded at 20m, with *Halophila* and *Heterozostera* (= *Zostera*) seagrasses on the sand, and mixed green taxa (e.g. several *Codium* species, abundant *Apjohnia laetevirens*, and mixed *Caulerpa* species) and various branched red taxa (e.g. *Polysiphonia* and *Areschougia*) on the hard substrate. The sessile reef fauna of Ward Island was characterised by the presence of common reef invertebrates, including corals (e.g. *Plesiastrea* sp.), sea tulips (ie. *Pyura* sp.), ascidians (eg. *Herdmania momus*), and sponges (e.g. *Tethya* sp.) (Edyvane and Baker, 1999c).

On the eastern side of Pearson Island, the **Topgallant Islands** consists of one main 20ha island (with cliffs to 75m high, and a summit of 101m), and a number of smaller islands. The larger island has a thick cover of aeolian calcarenite, forming extremely steep sides, overlying the underwater ridge of granite (Robinson *et al.*, 1996). Near shore, there are also calcareous blocks and rubble reef around **Topgallant**, similar to some of the other islands in the Investigator Group. The shores of the Topgallant Islands are steep, and there are sheers "walls" of eroding rock at some coastal points around the islands. The main island of **Topgallant** falls away steeply to more than 30m deep on the sheltered side, providing a high diversity of micro-habitats in various caves and crevices (S.A. Shepherd, pers. comm., 2004). On the exposed side, the island is characterised by extensive shallow habitat, comprising many "bommies" and valleys between them. Between the two islands there is a steep gully with many micro-habitats (S.A. Shepherd, pers. comm., 2004). The dominant reef biota of **Topgallant**, and other small islands in the group are not known for this report.

Flinders Island: A large (3642ha) island, 28km west-south-west of Cape Finniss. The island is composed of granite, with overlying calcarenite, visible along the scalloped coastline. Depending upon the thickness of the calcarenite and the shelter from prevailing swells, the coastline varies from broad sandy beaches to rocky headlands and continuous walls of cliffs, some up to 62m high (Robinson *et al.*, 1996). The tallest cliffs are at the north-eastern extremity of the island, and there are dunes on the lower western coast, formed by the predominantly south-westerly winds. There are saline pans at the northern end, supporting samphire species where the salt pans border a dune fringe (Robinson *et al.*, 1996). Information on benthic habitats at Flinders Island is not available for this report.

The **Waldegrave** Islands are closer to the coast, being remnants of Cape Finniss. The

	<p>coastal area is more sheltered from wave exposure compared with the beach area further north, along the Newland Barrier coast. Waldegrave Islands and Cape Finnis provide wave refraction and numerous reefs attenuate the waves in the area (DEH 2001). The main island of 292ha is separated from the Eyre Peninsula by a 3km passage. A submerged reef isthmus joins the north-eastern side of Waldegrave Island to the mainland. Little Waldegrave (32ha) lies in deeper water, off the north-western side of the main island, and is joined to it by a submerged reef. Like other islands in the Investigator Group, the Waldegrave Islands consist of granite bases and calcarenite tops. A thick mantle of calcarenite forms the main part of Waldegrave Island, which has a steep coastal perimeter. The granite base rock is visible on the northern shoreline, and the calcarenite of the southern side has been eroded into undercut cliffs, arches and sea caves. There are broad, sandy beaches on the more sheltered north-eastern side of Waldegrave (Robinson <i>et al.</i>, 1996).</p> <p>At Waldegrave Island, SARDI's 1993 benthic survey (see Edyvane and Baker, 1996a) recorded species of <i>Cystophora</i> (e.g. <i>C. moniliformis</i>, <i>C. pectinata</i>) as dominant on boulder reef at 5m – 6m, with the thick red macroalgae <i>Osmundaria prolifera</i>, and an understory of green macroalgae (e.g. <i>Caulerpa cactoides</i>, <i>Caulerpa flexilis</i>); smaller mixed red macroalgae (such as <i>Calliblepharis planicaulis</i>, and species of <i>Erythroclonium</i>, <i>Rhabdonia</i>, <i>Mychodea</i>, <i>Polysiphonia</i> and <i>Areschougia</i>), small browns (e.g. <i>Dictyopteris muelleri</i>, <i>Homoeostrichus sinclairii</i>), and encrusting corallines on boulders. At 10m were recorded <i>Cystophora</i> species (mainly <i>C. moniliformis</i>, <i>C. pectinata</i> and lesser cover of <i>C. monilifera</i>), <i>Sargassum</i> species (<i>S. spinuligerum</i>, <i>S. heteromorphum</i>), <i>Osmundaria prolifera</i>, large branched reds (<i>Cladurus elatus</i> and <i>Vidalia spiralis</i>), the smaller brown <i>Dictyopteris muelleri</i>, and an assortment of smaller red and brown macroalgae (e.g. <i>Homoeostrichus sinclairii</i>, <i>Botryocladia sonderi</i>, and species of <i>Mychodea</i>, <i>Areschougia</i>, and <i>Brongniartella australis</i>). Mixed red and brown understory species comprised around 60% of the surface cover in some samples taken at 10m. On sandy substrate at 10m, mixed beds of the seagrasses <i>Posidonia sinuosa</i> (with the brown epiphyte <i>Chordaria</i>) and <i>Halophila australis</i> were recorded.</p> <p>During the 1993 benthic survey, the sessile reef fauna of Waldegrave Island was characterised by the presence of a variety of common reef invertebrates, including soft corals (eg. <i>Capnella</i> sp.), ascidians (eg. <i>Sycozoa cerebriformis</i>) and sponges (e.g. <i>Tethya</i> sp., <i>Neofibularia</i> sp.). Several species of holothurians were also recorded (ie. <i>Pentacta</i> sp., <i>Neoamphicyclus lividus</i>, and <i>Psolidia</i> sp.), incidental to the survey of attached benthos (Edyvane and Baker, 1999c).</p>
<p>6. Taxonomic Diversity</p>	<p>Marine Plants</p> <p>The region is characterised by abundant macroalgae of high species diversity, including a number of uncommon species (Shepherd and Womersley, 1971; Edyvane and Baker, 1996a and 1999c). Shepherd and Womersley (1971) reported that 160 species of macroalgae were recorded from Pearson Island over a few days collecting, whereas other sampled parts of S.A. yielded lower species numbers after long term, regular sampling.</p> <p>Edyvane and Baker (1996a) recorded high numbers of red and green macroalgae at the Investigator Group, comparable to the recognised high diversity of macroalgae found in some parts of the south-east of S.A.. Up to 17 species of green macroalgae, and more than 100 species of red macroalgae, representing nearly 70 genera, have been recorded as locally common components of the benthos at Ward Island (Edyvane and Baker, 1996a and 1999c).</p> <p>Similar high levels of red macroalgal biodiversity were recorded at sites around Pearson Island (e.g. 95 red species recorded from representative quadrat sampling). SARDI's S.A. Benthic Survey program (Edyvane and Baker, 1996a) recorded 172 species of macroalgae from representative quadrat samples taken at Pearson Island, and 187 species at Ward Island, and a complete species inventory within the area would show that species diversity is even higher than that recorded from quadrat surveys. Shepherd and Womersley (1971) considered the species richness and relatively high biomass of green macroalgae at depth, to be due mainly to the very clear oceanic</p>

	<p>waters in the island group, resulting in high light penetration at depth.</p> <p>S. Shepherd (SARDI, pers. comm., 1998) considered Topgallant Islands to contain one of the highest recorded levels of macroalgal species diversity in the world.</p> <p>Bony and Cartilaginous Fish High species diversity of fish recorded (but unquantified relative to other islands in South Australia) in which at least 94 fish species (representing 46 families) have been recorded (90 of these were recorded by R. Kuitert from Pearson, Ward, Flinders, Topgallant Islands, and the “Hotspot” (Kuitert, 1983a; Branden <i>et al.</i>, 1986; museum and survey records, cited in Baker, in press). Some fish families in the area are rich in species numbers, such as Wrasses (10 species recorded) and Leatherjackets (9 species). Apart from the common South Australian reef fish species, sand-dwelling fish species, and commercial fish species, other species recorded include: Swallowtail (in schools), Bullseyes (three species), Cardinalfish (two species), Red Cod, Western Blue Devil, Noarlunga Hulafish and Southern Hulafish, Western Kelpfish, Sea Carp, Butterfly Perch, Barber Perch (including schools), several Threefin species, wrasses (10 species including Pretty Polly, Rosy Wrasse, Maori Wrasse, Brown-spotted Wrasse and Black-Spotted Wrasse), Southern Silverbelly, 7 species in the Odacidae (cale and weed whiting family), Leatherjackets (9 species, including some that are not commonly recorded in other parts of South Australia, such as the Stars-and-Stripes Leatherjacket), amongst others. A number of ray and shark species (including Catsharks) were also recorded (Kuitert, 1983a). The survey of Kuitert did not provide a complete reef species inventory, but does provide a good example of the high species diversity. Various benthic reef fish species have also been recorded in the area; in addition to those listed in Kuitert (1983), other examples including Red Velvetfish and Rosy Weedfish (museum and survey records, cited in Baker, in press).</p> <p>Invertebrates Shepherd (SARDI, pers. comm., 2004) considers the Topgallant Island area to contain very high species diversity of ascidians.</p> <p>SARDI's S.A. Benthic Survey program (Edyvane and Baker, 1996c, and unpublished data) recorded more than 75 species of bryozoan during the replicate quadrat sampling at three Investigator Group islands. The survey entailed representative quadrat sampling, and was not designed to provide a complete species list, hence it is likely that bryozoan species diversity is even higher in the area than that recorded during the 1993 survey.</p>
<p>7. Habitat for Endemic Taxa / Threatened Taxa / Rare or Uncommon Taxa</p>	<p>Marine Plants Pearson Island: Records of macroalgal species (Shepherd and Womersley, 1971; Womersley 1984, 1987, 1994, 1997, 1998; Edyvane and Baker, 1996a and 1999c), verified by HBS Womersley (State Biodiversity Centre), with ranges that are reported to be limited (Womersley, 1984; Cheshire <i>et al.</i>, 2000; Turner, 2000). Examples include the following from Pearson Island: <i>Rhipiliopsis robusta</i>, <i>Codium laminarioides</i> (not commonly recorded in S.A., being a species with western affinities – Womersley, 1984), <i>Ulvaria shepherdii</i>, and <i>Kallymenia spinosa</i>. Examples from Ward Island include: <i>Codium laminarioides</i>, <i>Chlorodesmis baculifera</i>, and <i>Scinaia proliferata</i>. Examples from the Elliston – Waldegrave Island area: <i>Kallymenia rubra</i> and <i>Callithamnion circinnatum</i>.</p> <p>Investigator Group: Presence of plant species with warmer water (including some tropical and sub-tropical) affinities. Examples include the following plants recorded during the SARDI S.A. Benthic Survey program (Edyvane and Baker, 1996c): <i>Chlorodesmis baculifera</i> (an uncommon green algae with tropical affinities, usually confined to deep water and shaded habitats, according to Womersley 1984); <i>Struvea plumosa</i> (a single southern Australian species from a genus of tropical green net-like macroalgae); and the red macroalga <i>Laurencia brongniartii</i> (a tropical species, according to Womersley, 1991).</p>

In some areas, mixed *Codium* species are dominant components of the benthos (Edyvane and Baker, 1996a and 1999c), and this appears to be an uncommon feature on reefs in S.A., apart from some areas in the South East of S.A.. A number of other red taxa (Rhodophyta) were also recorded during SARDI's benthic survey (1993) of **Ward Island**, that were not recorded in other parts of S.A. during SARDI's 8 year benthic survey program, but are not included here because their conservation status has not yet been determined.

Bony and Cartilaginous Fish

Habitat for the Crested Threefin *Trinorfolkia cristata*. To date, *Trinorfolkia cristata* has been recorded almost exclusively in South Australia, and is known from few sites (e.g **Flinders Island** in the Investigator Group (Kuitert, 1983a), Victor Harbor, Cape Jervis area, Yorke Peninsula, and Ceduna (Hutchins and Swainston, 1986; Fricke, 1994; Froese and Pauly, 2003; OZCAM database records, cited by Baker, in press).

Topgallant Island is the type locality for the unusual, light-emitting fish *Paratrachichthys pulsator* (Golden Roughy), which has not been found anywhere else in Australia (see Gomon and Kuitert, 1987; Gomon et al., 1994; Froese and Pauly, 2003).

The region provides habitats for fish species of warmer water, western affinity, some of which are more closely associated with (and more common in) the Western Australian part of what has been described by Womersley (1991) as the Flindersian Province (see Hutchins and Swainston, 1986; Gomon et al., 1994; Kuitert, 1996a and 1996b; Edgar, 2000; and Froese and Pauly, 2003, for distribution notes). Examples include Western Footballer; Short-Finned Snake-blenny (not commonly recorded in S.A.), Barred Threefin (=Western White-barred Threefin or Western Australian Black-head Triplefin), Western Foxfish, Blue-spotted Pufferfish, Hump-backed Boxfish, and Orange-spotted (Brown-Spotted) Wrasse (Kuitert, 1983a; Baker, in press).

Habitat for the uncommon syngnathid *Solegnathus robustus* (Robust Pipehorse), which is known mainly from 25 trawled specimens in South Australian waters, from Point Weyland to **Flinders Island** in the eastern Great Australian Bight, collected at depths of between 42m and 68m, between 1909 and 1982 (Dawson, 1985; Froese and Pauly, 2001, Pogonoski et al., 2002, and S.A. Museum records 1920, 1981, 1982).

Weedy Seadragon is known to occur in the Investigator Group. The species was listed by IUCN Red List (2000, 2002, 2003) as *Data Deficient*.

Reef fish species of potential conservation concern in the area include Western Blue Groper, Western Blue Devil Fish, Harlequin Fish, Brown-spotted Wrasse, Rosy Wrasse and other species of Wrasse, and several other reef fish species (see and Section 9.2 of this report, and section on **Issues for Risk and Impact Assessment**).

Saw Sharks (probably both Common and Southern species) and Whiskery Shark are fished commercially by shark fishers in deeper waters north, south and west of Elliston, although capture of both species is not confined to this region of the West Coast. The Common Saw Shark was listed as *Lower Risk, but Near Threatened* in the IUCN Red List 2000 and 2002, however the species was not included in the IUCN Red List 2003. Saw sharks were considered by Pogonoski et al. (2002) to be *Conservation Dependent* in Australian waters. The Whiskery Shark was listed as *Lower Risk, but Conservation Dependent* in the IUCN Red List 2000 and 2002, however the species was not included in the IUCN Red List 2003. The Southern Saw Shark *Pristiophorus nudipinnis* also occurs in the GAB, but has not been listed by IUCN to date (see Baker, in press).

Invertebrates

Investigator Group Islands: High number of endemic invertebrates and rare invertebrates. For example, a number of ascidian species have been recorded at the Investigator Islands, with no (or very few) other locations reported in summaries of distribution (see Kott, 1997; Australian Government Department of the Environment and Heritage, 2004b). Examples of these taxa include *Symplegma arenosa* (**Waldegrave Island**, on sandy substrate); *Leptoclinides fungiformis* (**Pearson Island**, from deeper water such as 50m, on gravelly bottom); *Lissoclinum* sp.1 (**Flinders Island**, on cliffs and ledges); *Atrium* sp. (found to date only in a cave at **Flinders Island**); *Pseudodistoma pilatum* and *Pseudodistoma pulvinum* (both

known from **Ward Island**, the type locality); *Polycitor nubilus* (found in caves at 8m deep, on **Flinders Island**); *Lissoclinum* sp. 2 (**Ward Island**), *Stomozoa australiensis* (known from **Topgallant Island**), and *Clavelina mirabilis* (**Waldegrave Island**). Other ascidian species recorded from the Investigator Group that may be endemic to South Australia, include *Leptoclinides* sp.1 (known from Spencer Gulf and **Investigator Group** Islands); *Ritterella compacta* (known from **Flinders Island**, Price Island and southern Spencer Gulf); *Euherdmania translucida* (known from **Flinders Island** and around Port Lincoln, sometimes in *Posidonia* beds); and *Pseudodistoma acuatum* (known from **Ward Island**, and from Nora Creina in the South-East).

Tropical invertebrate species, not commonly recorded in South Australia, also occur in the island group. Two examples are the ascidians *Stolonica vesicularis* (known from **Ward Island**, but also recorded in tropical waters of the Philippines) and *Euherdmania digitata* (known from northern W.A. and Queensland, and the tropical Indo-West Pacific, and also recorded at the **Investigator Group** islands in S.A.) (Kott, 1997; Australian Government Department of the Environment and Heritage, 2004b).

The hard coral *Plesiastrea versipora* is present at islands in the Investigator Group (Edyvane and Baker, 1999c). Hard corals are not abundant in southern Australian waters, compared with the tropics, and the *Plesiastrea* coral colonies at the Investigator Group are physically undamaged, unlike those further east in gulf waters of South Australia, which are reported to have suffered from the effects of prawn trawling (Edyvane, 1999b). *Plesiastrea* in South Australia is one of the species of conservation concern, included in South Australian Reef Watch's "Feral or In Peril" program (Reef Watch Community Environmental Monitoring Program, 2002). The hard coral *Cascinaea* also commonly found at the **Investigator Group Islands**, and this area is near the eastern end of the geographic range (S. Shepherd, pers. comm., 2004).

Marine Mammals

Australian Sea Lion breeding sites at **Ward, Pearson and Dorothee** Islands, and **Little (West) Waldegrave Island**; haul out sites at **Veteran and Topgallant Island** (Gales, 1990; Gales *et al.*, 1994; Shaughnessy *et al.*, 1997; Shaughnessy, 2002). Australian Sea Lion is classified as *rare* under S.A. legislation, and considered by pinniped researchers to be a threatened species (e.g. see Shaughnessy, 1999).

New Zealand Fur Seals breed on **Ward Island**, and there are haul out sites on rock platforms at **South Veteran, Pearson and Dorothee Islands** (Shaughnessy *et al.*, 1994; S.A. Coast and Marine Atlas, 2000; Shaughnessy, 2002). New Zealand Fur Seals have also been observed to breed on **Dorothee Island**, with a small number of pups noted in 1995 (see Shaughnessy, 2002). The New Zealand Fur Seal was classified in the IUCN Red List 2000 as *Lower Risk, but Conservation Dependent*, however the species was not included in the IUCN Red List 2003.

Coastal and Marine Birds

According to the Australian Heritage Commission's *Register of the National Estate* listing for the island group (undated) and Robinson *et al.* (1996), several rare and/or threatened bird species with disjunctive populations utilise the Investigator Group islands for breeding. Species listed as *rare* under S.A. legislation include: Osprey (**Flinders, Pearson and Ward Island; Waldegrave Islands**), Eastern Reef Egret (**Pearson Island and Flinders Island**), Rock Parrot, which often nests in the spray zone on coastal and offshore islands in South Australia (**Pearson, North Veteran, Dorothee, Ward and Topgallant Islands; Waldegrave Islands**), and Cape Barren Goose (**Flinders, Pearson and Dorothee Islands; Waldegrave Islands**) (Robinson *et al.*, 1996). Australian Heritage Commission's Register of the National Estate (undated) listed the Cape Barren Goose as the *second rarest goose species in the world*.

Pearson Island and Flinders Island: Red-tailed Tropic Bird, a tropical sea bird species that is rarely recorded in South Australia (usually listed as "vagrant" in ornithological records), has been recorded from Pearson Island and Flinders Island (Robinson *et al.*, 1996).

Species listed as *vulnerable* (see Australian Heritage Commission's *Register of the National Estate*, undated) under S.A. legislation include: White-bellied Sea Eagle

	<p>(Flinders, Pearson, Dorothee, Ward and Topgallant Islands; Waldegrave Islands), Hooded Plover (Pearson Island), and Fairy Tern (Pearson Island and Flinders Island).</p>
<p>8. Other Important Taxa</p>	<p>Marine Plants Pearson Island: High abundance (in terms of biomass) of green macroalgae, purportedly due to the high water clarity in the area and resulting in high light penetration (Shepherd and Womersley, 1971).</p> <p>Bony and Cartilaginous Fish Reefs at Flinders, Ward, Topgallant and Pearson Islands and Waldegrave Islands are used by one or more of the life stages of the following commercially and/or recreationally significant fish species: King George Whiting, Snapper, West Australian Salmon; Tommy Ruff, Yellow-eye Mullet, Trevally, Yellow-tail Kingfish, Leatherjacket species, Snook, Western Blue Groper and other Wrasse species, Sea Sweep, Silver Drummer; Gummy Shark and Whaler Sharks (Bryars, 2003). Surf beach area at Flinders Island is used by one or more of the life stages of the following commercially and/or recreationally significant fish species: School Whiting, West Australian Salmon, Tommy Ruff, Yellow-eye Mullet, Mulloway, flathead species, School Shark, Gummy Shark and Whaler shark species (Bryars, 2003). Seagrass beds at Flinders, Ward, and Pearson Islands are used by one or more of the life stages of the following commercially and/or recreationally significant fish species: King George Whiting, Snapper, West Australian Salmon; Tommy Ruff, Southern Sea Garfish, Trevally, Snook, flathead species, Leatherjacket species, and Whaler sharks (Bryars, 2003). Unvegetated sand habitat at Flinders, Topgallant, Ward, and Pearson Islands: The area is used by one or more of the life stages of the following commercially and/or recreationally significant fish species: King George Whiting, School Whiting, Snapper, West Australian Salmon; Tommy Ruff, Yellow-eye Mullet, Trevally, Snook, flathead species, Yellow-tail Kingfish, and Whaler sharks (Bryars, 2003). Some of these species (i.e. the whittings, West Australian Salmon, Tommy Ruff, Yellow-eye Mullet, Flathead and flounder species) also utilise the nearshore, sheltered beach habitat at Flinders Island (Bryars, 2003).</p> <p>Invertebrates Ward Island: Abundant numbers of Greenlip (<i>Haliotis laevis</i>) and Blacklip (<i>H. rubra</i>) Abalone are found in the area, as evidenced by catch figures from the area (see below) The smaller abalone species <i>Haliotis scalaris</i> also occurs in the area. Reef at Flinders, Ward, Topgallant and Pearson Islands: Habitat for one or more life stages of the following invertebrate species: Southern Rock Lobster, Southern Calamari, Giant Cuttlefish, Maori Octopus, Greenlip and Blacklip Abalone, and Purple Sea Urchin (Bryars, 2003). Surf beach at Flinders Island is reported to be used by one or more of the life stages of Sand Crabs and bait worm species (Bryars, 2003). Seagrass beds at Flinders, Ward, and Pearson Islands is reported to be used by one or more of the life stages of the Southern Calamari (Bryars, 2003). Unvegetated soft bottom (sand) habitats at Flinders, Topgallant, Ward, and Pearson Islands are reported to be used by one or more of the life stages of the following commercially and/or recreationally significant invertebrate species: Sand Crab and Southern Calamari (Bryars, 2003). Sand Crabs, and bait worm species, utilise the sheltered beach area at Flinders Island (Bryars, 2003). The Giant Turban Shell (<i>Turbo jordanii</i>), up to 20cm high and 17cm wide, occurs in the Investigator Group of Isles area (Shepherd and Womersley, 1971), and is common in the Great Australian Bight region, but not in other parts of South Australia. Large sponges, gorgonian corals, soft corals (e.g. <i>Capnella</i> sp.), ascidians, and hydroids are also locally common at some sites (e.g. Pearson Island, Ward Island) (Edyvane and Baker, 1999c).</p> <p>Coastal and Marine Birds (Australian Heritage Commission, undated; Robinson <i>et al.</i>, 1996; SA Coast and Marine Atlas, 2001)</p>

	<p>Pearson Island: Habitat for White-faced Heron, Masked Plover, Ruddy Turnstone (migratory), Red-necked Stint (migratory), Black Cormorant, and Crested Tern.</p> <p>Pearson Group (unspecified): According to the Australian Heritage Commission's Register of the National Estate listing (undated), "many" birds utilise the Investigator Group islands, which may be significant as intermediate points for birds migrating from Flinders Island to the Australian mainland, or as extended feeding territories for Flinders Island species.</p> <p>North Veteran Island: Seasonal habitat for Sooty Oystercatcher and Pacific Gull.</p> <p>South Veteran Island: Habitat for Sooty Oystercatcher and Pacific Gull.</p> <p>Dorothee Island: The island provides habitat for White-faced Heron, Sooty Oystercatcher, Ruddy Turnstone (migratory), Masked Plover, Pacific Gull and Black Cormorant.</p> <p>Ward Island: Habitat for Sooty Oystercatcher, and Pacific Gull.</p> <p>Topgallant Island: Habitat for White-faced Herons.</p> <p>Flinders Island: Habitat for Chestnut Teal and Grey Teal (N.B. Flinders is the only island in the Investigator Group on which these waterfowl species occur), White-faced Heron, Ruddy Turnstone, Red-necked Stint, Hooded Plover, Red-capped Plover, Masked Plover, Banded Plover / Lapwing, Double-banded Plover (the latter not recorded on the other islands in the Investigator Group), Fairy Penguin, Sooty and Pied Oystercatchers, Sacred Kingfisher (the only island in the Investigator Group on which this species has been recorded), Caspian Tern, Crested Tern, Pacific Gull, Silver Gull, Black-faced Cormorant, Black Cormorant, Little Black Cormorant, Pied Cormorant, Yellow-billed Spoonbill and Eastern Curlew.</p> <p>Waldegrave Islands: Habitat for Little Penguin, Black-faced Cormorant, Sooty Oystercatcher, Masked Plover, Pacific Gull, Silver Gull, Crested Tern and other tern species.</p>
<p>9. Notable Feeding, Breeding / Spawning and Nursery Areas</p>	<p>Marine Mammals Breeding colony and haul out sites for New Zealand Fur Seals at Ward Island. During the 1990's, Ward Island was one of the top 10 breeding sites in S.A. for New Zealand Fur Seals (Shaughnessy, 1990 and Shaughnessy <i>et al.</i>, 1994), and has maintained this status into the 2000s (see Shaughnessy, 2002).</p> <p>Breeding colonies of Australian Sea Lion at Ward, Pearson and Dorothee Islands (Gales, 1990; Gales <i>et al.</i>, 1994, and Dennis and Shaughnessy, 1996; SA Coast and Marine Atlas, 2001). In terms of Australian Sea Lion pup production, Pearson Island is one of the top 10 ranking locations in South Australia, however pup production at Dorothee Island is low (see Shaughnessy, 2002). In terms of Australian Sea Lion pup production, West Waldegrave Island was ranked 6th in a list of 38 sites where pups are produced in South Australia (Shaughnessy, 2002). Around 79 pups were recorded at West Waldegrave Island in 2002 (Shaughnessy and Dennis, 2002).</p> <p>Bony and Cartilaginous Fish Surf Beach at Flinders Island: The area is used by juvenile School Whiting (Bryars, 2003).</p> <p>The Investigator Group Islands may be a spawning area for Ocean Leatherjacket (Grove-Jones and Burnell, 1991).</p> <p>Coastal and Marine Birds Dorothee Island and Topgallant Island: Both islands contain breeding population numbers of White-faced Storm Petrel that are amongst the top 10 in S.A., in terms of abundance (5200 birds at Dorothee and 3900 birds at Topgallant) (Robinson <i>et al.</i>, 1996).</p> <p>Dorothee Island: Breeding colonies of Little Penguins, Pacific Gull, Short-tailed Shearwater (1896 birds), with nesting sites for White-bellied Sea Eagle.</p> <p>Topgallant Island: Breeding colony of Short-tailed Shearwater.</p> <p>Pearson Island: Breeding/nesting colonies of Little Penguin, Fairy Tern, Sooty Oystercatcher and Pacific Gull.</p> <p>North Veteran Island: Breeding colonies of Little Penguin and Short-tailed Shearwaters,</p> <p>Ward Island: Breeding colonies of Short-tailed Shearwaters and White-faced Storm Petrel.</p> <p>Flinders Island: Breeding colony of Little Penguins, and nesting areas for White-bellied Sea Eagle and Osprey (Robinson <i>et al.</i>, 1996)</p> <p>Waldegrave Islands: The second most important breeding area in S.A. for the Cape Barren Goose (Robinson <i>et al.</i>, 1996). Also a breeding and/or roosting area for</p>

	White-bellied Sea Eagle, Osprey, and Little Penguin (Robinson et al., 1996; Australian Heritage Commission, undated).
10. Shipwrecks and Artificial Reefs	Recorded shipwrecks that may be additional habitat are not known for the islands of the Investigator Group.
11. Popular Dive Sites	<p>(from DIASSA, undated; Aquanaut, undated; various dive promotion materials for the Eyre region; personal observation, and anecdotal information from divers).</p> <p>Pearson Island is recognised for the presence of Australian Sea Lions and New Zealand Fur Seals, Dolphins, high fish species diversity, presence of large Blue Groper, Seadragons, Western Blue Devil, Rock Lobster, large sponges, and abundant gorgonian and soft corals. The large granite boulder reefs are also a recognised dive feature of the area.</p> <p>“The Dice” on the south-east side of the southern island of Pearson, is recognised for its large, cube-shaped boulders forming caverns and tunnels, described as “harbouring prolific marine life”, with a variety of invertebrates and fish species.</p> <p>Topgallant Island is recognised for the “hundreds of caves, tunnels and swim-throughs”, the numerous pelagic fish and reef fish, seals, large Western Blue Groper and Western Blue Devil, Harlequin Fish, and the abundance and variety of sessile invertebrates e.g. “red, orange and yellow gorgonians, basket stars, sponges and every imaginable temperate water invertebrate” (Aquanaut, undated).</p>
12. National and / or International Importance	<p>Topgallant Island and Ward Islands are listed on the <i>Register of the National Estate</i>, due to the geological significance of the mainly granitic Investigator Group. Other important landforms within the group are of marine origin, including old coastal fore-dune deposits and formations indicating a higher sea level than present. The presence of Australian Sea Lions, New Zealand Fur Seals and breeding sites for threatened and potentially threatened sea birds also contributed to the AHC Register listing.</p> <p>Flinders Island is used by at least 4 migratory coastal bird species that are listed under international migratory bird treaties, namely Ruddy Turnstone (also on Pearson and Dorothee Island), Red-necked Stint (also on Pearson Island), Caspian Tern, and Eastern Curlew (Robinson et al., 1996).</p>
Major Commercial and Recreational Fish, Sharks, Molluscs and Crustaceans	<p>Information specific only to the Investigator Group is not available for this table, however some of the commercially and/or recreationally fished species that occur in parts of the area that collectively encompasses the Mid West Coast Waters (south of Searcy Bay, to south and west of Elliston, and including the Investigator Group), include:</p> <p><u>Fish</u>: Australian Salmon is a major commercial species in the mid-west coast region. Other commercially and/or recreationally significant species in the area include Ocean Leatherjacket, reef fish such as Western Blue Groper, Blue-throated Wrasse and other Wrasse species, Blue Morwong, Sweep, adult Snapper, Boarfish, Redfish, Rock Ling, King George Whiting, Trevally, Conger Eel, Mulloway, Flathead, Red “mullet”, Garfish, School Whiting, Tommy Ruff, Snook, Ocean Leatherjacket, and Striped Perch (the latter caught but not targeted).</p> <p><u>Sharks and Rays</u>: Gummy Shark and School Shark are the major shark species that are caught commercially in the area. Bronze Whaler and other shark species (e.g. Saw Shark, Whiskery Shark) are also caught in lesser numbers.</p> <p><u>Invertebrates</u>: Southern Rock Lobster and Greenlip and Blacklip Abalone are major invertebrate fisheries in the area. Western King Prawns are caught in part of the mid-west coast region, away from the islands. Other notable invertebrates in the mid-west coast region include Sand Crab, Velvet Crab, Southern Calamari, Maori Octopus, and Purple Sea Urchin.</p>

8.5 Thorny Passage (Eyre Bioregion)

Figure 7 shows the location of this area.



Figure 7: Thorny Passage

<p>1. Biogeographic Significance</p>	<p>Not known for this report, but see notes below on Major Physical Influences.</p>
<p>2. Major Physical Influences, and Relative Productivity Level</p>	<p>Major Physical Influences</p> <ul style="list-style-type: none"> ♦ Bottom of Jussieu Peninsula: Part of a major upwelling area (seasonal, cold water nutrient-rich upwellings), which occur close to the coast, extending from north of the Coffin Bay Peninsula, to north-western and western Kangaroo Island (Wenju <i>et al.</i>, 1990; Ward <i>et al.</i>, 2000; Butler <i>et al.</i>, 2002). ♦ The southern Eyre Peninsula coast is also one of the highest wave energy areas in South Australia, comparable to the Canunda region in the South East (Short and Hesp, 1984). ♦ Thorny Passage - Thorny Passage Islands: Area of high current flow (seasonally, and on shorter time scales, such as strong incoming and outgoing tidal currents, forming “tidal races”), which is a major physical influence in the region. Thorny Passage experiences North-South currents up to 100 cm s⁻¹, according to Petrushevics <i>et al.</i>, 1998). According to maps in the S.A. Coast and Marine Atlas (DTUP 2001, data by P. Petrushevics), south-western Spencer Gulf is one of the 8 areas in South Australian waters, in which current strengths are strongest, and with the zone of strong current influence being extensive (and more southerly) in winter compared with summer. Areas of low current flow also occur in the area: e.g. currents of 20 cm s⁻¹ are experienced East of Taylor Island (Petrusevics <i>et al.</i>, 1998). ♦ Southern Eyre Peninsula: The warm water masses that influence the western Eyre Peninsula / eastern Great Australian Bight area, particularly the warm water mass that is generated in the Bight (Herzfeld, 1997; Herzfeld and Tomczak, 1997), may periodically extend to southern Eyre Peninsula (see Griffin <i>et al.</i>, 1997; Herzfeld, 2000). <p>Relative Productivity Level</p> <ul style="list-style-type: none"> ♦ Bottom of Jussieu Peninsula, Thorny Passage and Thorny Passage Islands: The upwelling of southern Eyre Peninsula waters results in high phytoplankton and zooplankton biomass at the bottom of the peninsula (Mackie, 1995; Ward <i>et al.</i>, 2000), extending into Thorny Passage waters. ♦ The area supports high abundance of Pilchards, a significant species in marine food webs. The ecological significance of Pilchard abundance flows though either directly or indirectly to many other species that are abundant in the area (e.g. Australian Salmon and other predatory fish, New Zealand Fur Seals and Australian Sea Lions, cetaceans, sharks, and numerous seabird species, including Little Penguins, and many of the oceanic migrants) (Mackie, 1995; Dimmlich and Jones, 1997; Ward and McLeay, 1999a and 1999b; Ward <i>et al.</i>, 2000). ♦ The strong currents of the Thorny Passage area transport nutrients, larvae and food sources into the south-western part of Spencer Gulf. For example, the high productivity of abalone in the southern Spencer Gulf area is considered to be due to the provision of suitable food sources being transported through Thorny Passage (S. Shepherd, pers. comm., 1996).

<p>3. Bioregional Representativeness of Habitats</p>	<p>Features of the area that are representative of the Eyre Bioregion (see IMCRA Technical Group, 1998) include:</p> <ul style="list-style-type: none"> ♦ moderate to high deepwater wave energy coastline; ♦ influence of cold, nutrient-rich coastal upwellings; ♦ rocky coast, with numerous headlands; ♦ Precambrian meta-sedimentary cliffs; ♦ Pleistocene dune rock cliffs, headlands and shore platforms, interspersed with Holocene dune barrier beaches; ♦ numerous offshore islands; ♦ species of <i>Cystophora</i>, <i>Plocamium</i>, the large red <i>Osmundaria prolifera</i> and green <i>Caulerpa</i> species as dominant or sub-dominant macroalgal components of the reef benthos in some areas and ♦ colonies of New Zealand Fur Seal and Australian Sea Lion on the islands (mainly haul-out sites, in this region).
<p>4. Habitat Rarity</p>	<p>Not known for this report.</p>
<p>5. Habitat Diversity</p>	<p>Lincoln National Park – Thorny Passage - Thorny Passage Islands: Diversity of habitats in this region include:</p> <p>A variety of reef types and reef covers, due to differences in:</p> <ul style="list-style-type: none"> ♦ <i>depth gradients</i> e.g. a depth of 50m or greater within 1.5 – 2km of the shore of Williams and Smith Islands, at the bottom of Jussieu Peninsula and broad shallow depth gradient in northern Thorny Passage with depths of 5 m - 15 m between MacLaren Point and Observatory Point on Thistle island, and the northern islands Owen, Taylor, Grindal; ♦ <i>wave exposure</i> which varies from wave exposed headland areas, to relatively sheltered bays; ♦ <i>oceanographic conditions</i>, such as strong eddies, tidal rips and swells; ♦ <i>geological composition</i>: reefs in the region are composed of a variety of calcareous, metamorphic, granitic substrates; ♦ <i>variety of reef forms</i>, including cliffs, intertidal wave-cut platforms, boulders, islands, platform reef, patch reef, and pebble/cobble/rubble; ♦ <i>orientations</i>, including coastal submarine caves, ledges, holes/reef depressions, crevices, overhangs and ♦ <i>dominant benthic cover</i>, with differences in assemblages of large brown, red and coralline macroalgae; sponges and other sessile invertebrates dominating many of the platform reefs, boulder reefs, cliffs, caves, island and mixed sand/reef habitats. <p>(Examples of the variety of reef types in the area include: metamorphic and granitic cliff reefs; calcareous intertidal wave-cut platforms; sand-covered calcareous platform reef; ledge reef and patch reefs; benthic boulder reefs (mainly metamorphic and granitic), and island reefs (both calcareous and granitic).</p> <p>Habitats other than reefs in the region include:</p> <ul style="list-style-type: none"> ♦ coastal and island beach habitats; ♦ low density seagrass beds of mixed species; ♦ benthic sand habitats; ♦ coastal and island beach habitats of various wave exposures; ♦ seagrass beds; ♦ benthic sand habitats; ♦ mixed habitats: parts of the region (including some of the islands) contain both granite boulders and calcareous patch reef (dominated by different assemblages of

macroalgae, sponges and other invertebrates), interspersed with low density seagrass beds (mainly *Posidonia* and *Amphibolis* spp.), and “loose granulated sediments” / sandy habitat. Such “mixed” habitat provides opportunity for species that are associated with different habitats (e.g. reef- and seagrass-dwelling and sand-dwelling fish species) to occur in the same area.

Selected Habitat Notes

The **Thorny Passage** coast abuts the Lincoln National Park and Memory Cove Wilderness Area, on the **Jussieu Peninsula**. The coast in the **Thorny Passage** area comprises a series of rocky cliffs and shore platforms interspersed with narrow coves and beaches (DEH, 2004b). The coast of the peninsula adjacent to Thorny Passage, is typified by outcroppings of granitic basement rocks at the coast, often forming prominent points and bluffs on the coast. Overlying the granite, the most extensive exposure of rock is Bridgewater Formation calcarenite (limestone), which often shows karstic weathering, and forms spectacular high and steep cliffs on the coast. Recent and Quaternary sand dunes also cover extensive areas of the **Lincoln National Park (Jussieu Peninsula)** coast (DEH, 2004b).

Small coves include **Memory Cove** in southern **Thorny Passage**, and the cove south of **MacLaren Point**. The broad **Taylor’s Landing** area lies between the small headlands and coves of northern and southern Thorny Passage.

Coastal reef (West Point to Cape Donington)

Although very little information is available for this area, the coastal cliff and reef areas are mainly granitic. **Memory Cove** is a small bay surrounded by headlands, and has a small sandy beach. Boulder reef at **Memory Cove** is dominated by macroalgae (unspecified) that can rapidly colonise “disturbed” habitats (PISA Fisheries - Aquaculture Group, 1996). The area has a steep depth gradient close to shore, and sessile invertebrates dominate caves in the submarine cliffs. A granite platform and boulder reef at **Cape Donington** is dominated by *Ecklonia radiata*. Mixed species of *Cystophora* and *Sargassum* are also present. Sponges and encrusting calcareous reds form a significant part of the understory (up to 50% cover). Red macroalgae such as *Ballia callitricha*, *Pterocladia lucida*, *Solieria* sp., *Callophyllis rangiferina*, *Cladurus elatus* and green *Caulerpa* spp. (e.g. *C. obscura*) were also recorded (SARDI S.A. Benthic Survey data, 1995, unpublished).

Taylor Island and Grindal Island

Taylor island is fringed by a granite reef, small beaches, and a submerged sandbar leading to Owen Island (Robinson *et al.*, 1996). The boulder reef on the eastern side of Taylor Island is reportedly dominated by macroalgae (unspecified) that rapidly colonise “disturbed” habitats, according to the Aquaculture Management Plan by PISA Fisheries Aquaculture Group (1996). That report also described the bottom type “loose granulated sediments and small flat rock outcrops” and “diverse macro-biota” of the Taylor and Grindal Island areas as being similar, except for the abundance of the red macroalgae *Osmundaria prolifera* (a dominant cover on reefs around Taylor Island). Dominant macroalgal species recorded in the area included a variety of *Sargassum* species, and *Osmundaria prolifera*. The understory is dominated by a diverse sponge and ascidian fauna (more than 40 species, according to Hone *et al.* (1997), and large numbers of spider crabs (Majidae) and sea cucumbers. Soft corals and erect bryozoa are also common in the area.

A survey of the area (SARDI S.A. Benthic Survey data, 1995, unpublished) recorded the shallow reef (5 m) **north of Taylor Island** to be dominated by mixed brown macroalgae (species of *Cystophora* and *Sargassum*) with *Caulocystis* sp., *Myriodesma harveyanum* and *Scaberia agardhii* also recorded, with an understory of articulated coralline algae (e.g. two species of *Metagoniolithon*, and *Amphiroa anceps*), and smaller brown algae (e.g. *Zonaria angustata* and *Homoeostrichus sinclairii*). Coralline algae formed between 20 - 30% of the benthic cover at sampled sites in this area.

The shallow reef (5 m) south of **Taylor Island** is dominated by *Cystophora* species, and *Osmundaria prolifera* with *Ecklonia radiata*, *Seirococcus axillaris* and species of

	<p><i>Sargassum</i> as subdominants. The understory at sampled sites was dominated by mixed red macroalgal species (e.g. two species of <i>Plocamium</i>, <i>Coeloclonium</i> sp., <i>Botryocladia sonderi</i>, and <i>Laurencia filiformis</i>), green macroalgae (<i>Caulerpa brownii</i>) and articulated corallines (<i>Metagoniolithon radiatum</i> and <i>Amphiroa anceps</i>). Deeper (11+m) granite boulder reef at Taylor Island was dominated by <i>S. axillaris</i>, lesser cover of other fucooids (e.g. species of <i>Sargassum</i> and <i>Cystophora</i>) and <i>Ecklonia</i>, with a diverse understory of red taxa (species of <i>Plocamium</i>, <i>Hypnea</i>, <i>Rhabdonia</i>, <i>Mychodea</i>, <i>Polysiphonia</i>, <i>Cladurus</i>, <i>Cliftonaea</i>, <i>Dictymania</i>, <i>Echinothamnion</i>, <i>Areschougia</i>, amongst others) and the green <i>Apjohnia laetevirens</i>. Both granite and limestone reefs occur in the Grindal Island region (PISA Fisheries Aquaculture Group, 1996). Grindal Island is fringed by granite reefs, wave-cut platforms, and a bay on the west coast (Robinson <i>et al.</i>, 1996). Macroalgal assemblages dominate reef areas to approximately 6 m around Grindal Island, with seagrass beds dominant in deeper waters (PISA Fisheries Aquaculture Group, 1996). Seagrass beds (mainly of low density) of the genera <i>Posidonia</i>, <i>Amphibolis</i> and <i>Halophila</i> are also in the Taylor and Grindal Island area (PISA Fisheries - Aquaculture Group, 1996).</p> <p>Hopkins Island Rocky shoals and emergent rocks ring the island, with a small beach on the north shore (Robinson <i>et al.</i>, 1996). A granite reef (less than 10 m in depth) on the north side of the island is dominated by the leathery red macroalgae <i>Osmundaria prolifera</i>, and mixed brown macroalgae (up to six species of <i>Cystophora</i>, and <i>Ecklonia radiata</i>). <i>Acrocarpia paniculata</i> and <i>Sargassum</i> species are also present. Understorey species include a diversity of green macroalgae (up to five species of <i>Caulerpa</i>), the reds <i>Laurencia filiformis</i> (up to 30% of the cover at some quadrat sample sites), <i>Pterocladia lucida</i>, <i>Ballia callitricha</i>, and articulated coralline reds (<i>Amphiroa anceps</i>) are also present. In deeper waters (e.g. 15+m) on the north-western side, <i>Posidonia sinuosa</i> and <i>Halophila</i> sp. seagrasses have been recorded on sand, and patch reef in the same area is covered with <i>Ecklonia</i>, and mixed large browns (<i>Scytothalia dorycarpa</i>, and species of <i>Cystophora</i> and <i>Sargassum</i>) (SARDI S.A. Benthic Survey data, unpublished, 1995).</p> <p>The southern tip of the Jussieu Peninsula contains large igneous (granites and gneisses) cliffs, overlaid with calcarenite. The cliffs are interspersed with small sandy beaches and shores of the resistant basement rock.</p> <p>Williams Island At the southernmost tip of Jussieu Peninsula is Williams Island, about 1.8km south-south-east of West Point. The upper platform of the island is a bed of calcarenite resting on a U-shaped ridge of pink granite and porphyritic granite gneiss, intruded by dark, dolerite dykes (Robinson <i>et al.</i>, 1996). The northern coast is the most sheltered, and contains a small sandy beach encircled by the cliffs and talus slopes of the island's U-shaped ridge. Beyond the rim of igneous rock, a thin bed of calcarenite begins as a talus slope of fractured rock and scree, or as low cliffs and overhangs. There is a well developed soil on the island, supporting Marsh Saltbush or Grey Saltbush on the upper platform, and various other species on the granite outcrops near the south-eastern tip of the island (Robinson <i>et al.</i>, 1996).</p>
<p>6. Taxonomic Diversity</p>	<p>Marine Plants Thorny Passage and Islands: Diversity of macroalgae in some areas comparable at State-wide scale with the South East of South Australia. A minimum of eight genera of the large (canopy-forming) brown macroalgae has been recorded at some island sites, with up to 6 species of <i>Sargassum</i> and 6 species of <i>Cystophora</i> in some areas. There is a high percentage cover and genus-level diversity of reds at some sites, and high species level diversity in the green macroalgae (e.g. Hopkins and Taylor Island) (SARDI benthic survey data, unpublished, 1996).</p> <p>Invertebrates Lincoln National Park - Thorny Passage - Thorny Passage Islands: "Diverse" (Hone <i>et al.</i>, 1997; PISA Fisheries - Aquaculture Group, 1996) sponge and ascidian fauna (more than 40 common taxa, including species from the genera <i>Echinoclathria</i>, <i>Clathria</i>, <i>Haloclona</i>, <i>Tethya</i>, <i>Discodermia</i>, <i>Thorecta</i>, <i>Ritterella</i>, <i>Condomium</i> and <i>Polycarpa</i>) recorded around some of the south-western Spencer Gulf islands (e.g.</p>

	<p>Taylor and Grindal Island). The sessile fauna in the area has been described as “rich and diverse”, stimulated by the strong tidal movements (Wilson and Clark, 2004). A high abundance of sponges and ascidians form up to 50% of the benthic understorey at some surveyed sites on coastal reefs in the Cape Donington (= Cape Donnington) region, with soft corals (Alcyonarians) forming more than 20% of the benthic cover on reefs around Donington Island (SARDI S.A. Benthic Survey data, 1996, unpublished). Abundant invertebrates in parts of the region include gorgonian corals, soft corals, stony corals, ascidians, sponges, brittle stars, urchins, gastropods and bivalve molluscs, and some of these are further discussed in other sections of this table. Species richness data are not available.</p> <p>Bony and Cartilaginous Fish South-west Spencer Gulf: Anecdotal report of high diversity and abundance of shark and ray species. There are reported to be “many varieties of sharks and rays - many of the bays have a high population of rays and skates, along with the (benthic) Port Jackson Shark. Deeper waters are home to Mako, Hammerhead, School, Gummy, Thresher and White Sharks” (Flinders University Lincoln Science Centre promotional material, 1998). Whiskery Sharks, Saw Sharks, Cat Sharks, Wobbegongs, and other shark species also occur in the area. Specific information on fish species diversity in the area is not available for this report, though it is noted that the high diversity of habitat types (see sections above) would promote corresponding high species diversity amongst fish (e.g. that utilise the variety of reef, seagrass, cobble/rubble and sand habitats).</p>
<p>7. Habitat for Endemic Taxa/ Threatened Taxa/ Rare or Uncommon Taxa</p>	<p>Bony and Cartilaginous Fish Lincoln National Park - Thorny Passage – Thorny Passage Islands – Williams Island – West Point The region has a number of fish species of conservation concern, such as Leafy and Weedy Seadragon, Western Blue Groper (large individuals are found in the area), Blue-Throated Wrasse, Brown-spotted Wrasse, and other Wrasse species, Western Blue Devil, Harlequin Fish, Western Foxfish, and other reef fish species, including the uncommonly recorded leatherjacket species Gunn’s Leatherjacket. Leafy and Weedy Seadragon were listed in the IUCN Red List (2003) as <i>Data Deficient</i>. Western Blue Groper is a long-lived slow growing fish considered by some researchers to be potentially threatened (see Section 9.2), due to previous depletion of inshore populations by spearfishing and recreational line fishing, and current potential impacts on offshore populations due to bycatch in shark and Commonwealth scalefish fisheries. The species has been described as “highly vulnerable to over-exploitation” (Jones <i>et al.</i>, 1990). Wrasse species such as Western Blue Groper, Blue-throated Wrasse and Brown-spotted Wrasse are considered at State level to be potentially threatened species due to fishing-induced impacts on populations which are territorial, site-attached and have vulnerable population dynamics (e.g. Blue-throated Wrasse forms harem groups with size-based hierarchies, and is a protogynous hermaphrodite, i.e. sex reversal occurs) (Knight and Johnson, 1999). These and other reef fish species of conservation concern, such as Western Blue Devil, are discussed in Section 9.2, and in Baker (in press). There is a record of the apparently rare tropical species Deep Velvetfish <i>Kanekonia queenslandica</i> from the southern Eyre Peninsula / mouth of Spencer Gulf area (Gomon <i>et al.</i>, 1994; South Australian Museum record, cited in Baker, in press). The region is an important one for the Great White Shark. The species is listed in IUCN’s Red List (IUCN, 2003) as <i>vulnerable</i>; is also listed under the Commonwealth’s <i>EPBC Act 1999</i> as a <i>vulnerable</i> species, and was included, in September 2002, in Appendices 1 and 2 of the Bonn Convention on Migratory Species (see Parliament of Australia, 2002), which requires countries (“range states”) to co-operate in the protection of this species. In addition to the Great White Shark, a number of other shark species recorded in the southern Eyre Peninsula area are recognised as being of conservation concern in Australian waters (see Pogonoski <i>et al.</i>, 2002; Cavanagh <i>et al.</i>, 2003; Baker, in press). Examples include Smooth Hammerhead, School Shark, Whiskery Shark, Saw Shark species, and Wobbegong species, amongst others.</p> <p>Marine Mammals</p>

Lincoln National Park and Islands - Thorny Passage - Thorny Passage Islands

A breeding colony of Australian Sea Lions is found on **Albatross Island**. Haul out sites also occur at **Curta Rocks, Low Rock, Little Islet, Williams, Smith, Hopkins, Lewis, Thistle** and **Albatross Island**, the latter of which is also a minor breeding area (e.g. 7 pups recorded by Gales *et al.*, 1994). The Australian Sea Lion is currently listed as *rare* in South Australia under the *National Parks and Wildlife Act 1972*, and has also been considered by some researchers to be threatened (Gales, 1990; Gales *et al.*, 1994; Dennis and Shaughnessy, 1996, Shaughnessy, 1999). Australian Sea Lion populations are not increasing in SA; the species does not breed annually (unlike other pinnipeds), and pup mortality rates can be high in some areas (CSIRO media releases 1998 and 2000b; Shaughnessy, 2001b).

Bottlenose Dolphins and Common Dolphins are both found in the area (DEH, 2000b). The IUCN Red List (2003) listed the Bottlenose Dolphin as *Data Deficient*.

The region is part of the migratory path for Southern Right Whales (which were caught commercially from Thorny Passage during the 19th century). The Southern Right Whale was listed in the IUCN Red List (2003) as *conservation dependent*. The species is listed under S.A. legislation as *vulnerable*, and is also listed under the Commonwealth's *EPBC Act 1999* as a threatened species.

Other whale species (including species listed on the IUCN Red List, and protected under South Australian legislation) have been recorded moving through the area or stranding periodically. Examples of irregular strandings in the Thorny Passage area include Pygmy Right Whale and Sperm Whale (Kemper and Ling, 1991).

Lower Thorny Passage Islands, Albatross Island, Williams Island, Low Rocks, and Curta Rocks provide haul out sites for New Zealand Fur Seals, a species that was included in the IUCN Red List 2000 as *Lower Risk, but Conservation Dependent*, however New Zealand Fur Seal was not included in the IUCN Red List 2003.

Invertebrates

Southern Spencer Gulf (which includes **Thorny Passage and Islands** – e.g. **Taylor, Hopkins, Gindal** etc): The region is an important one for specimen shells from several families, and at least a dozen species are known to be collected from the area. Some specimen shell species in the area are rare, and most are of conservation concern due to their vulnerable population characteristics (see **Part 2**, of this table, and Section 9.2, and Baker, 2002). An incomplete list of specimen shell species known to occur in the Thorny Passage area include the following: *Zoila friendii thersites* (Hump-backed Cowrie); *Notocypraea piperita* (Peppered Cowrie) and *N. piperita* form *bicolor*; *Austrocypraea reevei* (uncommon and vulnerable – see Ponder and Grayson, 1998; Edgar, 2000; Baker, 2002); *Umbilia armeniaca* (Apricot-Coloured Cowrie – considered *rare* by shell authorities in Australia, and **Thorny Passage** supports a large, shallow-water population of particular note, given that the species is usually found in deeper waters, in the Great Australian Bight – see Wilson and Clarkson, 2004); *Zoila marginata orientalis* (= *Zoila marginata raybaudii*); *Amoria exoptanda* (Desirable Volute or Much-Desired Volute), *Amoria undulata* (Wavy Volute), *Notovoluta verconis* (Verco's Volute), *Conus anemone* form *compressus*; *Lyria mitraeformis*; *Semicassis (Anephalium) adcockii*, *Coralliophila mira*, *Xenophora flindersi* (Carrier Shell), *Austroharpa punctata* and *Sassia bassi* (the latter three species considered uncommon or rare, of limited distribution, and vulnerable - see Ponder and Grayson, 1998; Baker, 2002).

Southern Eyre Peninsula: The endemic nudibranch, *Sclerodoris trenberthi* (a small species which grows to a maximum size of 4.5 cm, golden red in colour with pale spots) is considered *rare*, has been found along southern Eyre Peninsula from Tumbly Bay around to Elliston (Shepherd and Thomas, 1989).

Southern Spencer Gulf (which includes **Thorny Passage**): The endemic ascidian *Ritterella compacta* is found along the coast of southern Spencer Gulf, and also around Flinders and Price Islands (Kott, 1997).

Thorny Passage: The endemic ascidians *Aplidium bacculum* (also recorded from Yorke Peninsula) and *Aplidium acroporum* (also recorded at Kangaroo Island) are found growing in the region (Kott, 1997; Australian Government Department of the Environment and Heritage, 2004b).

Thistle Island: The endemic ascidian *Aplidiopsis mammillata* has been recorded to date only from Thistle Island (Kott, 1997; Australian Government Department of the Environment and Heritage, 2004b).

Port Lincoln area: The Velvet Octopus *Grimpella thaumastocheir* is found in the area

	<p>(Zeidler and Norris, 1989), and the species has a restricted distribution in parts of southern Australia, and is considered to be “an unusual and relatively rare species” (Zeidler, S.A. Museum, pers. comm. to DEH, 2001).</p> <p>The endemic ascidian <i>Euherdmania translucida</i> is also found in the Port Lincoln area, growing in <i>Posidonia</i> beds (Kott, 1997; Australian Government Department of the Environment and Heritage, 2004b).</p> <p>Coastal and Marine Birds</p> <p>Lincoln National Park and Thorny Passage Islands: Breeding sites for seabirds, some of which have threatened or potentially threatened status in South Australia. Examples of potentially threatened species that breed or use habitat at coastal and/or island sites include: Little Penguin (breeding colonies at Lewis and Owen Islands), Fairy Tern (Owen Island), Hooded Plover (Owen and Williams Islands), and White-bellied Sea Eagle (Williams Island).</p> <p>Smith Island: Breeding population of the migratory Flesh-footed Shearwater, which is classified as <i>rare</i> under South Australian legislation. The species breeds on islands in the Indian Ocean, islands off south-western Western Australia and in the South Pacific (Robinson <i>et al.</i>, 1996). The Smith Island population is the first recorded breeding population of the Fleshy-footed Shearwater in South Australia (Robinson <i>et al.</i>, 1996)</p> <p>Williams Island and Grindal Island: Nesting area for Cape Barren Goose (Robinson <i>et al.</i>, 1996). Also recorded as using habitat on Smith, Lewis and Owen Islands. Cape Barren Goose has been described as the <i>second rarest goose species in the world</i> (Australian Heritage Commission, undated).</p> <p>Williams, Smith, Lewis and Owen Islands: Habitat for Rock Parrot, which has a coastal association, and is known to nest in the spray zone (Robinson <i>et al.</i>, 1996). The species is listed as <i>rare</i> under South Australian legislation.</p> <p>Several migratory Albatross species that pass through South Australia are listed under South Australian and Commonwealth legislation as threatened species, and also listed in the IUCN Red List 2003 (see Appendix 4). Albatross species are known to irregularly use the waters and island areas in Thorny Passage, but a species list for the area is not available for this report. It is noted that Buller’s Albatross, Northern Royal Albatross and the Southern Royal Albatross occur in the Eyre Peninsula area, which is generally recorded as the westerly limit (Environment Australia, 1998b).</p>
<p>8. Other Important Taxa</p>	<p>Marine Plants</p> <p>Lincoln National Park – Thorny Passage - Thorny Passage Islands: High percentage cover of encrusting and other coralline red algae (hypothesised to be important habitat for post-larval and juvenile abalone (Shepherd and Daume, 1996; Daume <i>et al.</i>, 1997). Also, high abundance of <i>Osmundaria prolifera</i> (large leathery red), forming a significant part of the benthic habitat in some areas.</p> <p>Bony and Cartilaginous Fish</p> <p>South-western Spencer Gulf: Regionally, the more exposed waters of south-western Spencer Gulf are important habitat for larger, older King George Whiting that migrate away from Spencer Gulf bays as they grow. Older Whiting utilise the patch reefs (which are covered with <i>Scaberia agardhii</i> and other fucalian macroalgae), sand patches, and the scattered <i>Posidonia</i> seagrass beds (Jones, 1986).</p> <p>Reefs at Cape Catastrophe, Thistle, Little, Lewis and Smith islands, and along the Lincoln National Park coast (including Williams Island), are reported to be used by one or more of the life stages of the following commercially and/or recreationally significant fish species: King George Whiting, Snapper, West Australian Salmon, Tommy Ruff, Yellow-eye Mullet, Trevally, Yellow-tail Kingfish, Leatherjacket species, Snook, Western Blue Groper and other Wrasse species, Sea Sweep, Silver Drummer, Gummy Shark and Whaler Sharks (Bryars, 2003).</p> <p>The surf beach on the southern coast of Thistle Island (i.e. False Creek), is reported to be used by one or more of the life stages of School Whiting, West Australian Salmon, Tommy Ruff, Yellow-eye Mullet, flathead species, and Whaler Sharks (Bryars, 2003).</p> <p>Seagrass beds along the Lincoln National Park coast, and at Grindal, Taylor, Thistle and Owen Islands, are reported to be used by one or more of the life stages of King George Whiting, West Australian Salmon, Tommy Ruff, Southern Sea Garfish, flathead species, Trevally, Snook, Leatherjacket species, and Whaler Sharks (Bryars, 2003).</p>

	<p>Subtidal soft bottom (sand) habitats along the Lincoln National Park coast, and at Grindal, Taylor, Thistle, Owen, Smith, Lewis and Little Islands, are reported to be used by one or more of the life stages of King George Whiting, School Whiting, Snapper, West Australian Salmon, Tommy Ruff, Yellow-eye Mullet, flathead species, Trevally, Snook, and Whaler Sharks (Bryars, 2003). Except for Trevally and Snook, all of these species, as well as flounder species, are reported to utilise the sheltered beach habitats along the Lincoln National Park coast, and at Thistle Island (Bryars, 2003).</p> <p>Invertebrates</p> <p>Thorny Passage: Important habitat and conditions (e.g. source of drift food) for Greenlip Abalone, which are highly abundant in the area, and the area contains major sites for recruitment, purportedly providing larvae to a number of sites in southern Spencer Gulf / Southern Eyre area) (Shepherd <i>et al.</i>, 1992, and S. Shepherd, pers. comm., 1996). There is a highly productive Greenlip Abalone fishery in the area. Thorny Passage is also an important area for Blacklip Abalone. Roe's Abalone is also found in the region (Branden and Shepherd, 1982 and 1983), although less abundant than the Greenlip and Blacklip Abalone.</p> <p>Thorny Passage Coast and Islands: High densities of <i>Heliocidaris erythrogramma</i> (Purple Sea Urchin / Spiny Sea Urchin) recorded at some sites (Branden and Shepherd, 1983). <i>H. erythrogramma</i> is an important food source for Rock Lobster, Port Jackson Shark, leatherjacket species and Snapper. Some habitats contain high percentage cover of sponges and soft corals (see Selected Habitat Notes, above). In addition to large numbers of Sea Urchins (particularly the common <i>Heliocidaris</i> sp. that is harvested commercially in other parts of Australia), other abundant invertebrates include Spider Crabs (Majidae), and the large crab <i>Leptomithrax gaimardii</i> (which occurs in seasonal "plagues"), and Sea Cucumbers (Holothuroidea), all of which occur in the Thorny Passage area, particularly around some of the Thorny Passage Islands (PISA Fisheries Aquaculture Group, 1996; Hone <i>et al.</i>, 1997; Wilson and Clarkson, 2004).</p> <p>In general, reefs at Cape Catastrophe, Thistle, Little, Lewis and Smith islands, and along the Lincoln National Park coast, are reported to be used by one or more of the life stages of the following commercially and/or recreationally significant invertebrate species: Southern Rock Lobster, Maori Octopus, Greenlip Abalone, Blacklip Abalone, and Purple Sea Urchin (Bryars, 2003).</p> <p>In general, subtidal soft bottom (sand) habitats along the Lincoln National Park coast, and at Grindal, Taylor, Thistle, Owen, Smith, Lewis and Little Islands, are reported to be used by Sand Crabs and Southern Calamari, the latter of which is also reported to utilise the seagrass beds along the Lincoln National Park coast, and at Thistle Island (Bryars, 2003). Sand Crabs and baitworm species are reported to utilise the sheltered beach habitats along the Lincoln National Park coast, and at Thistle Island (Bryars, 2003).</p> <p>Coastal and Sea Birds</p> <p>Lewis, Smith and Owen Islands: Roosting area for Pacific Gull (Owen Island), and habitat for Black-faced Cormorant and Sooty Oystercatcher (Robinson <i>et al.</i>, 1996).</p> <p>Taylor Island: Habitat for White-faced Heron, Masked Plover, and Pacific Gull (Robinson <i>et al.</i>, 1996).</p> <p>Grindal Island: Roosting area for Black-faced Cormorant, and habitat for White-faced Heron, Sooty Oystercatcher, and Crested Tern (Robinson <i>et al.</i>, 1996).</p> <p>Williams Island: Breeding area for Short-tailed Shearwater (Robinson <i>et al.</i>, 1996) (see <i>section below</i>).</p> <p>Other Species</p> <p>Williams Island: Supports a population of Native Bush Rats, which have a coastal association, and have been recorded feeding (and possibly nesting) in piles of cast-up macroalgae and other marine debris, on other South Australian islands (Robinson <i>et al.</i>, 1996).</p>
9. Notable	Bony and Cartilaginous Fish

<p>Feeding, Breeding / Spawning and Nursery Areas</p>	<p>Lincoln National Park – Thorny Passage: The region is characterised by a high abundance of pilchards which are a significant food chain/food web species, associated with nutrient-rich waters that flow into south-western Spencer Gulf, through the strong currents of Thorny Passage. Pilchard spawning is closely associated with upwelling areas (Mackie, 1995; Ward <i>et al.</i>, 2000). Pilchards are a major food source for many species (see above, on Relative Productivity), including West Australian Salmon, which feed along the edges of the major surf beaches of southern Eyre Peninsula.</p> <p>In general, reefs at Cape Catastrophe, Thistle, Little, Lewis and Smith islands, and along the Lincoln National Park coast, are reported to provide both spawning area and nursery area for Western Blue Groper and Sea Sweep (Bryars, 2003).</p> <p>The surf beach on the southern coast of Thistle Island is reported to be a nursery area for juvenile School Whiting (Bryars, 2003). Sheltered beach habitats along the Lincoln National Park coast, and at Thistle Island, are reported to be spawning areas for Yellow-eye Mullet (Bryars, 2003).</p> <p>Invertebrates</p> <p>Lincoln National Park – Thorny Passage - Thorny Passage Islands: A major site for recruitment and larval dispersal of Greenlip Abalone, purportedly providing larvae to a number of sites in southern Spencer Gulf / Southern Eyre area (e.g. see Shepherd <i>et al.</i>, 1992). Also, there is abundant coralline red algal cover in the area, which is hypothesised to be important habitat for larval abalone, particularly blacklip (e.g. Shepherd and Daume, 1996; Daume <i>et al.</i>, 1997), which are also abundant in the area.</p> <p>Coastal and Marine Birds (from Robinson <i>et al.</i>, 1996, unless otherwise stated).</p> <p>Lincoln National Park, Memory Cove, and Thorny Passage Islands: Significant breeding sites for seabirds, at coastal and island sites. Some of the islands contain larger breeding colonies of Short-tailed Shearwater e.g. estimates of 69, 760 birds at Hopkins Island; 57,860 birds at Williams Island. Breeding colony also at Smith Island (Robinson <i>et al.</i>, 1996). Feeding area for seabirds, which utilise baitfish such as Pilchards as a major food source. According to Mackie (1995), seabirds such as Crested Tern, Little Penguin and Australasian Gannet are known to feed on Pilchards, as a major dietary item. Several Albatross species, which are recorded along Eyre Peninsula (Environment Australia, 1998b) also feed in the area (L. Best, DEH, pers. comm., 2003). Curta Rocks is a significant nesting area for sea birds (DEH, 2000b).</p> <p>Albatross Island: Small breeding colonies of Pacific Gulls and Little Penguins;</p> <p>Lewis and Owen Islands: Breeding colonies of Little Penguin and White-faced Storm Petrel;</p> <p>Lewis Island: Breeding colonies of Silver Gulls, Pacific Gulls and Black-faced Cormorants;</p> <p>Little Islet: Breeding colonies of Sooty Oystercatchers and Pacific gulls;</p> <p>Smith Island: Breeding area for White-faced Storm Petrel.</p>
<p>10. Shipwrecks and Artificial Reefs</p>	<p>The significance of known wrecks in the area as additional habitat is not known for this report. At least 3 fishing vessels have sunk off the eastern Lincoln National Park coast during the 20th century, but the condition of their remains is not known. North of the area discussed in this table, at Donington Island, a sunken wooden tuna boat (the <i>Dege</i>) is a recognised dive site due to the marine life it has attracted since being sunk in 1974 (Christopher, 1988; DIASA, undated).</p>
<p>11. Popular Dive Sites</p>	<p>Island reefs in the area (e.g. Taylor Island, Thistle Island) are recognised mainly for kelp beds and associated fauna; topographic features such as “walls”, small caves and “swim-throughs”; reef fish; Abalone and Rock Lobster. Diving with pinnipeds is a feature of Hopkins Island. Memory Cove to Cape Catastrophe coast is recognised for reef “wall” diving, with invertebrate-dominated caves and overhangs, large Western Blue Groper, Southern Blue Morwong (“Queen Snapper”) and other reef fish, pinnipeds and dolphins (Christopher, 1988; DIASA, undated; Aquanaut, undated). There are several other dive sites in the Thorny Passage islands area.</p>
<p>12. National and/or International Importance</p>	<p>Cape Donington: The area comprising the narrow intertidal shore platforms, mainly 10 m – 20 m wide, and down to low water mark, is listed on the <i>Register of the National Estate</i>, due to the presence of mafic charnockite gneisses, a “rare” igneous rock form that forms part of the crystalline basement of Eyre Peninsula. Low water mark and a straight line joining AMG points bound area: 6028-Lincoln-899557 and 912563. (Australian Heritage Commission,</p>

	<p>undated).</p> <p>Lincoln National Park: On the <i>Register of the National Estate</i>. Area comprises the granitic and limestone Jussieu Peninsula, plus Smith, Hopkins, Lewis, Little, Owen and Albatross, Liguanea, Bickers and Rabbit Islands, Horse Rock, Donington Reef, Carcase and Curta Rocks (Australian Heritage Commission, undated).</p>
<p>13. Major Commercial and Recreational Fish, Sharks, Molluscs and Crustaceans</p>	<p>Information specific only to the Thorny Passage area is not available for this report, however, the main fish, shark and invertebrate species caught commercially (and some also caught recreationally) in the South-Western Spencer Gulf region are:</p> <p><i>Fish:</i> Pilchards, Australian Salmon, King George Whiting, Snapper, Tommy Ruff, Garfish, and Snook. Reef fish in the area known to be caught commercially and/or recreationally include various wrasse species, Blue Morwong, Red "Mullet" (Goatfish), Leatherjacket species, Sweep, Boarfish, Redfish, Dusky Morwong. Species associated with sand / sediment are also caught in the area, in small quantities (e.g. Yellow-eye Mullet, Flathead) (SARDI, unpublished data, and various recreational fishing records).</p> <p><i>Sharks and Rays:</i> Gummy Shark, School Shark, Bronze Whaler and/or Black Whaler all occur in the area. Species irregularly caught in the area include various ray species, Whiskery Shark, Saw Shark, Wobbegong and Elephant "Shark" (SARDI, unpublished data, and various recreational fishing records).</p> <p><i>Invertebrates:</i> Greenlip and Blacklip abalone are the single major species invertebrate fisheries (see Shepherd <i>et al.</i>, 1999). Southern Calamari is fished commercially and recreationally in south-western Spencer Gulf. Southern Rock Lobsters are also caught in parts of the area. Western King Prawns are caught commercially in part of the area, mainly east and north of Thistle Island (see map in MacDonald, 1998, and DEH, 2003a, Figure 14). Sand Crab and Mud Cockle are also taken in small quantities in parts of south-western Spencer Gulf (SARDI, unpublished data, and various recreational fishing records).</p>

8.6 Sir Joseph Banks Group & Dangerous Reef (including Tumby Bay) (Eyre Bioregion)

Figure 8 depicts the location of this area.



Figure 8: Sir Joseph Banks Group & Dangerous Reef

<p>1. Biogeographic Significance</p>	<p>Dangerous Reef supports one of the three largest breeding colonies of Australian Sea Lions in the world. The populations is estimated to be around 1650 individuals (Robinson and Dennis, 1988; Gales, 1990; Gales <i>et al.</i>, 1994; Robinson <i>et al.</i>, 1996; NPWSA, 2003). Pup production at Dangerous Reef has been ranked second in a list of South Australian sites, with 426 pups observed in 2002 (Shaughnessy, 2002)</p>
<p>2. Major Physical Influences, and Relative Productivity Level</p>	<p>Physical Influences</p> <ul style="list-style-type: none"> ♦ The areas of south-western Spencer Gulf described in this table experience much variation in the strength of swells, waves and currents, therefore it is not likely that any one of these oceanographic factors influences the entire region in the same way. Fuller <i>et al.</i> (1994) described Southern Spencer Gulf as being characterised by “complex oceanographic conditions”. Some of the physical influences are listed below for various sections of the coast described in the table. ♦ According to maps in the South Australian Coast and Marine Atlas (DTUP, 2001, data by P. Petrusevics), South-Western Spencer Gulf is one of 8 areas in South Australia where <i>current speeds</i> are strongest during spring tides, for all seasons of the year. <p>Apart from the periodic strong currents, no other unusual or outstanding oceanographic features are recorded for the Tumbay Bay coast and Sir Joseph Banks area, however the following information on physical influences is provided, as background.</p> <ul style="list-style-type: none"> ♦ South-western Spencer Gulf generally experiences predominantly moderate wave energy (PISA Fisheries – Aquaculture Group, 1996), but within the Sir Joseph Banks Group, local wave energy highly variable according to the position of the islands in the gulf, and the position of each island relative to neighbouring islands. Further towards the coast, Tumbay Bay is generally a region of low wave energy with prevailing offshore winds, and low exposure to swells (Petrusevics <i>et al.</i>, 1998). The islands of the Sir Joseph Banks Group provide the coastal area with some shelter from high winds and wave energy (PISA Fisheries – Aquaculture Group, 1996). ♦ There is seasonal exchange between warmer Spencer Gulf waters and cooler shelf waters (Lennon <i>et al.</i>, 1987; Bruce and Short, 1992; Petrusevics, 1993). In-flowing water enters the gulf through the western side (Bye and Whitehead, 1975), and the periodic inflow of lower-salinity shelf water, which influences the southern end of south-western Spencer Gulf, is therefore likely to also affect the Sir Joseph Banks and Dangerous Reef area. ♦ In the Sir Joseph Banks Group, there is highly variable benthic topography close to the islands, due to sandbars, submerged reefs and the existence of submarine rises, including remnants of a submerged range system at the northern end of the group (see Robinson <i>et al.</i>, 1996). Water depth close to the coast of each island is variable, according to the underwater topography, and the position of the islands in Spencer Gulf. Most island are surrounded by waters 5m – 15m deep (S.A. Coast and Marine Atlas, 2001), however there are deeper waters and steeper gradients towards the south-eastern end of the group (e.g. Spilsby Island). <p>Little information is available about the relative productivity of areas described in this table. However, it is noted that southern Spencer Gulf has abundant cool-water, carbonate-rich Holocene gravels and sands, dominated by molluscs and bryozoa. Fuller <i>et al.</i> (1994) recognised five sedimentary facies (i) molluscan gravel; (ii) branching coralline-algal gravel, associated with shallow, partially protected environments; (iii) molluscan-bryozoan sand; (iv) mixed bioclastic sand, representative of the deeper central region of the lower gulf; and (v) bryozoan gravel, an isolated facies developed in a semi-protected micro-environment. The sediments share the characteristics of both the southern shelf and upper Spencer Gulf (Fuller <i>et al.</i>, 1994).</p>

<p>3. Bioregional Representativeness of Habitats</p>	<p>The Sir Joseph Banks area is a transition zone between two bioregions and contains physical, biological and ecological characteristics of both bioregions. The Sir Joseph Banks Group and Dangerous Reef are contained within the Eyre Bioregion, with the northern most island in the Sir Joseph Banks Group being less than 5km from the designated boundary zone between the Eyre and Spencer Gulf bioregions. The Sir Joseph Banks Group contains habitats that are typical of the Eyre Bioregion (as described below), although the abundance of <i>Sargassum</i> species and <i>Scaberia agardhii</i> as dominant macroalgal canopy species on the reefs is a known characteristic of the Spencer Gulf bioregion (IMCRA Technical Group, 1998). The area may therefore be considered as a “transition zone”.</p> <p>Features of the area that are characteristic of the Eyre Bioregion (IMCRA Technical Group, 1998) include:</p> <ul style="list-style-type: none"> ♦ “numerous offshore islands”; ♦ typical Flindersian Province flora; ♦ shallow reefs adjacent to “rocky limestone shores” mainly dominated by species of the brown canopy macroalga <i>Cystophora</i>, and the red <i>Osmundaria prolifera</i> (with <i>Ecklonia</i> present in the canopy in some areas, and species of the green <i>Caulerpa</i> in the understory, in some areas); ♦ in sheltered areas, subtidal seagrass communities dominated by species of <i>Posidonia</i> and <i>Amphibolis</i> (e.g. <i>P. sinuosa</i>, <i>P. angustifolia</i>, <i>A. antarctica</i>, <i>A. griffithii</i>); ♦ Significant breeding colonies of the Australian Sea Lion. <p>The northern end of Tumby Bay represents a boundary between the Spencer Gulf and Eyre Bioregions. The area described in this table contains habitat that is mainly characteristic of the Spencer Gulf Bioregion (IMCRA Technical Group, 1998), with features including:</p> <ul style="list-style-type: none"> ♦ moderate wave energy coastline; ♦ intertidal areas dominated by tidal creeks, the grey mangrove <i>Avicennia marina</i> and <i>Zostera</i> seagrass; ♦ in sheltered areas, benthic seagrasses include <i>Heterozostera</i> (= <i>Zostera</i> – see Soros-Pottruff and Posluszny, 1995 and Kuo, 2004), <i>Amphibolis</i> (e.g. <i>A. antarctica</i>) and <i>Posidonia</i> (<i>P. sinuosa</i>, <i>P. angustifolia</i>) species, including extensive seagrass meadows of <i>Posidonia</i> in some areas; ♦ “reef and rocky shore algal communities” dominated by <i>Scaberia aghardii</i> (corkweed) particularly in shallow waters; species of <i>Sargassum</i> and <i>Cystophora</i>; mixed red macroalgae including <i>Osmundaria</i>, and the turfing brown <i>Lobophora</i> in the understory.
<p>4. Habitat Rarity</p>	<p>Morelli and de Jong (1995), in a description of the significance of Tumby Bay as a <i>Wetland of National Importance</i>, considered the area to be a good example of a supratidal and estuarine (particularly mangroves and samphire) coastal habitat and associated near-shore marine environments, which together constitute a coastal system that has <i>been considerably reduced in many parts of Eyre Peninsula</i>.</p>
<p>5. Habitat Diversity</p>	<p>The Sir Joseph Banks area contains a large variety of marine habitats - sand and boulder beaches; granite shore platforms; subtidal granite boulder, platform and rubble reefs (often dominated by large brown seaweeds such as <i>Scaberia</i>, and species of <i>Sargassum</i> and <i>Cystophora</i>, and the large red <i>Osmundaria</i>, in some areas), and calcareous reefs (platforms, ledges, patch reefs etc); intertidal and subtidal sand habitats; low to medium density seagrass beds (several different types of seagrasses); and mixed habitats, such as seaweed-covered boulders interspersed with seagrass beds and sand patches; and calcareous patch and rubble reefs, interspersed with seagrass and sand patches.</p> <p>Summary of habitat types, from Branden and Shepherd, 1983; SARDI S.A. Benthic Survey data, 1993, unpublished; Morelli and de Jong, 1995; Robinson <i>et al.</i>, 1996; PISA</p>

Fisheries - Aquaculture Group, 1997; and S.A. Coast and Marine Atlas, 2001):

The diversity of habitat types in the **Tumby Bay** region include:

- ♦ Wetland area of saltmarsh, with numerous small drainage channels throughout the samphire flats, connected to First and Second Creek;
- ♦ Intertidal mangrove areas (approx. 12ha at First Creek, and smaller areas at the northern end of Second Creek) with two main tidal inlet channels (First Creek and Second Creek). First Creek has a small catchment area compared with Second Creek, and enters the bay in the north and flows through the Tumby Bay township. Second Creek is the largest channel and is situated at the southern end of the wetland area;
- ♦ Low to medium energy beach habitats;
- ♦ Supratidal and intertidal sediment beds: organic mud, sand and shelly deposits. Intertidal sands are present at the creeks' entrances, along the coastal shore, and as a sandbar connecting Tumby Island to the mainland;
- ♦ Calcareous and sand island;
- ♦ Estuarine / intertidal seagrasses in the bay;
- ♦ Benthic seagrass meadows, including dense beds;
- ♦ Benthic sand habitat;
- ♦ Benthic reefs (e.g. granitic ledge reef and calcareous patch reef), covered mainly with mixed brown canopy-forming macroalgae, coralline red and green species;
- ♦ Mixed habitat: brown macroalgal-dominated reef (mainly granitic), seagrass and sand habitat in deeper waters.

Sir Joseph Banks Group

Examples of the variety of habitat types in the island group include:

- ♦ Various types and forms of macroalgal- and invertebrate-dominated reef, such as granitic shore platforms around islands; benthic boulder, platform and rubble reefs (mainly granitic); calcareous benthic platform reef, ledge reef and patch reefs;
- ♦ Beach habitats (both sand and boulder beaches present within the archipelago);
- ♦ Intertidal and shallow subtidal sandbars, and deeper benthic sand habitats;
- ♦ Low- to medium-density seagrass beds of different types (*Zostera / Heterozostera tasmanica* and species of *Posidonia*, *Amphibolis*, and *Halophila* all occur);
- ♦ Benthic sand habitat: According to study by Sinclair Knight Merz (cited by PIRSA 2002d), in depths over 15 metres, the bottom tends to be mainly bare, coarse sediment with undulations increasing in size with distance from the coast;
- ♦ Mixed habitat types. Examples include macroalgal- and invertebrate-covered granite boulders interspersed with seagrass beds (*Posidonia* spp. and *Amphibolis* sp.) and sand patches. Calcareous patch and rubble reefs, interspersed with seagrass beds and sand patches, also occur in some areas. Such "mixed" habitat provides opportunity for species that are associated with different habitats (e.g. reef-, seagrass- and sand-dwelling fish species) to occur in the same area.

Selected Habitat Notes

(SARDI S.A. Benthic Survey data, 1993 and 1995, unpublished; Morelli and de Jong, 1995; Robinson *et al.*, 1996; PISA Fisheries - Aquaculture Group, 1997).

The following description of **Dangerous Reef** is mainly from Robinson *et al.* (1996):

Dangerous Reef lies around 15.5km south-south-west of Stickney Island, and 17.5km from the nearest point on the mainland. The reef covers around 12ha., and comprises a chain of four large rocks, the largest being 3m high, and the remainder being barely dry. The reef consists of granite and pegmatite, which are the surface exposures of an isolated inselberg ridge. There is no covering of calcarenite on the reef. Vegetation occurs only on the largest islet, and consists of saltbush and herbs. The exposed rocks at the south-western end are covered with sea-bird guano, and

nests of seaweed. Subtidally, flat, macroalgal-dominated granite reef, seagrass beds and sand habitat occur in the vicinity of Dangerous Reef.

The **Sir Joseph Banks Group** is a cluster of 20 islands, islets and reefs, approximately 50km east-north-east of Port Lincoln. All of the islands are comparatively low lying, and composed of eroded, peneplained granite or gneiss, visible as shore platforms fringing some of the islands. Some of the granite has weathered to form a jagged, kaolinised rock. Weathered clays above the kaolinised granite form low cliffs in some areas, capped by younger calcrete (Robinson *et al.*, 1996). Most of the islands in the group are small and low-lying, and thus offer little shelter from the sea. Some of the larger islands in the group support beaches and sand dunes, and Marsh Saltbush is one of a number of shrubland species common on islands in the group. Many of the reefs (mainly granite) around the islands in the Sir Joseph Banks Group are covered mainly with brown canopy macroalgae, such as species of *Cystophora* and *Sargassum*, with lesser amounts of *Scaberia agardhii* and *Caulocystis* sp.. Many of the boulder reefs are interspersed with seagrass beds and/or bare sand. The large leathery red *Osmundaria prolifera* is also abundant on many reefs, as are articulated coralline algal species, and smaller turfing browns (e.g. species of *Lobophora* and *Zonaria*) in the understory. Sponges and bryozoa are common in the understory around some islands (SARDI S.A. Benthic Survey data, 1993, unpublished).

Kirkby Island: The island of 27ha. lies around 5.5km west of the southern tip of Reevesby Island, and 10.5km east of Point Bolingbroke (Robinson *et al.*, 1996). There are no bays or beaches on Kirkby Island, which is a dome-shaped granite island surrounded by rocky reef. There is a thin layer of calcarenite and calcrete overlying the granite on the east coast of Kirkby Island (Robinson *et al.*, 1996).

Sibsey Island: The island is 25m high and 30 ha in area, and lies around 13.5km south-east of Point Bolingbroke, and 25km north-east of Cape Donington. Sibsey is a mass of granite with no calcarenite capping, unlike other islands in the group. The island is surrounded by small bays encircled by steep granite ramps. There are no beaches on Sibsey Island, and the coast of the island is surrounded by deep water (Robinson *et al.*, 1996). According to a survey by Sinclair Knight Merz (cited by PIRSA, 2002d), north of Sibsey Island is one of 4 areas in south-western Spencer Gulf where the most dense seagrass beds are located, and *Halophila* is the dominant seagrass in the area.

English Island: A low, rounded granite island of 3ha that rises from deep water to 5m high. English Island is located 1.2km east-north-east of Sibsey Island. There is a remnant patch of calcarenite on the southern section, and the exposed rocks of the northern section are covered with bird guano, embedded with large rounded boulders of basement rock. All sides of the island are exposed to swells (Robinson *et al.*, 1996).

Stickney Island: The island lies around 8.3km east-south-east of Sibsey; covers approximately 70ha, and is around 30m above sea level. Stickney is granitic (gneiss), with a thin covering of calcarenite. There are two bays around the island, on the south-east and northern sides. The larger bay opens to the south-east, has a distinct "finger" of granite on the northern flank, named Linklater Point, which ends in a small islet connected by small, drying reefs. Sand deposition has occurred along the tip of Linklater Point. There is a boulder beach in the south-eastern bay, and a sand beach in the smaller northern bay. Apart from the gradual depth descent in the two bays, the rest of the island's sides descend steeply to the sea floor (Robinson *et al.*, 1996). In the subtidal, during a benthic survey in 1993, the following cover was recorded: At 20m, a sparse cover of *Posidonia* seagrass, with red macroalgal epiphytes, and a number of ascidians on the sand substrate. Another sampled site at 20m comprised mainly *Halophila* seagrass on the sand, with lesser cover of *Heterozostera* (= *Zostera*), and green *Caulerpa cactoides* plants. At a 20m site comprising sand interspersed with reef "bommies", *Amphibolis* and *Halophila* seagrasses were sparse on the sand. On the "bommie" surfaces, *Ecklonia* and mixed species of *Cystophora* and *Sargassum* were common on the lower parts of the reef, with *Ecklonia* and a species of *Cystophora* (*C. moniliformis*) becoming

more dominant on shallower surfaces (e.g. at 5m). Large ascidians, various forms of bryozoan (both plate-like and fern-like forms), and fine red macroalgae were also present at the reef / sand site at 20m. Similarly at 15m, the surface cover of a wave-exposed site comprised *Amphibolis*, *Posidonia* and *Halophila* on sand, and mixed *Cystophora* and *Sargassum* species on reef, with sponges, bryozoa, and various red and brown macroalgae in the understory. At 10m, on the exposed side of the island, a dense cover of *Posidonia* was recorded on sand. On reef at 10m, the survey recorded highly abundant cover of the red macroalga *Osmundaria prolifera* in some sampled areas, with mixed brown canopy species, including *Ecklonia radiata*, and various species of *Sargassum* and *Cystophora*. In the understory at 10m, mixed red (e.g. *Plocamium* species) and turfing brown taxa were prevalent, and a number of green *Codium pomoides* plants were also recorded. At another wave-exposed site at 10m, *Ecklonia* and mixed *Cystophora* and *Sargassum* species dominated, with turfing brown species, mixed reds, and sponges in the understory. In wave-sheltered areas, reef at 10m – 15m was covered with mixed brown canopy taxa, such as *Ecklonia radiata*, *Scaberia*, and species of *Cystophora* and *Sargassum*; with abundant coralline reds (e.g. *Jania*), sponges, and various red macroalgae (including succulent, multi-branched, and net-like forms) in the understory. Sampled sites at 5m on the exposed side of the island comprised the canopy species *Cystophora subfarcinata*, *Ecklonia radiata*, and other *Cystophora* species (e.g. *C. moniliformis*), with abundant *O. prolifera* plants, and an understory of mixed red taxa (species of *Plocamium* and other multi-branched species), articulated coralline algae, turfing brown species, the greens *Caulerpa brownii* and *Codium* sp., and bryozoa. Reef at 5m, at more wave-sheltered sites, contained a dense cover of several *Cystophora* species, with lesser cover of *Sargassum* species, *Scaberia*, *Osmundaria*, and turfing brown macroalgae in the understory. The seagrasses *Amphibolis* (with a dense cover of red macroalgal epiphytes) and *Heterozostera* (= *Zostera*), and articulated coralline algae, were recorded on sand at 5m. (SARDI S.A. Benthic Survey data, 1993, unpublished).

Spilsby Island is the largest (468ha) and most southerly of the Sir Joseph Banks group of islands, and is situated 30km east-north-east of Cape Donington, and 25km south-east of Point Bolingbroke. The highest point of the island is 41m above sea level. Typical of many in the Sir Joseph Banks Group, the island is granitic with a calcarenite capping. There are extensive outcrops of kaolinised granite along the western coastline, eroded by wave action into an irregular coastline. There are small bays around the island, rimmed with rough, jagged rock. Hawknest Bay, on the north-eastern side, is the largest bay on the island. On the more sheltered northern side, there is an exposed beach more than 1km long, with backing dunes that extend more than 300m inland. The dunes are backed by saltmarsh (Robinson *et al.*, 1996).

Boucat Island is a low, flat island of 7m high. The island lies around 2.3km north-east of Spilsby Island, and is connected to it by a submerged reef. Boucat has a rounded coastline, rising from shallow water as a rim of exposed granite, that grades through stranded sand beaches to a calcrete cap. There are low cliffs of iron-rich and kaolinised granite along the north-west coast, and a tide-dependent isthmus juts out of the south-east coast, connecting Boucat with **Seal Rock** (Robinson *et al.*, 1996).

Seal Rock: A small satellite islet connected to **Boucat Island**. The island is mainly bare, with the remains of a calcarenite cap and sand deposits (Robinson *et al.*, 1996).

Duffield Islet: A small (7.5ha) islet low lying island, 9m above sea level at the highest point. **Duffield Islet** is attached to **Spilsby Island** by a submerged reef, around 750m from the north-western tip of Spilsby. The coastal rim of Duffield Islet is predominantly exposed granite capped with calcarenite, and there are stranded sand beaches along the edge of the calcarenite, with the beginnings of dune formation evident at the north-eastern end of the island. There is a large pegmatite dyke that extends along the north-eastern shore at water level (Robinson *et al.*, 1996).

Hareby Island is one of the cluster of northern islands in the Sir Joseph Banks Group, which are connected subtidally by a submarine rise. Hareby is a long, flat island of

granite, with calcarenite capping. The island covers 53ha. and reaches 15m high at the eastern end. Hareby is ringed by low cliffs. There is a large sandy beach, part of a sandbar that joins Hareby to **Blyth Island**, running along the northern edge for around 900m. Most of the coastline is exposed granite, and behind the fringing coastal reef, there is deep, unconsolidated sand (supporting coastal vegetation) along much of the coast. The fringing reef extends seaward at the western end of the island, to form a drying reef around 200m long. This is the surface exposure of a submerged ridge that leads to **Smith Rock** and **Langton Island** (Robinson *et al.*, 1996).

Roxby Island is the most southerly rise of a mainly submerged northern range system. Roxby lies 1km south-east of **Hareby Island** and 6.5km north-north-west of **Spilsby**. The island of 92ha is 1.5km long and around 400m wide, and reaches 23m above sea level at the highest point. The granite core of Roxby island is exposed as shore platforms fringing the western coast. Most other coastal exposures on the island are kaolinised granite, eroded into an irregular coastline. Low, Iron-rich, clay cliffs overlie the granite along the northern and eastern coasts of the island. There are stranded sand beaches overlying the granite on the southern and western coasts, and a stable dune runs the length of the island (Robinson *et al.*, 1996). There are submerged reefs extending from the island's south-eastern corner, that rise rapidly from deep water. These are part of the submarine rise, that extends around 800m south-south-east.

Smith Rock, 925m north-east of **Langton Island**, is a small exposure of a ridge that runs south-west from **Hareby Island**. The island is composed of granite, and is almost completely submerged during high tides and heavy swells (Robinson *et al.*, 1996).

Langton Island, 4.6km west of Roxby Island, is the emergent summit of a ridge that runs south-west from **Hareby Island**. The flat island covers around 26ha, and is 12m high. The granitic island has a calcarenite mantle 3m – 4m thick, and cliffs (of kaolinised granite, clay and calccrete) along the north coast. The eastern tip of Langton Island is a rocky point around 200m long, covered with sand and bird guano. The north side of the eastern sand spit is the most sheltered area of the island's coast (Robinson *et al.*, 1996). In the subtidal, the following was recorded during a benthic survey in 1993: On sand, at 20m, a sparse cover of seagrasses *Posidonia*, *Halophila* and *Zostera (Heterozostera)*, with sparse coverage of red macroalgae and various sponges in the understorey. At 15m, a dense cover of *Posidonia* and *Amphibolis* seagrasses was recorded, and both species were also present at 10m, on sand patches interspersed with reef. On reef at 5m – 10m depth, the red macroalga *Osmundaria* dominated sampled sites, with a patchy and mostly sparse cover of *Sargassum* and *Cystophora* species (mainly *C. expansa*), *Scaberia*, and *Ecklonia radiata*. Coralline algae, large sponges, various species of small red macroalgae, turfing browns, and the green *Codium pomoides* were present in the understorey at 5m – 10m (SARDI S.A. Benthic Survey data, 1993, unpublished). On the more sheltered side of Langton, sampled sites on sand at 10m had a sparse to moderate cover of seagrasses *Posidonia*, *Halophila* and *Heterozostera* (= *Zostera* – see Soros-Pottruff and Posluszny, 1995, and Kuo, 2004) on a mostly bare sand substrate, with species such as *Pinna* Razorfish shells, bryozoa, and fine green macroalgae forming sparse cover in places. At 5m depth on the sheltered side of Langton Island, the 1993 survey recorded *Scaberia*, species of *Cystophora* and *Sargassum* and other furoid macroalgae in a mixed reef and sand habitat, with an understorey of turfing brown macroalgae and coralline algae. At 5m on mainly sandy substrate, *Posidonia* was recorded, with a lesser cover of *Heterozostera* (= *Zostera* – see Soros-Pottruff and Posluszny, 1995, and Kuo, 2004), sparse cover of *Scaberia*, and patches of branched red macroalgae (SARDI S.A. Benthic Survey data, 1993, unpublished).

Blyth Island, 5ha, lies around 750m north of **Hareby Island**, and is connected to it by a shallow sandbar. The sand deposits extend northwards from Blyth towards **Reevesby Island**, separated by a narrow channel (**McCoy Passage**). Blyth Island comprises a low ring of vegetated sand hills, around 12m at the highest point. The sand overlies a low platform of granite, which outcrops in a few places on the beach.

The dunes of Blyth Island form a ring, with a central depression around 9m below the rim. There is a bare sandy beach around the island (Robinson *et al.*, 1996).

Reevesby Island covers 344ha, and is the second largest island in the group. It is also the longest, stretching 6km from north to south. Reevesby is around 16km east from Point Bolingbroke, the nearest mainland point. The island is an example of a “tied island”, having originally been separated into 4 sections by rising sea levels, but now reunited into a continuous chain by sand deposited in the shallow channels. The four “lobes” of the island are distinguished by their granite, gneiss, amphibolite and calcarenite cap structure. The highest point of the island is around 25m above sea level, but most of the island is elevated 9m to 12m. There are long, curved beaches on the eastern side of Reevesby (e.g. McCoy Bay and Haystack Bay), and three salt pans, fringed by salt bushes, to the north and south of the beach that connects the southern lobe to the central section of the island (Robinson *et al.*, 1996). Subtidally, in mixed sand and reef habitat, a 1993 benthic survey recorded at 10m: *Posidonia* seagrass; bare sand; a species of the green macroalga *Caulerpa*; dense patches of *Sargassum* (possibly *S. linearifolium*) on reef surfaces; with lesser cover of other *Sargassum* species, *Scaberia agardhii*, and *Cystophora* species; and various sponges in the understorey. Similarly at sampled sites at 5m depth in relatively sheltered waters, *Sargassum* was the dominant cover on reef, and *Posidonia* on sand. Other brown canopy species at 5m included *Scaberia agardhii*, *Ecklonia radiata*, and minor cover of *Cystophora* species. On the more wave-exposed western side, the seagrass *Halophila* was recorded as a sparse cover on fine silty sediments at 20m. There were few other taxa present on the substrate, except small red macroalgae, and various ascidians. At 10m, *Posidonia* and *Halophila* occurred on sand, and reef surfaces were covered with mixed species of *Sargassum* (four species recorded) and *Cystophora* (e.g. *C. monilifera* and *C. expansa*), with a sparse cover of turfing brown macroalgae in the understorey. Reef at 5m on the western side was covered mainly with several species of *Cystophora* (mainly *C. monilifera*), with lesser cover of *Scaberia* and a *Sargassum* species, and the red *Osmundaria*, turfing brown macroalgae, and articulated corallines in the understorey. On sand at 5m, species of the seagrasses *Amphibolis*, *Posidonia* and *Heterozostera* (= *Zostera*) were recorded at some of the sampled sites, interspersed with the patches of reef flora (SARDI S.A. Benthic Survey data, 1993, unpublished).

Dalby Island, is a low, flat hemisphere-shaped island covering 5.5ha. The island is 11m above sea level at its highest point. On the north-western side, low dunes back a small beach, and granite gneiss extends from the subtidal to the calcareous layer around the rest of the island, forming low, rounded cliffs in places. Dalby is steep on all sides except the south-west, where a patch of emergent reef lies offshore (Robinson *et al.*, 1996).

Lusby Island is a low, flat island of 14ha, lying to the west of **Reevesby Island**'s southern end, and is connected to Reevesby by a rock reef that is partially covered with sand. Lusby is 9m above sea level at the highest point, and has a rounded coastline of pink gneissic granite, capped with calcarenite. There is an old sand dune in the centre of the island, and sand deposition on the island's northern end has formed a small beach, fringed by a sand bar and small dunes to 3m high. The island is surrounded by shallow, protected waters (Robinson *et al.*, 1996).

Marum Island, around 10ha, is 900m north of **Partney Island**, and is connected to Partney by a shallow sandbar. Marum rises from a granite base to a cap of calcarenite and sand, and is around 11m high. There is a cave on the south-western side, of 15m wide, 6m deep, and 1 to 2m high. The cave, which was previously mined for guano in the early 20th century, has three seaward entrances, and a vertical entrance 5m from the lip of the island. The surrounding waters are sheltered from exposure, due to the proximity of **Reevesby** and **Partney Island** (Robinson *et al.*, 1996). Subtidally, a 1993 benthic survey recorded at 20m: a sparse cover of the seagrass *Halophila*; turfing brown macroalgae (species in the Zonarieae group); species of the green macroalgae *Caulerpa* (possibly *C. trifaria*) and *Codium*; the succulent red macroalga *Botryocladia sonderi*; crustose and articulated red algae, and various sponge species. At 10m, *Posidonia* seagrass covered with a brown epiphyte was recorded on sand, with sparse quantities of the small seagrass

Heterozostera (= *Zostera*) also present. On reef surfaces at 10m, species of the brown macroalgae *Caulocystis* and *Cystophora* were recorded, with minor cover of *Scaberia*, and articulated coralline algae, sponges, and the red macroalga *Botryocladia* in the understory. At 5m, the survey recorded on reef: patchy cover of *Caulocystis*, various *Sargassum* and *Cystophora* species, and *Scaberia agardhii*; with sparse brown macroalgae in the understory, such as *Colpomenia* sp., and *Lobophora variegata* (SARDI S.A. Benthic Survey data, 1993, unpublished). On sand at 5m, *Posidonia* was dense at sampled sites, with a lesser cover of *Halophila* and *Heterozostera* (= *Zostera*) (SARDI S.A. Benthic Survey data, 1993, unpublished).

Partney Island lies around 4.6km north-east of Kirkby island, and 1.5km west of central Reevesby Island. Partney covers 40ha and rises to 9m above sea level. Partney Island is connected to **Marum Island** by a submerged sandbank. Partney is based on a concealed granite platform, visible as a narrow strip above the waterline. There is a well developed calcarenite cap covering most of the island, extending into the sea on the north-eastern and western-most sides, where it is more than 3m thick. There is a small beach with a spit of sand and gravel, on the north-eastern side, and the rest of the coast is made up of granite and calcrete boulders. The island lies in relatively sheltered waters (Robinson *et al.*, 1996)

Winceby Island, which covers 30ha and rises to 10m above sea level, lies 1.3km north of Reevesby, and is the most northerly island in the group. The island's base is a pink and grey granite, visible as a wave-washed shelf along the coastal perimeter. Around most of the island, the granite is covered by a cap of calcarenite, and there are large deposits of guano from the resident cormorants. There is a small beach on the northern coast, and a shallow rocky reef at the north-western corner, extending for about 100 metres. Most of the coast around Winceby is rocky, and descends into deep water.

Buffalo Reef is the easternmost component of the Sir Joseph Banks Group, and lies 43.5km east of Cape Donington, and 11.5km south-east of **Spilsby Island**. Buffalo Reef is a low, flat outcrop of porphyritic granite and biotite gneiss with pegmatite intrusions, rising 3m above sea level, and is submerged at times (Robinson *et al.*, 1996).

Tumby Bay: The intertidal wetland area of Tumby Bay (comprising samphire, mangrove, mud, sand, seagrass and macroalgal habitats) covers an area of approximately 1000ha (J. Morelli, pers. comm., cited by PISA Fisheries – Aquaculture Group, 1997). There are two main tidal inlet channels, forming three creeks. The main estuary is **Salt Creek**, at the north-eastern end of Tumby Bay, which extends approximately 2km inland (PIRSA, SARDI and DEH map, in Bryars, 2003). *Avicennia marina* var. *resinifera* Grey Mangrove communities are found edging **First Creek** (12 hectares) near the Causeway, and a larger stand occurs at the northern end of **Second Creek** (Morelli and de Jong, 1995; Minister for Transport and Urban Planning, 1998). Samphire saltmarsh occupies the region between First Creek (south of the Tumby Bay Marina) and Second Creek, and extends south of Second Creek (PIRSA, SARDI and DEH map, in Bryars, 2003). The samphire *Sarcocornia quinqueflora* occupies frequently-inundated muds near the mangroves and tidal channels (Morelli and de Jong, 1995). On the drier supralittoral zone, *Halosarcia* sp. dominates; and *Atriplex paludosa* and *A. calamifolia* grow in elevated, well-drained areas. Sand dune slopes support *Atriplex cinerea*, *Cakile maritima* and *Salsola kali*; the crest of the dunes supports *Allocasuarina verticillata*, and several shrub and herb species (Lange, Dames & Campbell Australia Pty. Ltd. 1990, cited by Morelli and de Jong, 1995). There is a beach that runs from the **Tumby Bay** township, north-eastwards to **Salt Creek**, at the north-eastern end of the bay. Within the shallows of the bay, mixed seagrass / patch reef / and sand habitats occur (PIRSA, SARDI and DEH map, in Bryars, 2003).

The following benthic habitat notes for the subtidal off **Tumby Bay** are from Morelli and de Jong, 1995; SARDI S.A. Benthic Survey data, 1995, unpublished; and PISA Fisheries – Aquaculture Group, 1997: Out of the bay, mixed rock (mainly granitic)

	<p>and sand habitat in Tumby Bay (6m - 10m) is dominated by <i>Sargassum</i> species on reef, with <i>Scaberia</i> and species of <i>Cystophora</i> also in the canopy, and an understory comprising mainly the small brown <i>Lobophora</i>, and encrusting corallines. Generally, <i>Scaberia</i> is common in the Tumby Bay reef area. <i>Amphibolis</i> and <i>Posidonia</i> seagrasses dominate the sand areas adjacent to reefs. On the southern side of Tumby Island, granitic ledge reef at 4m is mainly “bare”, with sparse cover of <i>Scaberia</i> and <i>Cystophora</i> species. Articulated corallines (e.g. species of <i>Metagoniolithon</i> and <i>Jania</i>), small turfing brown species (<i>Lobophora</i>) and green species (<i>Caulerpa</i>) also occur. In sandy areas adjacent to the reef, the seagrasses <i>Posidonia</i> and <i>Heterozostera</i> (= <i>Zostera</i>) occur. In the Tumby Bay region, coarse sandy habitat from 5m to 20m contains both dense seagrass stands and patches (predominantly <i>P. australis</i> and <i>P. sinuosa</i>) interspersed with bare sand ripple beds. The small seagrass <i>Halophila</i> also occurs in the area. Between 20m and 30m in the Tumby Bay area, mixed seagrass beds occur (containing three forms: <i>Halophila</i>, <i>Heterozostera</i> / <i>Zostera</i>, and <i>Posidonia</i>), with filamentous red algae, bryozoa and encrusting corallines in some areas. Unvegetated sand habitat also occurs at this depth, dominated by worm burrows and attached bivalve molluscs.</p> <p>Tumby Island: About 5km south-east of Tumby, around 600m offshore. A low sand and limestone island, linked to the mainland by a sand spit which is only exposed at low tide. There are native and introduced shrubs on the island (Australian Heritage Commission, undated), principally <i>Allocasuarina verticillata</i> woodland, <i>Eucalyptus incrassata</i> open scrub and <i>Atriplex</i> shrubland (Lange, Dames & Campbell Australia Pty. Ltd., 1990, cited by Morelli and de Jong, 1995).</p> <p>Salt Creek Beach occurs at the northern end of Tumby Bay. Further north, there are scattered nearshore reef and beach areas close to the coast, in the vicinity of Lipson Cove and Lipson Island, and mixed seagrass / reef patches / sand habitat offshore (PIRSA, SARDI and DEH map, in Bryars, 2003) .</p> <p>Lipson Island is a small sandy islet, on a granite base, linked to the coast at low tide. The remains of a connecting land bridge form a semi-submerged reef, overlaid by a tidally-exposed sandbar that extends to the mainland from the island beach. Vegetation is limited to a shrubland that includes <i>Atriplex</i> saltbush species and several others (Robinson <i>et al.</i>, 1996; Australian Heritage Commission, undated). On the eastern side of Lipson Island, there is a boulder and cobble slope of granite gneiss from the intertidal to around 3m depth, and dominant flora on the reef, at the time of a survey during the early 1980s, included <i>Cystophora moniliformis</i> and <i>C. subfarcinata</i>, <i>Ecklonia radiata</i>, and <i>Sargassum</i> species, with corallines (e.g. <i>Jania</i> sp.) in the understory (Branden and Shepherd, 1982).</p>
<p>6. Taxonomic Diversity</p>	<p>Bony and Cartilaginous Fish Over 70 fish species have been recorded from the Sir Joseph Banks Group (Australian Heritage Commission, undated), and a complete species inventory would likely reveal a higher number. Many different fish species associated with reefs, seagrass, and sand areas, as well as highly mobile species that range over a variety of habitats, all inhabit south-western Spencer Gulf, due to the variety of habitats and micro-habitats provided by the area, and the abundant food sources.</p> <p>Invertebrates The Australian Heritage Commission (undated), reported that the waters surrounding Sir Joseph Banks Group contain “rich marine communitiessupporting shellfish, echinoderms, hydroids, and crustaceans”. There are popular accounts from diving groups, that the Tumby Bay jetty supports a “diversity of invertebrates”. This anecdotal information cannot be quantified for this report.</p> <p>Estuarine, Coastal and Marine Birds Tumby Bay: Around 22 estuarine and coastal bird species recorded, 5 of which are listed under international treaties (Morelli and de Jong, 1995). Sir Joseph Banks Group: Approximately 38 coastal wading bird and seabird species</p>

	<p>have been recorded using the area, including around 11 species that breed on the islands (Copley, 1996; Robinson <i>et al.</i>, 1996; Australian Heritage Commission, undated).</p> <p>Dangerous Reef: No complete species lists are available for Dangerous Reef for this report, however the Australian Heritage Commission (undated) described the bird life of Dangerous Reef as being “varied and abundant”.</p>
<p>7. Habitat for Endemic Taxa / Threatened Taxa / Rare or Uncommon Taxa</p>	<p>Coastal Plants Tumby Bay: The Swamp Paperbark <i>Melaleuca halmaturorum</i> occurs in the area (e.g. adjacent to the present marina channel (Minister for Transport and Urban Planning, 1998). Swamp Paperbark (<i>Melaleuca halmaturorum</i>) is an ecologically important habitat type that has been reduced in South Australia due to coastal developments.</p> <p>Marine Plants Sir Joseph Banks Group: Presence of macroalga species <i>Corynophlaea cristata</i> (Phaeophyta) (Womersley, 1987) that is recognised nationally as a species with <i>limited range</i> (Cheshire <i>et al.</i>, 2000; Turner, 2000), found only within a small number of regions in South Australia.</p> <p>Bony and Cartilaginous Fish Sir Joseph Banks Group and Dangerous Reef: Important area for Great White Sharks (Bruce, 1992; Presser, 1995, and unpublished information), including breeding females, based upon unpublished observations of live sharks and dead specimens from the area during the past two decades. The Great White Shark was listed in IUCN’s Red List 2003 as <i>vulnerable</i> and <i>conservation dependent</i>, and is a protected species under the Commonwealth’s <i>EPBC Act 1999</i>, and under South Australian Fisheries legislation.</p> <p>South-western Spencer Gulf (includes Sir Joseph Banks area): Various wrasse species occur in the waters of south-western Spencer Gulf, and are caught commercially and/or recreationally. Examples include Blue-Throated Wrasse, Brown-Spotted Wrasse and Senator Wrasse. Reef-associated wrasse species are of conservation concern (see Section 9.2) due to fishing-induced impacts on populations that are territorial, site-attached and have vulnerable population dynamics –: for example, Blue-throated Wrasse form harem groups, with size-based hierarchies, and sex reversal also occurs (Shepherd, pers. comm.; Knight and Johnson, 1999). Western Blue Groper also occur in the area, but are protected from fishing in Spencer Gulf, under the <i>South Australian Fisheries Act 1982</i>.</p> <p>The Leafy Seadragon (protected under <i>South Australian Fisheries Act 1982</i>) is found at Tumby Bay (Dragon Search records 1996 – 2003; and Flinders University Lincoln Marine Science centre web site, 2001). Divers have also reported other syngnathid species in the area (e.g. Weedy Seadragon; Short-Headed Seahorse).</p> <p>Sculptured Sea Moth, is known to occur in the Tumby Bay area, and has been observed by divers. Sculptured Sea Moth is a sand-dwelling fish that may be of conservation concern (see Pogonoski <i>et al.</i>, 2002, and Section 9.2 of this report). The Common or Eastern Stargazer fish is also regularly observed in the Tumby Bay area, and despite its name, this benthic fish species is regularly recorded only in the S.A. gulfs region, and is considered uncommon on a national basis (e.g. Edgar, 2000). The Spotted Snake-blenny, <i>Ophiclinops pardalis</i>, a small fish species that may be endemic within South Australia, has also been recorded in the Tumby Bay area, and a few other locations in S.A. (such as Kangaroo Island) (see Baker, in press, for summary).</p> <p>See section on <i>Issues for Risk and Impact Assessment</i>, for more information on fish and shark species of conservation concern that occur in the Sir Joseph Banks Group and Tumby Bay area.</p> <p>Invertebrates Sir Joseph Banks Group and Dangerous Reef: Specimens shells of conservation concern, such as extensive colonies of <i>Zoila friendii thersites</i>, occur in sandy reef and sponge habitat around islands in the Sir Joseph Banks Group (e.g. see Wilson and Clarkson, 2004). Also, around 17 species of supposedly rare (including some “very rare”) bivalve and gastropod mollusc species have been recorded in the Sir Joseph Banks region (Zeidler and Gowlett, 1985, uncited reference in Edyvane, 1999b). Some examples reportedly include the endemic <i>Brechites (Foegia) veitchi</i>, a bivalve</p>

recorded north of **Marum Island**, and between **Reevesby** and **Winceby** Islands in depths of 6m - 12m, and also known from fossil assemblages in Western Australia (Lamprell and Healy, 1998); a supposedly rare species of bivalve, *Myadora pervalida*, however it is noted that this species occurs in all southern Australian states (Lamprell and Whitehead, 1992; Academy of Natural Sciences, 2003); *Semele monilis*, a reportedly "uncommon" bivalve recorded north of **Marum Island** and south-east of **Winceby Island**; and the helmet shell *Phalium* (= *Semicassis*) *adcockii*, which occurs across southern Australia.

Sir Joseph Banks Group: The unusually structured Velvet Octopus *Grimpella thaumastocheir* (Norman and Reid, 2000) has a limited known distribution in South Australia, and has been recorded from Port Lincoln, **Tumby Bay**, **Sir Joseph Banks Group** and Edithburgh (Zeidler and Norris, 1989).

Sir Joseph Banks Group: type locality for the endemic ascidian *Cnemidocarpa amphora*, in a genus that contains mainly tropical species (Kott, in Australian Government Department of the Environment and Heritage, 2004b).

There is also an unconfirmed record from the 1930s (cited by Zeidler and Norris, 1989), based on several specimens, of the "little known" deep water bob-tailed squid *Rossia australis* occurring in shallow water at **Reevesby Island**. The Southern Pygmy Squid, *Idiosepius notoides*, is restricted to seagrass habitats in Spencer Gulf and St Vincent Gulf (W. Zeidler, pers. comm. to DEH, 2001), which may include the Sir Joseph Banks Group.

Southern Eyre Peninsula: The nudibranch *Sclerodoris trenberthi* (a small species which grows to 4.5cm, golden red in colour with pale spots) may be endemic to South Australia, and is considered "rare", to date having been found only along southern Eyre Peninsula (from **Tumby Bay** around to Elliston) (Burn, 1989).

A number of species of macroalgae, invertebrates and fish that occur in the south-western Spencer Gulf region are endemic to southern Australia. Quantification is not possible for this report. Examples of invertebrate taxa that may be endemic within South Australia only, are provided in the section above.

Marine Mammals

Sir Joseph Banks Group and Dangerous Reef: Dangerous Reef (East and West reefs) is recognised regionally, nationally and internationally for providing significant breeding and haul out sites for Australian Sea Lions. The region supports one of the three largest breeding colonies of Sea Lions in the world (Robinson and Dennis, 1988; Gales *et al.*, 1994; Robinson *et al.*, 1996). The endemic Australian Sea Lion is considered by some researchers to be endangered (Gales, 1990; Gales *et al.*, 1994), and has been classified as *rare* under S.A. legislation. Breeding and/or haul out sites also occur at **English Island**, **Langton Island** (e.g. the sandy north-eastern spit), **Reevesby Island**, **Buffalo Reef** and **Smith Rock** (Robinson *et al.*, 1996; S.A. Coast and Marine Atlas, 2001).

Sir Joseph Banks Group: Bottlenose Dolphins are regularly present in the waters off Sir Joseph Banks Islands. IUCN Red List 2003 classified Bottlenose Dolphin as *Data Deficient*.

Tumby Bay: There are frequent sightings of various species of whales in the Tumby area (C. Kemper, S.A. Museum, pers. comm. cited by PISA Fisheries Aquaculture Group, 1997). All whale species entering South Australian waters are protected under the *National Parks and Wildlife Act 1972*.

Coastal and Marine Birds

(Morelli and de Jong, 1995; Robinson *et al.*, 1996; Australian Heritage Commission, undated; S.A. Coast and Marine Atlas, 2001).

The Eastern Reef Egret has been recorded on **Sibsey**, **Stickney**, **Boucat**, **Hareby**, **Roxby**, **Reevesby** and **Marum Islands**). Eastern Reef Egret is listed as *rare* under South Australian legislation.

Breeding and nesting sites for Cape Barren Goose on **Kirkby**, **Sibsey**, **Stickney**, **Boucat**, **Duffield**, **Hareby**, **Roxby**, **Langton**, **Blyth**, **Reevesby**, **Lusby**, **Marum**, **Partney** and **Winceby Islands**. The Sir Joseph Banks Islands are collectively considered to be the most important winter breeding area in South Australia for this species. Approximately half (1500 birds) of the entire breeding population of Cape Barren Goose in South Australia was recorded by NPWSSA survey in 1979 (Robinson *et al.*, 1996). Australian

	<p>Heritage Commission's <i>Register of the National Estate</i> (undated) listed Cape Barren Goose as "the second rarest goose species in the world".</p> <p>The Rock Parrot has a coastal association, often nesting in the spray zone, and is listed as <i>rare</i> under South Australian legislation. There is a large breeding and nesting population on Boucat Island (Robinson <i>et al.</i>, 1996). The species has also been recorded at Kirkby, Sibsey, Stickney, Spilsby, Duffield, Hareby, Roxby, Langton, Blyth, Dalby, Reevesby, Lusby, Marum, Partney, and Winceby Islands in the Sir Joseph Banks Group, and at Tumby Island, near Tumby Bay.</p> <p>Glossy Ibis is listed as <i>rare</i> under S.A. legislation and has been recorded at Spilsby and Boucat Islands.</p> <p>White-bellied Sea Eagle has nesting sites on Stickney Island, and has also been recorded at Sibsey, English, Spilsby, Langton and Winceby Islands. The species is listed under S.A. legislation as <i>vulnerable</i>.</p> <p>Fairy Tern, listed under S.A. legislation as <i>vulnerable</i>, is found on Kirkby, Stickney, Langton, Blyth, Reevesby, Partney, and Winceby Islands.</p> <p>Hooded Plover, listed under S.A. legislation as <i>vulnerable</i>, is found on a number of the islands, such as Reevesby and Lusby (Robinson <i>et al.</i>, 1996).</p> <p>Species that were formerly more abundant on the islands, according to previous surveys in the 1930s, but are now rarely seen, according to Robinson <i>et al.</i> (1996) include Pacific Black Duck; Little Black Cormorant; Glossy Ibis (<i>rare</i> under S.A. legislation, and listed under the Commonwealth's <i>EPBC Act 1999</i>); Lesser Golden Plover (a migratory species, listed under international conservation agreements); Flesh-footed Shearwater (<i>rare</i> under S.A. legislation, and listed under the Commonwealth's <i>EPBC Act 1999</i>); and Eastern Curlew (<i>vulnerable</i> under S.A. legislation).</p> <p>Albatross species are regularly observed at the Sir Joseph Banks Group islands, but these species are not detailed here because (i) Albatross are wide-ranging oceanic species that breed mostly in the sub-Antarctic islands (and some Albatross species breed in New Zealand), with limited site association to the coast in S.A.. However, many Albatross species that periodically occur in South Australia are listed as <i>vulnerable</i> (and 3 are listed as <i>endangered</i>) under the <i>Commonwealth's EPBC Act 1999</i>, and most are also listed as threatened species in the IUCN Red List 2003 (see Appendix 4, this report).</p> <p>A number of migratory bird species listed under international treaties are found in the region (see section below on National and/or International Importance).</p> <p>Tumby Bay provides habitat for bird species Eastern Curlew and Fairy Tern, both listed as <i>vulnerable</i> under S. A. legislation.</p> <p>During regular surveys of the Tumby Bay sewage ponds in 1998 and 1999, 40 native bird species were recorded, including an influx in August-September 1999 of more than 20 Australian Spotted Crake, and more than 15 Baillon's Crake, the latter being recorded rarely on the Eyre Peninsula, and listed as <i>rare</i> under S.A. legislation (Cox, 2001).</p> <p>Lipson Island provides breeding habitat for Fairy Tern (Copley, 1996, cited by Edyvane, 1999b; DEH, 2003a) listed as <i>vulnerable</i> under legislation.</p>
<p>8. Other Important Taxa</p>	<p>Marine Plants</p> <p>Sir Joseph Banks Group: High abundance of the large red macroalga <i>Osmundaria prolifera</i> (e.g. up to 50% - 90% of the benthic cover in samples from some shallow reefs in the area) and high abundance of articulated coralline algae in some areas (SARDI S.A. Benthic Survey data, 1993, unpublished). Due to their abundance and density, these species may be important components of the benthic habitat, particularly for epifauna and other invertebrates.</p> <p>Bony and Cartilaginous Fish</p> <p>Reef areas at the Sir Joseph Banks Group islands, Dangerous Reef and Buffalo Reef, and near the Tumby coast (e.g. Tumby Island, and Cape Euler) are reported to be used by one or more of the life stages of the following commercially and/or recreationally significant fish species: King George Whiting, Snapper, West Australian Salmon, Tommy Ruff, Yellow-eye Mullet, Trevally, Yellow-tail Kingfish, Leatherjacket species, Snook, Western Blue Groper and other Wrasse species, Sea Sweep, Silver Drummer; Gummy Shark and Whaler Sharks (Bryars, 2003).</p> <p>South-west Spencer Gulf, including Sir Joseph Banks Islands: Regionally, the more</p>

	<p>exposed waters of south-west Spencer Gulf and the Sir Joseph Banks Islands are important habitats for larger, older King George Whiting that migrate away from Spencer Gulf bays as they grow. The larger older whiting utilise the patch reef areas covered with <i>Scaberia agardhii</i> and other furoid macroalgae, sand patches, and the scattered <i>Posidonia</i> seagrass beds (Jones, 1986). Further evidence for the prevalence of larger King George Whiting in the area comes from the significant commercial, recreational and charter boat fishery in southern Spencer Gulf, for larger whiting that have moved out of the bays closer to shore. Although spawning is not known to occur in this area, larger older King George Whiting are considered to make a significant contribution to the spawning stock of this species in S.A. waters.</p> <p>Seagrass stands at the Sir Joseph Banks Group islands and around Dangerous Reef, are reported to be used by one or more of the life stages of the following commercially and/or recreationally significant fish species: King George Whiting, West Australian Salmon, Tommy Ruff, Southern Sea Garfish, Trevally, Snook, flathead species, Leatherjacket species, and Whaler Sharks (Bryars, 2003).</p> <p>Seagrass meadows along the Tumby coast are reported to support most of these species, as well as Snapper and Red "Mullet" (Bryars, 2003).</p> <p>Unvegetated soft bottom habitats at the Sir Joseph Banks Group islands, and around Dangerous Reef and Buffalo Reef, are reported to be used by one or more of the life stages of the following commercially and/or recreationally significant fish species: King George Whiting, School Whiting, Snapper, West Australian Salmon, Tommy Ruff, Yellow-eye Mullet, Trevally, Snook, flathead species, Yellow-tail Kingfish, and Whaler Sharks (Bryars, 2003). Unvegetated soft bottom habitat along the Tumby coast is reported to support all of these species, as well as Yellow-fin Whiting, Southern Sea Garfish, Red "Mullet" and flounder species (Bryars, 2003).</p> <p>Sheltered beach habitats at Reevesby I., Blyth I., and Spilsby I., are reported to be used by one or more of the life stages of the following commercially and/or recreationally significant fish species: King George Whiting, School Whiting, West Australian Salmon, Tommy Ruff, Yellow-eye Mullet, flathead species, flounder species, and Whaler Sharks (Bryars, 2003). Sheltered beach habitat along the Tumby coast is reported to support all of these species, as well as Yellow-fin Whiting, and flounder species (Bryars, 2003).</p> <p>Tidal flat habitats in the Tumby area (i.e. near First Creek, Second Creek, and Salt Creek) are reported to support one or more of the life stages of Yellow-fin Whiting, King George Whiting (First Creek), School Whiting, West Australian Salmon, Tommy Ruff, Southern Sea Garfish, Yellow-eye Mullet, Yellow-tail Kingfish, flathead species, and flounder species (Bryars, 2003). The tidal creeks reportedly support King George Whiting, Yellow-fin Whiting, West Australian Salmon, Tommy Ruff, Southern Sea Garfish, Yellow-eye Mullet and Snook. Black Bream and flathead species are also found in Salt Creek (Bryars, 2003).</p> <p>Invertebrates</p> <p>Sir Joseph Banks Group: The Australian Heritage Commission's summary of the area for the <i>Register of the National Estate</i> listing, stated that the waters surrounding the Sir Joseph Banks Group islands contain rich marine communities, including some rare and uncommon species, and supporting shellfish, echinoderms, hydroids, and crustaceans. Many different invertebrate groups inhabit the Sir Joseph Banks Group islands due to the variety of habitats and micro-habitats provided by the group. Various species of sponge, bryozoan and ascidian are abundant in deeper waters (e.g. 15 - 20+m) at some of the islands (e.g. Stickney Island) (SARDI S.A. Benthic Survey data, 1993, unpublished).</p> <p>Reef areas at the Sir Joseph Banks Group islands, Dangerous Reef and Buffalo Reef, are reported to be used by one or more of the life stages of the following commercially and/or recreationally significant invertebrate species: Southern Rock Lobster, Southern Calamari, Giant Cuttlefish, Maori Octopus, Greenlip and Blacklip Abalone, and Purple Sea Urchin (Bryars, 2003). Reef areas near the Tumby coast (e.g. Tumby Island, and Cape Euler, are reported to support Southern Calamari, Giant Cuttlefish, and Purple Sea Urchin (Bryars, 2003).</p> <p>Seagrass stands at the Sir Joseph Banks Group islands and around Dangerous Reef, are reported to provide habitat for Southern Calamari (Bryars, 2003).</p> <p>Unvegetated soft bottom habitats at the Sir Joseph Banks Group islands, and around Dangerous Reef and Buffalo Reef, are reported to provide habitat for Southern Calamari, and Sand Crabs (Bryars, 2003).</p>
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	<p>Sheltered beach habitats at Reevesby I., Blyth I., and Spilsby I., are reported to provide habitat for Sand Crabs, and bait worm species (Bryars, 2003). Various other crab species are also present (some in abundance) at the Sir Joseph Banks Group islands, in some intertidal areas such as rock pools, according to regional promotion materials. Additionally, the abundant seagrass and canopy macroalgae provide important habitats for a number of invertebrate groups that are found on macroalgal blades and holdfasts, and on seagrass blades.</p> <p>Tumby Bay coast: Molluscs (such as Razorfish, Roe’s Abalone, and various gastropod molluscs); echinoderms (e.g. <i>Helicoidaris erythrogramma</i>), crustaceans (e.g. Red Bait Crab, mud crab species, Smooth Pebble Crab, Blue Swimmer Crab) and worm species are abundant in the area (Branden and Shepherd, 1982; Morelli and de Jong, 1995; Tumby Bay Telecentre, 2000). Bryozoa (lace “corals”) are abundant in deeper waters out of Tumby Bay.</p> <p>Unvegetated soft bottom habitats along the Tumby coast are reported to support Blue Swimmer Crabs, Sand Crabs, Western King Prawns, Razorfish, King and Queen Scallops, and Southern Calamari (Bryars, 2003). Seagrass meadows along the Tumby coast support Blue Swimmer Crabs, Razorfish, King and Queen Scallops, and Southern Calamari (Bryars, 2003). The sheltered beach habitats in the area support Blue Swimmer Crabs, Western King Prawns, and bait worm species. The tidal flat habitats (i.e. near First Creek, Second Creek, Salt Creek) also provide habitat for these species, and Blue Swimmer Crabs are also reported in Second Creek itself (Bryars, 2003).</p> <p>Coastal and Marine Birds</p> <p>Sir Joseph Banks Group: In addition to the significant breeding populations (see section below) and rare or threatened species (see section above), other bird species coastal and sea bird species recorded on and around the islands include: Australian Gannet, White-faced Heron, Red-necked Stint, Masked Plover, Red-capped Dotterel, Red-kneed Dotterel, Ruddy Turnstone, Greenshank, Sooty Oystercatcher, Pied Oystercatcher, Pied Cormorant, Little Pied Cormorant, Little Black Cormorant, Black-Faced Cormorant, and Australian Pelican (Copley, 1995 and 1996; Robinson <i>et al.</i>, 1996).</p> <p>Tumby Island provides habitat for coastal / water birds such as Australian Pelican, Pacific Gull, Grey Teal, White-faced Heron, Crested Tern, Caspian Tern and Black Swan (Australian Heritage Commission, undated; PISA Fisheries – Aquaculture Group, 1996).</p> <p>In addition to providing breeding areas for Crested Terns and Little Penguins (see sections below), Lipson Island also provides habitat for Black-faced Cormorants, Pied Cormorants, Sooty Oystercatcher, Pacific Gull and Silver Gull (Copley, 1995 and 1996; PISA Fisheries – Aquaculture Group, 1996; Robinson <i>et al.</i>, 1996).</p>
<p>9. Notable Feeding, Breeding / Spawning and Nursery Areas</p>	<p>Marine Mammals</p> <p>Sir Joseph Banks Group: Breeding and haul out sites for Australian Sea Lion at Dangerous Reef, English Island, Langton Island, Buffalo Reef and Smith Rock (Robinson and Dennis 1988; Gales, 1990; Robinson <i>et al.</i>, 1996).</p> <p>Dangerous Reef: The East and West reefs of Dangerous Reef area support one of the three largest breeding colonies of Australian Sea Lions in S.A. (Robinson and Dennis 1988; Gales, 1990; Robinson <i>et al.</i>, 1996).</p> <p>Bony and Cartilaginous Fish</p> <p>Habitats along the Tumby coast, such as seagrass meadows, unvegetated soft bottom, and sheltered beach areas, are reported to be nursery areas for juvenile King George Whiting, Yellow-fin Whiting, Snapper, West Australian Salmon, Tommy Ruff, Southern Sea Garfish, Yellow-eye Mullet, Red “Mullet”, Trevally, and species of flathead and flounder (Bryars, 2003).</p> <p>Tumby Bay: Morelli and de Jong (1995) reported that “an extremely large number of juvenile fish” has been observed in the Tumby Bay waterways, some feeding on crabs and polychaetes. Tumby Bay mangrove creeks are a nursery area for King George Whiting (Jones <i>et al.</i>, 1990), and a nursery and feeding area for various other fish species, including a number of commercially and recreationally significant species. For example, tidal flat habitats in the Tumby area (i.e. near First Creek, Second</p>

	<p>Creek, and Salt Creek) are reported to be a nursery area for juvenile School Whiting, King George Whiting (First Creek), West Australian Salmon, Tommy Ruff, Southern Sea Garfish, Yellow-eye Mullet, flathead species, and flounder species (Bryars, 2003). Second Creek is reported to be a nursery area for King George Whiting, West Australian Salmon, Tommy Ruff, Southern Sea Garfish, and Yellow-eye Mullet (Bryars, 2003). Salt Creek is reported to provide habitat for juvenile West Australian Salmon, Yellow-eye Mullet and Black Bream (Bryars, 2003).</p> <p>Reef area along the Tumby coast (e.g. around Tumby Island, and Cape Euler): reported to be a habitat for juvenile King George Whiting, Snapper, West Australian Salmon, Tommy Ruff, Trevally, and Sea Sweep (Bryars, 2003).</p> <p>Sir Joseph Banks Group and Dangerous Reef: Purported breeding area for Great White Sharks, according to regular sightings of pregnant females during the past two decades.</p> <p>Sir Joseph Banks Group: Habitat around Sir Joseph Banks Group is considered by some to be "important fish spawning grounds" (District Council of Tumby Bay, submission to Primary Industries South Australia, 1994). There are unpublished accounts from boating visits to the Sir Joseph Banks Group, of abundance of small fish in the shallow waters surrounding some of the islands. It is not known for this report whether they are juveniles of larger species, or species of small fish.</p> <p>The abundant canopy macroalgae on reefs at the Sir Joseph Banks Group islands, and the various seagrass types in the area, provides an important habitat for many fish species that feed in macroalgal stands or seagrass, or use the plants for shelter.</p> <p>Invertebrates</p> <p>Habitats along the Tumby coast, such as seagrass meadows, unvegetated soft bottom, and sheltered beach areas, are nursery areas for juvenile Blue Swimmer Crabs, Western King Prawns, King and Queen Scallops, and baitworm species (Bryars, 2003).</p> <p>Tumby Bay's tidal flats and creeks (i.e. First Creek, Second Creek, and Salt Creek), and associated mangrove forest, provide nursery and feeding areas for juvenile Blue Swimmer Crabs and other crab species, Western King Prawns, and various other invertebrates, including bait worm species (Bryars, 2003).</p> <p>Coastal and Marine Birds</p> <p>Tumby Bay and Tumby Island are important breeding and/or feeding habitats for Black Swan, Australian Pelican, White-faced Heron, Little Pied Cormorant, other cormorant species, and 5 species of migrant shorebird (see National and/or International Significance) (Morelli and de Jong, 1995).</p> <p>Lipson Island supports a large breeding colony of Crested Tern (Copley, 1996; Robinson <i>et al.</i>, 1996), and is also a breeding area for Little Penguin (Robinson <i>et al.</i>, 1996).</p> <p>Sir Joseph Banks Group: At least 11 coastal marine bird species breed on the Sir Joseph Banks islands. Major breeding populations include:</p> <p><i>Cape Barren Goose</i>: The island group is one of the most important winter breeding areas in South Australia, containing half of the known breeding population in S.A.. The species nests on 15 islands in the group and has been recorded on 17 of the islands (Copley 1996; Robinson <i>et al.</i>, 1996; Australian Heritage Commission undated).</p> <p><i>White-faced Storm Petrel</i>: The species breeds on at least 16 of the islands. A previous survey recorded 113,100 birds on Reevesby Island, which is the largest breeding colony of this species in S.A. (Robinson <i>et al.</i>, 1996). Previous survey records for other islands in the group include 24,050 White-faced Storm Petrels at Partney Island; 9750 at Winceby; 9100 at Hareby; 4800 at Kirkby; 1950 at Blyth and 1300 at Dalby Island (Robinson <i>et al.</i>, 1996);</p> <p><i>Little Penguin</i> breeding colonies have been recorded on more than half of the Sir Joseph Banks islands: Kirkby, Sibsey, English, Duffield, Hareby, Roxby, Langton, Blyth, Reevesby, Partney and Winceby Islands, with burrows common along the coastal fringes (Robinson <i>et al.</i>, 1996).</p> <p>Many of the Sir Joseph Banks islands are covered in shrublands dominated by marsh saltbush, which in its undisturbed state supports breeding populations of <i>Short-tailed Shearwaters</i> (Australian Heritage Commission, undated). Other, smaller breeding populations on some of the islands include <i>Rock Parrot</i>, which sometimes nests in</p>
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	<p>coastal spray zones; <i>Black-faced Cormorant</i> and <i>Pied Cormorant</i> (e.g. both species breed on English Island, and the black-faced cormorant also breeds on Sibsey, Lusby, and Winceby Island, where relatively large breeding colonies make nests of seaweed, driftwood, grass and herbs); <i>Black-fronted Dotterel / Plover</i> (on English, Stickney, Reevesby, and nesting on Hareby); <i>Crested Tern</i> (on Kirkby, English, Hareby, Roxby, Partney, and Winceby Islands and a breeding population on Stickney Island); <i>Caspian Tern</i> (e.g. breeding on Sibsey Island, and also found on Kirkby, Blyth, Reevesby, Lusby, Roxby, Winceby and Partney Islands); <i>Pacific Gull</i> (found on 17 of the Sir Joseph Banks Group islands, with breeding and/or nesting populations known from Marum, Langton, Roxby, Boucaut, Duffield, Stickney, Sisbey, English, Kirkby Islands (Copley, 1995, 1996; Robinson <i>et al.</i>, 1996).</p> <p>Dangerous Reef: Supports breeding populations of the Black-faced Cormorant, Pacific Gull, and Silver Gull (Robinson <i>et al.</i>, 1996; S.A. Coast and Marine Atlas, 2000).</p>
<p>10. Shipwrecks and Artificial Reefs</p>	<p>The significance of known wrecks in the area as additional habitats is not known for this report. At least nine ships (historic wooden or iron vessels and modern fishing vessels) have sunk off the Sir Joseph Banks Group, and although several of these have been found, their significance as additional habitat (which is determined mainly by the extent of their remains) is not known for this report. At least two wrecks are known in the Dangerous Reef area (one historic, one modern), however their condition and status as additional habitat is not known for this report.</p>
<p>11. Popular Dive Sites</p>	<ul style="list-style-type: none"> ♦ The Sir Joseph Banks Group islands are considered to be popular diving spots due to numerous reefs and associated reef fauna, and a variety of reef fish. Islands in the group are also recognised by divers for the presence of Rock Lobster, Scallops and sea lions, and high water clarity in the area (according to DIASA, undated, and tourism promotion materials for Eyre Peninsula). Examples of such areas include the reefs around Stickney Island (listed in Christopher’s Diver’s Guide to S.A., 1988) and Spilsby Island, listed in Aquanaut’s S.A. dive site directory, with features of interest including the clear water, corals, Rock Lobster, sea lions, and “prolific marine life”. Dangerous Reef is well recognised for cage diving opportunities in the presence of Great White sharks, which occur regularly in the area. ♦ The Tumby Bay jetty and the surrounding area is recognised for the presence of stingrays and less common fish species (e.g. Sculptured Sea Moth; stargazers) that occur in the sandy areas around the jetty. Other biotic features of interest to divers include Leafy Seadragons and Short-headed Seahorses; the abundant sessile invertebrates on the jetty pylons; the seagrasses with abundant leatherjackets and other fish; and jetty-attracted fish such as large schools of Old Wife fish, as well as Moonlighters, Southern Cardinalfish, Cowfish and Puffer Fish. Octopus species, Red Bait Crabs, and mantis shrimps are also mentioned as features of this jetty (Christopher, 1988; DIASA, undated; Tumby Bay Telecentre, 2000; Muirhead, 2002).
<p>12. National and/or International Importance</p>	<p>Tumby Bay is listed as a Wetland of National Importance (ANCA, 1996; Environment Australia, 2001).</p> <p>Tumby Island and Lipson Island are on the <i>Register of the National Estate</i>, due to their role in providing breeding, roosting and feeding habitats for sea birds (Australian Heritage Commission, undated).</p> <p>The Tumby Bay area is used by at least 5 migratory coastal bird species that are listed under international migratory bird treaties (species include Pacific Golden Plover <i>Pluvialis fulva</i>, Grey Plover <i>P. squatarola</i>, Eastern Curlew <i>Numenius madagascariensis</i>, Sharp-tailed Sandpiper <i>Calidris acuminata</i>, and Ruddy Turnstone <i>Arenaria interpres</i> (Eckert, 1972, 1973; Lange, Dames & Campbell Australia Pty. Ltd., 1990, cited by Morelli and de Jong, 1995).</p> <p>Sir Joseph Banks Group: The group of islands is on the <i>Register of the National Estate</i>, in</p>

	<p>recognition of the geological formation known as the Spilsby Suite of the Lincoln geological complex (reference locality at a site on the southern peninsula of Spilsby Island); the importance of the island group for the breeding population of Cape Barren Goose; and the provision of breeding and haul-out areas for Australian Sea Lion.</p> <p>Migratory species from the northern hemisphere, which are listed under JAMBA and/or CAMBA international agreements, are known to occur at some of the islands in the Sir Joseph Banks Group (Morelli and de Jong, 1995; Copley, 1995; Robinson <i>et al.</i>, 1996; Australian Heritage Commission, undated). Examples include Greenshank and Ruddy Turnstone (e.g. both species at Hareby and other islands); Sharp-tailed Sandpiper (e.g. Roxby); Lesser Golden Plover (Partney); Grey Plover (Spilsby) and Sharp-tailed Sandpiper (Hareby and Roxby Islands).</p> <p>The Spencer Gulf region has been identified as an area of international importance for shorebirds, by Watkins (1993, cited by Morelli and de Jong, 1995).</p>
<p>13. Major Commercial and Recreational Fish, Sharks, Molluscs and Crustaceans</p>	<p>Some of the fish, shark and invertebrate species caught commercially and/or recreationally in the south-western Spencer Gulf area include:</p> <p><u>Fish</u>: Pilchards (commercial only, away from the islands), West Australian Salmon, King George Whiting, School Whiting, Yellow-fin Whiting (further north, Tumby Bay area), Snapper, Tommy Ruff (Australian Herring), Garfish, Snook, Wrasse species, Blue Morwong, Red "Mullet" (Blue-spotted Goatfish), Leatherjacket species, Sweep, Boarfish, Redfish, Dusky Morwong, Yellow-eye Mullet, flathead species, flounder species, Common Weedfish (caught, but not targeted), and Black Bream (the latter in the Salt Creek area).</p> <p><u>Sharks and Rays</u>: Gummy Shark, School Shark, Bronze Whaler and/or Black Whaler, Whiskery Shark, Saw Shark, and Wobbegong species, as well as the Elephant "Shark", various ray species.</p> <p><u>Invertebrates</u>: Southern Calamari, Southern Rock Lobster (southern areas), Greenlip and Blacklip Abalone, Western King Prawns (south and east of the Sir Joseph Banks Islands), Blue Swimmer Crab (Tumby area), Sand Crab, Mud Cockle, Oysters, King Scallops, Queen Scallops, and bait worm species.</p>

8.7 Neptune Islands Group (Eyre Bioregion)

Figure 9 shows the location of this area.



Figure 9: Neptune Islands Group

<p>1. Biogeographic Significance</p>	<p>North and South Neptune: The islands contain a nationally significant breeding population of New Zealand Fur Seals. During the early 1990s, North and South Neptunes contained half of the breeding population of New Zealand Fur Seals in Australia and 61% of the South Australian population. Up to 9400 and 13500 Fur Seals were counted on South Neptune and North Neptune Islands respectively, in 1992-93 (Shaughnessy <i>et al.</i>, 1996). In February 2000, the Neptune Islands' congregation was still the largest known in Australia (Shaughnessy, 2001a). North Neptune Island is the most important area in South Australia for production of New Zealand Fur Seal pups, and South Neptune is ranked third most important in the State (Shaughnessy, 2002; Shaughnessy and McKeown, 2002). New Zealand Fur Seal was classified in the IUCN Red List 2000 as <i>Lower Risk, but Conservation Dependent</i>, however the species was not included in the 2003 Red List.</p>
<p>2. Major Physical Influences, and Relative Productivity Level</p>	<p>Major Physical Influences Some of the major oceanographic influences in the area are:</p> <ul style="list-style-type: none"> ♦ high wave energy (particularly on the south-western coasts); ♦ the strong ocean swells, particularly from the south-west (Sturt, 1847) ; and ♦ the steep depth gradients (particularly on the western side of North Neptune, and most directions out from South Neptune Island). According to interpolated depth contours in the S.A. Coast and Marine Atlas (DTUP, 2001), water depth on the western side of North Neptune descends steeply, to around 80m deep within 1.5km from the coast, and similarly on south-eastern side of South Neptune, the depth grades to around 75m – 80m, within 2km of the coast. ♦ The easterly extent of warm water masses that influence the western Eyre Peninsula / eastern Great Australian Bight area, particularly the warm water mass that is generated in the Bight (Herzfeld, 1997; Herzfeld and Tomczak, 1997), may periodically extend to southern Eyre Peninsula (see Griffin <i>et al.</i>, 1997; Herzfeld, 2000). <p>Information on relative productivity is not available for this area, for this report. The highly productive area of upwelling along southern Eyre Peninsula (which results in high concentrations of phytoplankton, high abundance of zooplankton, and consequently high abundance of baitfish and their predators) occurs closer to the Southern Eyre coast (e.g. see Ward <i>et al.</i>, 2002); however the Neptune Islands may, to a lesser extent, be part of the zone of influence of upwelling in this region.</p>
<p>3. Bioregional Representativeness of Habitats</p>	<p>Neptune Islands are composed of granite inselbergs, boulder reefs, and sand habitats, typical of the exposed southern part of the Eyre Bioregion. The main features of the area that match the description of the Eyre Bioregion provided by IMCRA Technical Group (1998) are as follows:</p> <ul style="list-style-type: none"> ♦ the waters experience “high deepwater wave energy” and ♦ the presence of “significant breeding colonies of the New Zealand Fur Seal”.
<p>4. Habitat Rarity</p>	<p>Not known for this report.</p>
<p>5. Habitat Diversity</p>	<ul style="list-style-type: none"> ♦ Intertidal granite platforms (Robinson <i>et al.</i>, 1996), and cliff reefs which have steep depth gradients. For example, at points 1 km offshore on both of the main islands, the water reaches a depth of 50m, and 90m deep within 3km of the north island, according to depth contour maps in the S.A. Coast and Marine Atlas (DTUP, 2001). ♦ Subtidal granite reefs of various forms and orientations, including platforms, boulders, caves, crevices. The south-western sides of the islands are extremely exposed to high waves and swell, with “walls of water” recorded pounding the nearshore reefs (Robinson <i>et al.</i>, 1996). Dominant reef cover at the Neptune Islands not known for this report, however the canopy-forming browns <i>Ecklonia</i>, <i>Acrocarpia</i>, and species of <i>Cystophora</i> have been recorded on shallow reefs around other granite islands along the exposed southern Eyre Peninsula coast (see Southern Eyre Peninsula). Mixed sessile invertebrates (e.g. sponges, ascidians and hydroids), red macroalgae such as

	<p><i>Osmundaria prolifera</i>, <i>Sonderopelta coriacea</i>, and species of <i>Melanthalia</i>, <i>Phacelocarpus</i> and <i>Plocamium</i>, coralline reds (e.g. <i>Haliptilon roseum</i>, and coralline-covered rocks, have been recorded as dominant benthos on deeper reefs in the photic zone, at other exposed granite islands along southern Eyre Peninsula (see Southern Eyre Peninsula), and it is likely that similar benthic composition may occur around the Neptunes.</p> <ul style="list-style-type: none"> ♦ Benthic sand habitats also occur in the area; ♦ Survey information not available for this report for deeper waters around the Neptune Islands, however substrate cover (apart from areas of sand) in the deeper waters is likely to be dominated by soft benthos (e.g. soft corals, sponges etc.).
<p>6. Taxonomic Diversity</p>	<p><i>Bony and Cartilaginous Fish</i> Fish species are not quantified, although it is noted that at least 25 species (mainly pelagic schooling fish and reef fish) are caught commercially and/or recreationally in the deeper State waters of the southern Eyre region, and many more species found in deeper coastal waters are likely to be present in the area, due to the steep depth gradients and deep waters relatively close to the islands' coasts.</p> <p>There is very little information available for this report on the number of shark species in the area, however at least 8 shark species are known to commonly occur in the region, as well as several ray species, and a species inventory would likely indicate a far higher number, due to the steep depth gradients close to the islands, providing habitat for deeper water shark species not normally found close to the coast.</p> <p><i>Coastal and Marine Birds</i> The Australian Heritage Commission's <i>Register of the National Estate</i> (undated) listing, described "many" seabird species as breeding on the Neptune Islands, although only nine species with marine association were listed as examples.</p>
<p>7. Habitat for Endemic Taxa / Threatened Taxa / Rare or Uncommon Taxa</p>	<p><i>Bony and Cartilaginous Fish</i> Important area for the Great White Shark, which was listed in the IUCN's Red List 2003 as <i>vulnerable</i> and <i>conservation dependent</i>, and is protected under State legislation (<i>Fisheries Act 1982</i>), and nationally under the Commonwealth's <i>EPBC Act 1999</i>. Regular sightings of tagged sharks in the area indicate that some shark individuals regularly use the Neptune Islands, but also migrate from the Neptunes to other areas. For example, archival tagging has shown that an individual that was considered a "resident" of the Neptune Islands moved around 600km from those islands to the Great Australian Bight over a 10 day period, after residing in the vicinity of Southern Eyre for 64 days (CSIRO Information Sheet 41, 2000).</p> <p>Western Blue Groper is present in the region, and is fished commercially and recreationally. Blue Groper is a long-lived slow growing, site-associated reef fish species, and there are recognised risks to the populations, as discussed in Section 9.2.</p> <p><i>Marine Mammals</i> Lighthouse Island and South Neptune Island: Breeding and/or haul out sites for Australian Sea Lions. Australian Sea Lion classified as <i>rare</i> under S.A. legislation), and is considered by some researchers to be threatened (Gales, 1990; Gales <i>et al.</i>, 1994). According to SA Coast and Marine Atlas (DTUP, 2001), less than 50 Australian Sea Lions haul out on Lighthouse Island, and more than 50 sea lions breed and haul out on South Neptune Island. According to Robinson <i>et al.</i> (1996), Australian Sea Lions haul out on all islands in the Neptune group.</p> <p>North and South Neptune: Breeding populations of New Zealand Fur Seals are found on the islands (see section below, on Notable Feeding, Breeding / Spawning and Nursery Areas). The New Zealand Fur Seal was classified on the IUCN Red List 2000 as <i>Lower Risk, but Conservation Dependent</i>, however the species was not included in the 2003 Red List.</p> <p>Southern Eyre: Presence of threatened Southern Right Whale. Southern Right Whale was listed in the IUCN Red List (2003) as <i>conservation dependent</i>; it is listed under S.A. legislation as <i>vulnerable</i>, and is recognised as a threatened species, under the Commonwealth's <i>EPBC Act 1999</i>. At least five other species of whales are regularly recorded along the Southern Eyre coast and offshore islands (ANCA, 1996), including</p>

	<p>species listed in the IUCN Red List, and also under S.A. legislation, but the specific association of these species with the area around the Neptune Islands is not known for this report.</p> <p>Invertebrates A number of uncommon, and possibly endemic gastropod shell species have been recorded from the deeper waters around the Neptune Islands. Examples include the turrid shell <i>Taranis mayi</i>, and the typhine shell <i>Monstrotyphis bivaricata</i> (Wilson et al., 1993, 1994; Academy of Natural Sciences, 2003).</p> <p>Coastal and Marine Birds South Neptune Island: Possible breeding location for the Red-tailed Tropic Bird (Robinson et al., 1996; Tarburton, 1999; Rogers, 2002), which is considered to be rare in South Australia. Peregrine Falcon and Rock Parrot (which is one of the few parrot species that associates with island habitats) also occur at the Neptune Islands, and both species are listed as <i>rare</i> under South Australian legislation (Robinson et al., 1996). North and South Neptune Island contain breeding / nesting areas for Cape Barren Goose (Robinson et al., 1996), described by Australian Heritage Commission (undated) as the second rarest goose species in the world. South Neptune and Islet of North Neptunes: Breeding sites for Fairy Tern, according to Copley (1996, cited by Edyvane, 1999b) and SA Coast and Marine Atlas (DTUP, 2001). Fairy Tern is listed as <i>vulnerable</i> under South Australian legislation. Fairy Tern breeding success has declined markedly in some parts of S.A. in recent years (NPWS, 1995). North, South and other Neptune Islands: White-bellied Sea Eagle occurs in the area, including nesting sites on the uninhabited islands. This eagle species is listed as <i>vulnerable</i> under South Australian legislation, and is considered to be “generally uncommon” in South Australia, but moderately common in the southern Eyre Peninsula area (DEHAA, 1999). This species is considered vulnerable to human disturbance. According to DENR (1995, cited by PISA-Fisheries Aquaculture Group, 1996), Osprey and Peregrine Falcon also breed on the Neptune Islands. Both are listed as <i>rare</i> under S.A. legislation. Visitors to the islands have observed oceanic Albatross species (which may include threatened Albatross species listed under Commonwealth legislation and IUCN), utilising waters around the Neptune Islands to some extent, but details are not available for this report.</p>
<p>8. Other Important Taxa</p>	<p>Bony and Cartilaginous Fish Visitors, such as charter boat groups, to the islands report abundance of large rays (such as Smooth Stingray, and other species), however abundance relative to other parts of southern Eyre Peninsula is not known for this report. Reef areas at North Neptune and South Neptune are reported to be used by one or more of the life stages of the following commercially and/or recreationally significant fish species: King George Whiting, Snapper, West Australian Salmon, Tommy Ruff, Yellow-eye Mullet, Trevally, Yellow-tail Kingfish, Leatherjacket species, Snook, Western Blue Groper and other Wrasse species, Sea Sweep, Silver Drummer; Gummy Shark and Whaler Sharks (Bryars, 2003). Examples of other reef fish species known from the Neptune Islands include Barber Perch (often found in shallower water at the Neptune Islands, compared with some other parts of S.A.), Southern Blue Morwong, Swallowtail, and Redfish (museum and fishing records, cited in Baker, in press).</p> <p>Invertebrates Reef areas at North Neptune and South Neptune are reported to be used by one or more of the life stages of the following commercially and/or recreationally significant invertebrate species: Southern Rock Lobster, Southern Calamari, Giant Cuttlefish, Maori Octopus, Greenlip and Blacklip Abalone, and Purple Sea Urchin (Bryars, 2003).</p> <p>Coastal and Marine Birds</p>

	<p>Other species recorded on the islands include Little Penguin, Ruddy Turnstone, Australian Kestrel, and Swamp Harrier (Robinson <i>et al.</i>, 1996).</p> <p>(see following section for information on major breeding colonies of other seabird species)</p>
<p>9. Notable Feeding, Breeding / Spawning and Nursery Areas</p>	<p>Marine Mammals South and North Neptune Island: 61% of the New Zealand population in S.A. (49% of the Australian population) occurs on these islands (Shaughnessy <i>et al.</i>, 1994). Previously, up to 9400 and 13500 fur seals were counted on South Neptune and North Neptune Islands in 1992-93 (Shaughnessy <i>et al.</i>, 1996). The Neptunes are a very important area for pup production. In 1992-93, 2756 pups were recorded on North Neptune, and 1916 pups on South Neptune Island (Shaughnessy <i>et al.</i>, 1996). Since 1992-93, pup numbers have increased by 53% (representing around 6.3% per annum) on North Neptune Island, although pup numbers have decreased by approximately 1% per annum at South Neptune, possibly due to carrying capacity of the habitat being reached (Shaughnessy, 2001a). Recent estimates of pup numbers are approximately 4220 pups at North Neptune and 1770 at South Neptune Island (Shaughnessy, 2001a), indicating the significance of the Neptune Islands as a breeding site for this species. Shaughnessy (2002) ranked North Neptune Island as the most important area in South Australia for pup production, with 4221 counted in 1999 (Shaughnessy and McKeown, 2002). South Neptune was ranked 3rd most important area in South Australia for pup production, with 1767 pups counted in 1999 (Shaughnessy and McKeown, 2002). Waters around the Neptune Islands are important foraging areas for Fur Seals.</p> <p>Bony and Cartilaginous Fish The large production of Fur Seal pups on Neptune Islands provides a major food source for Great White Sharks. Waters off South Neptune Island have been described as “probably the best feeding ground for White Pointers in the southern ocean” (R. Fox, pers. comm., cited by Anon., 2000).</p> <p>Coastal and Marine Birds The islands contain important breeding sites for the burrowing Short-tailed Shearwater, which is present on the islands during the summer breeding season; however the nests / burrows remain all year round. On North Neptune and Lighthouse Island there are important breeding populations of Short-tailed Shearwater (approx. 18,900 at North Neptune and 13,248 at Lighthouse Island, according to counts published in Robinson <i>et al.</i>, 1996). There are also 3680 breeding Short-tailed Shearwaters on South Neptune Island (Robinson <i>et al.</i>, 1996).</p> <p>Neptune Islands also contain breeding / nesting colonies of Crested Tern, Rock Parrot, Sooty Oystercatcher, Pacific Gull, Silver Gull, Cape Barren Goose (nesting recorded on both North and South Neptune Island) and White-bellied Sea Eagle (Pizzey, 1988; Australian Heritage Commission, undated; Robinson <i>et al.</i>, 1996). The Neptune Islands are considered to support a “healthy population” of White-bellied Sea Eagles, and nesting sites occur on the uninhabited islands in the group.</p> <p>South Neptune and Lighthouse Islands: Breeding / nesting populations of Silver Gull, Sooty Oystercatcher, Pacific Gull, Rock Parrot (Robinson <i>et al.</i>, 1996), Caspian Tern (on South Neptune Islands, according to Copley, 1996, cited by Edyvane, 1999b) and Crested Tern (Copley, 1996, cited by Edyvane, 1999b; S.A. Coast and Marine Atlas, 2000).</p>
<p>10. Shipwrecks and Artificial Reefs</p>	<p>The extent to which shipwrecks in this area provide additional habitat is not known for this assessment. Seven shipwrecks are known in the area, but none have been found, and are likely to be significantly broken up due to the extreme oceanographic conditions in this area.</p>
<p>11. Popular Dive Sites</p>	<p>Viewing of Great White Sharks through cages is the major diving attraction in the area. There are few other reported biotic features of interest to divers, apart from the large stingrays. The lack of information about features of interest for divers, other than the sharks, is possibly due to the relative inaccessibility of the islands, and the fact that</p>

	<p>much of the island area has bathymetry that is too deep for recreational diving, and hazards (e.g. sharks) are present for unprotected divers.</p>
<p>12. National and/or International Importance</p>	<p>The 4 Neptune Islands are listed on the <i>Register of the National Estate</i>, in recognition of the large breeding colony of Short Tailed Shearwaters; the Little Penguins, Crested Terns, Rock Parrots, Sooty Oystercatchers, Pacific Gulls, Silver Gulls, Cape Barren Geese and White-bellied Sea Eagles; as well as the colonies of New Zealand Fur Seals and Australian Sea Lions (Australian Heritage Commission, undated).</p>
<p>13. Major Commercial and Recreational Fish, Sharks, Molluscs and Crustaceans</p>	<p>Some of the commercially and/or recreationally fished species that occur in deeper waters south of the Spencer Gulf mouth (including Neptune Islands and surrounds) include the following:</p> <p><u>Fish</u>: Ocean Leatherjacket (commercially fished), Southern Blue Morwong, Western Blue Groper (including large individuals), King George Whiting, Blue-Throated Wrasse and other Wrasse species, Redfish (Red “Snapper”), West Australian Salmon, Sweep, Trevally, Barber Perch, various Leatherjacket species, Swallowtail, Rock Ling, Snook, School Whiting, rock cod species, Mackerel, Barracouta, Yellow-tail Kingfish, Red “Mullet”, Boarfish, Flathead Species, Sergeant Baker (a fish species that is caught but not targetted) and Conger Eel.</p> <p><u>Sharks and Rays</u>: The deeper waters south of the Spencer Gulf mouth have traditionally been one of the major fishing areas in S.A. for Gummy Shark and School Shark. Other sharks such as Bronze Whaler and/or Black Whaler, Whiskery Shark, Saw Shark, Mako Shark, Wobbegong species, and various ray species, are caught in lesser numbers.</p> <p><u>Invertebrates</u>: Southern Rock Lobster and Abalone are single-species fisheries in the area, and other commercially and/or recreationally significant invertebrates include Southern Calamari, Octopus species and Giant Crab.</p>

8.8 Gambier Islands Group (Eyre Bioregion)

Figure 10 depicts the location of this area.



Figure 10: Gambier Islands Group

1. Biogeographic Significance	See section below on Major Physical influences , for information about oceanographic boundary zone, which is of regional (but not national) biogeographic significance.
2. Major Physical Influences, and Relative Productivity Level	<p>Major Physical Influences The Gambier Islands are located:</p> <ul style="list-style-type: none"> ♦ at the physical boundary of seasonal sea surface temperature fronts, where the warmer gulf waters and cooler waters from western S.A. meet, causing strong benthic temperature and salinity differentials (Bruce and Short, 1992; Petrusevics, 1993), ♦ in the vicinity of a nutrient rich summer-autumn upwelling from the south-west, which extends into southern Spencer Gulf (see Ward <i>et al.</i>, 2000, 2001, and references and discussion in tables for Southern Eyre Peninsula, and South-Western, Western and Far North-Western Kangaroo Island). ♦ Other significant physical influences on the biota in the area are likely to be the large variation in reef topography, and the steep depth gradients off some parts of the island group (e.g. South-West Rocks). <p>Relative Productivity Level Little information is available, however the following information is noted:</p> <ul style="list-style-type: none"> ♦ The location of the islands at the boundary of major gulf and oceanic ecosystems, may result in the area containing elements of both systems. Also, the influence of regional upwelling to the south-west of the area, may be partly responsible for the relatively high levels of species diversity, particularly macroalgae (Edyvane and Baker, 1998a), reef fish, and some invertebrate groups in the area.
3. Habitat Representativeness	<p>The Gambier Islands group contains a number of features, which are characteristic of the Eyre Bioregion (IMCRA Technical Group, 1998). These include:</p> <ul style="list-style-type: none"> ♦ offshore islands; ♦ localised cool water nutrient-rich upwellings; ♦ moderate to high deepwater wave energy coastline; ♦ exposed rocky coasts, including calcarenite cliffs and shore platforms*; ♦ subtidal macroalgal communities dominated by <i>Ecklonia radiata</i>, a number of <i>Cystophora</i> species, <i>Plocamium</i> spp., <i>Osmundaria prolifera</i> and <i>Caulerpa</i> spp.; ♦ sheltered sandy areas dominated by seagrass (<i>Posidonia</i> spp.); ♦ high plant species diversity, particularly amongst the red macroalgae (Rhodophyta); ♦ breeding colonies of the Australian Sea Lion. <p>*Note that the major reef type of the islands (granite) is not listed by IMCRA Technical Group (1998) as being characteristic of the Eyre bioregion, although there are numerous granite islands and subtidal granite reefs in this bioregion.</p>
4. Habitat Rarity	<i>Unable to determine for this report.</i>
5. Habitat Diversity	<p>Habitats represented in the Gambier Island group include:</p> <ul style="list-style-type: none"> ♦ islands, with associated intertidal and subtidal reefs of various compositions and forms. Examples of reef types and forms in the area include: granitic platform/shelf reefs, boulder and vertical reefs (“rock walls”) with a diversity of micro-habitats (ledges, boulders, caves, crevasses, overhangs, isolated reef outcrops), fringing calcarenite cliffs, platform reefs, blocks and cobble/rubble; ♦ beach habitats (minor, on sheltered sides of two islands); ♦ samphire / saltmarsh (very minor extent, at Wedge Island); ♦ mixed subtidal habitats (e.g. sand/ granite reef/calcarenite block/rubble reef habitat); ♦ benthic sand;

- ♦ subtidal seagrass (e.g. sheltered sites at North Islet and Wedge Island). (Robinson *et al.*, 1996; Edyvane and Baker, 1998a).

Selected Habitat Notes

(Robinson *et al.*, 1996; Edyvane and Baker, 1998a, and unpublished SARDI S.A. Benthic Survey data).

Wedge Island forms the largest emergent part of a reef range of Lincoln Complex granites and gneisses, most of which is below present sea level. A number of small peaks of Lincoln Complex Granite occur as reefs and islets around **Wedge**. The largest of these are capped with calcarenite, including **North Islet**, **South-West Rock**, **West Peaked Rock** and **East Peaked Rock** (Robinson *et al.*, 1996). South-West Rock is 3.2 km south-west of Wedge, and its granite base is divided by a shallow channel of surge, in an eroded joint in the platform (Robinson *et al.*, 1996). Peaked Rocks are two granite platforms capped with calcarenite remnants, situated south-south-east of the south-eastern tip of Wedge.

Wedge Island: The largest island in the Gambier Group, composed of Lincoln Complex granites and gneisses, with overlying Bridgewater Formation calcarenite (Robinson *et al.*, 1996). On the wave-exposed southern and western sides, there are cliffs (to 202m in places), above wave-cut platforms and rubble reef, comprising calccrete and sandstone blocks eroded from the cliffs above. In contrast, the northern and eastern sides of the island comprise low cliffs, grading to a continuous stretch of sand beach (Robinson *et al.*, 1996). There is saltmarsh in an inland depression, at the western end of the island. In the subtidal, dominant reef flora differ according to the depth and degree of wave exposure, on different sides of the island. A 1993 survey (Edyvane and Baker, 1998a, and unpublished SARDI S.A. Benthic Survey data) showed that shallow reef areas (5m) are dominated by mixed brown macroalgal taxa, such as *Acrocarpia paniculata*, *Ecklonia radiata*, and several mixed species of *Cystophora* and *Sargassum*. The large brown *Xiphophora chondrophylla* and large red *Osmundaria prolifera* also occur. Species of the green *Caulerpa* are common in the understory. Mixed sand and reef habitats at 5m on the eastern side are dominated by species of the seagrasses *Halophila* and *Posidonia*, on sand. Brown, canopy-dominating macroalgae such as species of *Cystophora* and *Sargassum* occur on reef patches, with mixed red macroalgae including several large taxa, species of the green *Caulerpa*, and a base of coralline algae in the understory.

Ecklonia radiata, *Seirococcus axillaris*, and mixed species of *Cystophora* and *Sargassum* dominate reefs at 10m – 15m on the eastern side of the island, with a mixed red and brown understory (e.g. species from the genera *Lenormandia*, *Asparagopsis*, *Plocamium*, *Homoeostrichus* and *Zonaria*). The seagrasses *Posidonia* (with heavy cover of *Cladosiphon* epiphyte), *Zostera (Heterozostera) tasmanica* and *Amphibolis antarctica* were recorded on the sand at 10m.

In areas of moderate exposure to water movement, reefs at 10m – 20m are dominated by the canopy-forming brown macroalgae *Ecklonia radiata*, *Scytothalia dorycarpa* and *Sargassum* species, such as *S. fallax*. The large brown *Acrocarpia paniculata* is also present. Small turfing brown taxa such as *Homoeostrichus sinclairii* and species of *Chlanidophora*, and reds such as species in the genera *Plocamium* and *Phacelocarpus*, and coralline turf, are common in the understory at 10m (Edyvane and Baker, 1998a). Mixed sponges, bryozoa and hydroid species formed between 10% and 60% of the surface cover on sampled reefs in some areas, such as those at 20m.

Caves and crevices are dominated by a variety of invertebrates (sponges, gorgonian corals, ascidians, soft corals etc) (Edyvane and Baker, 1998a and SARDI S.A. Benthic Survey data, 1993, unpublished; and various unpublished observations by divers and dive groups).

North Islet: The island, of 64ha, is situated 2.3km north-east of the northern point of Wedge Island. Like Wedge, North Islet is composed of Lincoln Complex granite, capped with calcarenite. There are calcareous cliffs around the entire perimeter, some vertical and unbroken, and others forming smaller ledges dissected by cones of rubble, in areas where the cliff face has collapsed (Robinson *et al.*, 1996). A 1993 benthic survey

	<p>(Edyvane and Baker, 1998a, and unpublished SARDI S.A. Benthic Survey data) showed that reefs in the shallows (5m) on the moderately exposed eastern side are not dominated by brown macroalgae, although mixed <i>Cystophora</i> species and <i>Ecklonia radiata</i> were present. The green <i>Caulerpa</i> dominated the cover on these shallow reefs, with smaller quantities of mixed reds (species of <i>Dasya</i> and <i>Plocamium</i>, and <i>Asparagopsis armata</i>) in the understory. Sandy areas at 10m – 15m were dominated by species of the seagrass <i>Posidonia</i>, with red epiphytes, and sponges (5% cover) in the understory.</p> <p>In some areas the water reaches a depth of 55 – 60m, less than 1km from shore (south of South-West Rocks), according to the interpolated depth contours in the S.A. Coast and Marine Atlas, 2001. Reef composition in deeper waters is not known for this report.</p>
<p>6. Taxonomic Diversity</p>	<p>Marine Plants Gambier Islands: High species diversity and abundance of all major groups of macroalgae, particularly large Rhodophyta and Phaeophyta species (also articulated corallines and Chlorophyta species). For example, in a 1993 benthic survey of the region, Wedge Island had the highest species diversity of brown macroalgae (Phaeophyta) and the 3rd highest species diversity of red macroalgae (Rhodophyta), when compared to 16 other regions sampled across southern Yorke Peninsula, including the island groups (Edyvane and Baker, 1998a).</p> <p>Bony and Cartilaginous Fish Gambier Islands: Anecdotal evidence from divers and fishers suggests that the region supports a high diversity and abundance of reef fish. Some of the reef species known in the area include: Western Blue Groper, Western Blue Devil, Ornate Cowfish, Spiny Boxfish, Western Talma, Harlequin Fish, Herring Cale, Zebra Fish, Barber Perch, Blue-throated Wrasse, Senator Wrasse and several other species of wrasse, various species of Leatherjacket, amongst many others. Reef fish in deeper waters around the islands include Snapper, Southern Blue Morwong, Redfish (Red “Snapper”), leatherjackets, amongst others.</p> <p>Invertebrates Gambier Islands: Diversity (taxonomic levels not known in detail) and abundance of invertebrates such as sponges, ascidians, bryozoa, and hydroids. Invertebrate diversity at the Gambier Islands is popularly known, but unquantified relative to other areas. In waters around parts of Wedge Island at a depth of 20m, mixed sponges, bryozoa and hydroid species formed up to 40% - 60% of the surface cover on reefs (Edyvane and Baker, 1998a, and unpublished 1993 benthic survey data).</p>
<p>7. Habitat for Endemic Taxa / Threatened Taxa / Rare or Uncommon Taxa</p>	<p>Marine Plants Gambier Islands: Presence of:</p> <ul style="list-style-type: none"> ♦ <i>Myriodesma harveyanum</i> (recorded by SARDI benthic survey – see Edyvane and Baker 1998a), a large brown macroalga with nationally recognised limited range (according to Cheshire et al., 2000 and Turner, 2000). <i>M. harveyanum</i> appears to be restricted to the western coasts of S.A., where it occurs at and just below low tide level (to 8m deep) in areas of strong water movement (Womersley, 1987). ♦ <i>Echinothamnion hookeri</i> (recorded in 1993 by SARDI survey, verified by HBS Womersley), considered by Cheshire et al. (2000) and Turner (2000) to be “potentially endangered”, although the status may be more indicative of lack of published records in South Australia. ♦ <i>Avrainvillea clavatiramea</i>, a tropical chlorophyte which has very rarely been recorded in S.A. (O’Leary, 1992, cited by Edyvane and Baker, 1998a; Womersley, 1984); ♦ <i>Jania pulchella</i>, a coralline macroalgae reported to have a nationally recognised limited range (according to Cheshire et al., 2000). Found in deep water on rough coasts, growing epiphytically on various algae (Womersley, 1996). <p>Bony and Cartilaginous Fish Gambier Islands: Presence of Leafy Seadragon (Dragon Search monitoring project,</p>

	<p>unpublished data, 1999) and Western Blue Groper (Baker, pers. obs., 1993; DIASA, undated). Other species (particularly reef fish) of potential conservation concern that are found in the area include several wrasse species, Harlequin Fish, and Western Blue Devil (according to unpublished observations from various individual divers and diving groups). The Leafy Seadragon is protected under legislation in South Australia, and was classified in IUCN's Red List 2003 as <i>Data Deficient</i>. Notes on the apparent population status of (and threats to) various reef fish species are provided in Section 9.2. Shark species of conservation concern, such as Saw Shark and Whiskery Shark (see Section 9.2), are caught in the southern Spencer Gulf area. The level of association of these species with the Gambier Islands is not known for this report, however fishing charter are known to catch Whiskery Shark at the Gambier Isles.</p> <p>Marine Mammals Gambier Islands: Australian Sea Lions breed and haul out at North Islet and Peaked Rocks, and haul out at South-West Rock. Population estimates include around 190 Sea Lions (24 of which were pups) at Peaked Rocks during the early 1990s (Gales, 1990; Gales <i>et al.</i> 1994), and more recently, reportedly less than 100 at both North Islet and Peaked Rocks (uncited data in S.A. Coast and Marine Atlas, 2001). Numbers have varied from 6 to 122 animals at Peaked Rocks and 4 to 73 animals at South-West Rock (Robinson <i>et al.</i>, 1996). Australian Sea Lion is classified as <i>rare</i> under S.A. legislation, and considered to be a threatened species (e.g. see Shaughnessy, 1999).</p> <p>Coastal and Marine Birds Wedge Island and North Islet: Habitat for Peregrine Falcon (Robinson <i>et al.</i>, 1996), listed as <i>rare</i> under South Australian legislation. Wedge Island: Habitat for Osprey and Rock Parrot (also at Peaked Rocks) (Robinson <i>et al.</i> 1996), both of which have a coastal association, and are listed as <i>rare</i> under South Australian legislation. Nesting area for White-bellied Sea Eagle, which is listed as <i>vulnerable</i> under South Australian legislation.</p> <p>Endemic taxa could not be readily determined for this report. A large number of invertebrates and macroalgae, and a smaller number of fish species, that occur in the nominated area are endemic to southern Australia, but quantification is not possible for this report. Examples of species in the area that may be endemic within South Australia only include:</p> <p>Wedge Island: Presence of the corals which were recorded during the early 1980s as being endemic to South Australia, such as the red and white soft coral <i>Nephthea cornuta</i>, which grows to more than 20cm high, and the endemic dome-shaped grey soft coral <i>Capnella shepherdii</i> (Southcott and Thomas, 1982). Wedge Island: the ascidian <i>Morchellium albidum</i> is known to date only from the type locality, at Wedge Island (Kott, in Australian Government Department of Environment and Heritage, 2004b).</p>
<p>8. Other Important Taxa</p>	<p>Marine Plants Gambier Islands and surrounding Reef: High abundance of coralline red macroalgae on reefs in some parts of the area (Edyvane and Baker, 1998a, and unpublished 1993 benthic survey data), which forms an important habitat for a number of fish and invertebrates.</p> <p>Bony and Cartilaginous Fish Reef areas at the Gambier Isles are reported to be used by one or more of the life stages of the following commercially and/or recreationally significant fish species: King George Whiting, Snapper, West Australian Salmon, Tommy Ruff, Yellow-eye Mullet, Trevally, Yellow-tail Kingfish, Leatherjacket species, Snook, Western Blue Groper and other Wrasse species, Sea Sweep, Silver Drummer; Gummy Shark and Whaler Sharks (Bryars, 2003).</p> <p>Invertebrates Gambier Islands (in general): High abundance of mixed benthic invertebrate assemblages</p>

	<p>(sponges, ascidians, bryozoa and hydroids) in some parts of the area (e.g. forming up to 60% of the benthic cover, around parts of Wedge Island); local abundance of gorgonians and soft corals (uncommon in abundant aggregations in shallow water, at statewide scale).</p> <p>Wedge Island: Divers report abundant ascidians, molluscs, sea-stars, and crustaceans (species list not available for this report).</p> <p>Reef areas at North Neptune and South Neptune are reported to be used by one or more of the life stages of the following commercially and/or recreationally significant invertebrate species: Southern Rock Lobster, Southern Calamari, Giant Cuttlefish, Maori Octopus, Greenlip and Blacklip Abalone, and Purple Sea Urchin (Bryars, 2003).</p> <p>Marine Mammals</p> <p>Gambier Islands: Haul out sites for New Zealand Fur Seals (Shaughnessy, 1990). According to the S.A. Coast and Marine Atlas (2001), numbers of fur seals range from approximately 50 animals on Wedge Island, 200 on Peaked Rocks, 10 on North Islet and 50 on South West Rock. The New Zealand Fur Seal was classified in the IUCN Red List (2000) as <i>Lower Risk, but Conservation Dependent</i>, however the species was not included in the 2003 IUCN Red List.</p> <p>South-western Yorke Peninsula and Island groups: Common Dolphins are regularly present in the region.</p> <p>Coastal and Marine Birds</p> <p>Wedge Island: Breeding colonies of Little Penguins (more than 100, according to S.A. Coast and Marine Atlas, 2001) and migratory White-faced Storm Petrels (see note in the following section on Notable Feeding, Breeding / Spawning and Nursery Areas) (Copley, 1996).</p> <p>North Islet: Breeding population of Short-tailed Shearwater (mutton bird), estimated in 1996 to be around 6732 birds (Robinson <i>et al.</i>, 1996). This is not a major breeding population however, as the population ranges in numbers from dozens to thousands.</p>
<p>9. Notable Feeding, Breeding / Spawning and Nursery Areas</p>	<p>Bony and Cartilaginous Fish</p> <p>Gambier Islands: Spawning area for King George Whiting (Fowler and McGarvey, 1997).</p> <p>Coastal and Marine Birds</p> <p>Wedge Island: A major breeding area for White-faced Storm Petrels (Copley, 1996; DTUP, 2001), comprising approximately 16,250 pairs (T. Dennis, pers. comm., 2003).</p>
<p>10. Shipwrecks and Artificial Reefs</p>	<p>The wreck of the <i>Glenpark</i>, on the northern side of North Islet, has been promoted for diving (Dive Oz, 2003), with some of the features including Western Blue Groper, Rock Lobster, abundant marine life, including the attached biota on the wreck. Two other found shipwrecks have been documented for the Gambier Islands area. One sank in 1840 and is scattered on the seafloor, and the other is the modern fishing vessel <i>Saori</i>, wrecked in 1975, but it is assumed not to be important as additional benthic habitat, since it is stranded on a ledge at the base of cliffs. There are no documented artificial reefs in the area.</p>
<p>11. Popular Dive Sites</p>	<p>Wedge Island was listed by DIASA (undated); Christopher (1988); Dive Oz's dive site directory (1998-2003); Aquanaut's dive site list for S.A. (undated) and in various other recreational dive site promotional materials. Habitat and species features of interest in the area include the variety of micro-habitats (e.g. caves, shelves, "drop-offs", "swim-throughs", vertical reef "walls") at various sites, including West Bay; invertebrate-dominated submarine caves; abundant soft corals and gorgonian corals, large Western Blue Groper, Western Blue Devil, Harlequin Fish, Redfish (Red "Snapper"), large variety and abundance of other reef fish species (including Barber Perch, Victorian Scalyfin, species of cowfish, various leatherjacket species, and many others), Sea Lions and Fur Seals, Rock Lobster, Abalone, and Leafy Seadragons. Tourism materials promote Wedge Island as being an area where numerous, large specimens of Rock Lobster, Abalone, Southern Calamari, Whiting, Western Blue Groper and a number of other Wrasse species, Redfish, Sweep and Snapper can be found.</p>

<p>12. National and/or International Importance</p>	<p>Gambier Islands: North Islet, Peaked Rocks, and South-West Rock are on the <i>Register of the National Estate</i>. Marine features listed in the Statement of Significance for registration relate to the use of the islands by sea birds, and the population of Australian Sea Lions.</p>
<p>13. Major Commercial and Recreational Fish, Sharks, Molluscs and Crustaceans</p>	<p>Some of the fish and shark species that are caught commercially (and in some cases only recreationally) south of Spencer Gulf i.e. around the Gambier Isles, Neptune Islands, Thistle Island, and north-western and western Kangaroo Island, include the following:</p> <p><u>Fish</u>: Ocean Leatherjacket (mainly commercial), King George Whiting, Redfish (Red “Snapper”), Blue Morwong, Snapper, Western Blue Groper, Sweep, Australian Salmon, various Wrasse species, Harlequin Fish, Yellow-tail Kingfish, Samson Fish, Boarfish species, Trevally, Tommy Ruff, Garfish, Swallowtail, Ling, Red “Mullet” (Blue-spotted Goatfish), flathead species, Conger Eel, various Leatherjacket species, Sergeant Baker and other deeper water reef fish (some caught but not targeted).</p> <p><u>Sharks and Rays</u>: School and Gummy Sharks (which dominate the commercial shark yields from the area), Bronze Whaler and/or Black Whaler, Whiskery Shark, Saw Shark, Wobbegong, various ray species.</p> <p><u>Invertebrates</u>: Greenlip and Blacklip Abalone, Southern Rock Lobster, Southern Calamari, Octopus.</p>

8.9 Franklin Harbour and surrounding waters (Spencer Gulf / North Spencer Gulf Bioregions Boundary)

Figure 11 shows the location of this area.

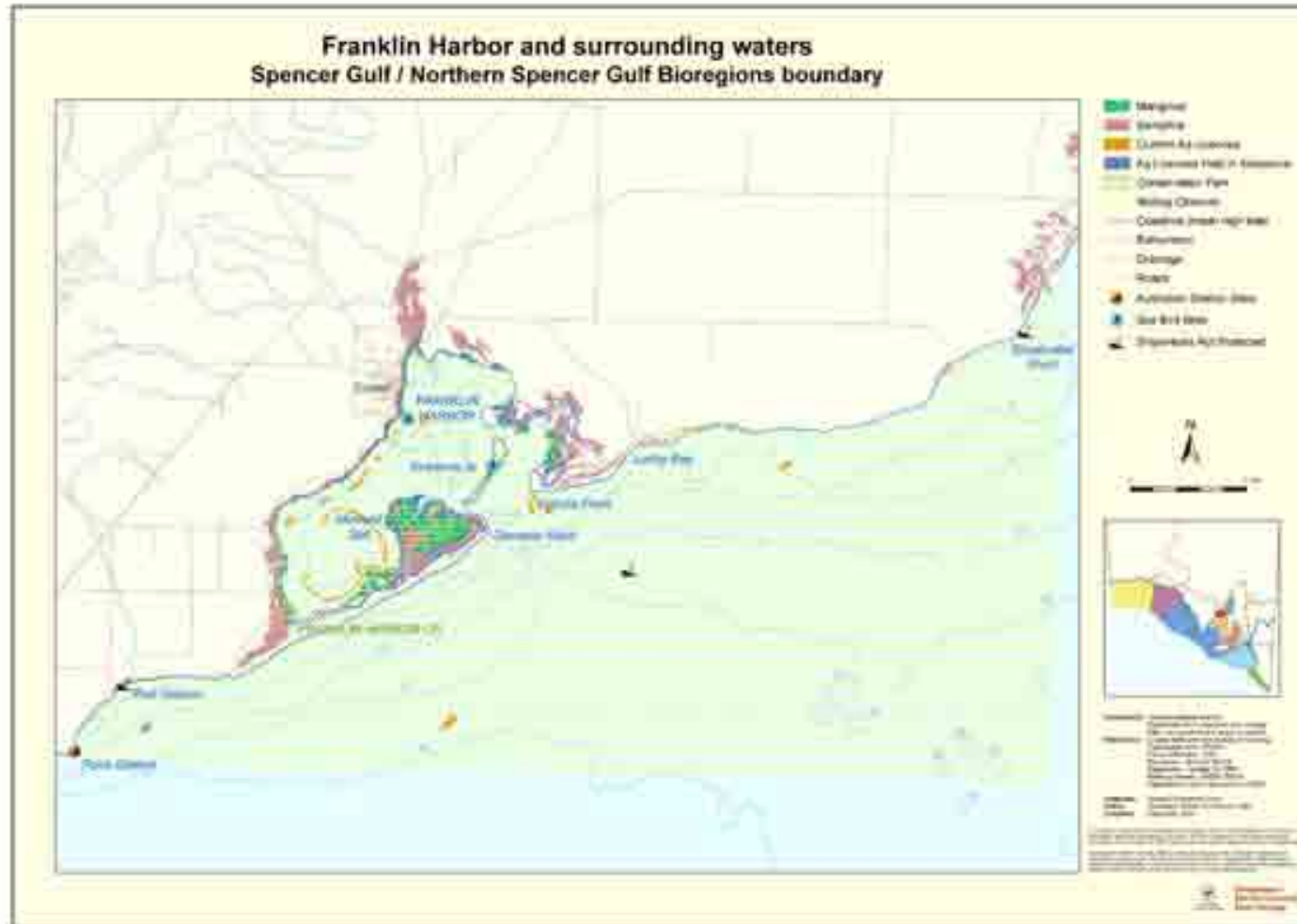


Figure 11: Franklin Harbour and surrounding waters

<p>1. Biogeographic Significance</p>	<p>Both the Australian Heritage Commission (which oversees <i>Register of the National Estate</i> listings) and Environment Australia (which oversees the <i>Wetlands of National Importance</i> listings), considered that coastal areas consisting of supratidal samphire and intertidal mangroves and associated bay habitats, constitute a coastal system that has been “considerably reduced in many parts of Eyre Peninsula” and “markedly depleted” in South Austral</p> <p>ia. Franklin Harbour is an example of such a coastal system.</p>
<p>2. Major Physical Influences, and Relative Productivity Level</p>	<p>No unusual or outstanding oceanographic features are recorded for the area, however the following information on physical influences is provided, as background.</p> <p>Physical Influences</p> <ul style="list-style-type: none"> ♦ Franklin Harbour is a shallow, tide-dominated (range 1.5m), semi-enclosed bay. The shallow harbour is subject to low wave energy (height averages less than 1m), and has accumulated extensive flood/ebb tide delta deposits (approx. 17 km², according to NLWRA 2000 assessment, cited by GeoScience Australia, 2001). ♦ In general, the surrounding coastal marine area is subject to moderate wave exposure and swell, however waters to the south of Shoalwater Point are subject to moderately high wave energies, where the coast faces the strong south to south-westerly winds, waves and occasional ocean swell. From Germein Point to Point Gibbon, the whole of the coast is exposed to relatively high energy swells and wind, and the cliffs and beaches in the area are subject to relatively high wave energy (Edyvane, 1995b; Smallridge, 1995). ♦ Currents are strong near the coast adjacent to Franklin Harbour, such as Shoalwater Point and Lucky Bay. Current speeds recorded in the area have been as high as 2 knots or 100cm/sec, but lower in the mid-gulf area away from the coast, and there is an anticlockwise gyre on the western side of the middle gulf (Petruševics <i>et al.</i>, 1998). The coastal area is also periodically subjected to strong wind-generated waves. <p>No specific information on relative productivity level is available for this area, for this report.</p>
<p>Bioregional Representativeness of Habitats</p>	<p>The area contains examples of features that are considered to be characteristic of the Spencer Gulf bioregion, according to description by IMCRA Technical Group (1998), such as:</p> <ul style="list-style-type: none"> ♦ low wave energy (e.g. enclosed bay of Franklin Harbour) to moderate wave energy (e.g. surrounding Spencer Gulf coast) coastline; ♦ tidal plain coast with shallow offshore gradients; ♦ extensive supratidal and intertidal area; ♦ the mangrove <i>Avicennia marina</i> in intertidal areas, including tidal creeks in bays; ♦ dunes, beaches and estuarine deposits; ♦ coastal <i>Wetland of National Importance</i> (Franklin Harbour); ♦ extensive seagrass meadows dominated mainly by <i>Posidonia</i> species; ♦ small shore-fringing macroalgal reef communities; ♦ macroalgal reef communities dominated by the brown macroalgae <i>Scaberia agardhii</i>, and <i>Sargassum</i> species, the red macroalga <i>Osmundaria prolifera</i>, and the turfing brown alga <i>Lobophora variegata</i>.
<p>4. Habitat Rarity</p>	<p>Shoalwater Point: Large colonies (up to 1.5m high) of the stony coral <i>Plesiastrea versipora</i> have been recorded on reefs in waters less than 10m in the area (SARDI S.A. Benthic Survey, unpublished data, 1995, cited by Edyvane, 1999b). According to Edyvane (1999b), it is probable that old massive colonies such as those at Shoalwater Point are now rare and isolated in the gulf regions, because many such colonies may have been destroyed in deeper waters of the gulf from long term trawling activities.</p>

	<p>Large, mixed red macroalgae are dominant on some reefs in the Shoalwater Point area (SARDI S.A. Benthic Survey data, 1995, cited by Edyvane and Baker, 1996c), which is an uncommon feature in the mid western Spencer Gulf region.</p> <p>Along the Point Germein Peninsula, mudflats are covered by the blue-green alga <i>Oscillatoria</i> sp., forming stromatolite-like mounds of sediment (Butler, 1975, cited by Edyvane, 1995b). Although smaller in extent than the renowned stromatolites at Shark Bay in W.A., stromatolite mounds are an uncommon feature in South Australia (NPWSA, 2002).</p>
<p>5. Habitat Diversity</p>	<p>Marine habitats within the enclosed barrier estuary of Franklin Harbour include:</p> <ul style="list-style-type: none"> ♦ supratidal saltmarsh; ♦ intertidal mangroves; ♦ extensive flood / ebb tide delta deposits, cut by three major tidal channels. Deposits have been classified as mainly sandy mud and muddy sand, but shelly deposits also occur; ♦ small calcareous patch reefs in the bay, dominated by the brown macroalga <i>Scaberia</i>; ♦ sandy internal bay islands; ♦ estuarine/intertidal and shallow subtidal seagrasses in the bay, including dense beds (mostly <i>Posidonia sinuosa</i>) in some areas such as the northern and south-western sections of the Harbour; <p>Marine habitats in the coastal areas outside of Franklin Harbour include:</p> <ul style="list-style-type: none"> ♦ Moderate wave energy sandy beach habitat; ♦ Calcareous coastal reef (low cliffs and shore reef); ♦ Intertidal (extending to shallow subtidal) sandy mud flats, covered with fine <i>Zostera</i> sp., and <i>Zostera</i> (= <i>Heterozostera</i>) <i>tasmanica</i> in places; ♦ Shallow subtidal and benthic seagrass, including dense seagrass beds composed of mostly <i>Posidonia</i> species; ♦ Benthic sand habitat; ♦ Benthic reefs e.g. macroalgal-dominated patch reefs (geological composition not known for this assessment) and coral patch reefs; ♦ Mixed habitats of mixed patches of reef, seagrass and sand in deeper waters. <p>Selected Habitat Notes (Australian Heritage Commission, undated; Burchill Bate Parker & Partners Pty. Ltd. 1992; Morelli and de Jong, 1995; Smallridge, 1995; Aquaculture Group – PISA Fisheries, 1996; Edyvane and Baker, 1996c; Edyvane, 1999b; GeoScience Australia, 2001; SARDI survey data, 2002; Bryars, 2003).</p> <p>Franklin Harbour A shallow, almost totally landlocked bay (48 km square, according to Eyre Peninsula Tourist Association, 1995, or approx. 4600 ha, according to Smallridge, 1995) with two entrance points to the inner harbour, one 300m wide and another 400m wide. Franklin Harbour was mapped in 2000 as part of the National Land and Water Resources Audit, and the following statistics were calculated (see GeoScience Australia, 2001 - 2004): Water area (km²) 57.14 Central Basin area (km²) 43.94 Flood/ebb delta (km²) 17.04 Channel (km²) 3.51 Intertidal flats (km²) 2.42 Mangrove (km²) 8.07 Floodplain (km²) 0.88 Saltmarsh / salt flat (km²) 7.13 Seagrass (km²) 41.6 Rocky reef (km²) 0.47</p>

Bedrock perimeter (km) 0.90
Entrance width (km) 2.31
Perimeter (km) 55.39
Entrance length (km) 4.13
Maximum length (km) 15.61
Maximum width (km) 5.05

Franklin Harbour comprises a long narrow sandy peninsula that protects the Harbour, with four inner bay islands near the mouth. There is a beach at the entrance (**Germein Point**), and a longer sandy beach (**Windmill Beach**) on the seaward side of the peninsula. The upper intertidal region of the Harbour, including two of the islands, is dominated by the mangrove *Avicennia marina*. The largest stand of mangroves occurs in the **Entrance Creek** area (PIRSA, SARDI and DEH map, in Bryars, 2003), however mangroves occur in a narrow band around almost all of the harbour. The mangroves grade into supratidal samphire shrubland (mainly *Halosarcia* and *Sarcocornia* spp.). Within **Franklin Harbour**, there are extensive areas of bare mud and sand. The wide intertidal sandy and muddy flats are largely devoid of seagrass, although they support eelgrass *Zostera mucronata* and *Zostera (Heterozostera) tasmanica* in some places (Aquaculture Group PISA – Fisheries, 1996). Mats of small green algae *Enteromorpha* sp. and small brown algae *Ectocarpus* sp. also occur in the intertidal area. The intertidal area is extensive, and the tidal flats merge with extensive subtidal seagrasses at the low water mark. There are several major channels in the Harbour, and the two main creeks are **Entrance Creek** near the mouth of the harbour, and **Poondra Creek**, near **Cowell**. The seagrass *Zostera (Heterozostera) tasmanica* occurs in the shallow subtidal in Franklin Harbour, but dense beds of *Posidonia sinuosa* dominate most of the shallow subtidal areas. Seagrass beds are more prevalent in the northern part of the harbour than the south, and there are patches of unvegetated soft bottom / sand in the central, southern and eastern parts of the harbour (Bryars, 2003). The brown macroalga *Scaberia agardhii* dominates the scattered rocky surfaces within the Harbour. At high tide the maximum depth in **Franklin Harbour** is 4-5 m.

According to Bucher and Saenger (1989, cited by Edyvane, 1995b), the size of the **Franklin Harbour** estuary and the extent and diversity of its associated wetlands suggest that its contribution to the ecology of Spencer Gulf would be significant.

Outside of **Franklin Harbour**, shallow water seagrass beds consist mainly of *Posidonia* species (especially *P. sinuosa*), although *Amphibolis antarctica* and *H. tasmanica* are also present. Seagrass forms virtually continuous stands to a depth of 10 metres. In general, patchy reef areas in the **mid western Spencer Gulf area** are dominated in places by the brown canopy macroalga *Ecklonia radiata* and mixed fucoids (e.g. *Sargassum linearifolium*, *S. spinuligerum*, *S. lacerifolium* and *S. distichum*), with an understory dominated by the brown turfing macroalga *Lobophora variegata* and coralline algae.

Germein Point to Point Gibbon (coast south-west of Franklin Harbour)

The coastal area is dominated by exposed cliffs and rocky outcrops, interspersed with moderately high energy beaches. Rock outcrops include **Flat Rocks**, **The Knob**, and **Point Gibbon** (south of **Port Gibbon**) (PIRSA, SARDI and DEH map, in Bryars, 2003). The intertidal area along this stretch of coast is narrow, and seagrass beds commence relatively close to shore. Shallow water seagrass beds consist mainly of *Posidonia* species (especially *P. sinuosa*), although *Amphibolis antarctica* and *Zostera (Heterozostera) tasmanica* are also present. Seagrass forms virtually continuous stands to a depth of 10 metres (Edyvane, 1995b; Aquaculture Group PISA – Fisheries, 1996).

Victoria Point to Shoalwater Point (coast north-east of Franklin Harbour)

The coastal area is dominated by tidal flats backed by saltmarsh. There are calcreted relic dunes along the coast (extending into the subtidal), and sandy beach extends along almost all of the shoreline between **Victoria Point** and **Lucky Bay**. North east of **Victoria Point**, there are saltmarshes and tidal creeks in the vicinity of **Lucky Bay**, and small stands of mangroves 3km – 4km east of Lucky Bay (PIRSA, SARDI and DEH map, in Bryars, 2003). A portion of the coast adjacent and north-east of **Lucky Bay**, as well as the Lucky Bay area itself, is slightly unstable, with parts of the coast also at risk from inundation (Aquaculture Group - PISA Fisheries, 1996), particularly the low-lying land

	<p>behind the calcreted dunes that line the coast. In the subtidal, sediment is fine close to the coast, and waters are likely to often be turbid, due to resuspension of fine sediment by the periodically strong currents and wind waves in the area. Seagrass meadows and unvegetated soft bottom habitats dominate the shallow subtidal. A recent survey off the coast at Lucky Bay, showed that between 5m – 8m, the dominant benthic cover was beds of <i>Posidonia</i> and <i>Amphibolis</i> seagrass, with (i) abundant colonial ascidians in the seagrass beds in which <i>Posidonia</i> was a lesser component and <i>Amphibolis</i> formed around 60% of the cover, and (ii) abundant sponges in the medium-density stands of <i>Posidonia</i>. Interspersed with the <i>Posidonia</i> beds were dense patches of brown macroalgae, red macroalgae and sponges (SARDI data, 2002). Between 8m and 12m, the benthic cover comprised dense <i>Posidonia</i> (around 90% surface cover), with some sessile invertebrates such as colonial ascidians (SARDI data, 2002).</p> <p>At Shoalwater Point, a survey in 1995 showed that subtidal communities at sampled sites were dominated by a mixed red algal assemblage, including the large reds <i>Osmundaria prolifera</i>, <i>Dictyomenia sonderi</i> and <i>Cladurus elatus</i> amongst others, with the canopy browns <i>Caulocystis</i> sp. and <i>Sargassum spinuligerum</i> present to a lesser extent (Edyvane and Baker, 1996c, and unpublished SARDI S.A. Benthic Survey data, 1995). There is a stony coral community in the Shoalwater Point area (Edyvane, 1999b).</p>
<p>6. Taxonomic Diversity</p>	<p>Little information on taxonomic diversity is available for this area, for this report, other than the following:</p> <p>Around 14 commercially and/or recreationally significant fish species are known from Franklin Harbour (Morelli and de Jong, 1995, and unpublished fishing records), however the total number of fish species in the bay is likely to be higher than this recorded number, if small seagrass-dwelling and sand-dwelling fish species are also included.</p> <p>Morelli and de Jong (1995) reported 14 waterbird species in Franklin Harbour. Taxonomic diversity in the coastal waters surrounding Franklin Harbour is not known for this report.</p>
<p>7. Habitat for Endemic Taxa / Threatened Taxa / Rare and Uncommon Taxa</p>	<p>Marine Plants Franklin Harbour contains the seagrass <i>Zostera mucronata</i>, which is listed as <i>rare</i> under the SA <i>National Parks and Wildlife Act 1972</i>.</p> <p>Invertebrates Shoalwater Point: Large colonies (up to 1.5m high) of the stony coral <i>Plesiastrea versipora</i> have been recorded on reefs in waters less than 10m in the area (Edyvane, 1999b). According to Edyvane (1999b), it is probable that old massive colonies such as those at Shoalwater Point are now rare and isolated in the gulf regions, because many such colonies may have been destroyed in deeper waters of the gulf due to long term trawling activities. This species is currently one that is being monitored by a community reef monitoring group in SA (Reefwatch), due to its limited distribution and potential risks to some remaining colonies in coastal waters.</p> <p>Bony and Cartilaginous Fish Both Leafy and Weedy Seadragons are found in the coastal waters outside Franklin Harbour. A fisher in the area reported to Dragon Search (community-based seadragon monitoring program) that from Cowell southwards, seadragons are commonly observed, usually in 4-18m water, behind reefs / overhangs. There is also a report of leafy seadragons being observed during 1985 – 87 in the bycatch of prawn trawlers operating in reef ledge habitat with sponges, and adjacent seagrass, off the Cowell area, on the mid western side of Spencer Gulf, and a Snapper survey report from 2002, of a Weedy Seadragon observed out of the mouth of Franklin Harbour. The Tiger Pipefish <i>Filicampus tigris</i> has also been recorded in the mid-eastern spencer Gulf region (e.g. Shoalwater Point area) (museum record, cited in Baker, in press). See section in Issues for Risk and Impact Assessment, for further information about fish species of potential conservation concern.</p>

	<p>Marine Mammals Haul out site for a small colony of Australian Sea Lions at Point Gibbon. Australian Sea Lion classified as <i>rare</i> under S.A. legislation, and considered by some researchers to be threatened (e.g. see Gales, 1990; Gales <i>et al.</i>, 1994, Shaughnessy <i>et al.</i>, 1996).</p> <p>Coastal and Marine Birds Franklin Harbour: Habitat for Musk Duck (Morelli and de Jong, 1995), listed as <i>rare</i> under South Australian legislation. Breeding habitat for White-bellied Sea Eagle (Morelli and de Jong, 1995), listed as <i>vulnerable</i> under South Australian legislation. Four migratory bird species listed under international treaties are known in the area (Morelli and de Jong, 1995)</p> <p>Endemic taxa in the area could not be readily determined for this report. An unquantified number of species of macroalgae, invertebrates and fish that occur in the Spencer Gulf region are endemic to southern Australia.</p>
<p>8. Other Important Taxa</p>	<p>Marine Mammals Franklin Harbour: Bottlenose Dolphin pods occur (CAS Franklin Harbour Information Page, 2002).</p> <p>Bony and Cartilaginous Fish The seagrass beds in Franklin Harbour provide habitat for one or more of the life stages of the following commercially and/or recreationally significant species: King George Whiting, Snapper, West Australian Salmon, Tommy Ruff, Southern Sea Garfish, Red "Mullet", flathead species, Trevally, Yellow-tail Kingfish, Leatherjacket species, and Snook. Most of these species (except Leatherjackets) are also reported to occur on unvegetated soft bottom habitat in Franklin Harbour, along with Yellow-fin Whiting, School Whiting, Yellow-eye Mullet, flounder species, and Bronze Whaler sharks (Australian Heritage Commission, undated; Morelli and de Jong, 1995; Bryars, 2003). Nearshore (e.g. at Point Gibbon, Flat Rocks etc) and offshore patch reefs in the area are reported to support King George Whiting, West Australian Salmon, Snapper, Tommy Ruff, Southern Sea Garfish, Yellow-eye Mullet, Trevally, Yellow-tail Kingfish, Leatherjacket species, Wrasse species, Snook, Sea Sweep, Silver Drummer, Gummy Shark and Whaler sharks (Bryars, 2003). Other habitats in the area (e.g. seagrass meadows, and unvegetated soft bottom / sand habitats), also support most of these species, as well as Yellow-fin Whiting, School Whiting, Red "Mullet", flathead species, and flounder species (Bryars, 2003). Beach habitats in the area (such as Windmill Beach) support the three whiting species listed above, as well as Tommy Ruff, Yellow-eye Mullet, Flounder and flathead species, and Whaler sharks (Bryars, 2003). Tidal flats (such as Howard Spit, Victoria Point and other areas) as well as tidal creeks (such as Entrance Creek, and Poondra Creek, and Lucky Bay) support whiting species, West Australian Salmon, Tommy Ruff, Southern Sea Garfish, Yellow-eye Mullet, and species of flathead and flounder (Bryars, 2003).</p> <p>Invertebrates Franklin Harbour: There are abundant Razorfish and Scallops in the sand and seagrass areas of the harbour (Morelli and de Jong, 1995). Franklin Harbour: The entrance channel has a "remarkable sponge and hydroid fauna" (S. Shepherd, pers. comm., 2004, citing observations by J.E. Watson). Franklin Harbour: Abundant Blood Worms, which are ecologically important in terms of their role as food for fish and some bird species, and nutrient recycling. "Swarms" of large numbers of Blood Worms occur in surface waters after the full moon (Westlake <i>et al.</i>, 2002). Franklin Harbour and Coastal Waters: Abundant Blue Swimmer Crabs in the seagrass beds, sand habitats, and tidal flats, evidenced by the yields from commercial and recreational fishing in the area (see Notes on Social and Economic Values and Uses, for this area). In addition to the above invertebrate species, seagrass beds in Franklin Harbour also provide habitat for Southern Calamari (Bryars, 2003). Western King Prawns are found in the Franklin Harbour area (e.g. reported to occur in the unvegetated soft bottom habitat, as well as near sheltered beaches, tidal flats and</p>

	<p>tidal creeks (Bryars, 2003). Nearshore (e.g. at Point Gibbon, Flat Rocks etc) and offshore patch reefs are reported to support Giant Cuttlefish, Southern Calamari, and Purple Sea Urchin (Bryars, 2003). Other habitats in the area (e.g. seagrass meadows, and unvegetated soft bottom / sand habitats), support Blue Swimmer Crabs, Sand Crabs, Western King Prawns (the latter two species mainly in the sand habitats), Razorfish, Southern Calamari, and King and Queen Scallops (Bryars, 2003). Beach habitats in the area (such as Windmill Beach) support Blue Swimmer Crabs, Western King Prawns, and bait worm species (Bryars, 2003). Other benthic invertebrate fauna found in abundance in the Franklin Harbour include various species of sponges, tube worms, echinoderms, and ascidians.</p> <p>Coastal and Marine Birds Franklin Harbour: Migratory stop over for the Grey Plover, Sharp-tailed Sandpiper and Bar-tailed Godwit (Eckert, 1972, 1973; Burchill Bate Parker & Partners Pty. Ltd., 1992, cited by Morelli and de Jong, 1995). Breeding colony of Pied Cormorant and Black-faced Cormorant (Morelli and de Jong, 1995). White-faced Herons and large flocks of Grey Teal feed in the tidal shallows (Edyvane, 1995b). Entrance Island provides habitat for a small breeding colony of Caspian Terns (South Australian Coast and Marine Atlas, 2001). Australian Pelicans occur in the area (CAS Franklin Harbour Information Page, 2002). The islands provide a safe roosting and feeding site for coastal birds (Morelli and de Jong, 1995).</p> <p>Marine Plants Along the Point Germein Peninsula, mud flats are covered by the blue-green alga <i>Oscillatoria</i> sp., forming stromatolite-like mounds of sediment. These mounds in the Franklin Harbour area are considered important (Edyvane, 1995b, citing Butler <i>et al.</i> 1975), and stromatolites are generally rare in south Australia (NPWSA 2002). Shoalwater Point: Some reefs in the area have abundant large red macroalgae, forming up to 60% of the benthic cover (Edyvane and Baker, 1996c). Reef areas dominated by large red macroalgae are uncommon in the mid to upper Spencer Gulf (Edyvane and Baker, 1996c).</p>
<p>9. Notable Feeding, Breeding / Spawning and Nursery Areas</p>	<p>Bony and Cartilaginous Fish Franklin Harbour: considered to be a significant nursery area for a variety of fish species. The dense, widespread shallow seagrass beds throughout the area are considered to be important sites of spawning, breeding or shelter for “numerous fish species” (Morelli and de Jong, 1995). The estuary is considered to support “substantial and diverse” areas of wetland that would provide habitat for estuarine and offshore fish stocks (Bucher and Saenger, 1989, cited by Edyvane, 1995b). PIRSA (1996) stated that, apart from the subtidal seagrass, the intertidal and supratidal communities (mangrove and samphire) of Franklin Harbour provide important nursery habitat for numerous fish species of commercial importance. According to Bryars (2003), the seagrass beds in Franklin Harbour provide nursery habitat for juvenile King George Whiting, Snapper, West Australian Salmon, Tommy Ruff, Southern Sea Garfish, Red “Mullet”, flathead species, Trevally, Leatherjacket species, and Whaler sharks (Australian Heritage Commission, undated; Morelli and de Jong, 1995; Bryars, 2003). Tidal flats (such as Howard Spit), tidal creeks (such as Entrance Creek, and Poondra Creek) and associated mangroves, are nursery areas for whiting species, West Australian Salmon, Tommy Ruff, Southern Sea Garfish, Yellow-eye Mullet, and species of flathead and flounder (Bryars, 2003). Around 13 fish species are recorded as regularly using the Franklin Harbour area, particularly juvenile King George Whiting, Southern Sea Garfish, Tommy Ruff and Australian Salmon (commercial and recreational fishing records, 1995 – 2002). Franklin Harbour is considered to be one of the most important nurseries for King George whiting in South Australia (Fowler and McGarvey, 1999). Tagged King George Whiting from the nursery area at Franklin Harbour have been reported from Port Neill, Tumby Bay, the Sir Joseph Banks Group and the Port Lincoln bays (Jones and Retallick, 1990a and 1990b), indicating the regional importance of the nursery area as a source of fish for lower parts of Spencer Gulf. McGlennon and Jones (1997, cited by Fowler, 2000) recorded a concentration of Snapper spawning activity in an area from Franklin Harbour northwards past</p>

	<p>Shoalwater Point, to Middle Bank. However, it is not known how important this area is relative to other areas in Spencer Gulf or other parts of the State, in terms of Snapper spawning, due to lack of survey information for other areas.</p> <p>Invertebrates</p> <p>Shoalwater Point was identified as one of the 5 main prawn nursery areas in Spencer Gulf, with a larger number of juveniles present on the western side of Spencer Gulf compared with the eastern side (Carrick, undated report on FRDC Project 91/3; Carrick, 2003). The vicinity of Franklin Harbour is one of the key nursery areas for prawns in Spencer Gulf (S.A. Prawn Industry Association web site, 2000). The entire coastal area from Franklin Harbour northwards to Munyaroo Conservation Park (north of Shoalwater Point) has also been described as “an important prawn nursery” (Smallridge, 1995).</p> <p>Franklin Harbour: The habitats within the harbour (as well as soft bottom intertidal habitats north-east of the harbour) provide nursery area for juvenile Blue Swimmer Crabs and Western King Prawns (Morelli and de Jong, 1995; Bryars, 2003; Carrick, 2003, Figure 17). Adult Scallops and Razorfish occur in Franklin Harbour (Bryars, 2003), and therefore so do the juveniles of these sedentary species that reproduce at a local scale.</p> <p>Coastal and Marine Birds (see section 8 above, on Other Important Taxa)</p>
<p>10. Shipwrecks and Artificial Reefs</p>	<p>Although several wrecks are known in the area, their significance as additional habitat is not known for this assessment.</p>
<p>11. Popular Dive Sites</p>	<p>Recognised dive sites described in terms of significant ecological features, are not known for this area, for this report.</p>
<p>12. National and/or International Importance</p>	<ul style="list-style-type: none"> ♦ The Franklin Harbour peninsula and islands, designated as the Franklin Harbour Conservation Park (1334 ha), are on the <i>Register of the National Estate</i>, partly in recognition of the role of the park in preserving an area of mangrove and samphire flats, (an association that is considered by the Australian Heritage Commission to be “markedly depleted in South Australia”), and due to the islands within the harbour providing a safe roosting and feeding site for sea birds. ♦ Franklin Harbour is listed as a <i>Wetland of National Importance</i> (ANCA, 1996), described as “a shallow almost totally landlocked embayment, which includes four sand islands within the bay, a coastal dune system, sand flats and tidal mud flats of mangrove and samphire”. The Harbour is considered to be a significant nursery area for a variety of fish species, and the dense, widespread seagrass beds throughout the area are important sites of spawning, breeding or shelter for numerous fish species. The bay provides habitat for migratory waders, and the islands provide a safe roosting and feeding site for seabirds (Morelli and de Jong, 1995). ♦ The Spencer Gulf region has been identified as an area of international importance for shorebirds, by Watkins (1993, cited by Morelli and de Jong, 1995 and Australian Heritage Commission, undated). ♦ The Franklin Harbour area is used by at least four migratory coastal bird species that are listed under international migratory bird treaties (Morelli and de Jong, 1995). Species include the Grey Plover, Sharp-tailed Sandpiper and Bar-tailed Godwit (Eckert, 1972, 1973; Burchill Bate Parker & Partners Pty. Ltd., 1992, cited by Morelli and de Jong, 1995).
<p>Major Commercial and Recreational Fish, Sharks, Molluscs and Crustaceans</p>	<p>The commercially and/or recreationally significant species that occur in Franklin Harbour include the following: <i>Fish:</i> Garfish, King George Whiting, Tommy Ruff, Yellow-fin Whiting, Sand Whiting, Snook, Mullet, Flathead. Other fish species in the area include Leatherjackets, Weedy Whiting, Australian Salmon, Snapper, Red “Mullet” and Sweep. <i>Sharks and Rays:</i> Bronze Whaler</p>

	<p><u>Invertebrates</u>: Blue Swimmer Crab, Western King Prawn, Southern Calamari, Razorfish.</p> <p>South-west of Franklin Harbour, to approximately Dutton Bay, major commercially and/or recreationally fished species known from the area include:</p> <p><u>Fish</u>: King George Whiting, Garfish, Snapper and Snook (the aforementioned 4 species all caught in larger quantities than the following): Red "Mullet", Sweep, Leatherjacket species, flathead species, Tommy Ruff (Australian Herring), Yellow-fin Whiting, Silver Drummer, various wrasse species, Blue Mackerel and Trevally).</p> <p><u>Sharks and Rays</u>: Gummy Shark, Whiskery Shark, School Shark, Bronze Whaler and/or Black Whaler and other shark species.</p> <p><u>Invertebrates</u>: Western King Prawn (the major invertebrate fished commercially in the area, in deeper waters seaward of Franklin Harbour), and Southern Calamari. Greenlip Abalone, Blacklip Abalone and Rock Lobster also occur, away from the harbour.</p> <p>Some of the commercially and/or recreationally significant species that occur North of Franklin Harbour (to approximately Munyaroo Conservation Park) and east (to the centre of Spencer Gulf), include the following:</p> <p><u>Fish</u>: Tommy Ruff (Australian Herring), Snapper, Garfish, King George Whiting and Snook (all of which are abundant in the area and are regularly taken in significant quantities), Yellow-fin Whiting, Leatherjacket species, Striped Perch (caught not often targeted), Yellow-eye Mullet, Australian Salmon, Red "Mullet", flathead species, flounder species and Black Bream.</p> <p><u>Sharks and Rays</u>: Bronze Whaler and/or Black Whaler and other shark species.</p> <p><u>Invertebrates</u>: Western King Prawn (one of the several major locations for yields in the commercial fishery is in the deeper waters seaward of Franklin Harbour), Blue Crab (significant area for the commercial fishery), Cuttlefish, and Southern Calamari. Greenlip Abalone and Blacklip Abalone also occur in the area, and are caught in minor quantities.</p>
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8.10 Upper Spencer Gulf (North Spencer Gulf Bioregion)

Figure 12 shows the location of this area.



Figure 12: Upper Spencer Gulf

<p>1. Biogeographic Significance</p>	<ul style="list-style-type: none"> ♦ Far Northern Spencer Gulf is considered to be a unique coastal marine ecosystem compared to the rest of Southern Australia. The benthic biota contained within the upper Gulf contain a number of species with tropical and subtropical affinities, as well as a number of endemic species, as described in other sections of this table (Shepherd, 1983a, and Shepherd, pers. comm., cited by Aquaculture Group - PISA Fisheries 1996; Morelli and de Jong, 1995; IMCRA Technical Group, 1998; Edyvane, 1999b; DEH, 2000a). ♦ Northern Spencer Gulf contains the largest area of temperate tidal wetlands (saltmarsh), mangroves, and shallow seagrasses in South Australia, with the spatial extent of the mangrove stands considered significant at a national level (Morelli and de Jong, 1995; Edyvane, 1995c; Edyvane, 1999b). The region also includes some of the largest <i>undisturbed</i> stands of mangroves remaining in South Australia, such as the Chinaman Creek / Winninowie area (Morelli and de Jong, 1995; DEH, 2000a). ♦ The Redcliff region is reported to be one of the finest examples of a sub-tropical marine and coastal ecosystem in the southern hemisphere, and contains the “richest and most diversified coastal flora in South Australia” (Morelli and de Jong, 1995; Environment Australia, 2001b). ♦ In addition to their high ecological value, the seagrass beds of upper Spencer Gulf provide a geologically important record of sea level changes during the Holocene, when peritidal sedimentation in shallow seagrass beds began to occur, and bioclastic sediments accumulated rapidly (DEH, 2000a).
<p>2. Major Physical Influences, and Relative Productivity Level</p>	<p>The warm, hyper-saline inverse estuary of the Northern Spencer Gulf (Bailey, 1975, cited by Shepherd, 1983; Nunes and Lennon, 1986) is characterised by extremes in:</p> <p><i>Tidal ranges:</i> The extreme spring tidal ranges are 3.44m at Port Pirie, 3.06m at Whyalla, and 4.32m at Port Augusta (Noye, 1984), the latter figure making Far Northern Spencer Gulf a macrotidal system, the only example in southern Australia (Harris and O'Brien 1998). Other examples of reported estimates include tidal range of up to 3.5m in the Port Pirie - Whyalla region and 3.9m at Port Augusta; with maximum range over a single tidal cycle reported to be 2.9m in some parts of the upper gulf (Johnson, 1981a; unreferenced, cited by Morelli and de Jong, 1995 and Edyvane, 1999b). The regular period of minimal tidal movement (“dodge tide”) is also significant in Northern Spencer Gulf (Nunes and Lennon, 1986).</p> <p><i>Low rainfall and high evaporation:</i> Spencer Gulf is well known oceanographically as a negative or inverse system, in which evaporation exceeds runoff, forming a dense, saline bottom-water mass that flows seawards under certain conditions (Noye, 1984; Nunes and Lennon, 1986; Nunes-Vaz <i>et al.</i>, 1990, cited by Harris and O'Brien, 1998). Although classified as an estuarine area, Northern Spencer Gulf receives very little freshwater input – i.e. rainfall amounts to around 242 mm/a (Saenger, 1995). Rainfall at Port Augusta is reported to be around 236 mm/a, which is less than 10% of the “pan” evaporation rate of 2507 mm/a, and there is no fluvial input of freshwater to upper Spencer Gulf at any time (Gostin <i>et al.</i>, 1984, cited by Harris and O'Brien, 1998).</p> <p><i>Average minimum and maximum sea surface temperature:</i> Examples of ranges include 11°C to 24°C at Point Lowly and 13°C to 29°C at Port Augusta, with strong temperature gradient between Lowly Point and Port Augusta (Johnson, 1981a and unreferenced citations reported by Morelli and de Jong, 1995 and Edyvane, 1999b; Nunes and Lennon, 1986, cited by Harris and O'Brien, 1998). Burne and Colwell (1982, cited by Harris and O'Brien, 1998) collated minimum and maximum temperature value for the Port Augusta Bridge (adjacent to the berth area) as 11°C to 26°C.</p> <p><i>Salinity:</i> In addition to evaporation, salinity in northern Spencer Gulf may be affected by saline water runoff and groundwater seepage (Gostin <i>et al.</i>, 1984; Bye and Harbison, 1991), and salinity is therefore not completely dependant upon evaporation rate. At Port</p>

Augusta, salinity in intertidal ponds may be as high as 100ppt under certain conditions (Burne and Colwell, 1982, cited by Harris and O'Brien, 1998). Burne and Colwell (1982, *op. cit.*) collated minimum and maximum salinity values for several locations in the gulf; e.g. for **Port Pirie**, the range was 41.2ppt to 47.2ppt (however the maximum value conflicted with the maximum estimates of Bye, 1981, and Nunes and Lennon, 1986), and at the **Port Augusta** Bridge (adjacent to the berth area), the range was 44ppt to 49.6ppt. Nunes and Lennon (1986) reported similar values for **Port Augusta**, based on CTD surveys between 1982 and 1985. One station located 10 km down-channel from **Port Augusta** showed salinity ranging from a high of 47.3ppt in January 1983 to a low of 43.5ppt in August 1983. Based on a CTD survey conducted in March 1984, Nunes and Lennon (1986, cited by Harris and O'Brien, 1998) reported a depth-averaged salinity of 48ppt in the vicinity of **Port Augusta**; in excess of 42ppt in the **Port Pirie** area, and between 39.5 and 40ppt in the vicinity of **Whyalla**. Estimates by Johnson (1981a) were similar to those cited above, with ranges of surface salinities of seawater in the Northern Spencer Gulf area being 39.9ppt – 44.8ppt in the **Point Lowly / Fitzgerald Bay** area, and 43.2 - 48.6ppt at **Port Augusta**, with records of up to 50ppt at the head of the Gulf in late summer.

The variety of different current types in the area is also a major influences. Examples of currents in Northern Spencer Gulf include the following (see Noye, 1984; Nunes and Lennon, 1986; Nunes-Vaz *et al.*, 1990; Harris and O'Brien, 1998):

- ♦ *Tidal currents*: which dominate the Northern Spencer gulf area, and are also responsible for a significant gyre around **Point Lowly**, and other local circulations around the banks and shoals. Currents in Northern Spencer Gulf are driven mainly by the tides, and speeds of up to 0.75 m/s occur in the central **Flinders Channel**, with weaker flows occurring along the channel margins (AUS Chart 778, cited by Harris and O'Brien, 1998). Near **Whyalla**, strong currents of up to 1m/s may occur adjacent to **Fairway Bank** in the main channel, with weaker flows occurring along the channel margin (Noye, 1984, cited by Harris and O'Brien, 1998). Tidal currents in the vicinity of **Port Pirie** are around 0.5 m/s adjacent to **Ward Spit**, and up to 1m/s near **Eastern Shoal**, at the entrance to **Germein Bay** (AUS chart 778), cited by Harris and O'Brien, 1998). Noye (1984, cited by Harris and O'Brien, 1998) reported maximum tidal currents at **Port Augusta** of 0.5 m/s, with a tidal excursion length of about 18 km. Tidal currents carry and deposit fine suspended sediment in the upper reaches. The tidal channels leading to **Port Augusta** are very dynamic, since nearly 33% of the surface area of Northern Spencer Gulf is intertidal in nature (Gostin *et al.*, 1984). Strong tidal currents give rise to a suite of tidal bedforms that have been studied in some detail (e.g. Shepherd and Hails 1984, cited by Harris and O'Brien, 1998). For example, the strong tidal currents that scour the channel floor in Northern Spencer Gulf are responsible for the formation of belts of sand "mega-ripples" (oriented parallel to the channel margins), also described as benthic "dunes" (Shepherd, 1983b; Shepherd and Hails, 1984; Short *et al.*, 1986, cited by Edyvane, 1995b; Harris and O'Brien, 1998).
- ♦ *Wind-driven currents*: include the funnelling effect of periodic wind-induced storm surges. Wind-driven currents, with speeds of up to 0.17 m/s or more, are a weaker influence than tidal currents in Northern Spencer Gulf, but are a stronger force than density-driven currents (Tronson, 1974; Noye, 1984, cited by Harris and O'Brien, 1998);
- ♦ *Thermo-haline currents / density-driven currents*, with speeds of up to 0.1 m/s;
- ♦ slow, long period *mean sea level oscillations* caused by pressure variations and wind stress; and
- ♦ currents driven by *surface wind-waves* in very shallow water (Radok, 1978; Bye, 1983; Steadman and Associates, 1983). There is a "shearing" effect of stronger surface currents over weaker bottom currents in some areas.

Other major physical factors that influence the function of the Northern Spencer Gulf system include:

- ♦ the low to very low wave energy in the upper reaches;
- ♦ the abrupt bathymetry variations, due to the extreme tidal movements and sea level

oscillations over the large central banks and extensive coastal flats, and consequent significant variation in exposed surface area and depth (Radok, 1978). Some channel areas in shallow waters of Northern Spencer Gulf are steep, and grade over a short distance to more than 20m deep (e.g. see Shepherd, 1974); and

- ♦ the geological history (see below) and present geological and geo-morphological processes operating in Northern Spencer Gulf (see below).

The geology of Northern Spencer Gulf has had a major influence on the type of marine communities that currently exist, due to the build-up of sediments. Quaternary sea level oscillations resulted in a number of marine transgressions and regressions into northern Spencer Gulf, resulting in alternations of marine and alluvial sediments in the sub-surface of the gulf. Marine strata from these transgressions occur beneath the sea floor of the upper gulf, where they have been studied by submarine coring and seismic reflection profiling techniques (Belperio, 1995, cited by DEH, 2000a). The Holocene sea flooded the northern Gulf and reached present level about 6,600 years BP. Much of the northern Gulf area was then under several metres of water, with the coast up to 5km further inland than its present position. Shell beds and large, rounded quartzite boulders at the base of Mt Grainger indicate that the sea level was up to 4m higher than at present (Belperio *et al.*, 1984, cited by DEH, 2000a). Peritidal sedimentation began at this time, with the vertical accumulation of sediments in shallow seagrass meadows. Bioclastic sediment accumulated rapidly, creating bioclastic seagrass beds. *This has been the most important sedimentary process that has occurred in Northern Spencer Gulf, as there has been a 60% decrease in the sub-tidal area of the Gulf since the initial Holocene inundation.* Sea level gradually fell from 6,600 years BP to the present as a result of isostatic uplift of the northern Gulf (Belperio, 1995, cited by DEH, 2000a). As the sea level fell, wide tidal flats (intertidal and supratidal areas) evolved on the surface of the seagrass banks (Harbison and Wiltshire, 1993). The wide tidal flats created ideal conditions for colonisation by intertidal mangrove woodlands and samphire flats about 1,400 years ago, and for continued progradation of the coastline seawards. Old mangrove stumps can now be excavated several kilometres inland from where they presently grow.

Relative Productivity Level

- ♦ The extensive supratidal and shallow intertidal mudflats, and tidal creeks and mangrove areas of the shallow, hyper-saline northern Spencer Gulf system are an important decomposition area, and the site of a significant detritus-based food chain (with drifting and decomposing plant material, and microbiota as the basis).
- ♦ The saltmarsh and mangrove sediments supply abundant nutrients to filamentous blue-green algae, which trap the sediments and form algal mats. Carbon is fixed by the algal mats, and it has been estimated that the productivity of these algal mats may exceed that of the mangrove plants themselves (Ward *et al.*, 1983). Organic carbon produced by the algal mats becomes the primary energy source for sulphate-reducing bacteria, which produce the hydrogen sulphide that accumulates beneath the algal mats (Warren, 1981). By binding the silt and clay particles together, the algal mats help to stabilise sediments, which reduces turbidity and erosion, and contributes to a continuous advancement of the shoreline (progradation), with the mangrove community growing seaward (DEH, 2000a). The algal mats also provide a more physically stable environment for burrowing organisms.
- ♦ The food chain of intertidal mudflats and mangrove estuaries is well-documented. One study (cited by Edyvane, 1995c) reported that one square kilometre of mangrove forest contributes around 600 tonnes per annum of leaf litter to the detrital food chain. One visible indication of the productivity is the abundance of worms and other infauna; and the number of birds, marine snails and crabs that feed on or in the mudflats. Small gastropod and bivalve molluscs, polychaete worms, barnacles, shrimps, sea lice, insects (including mosquitoes) and other small fauna and their larvae in mangrove systems have important ecological roles (e.g. as food source for juvenile fish and crustaceans, and some coastal bird species). Extensive tidal channels and sediment flats in the area are also important habitat for shorebirds (local, regional and migratory coastal bird species), as well as the fish and crustaceans which feed in the area. Mangrove areas have an important role in recycling and redistributing nutrients within estuarine systems, and also help to stabilise sediments and control coastal erosion

	<p>(Ministry of Conservation, 1980, cited by PPK <i>et al.</i>, 1992; Butler <i>et al.</i>, 1975; McLaren and Wiltshire, 1984; Edyvane, 1995c; Harbison and Wiltshire, 1993, cited by DEH, 2000a).</p> <ul style="list-style-type: none"> ♦ It is also recognised that saltmarsh / samphire areas are important feeding grounds and refuges from predators for larval and juvenile fish; provide feeding areas for crustaceans; support high numbers of small molluscs, insects and other food sources for estuarine fish and birds; and play an important role in soluble nutrient recycling in estuarine systems (see details in other sections of this table, and references by Morton <i>et al.</i>, 1987; Morrisey, 1995; Adam, 1995; Connolly <i>et al.</i>, 1997; Connolly, 1999). ♦ The seagrass meadows of Spencer Gulf, particularly the northern sections of the gulf, have been described as a major “carbonate factory”, with high rates of <i>in situ</i> carbonate production and skeletal accumulation (Davies, 1970; Patriquin, 1972; Gostin <i>et al.</i>, 1994, cited by Edyvane, 1995b; Ward <i>et al.</i>, 1993). Terrigenous and aeolian detrital grains, as well as other fine sediments, are also trapped by the seagrass. Coralline algae in the seagrass beds are important producers of carbonate sediment, as are benthic and epiphytic foraminifera. Encrusting diatoms, bryozoa, gastropods, hydroids, echinoderms and ascidians also contribute to sediment production in the area. An abundant and species-rich epibiota occurs on the seagrass blades. The epiflora provide feeding and sheltering micro-habitats for some smaller fauna. Johnson (1981c) recorded 48 species of red and brown macroalgal epiphytes on <i>Posidonia</i> spp. leaves in upper Spencer Gulf. Small epifauna and some of the epifloral species also contribute to sediment production (<i>see above</i>). ♦ The seagrass meadows of Northern Spencer Gulf are also a significant contributor to the total primary productivity of the area, in terms of plant biomass production and nutrient recycling. Growth of <i>Posidonia</i> species is vigorous, with high rates of leaf blade production (in excess of 9kg per square metre in shallow water) and turnover rates (West and Larkum, 1979, cited by Shepherd, 1983a). The seagrass blades baffle wave action; promote water clarity; reduce water movement (so that fine suspended particles settle out, and are trapped by the root mesh of the seagrass); and help to control coastal erosion (Scoffin, 1971, cited by Edyvane, 1995c; Larkum <i>et al.</i>, 1989). They also have an important role in stabilising existing sediments, and promoting new sediment production, as discussed above. ♦ In conjunction with the samphire / mangrove / mudflat / sandflat areas, the seagrass meadows of Northern Spencer Gulf are also a major contributor to the significant productivity of fish, crabs and prawns in Spencer Gulf, both locally and regionally. The seagrass beds (including fine intertidal seagrasses, and meadows of subtidal seagrasses) have an important function as larval settlement, nursery, feeding, and sheltering areas for fish and crustacean species (described in other sections of this table). Important micro-biota within seagrass beds of Northern Spencer Gulf include micro-organisms, isopods, amphipods, polychaetes and molluscs, that in turn support an abundance of fish and crustacean species (Harbison and Wiltshire, 1993), including many commercially and recreationally significant species. <p>In summary, the samphire, mangrove, algal mat, and seagrass communities all are important primary producers, and have been described as “a major nutrient pool for Upper Spencer Gulf” (Harbison and Wiltshire, 1993, cited by DEH, 2000a). The saltmarsh, mudflat, sandflat, mangrove and seagrass habitats in the area have outstanding ecological significance, and are recognised as important contributors to the biological productivity and ecological functioning of Spencer Gulf, particularly the northern part.</p>
<p>3. Bioregional Representative-ness of Habitats</p>	<p>Saltmarsh and mangroves, and subtidal seagrass beds and sandy / muddy habitats, are the primary representative habitats of Northern Spencer Gulf. The area described in this table contains physical, oceanographic and biotic features that are characteristic of the Northern Spencer Gulf Bioregion, as classified by IMCRA Technical Group (1998). These are:</p> <ul style="list-style-type: none"> ♦ confined “inverse” estuary, with minimal freshwater input and higher temperatures and salinities in the upper reaches of the Gulf. ♦ mean sea surface temperatures varying from 11-24°C at Point Lowly and 13-29°C at Port Augusta. ♦ mean salinity increases from 42.0-44.8ppt at Point Lowly, to 43.2 - 48.6ppt at Port

	<p>Augusta;</p> <ul style="list-style-type: none"> ♦ low wave energy coastline; ♦ tidal range micro-tidal to meso-tidal (1.8 - 3.6m) (<i>but see information in previous section of this table, about periodic macro-tidal range at Port Augusta</i>); ♦ tides typified by regular period of minimal tidal movement (“dodge” tide); ♦ tidal plain coast, comprising shallow offshore gradients; ♦ geology includes Holocene sandflats, beach ridges, recurved spits, and extensive supratidal and intertidal flats; ♦ extensive supratidal and intertidal areas dominated by samphires, mangrove and (fine) seagrasses; ♦ marine flora typified by Flindersian Province, but with a distinct sub-tropical element; ♦ tropical species such as the brown macroalga <i>Sargassum decurrens</i> and <i>Hormophysa triquetra</i>; ♦ in sheltered areas, intertidal flats dominated by extensive areas of the grey mangrove <i>Avicennia marina</i>, the brown macroalga <i>Hormosira banksii</i>, and the seagrasses <i>Zostera muelleri</i> and <i>Zostera (Heterozostera) tasmanica</i>; ♦ subtidal areas characterised by extensive sandy substrates and seagrass meadows, dominated by <i>Posidonia australis</i> in shallow waters, and <i>Posidonia sinuosa</i>, <i>Posidonia angustifolia</i> and <i>Amphibolis antarctica</i> in deeper waters, with small, shore-fringing macroalgal communities; ♦ in limited rocky areas, macroalgal communities dominated by <i>Scaberia agardhii</i>, <i>Lobophora variegata</i>, <i>Cystophora botryoides</i>, <i>Cystophora expansa</i> and <i>Caulocystis</i> sp. ♦ low diversity of marine plant species; ♦ animal-dominated assemblages in waters deeper than approximately 17m (i.e. sparse to no plant cover); ♦ coastal wetland of national importance (Northern Spencer Gulf). <p>N.B. According to Shepherd (1983a), although the temperature and salinity environments of upper Spencer Gulf and upper Gulf St Vincent are very similar, the benthic composition and biota differ considerably between the two gulfs. The northern reaches of Spencer Gulf are characterised by relatively deep channels, stronger water currents, and well-sorted medium to coarse shelly sands, features that are not prevalent in northern Gulf St Vincent. The common benthic invertebrates present also differ considerably between the two gulfs (Shepherd, 1983a).</p>
<p>4. Habitat Rarity</p>	<p>Far Northern Spencer Gulf is considered to be a distinct ecosystem, unlike any other known in southern Australia (see description by IMCRA Technical Group, 1998). Apart from the unusual physical and oceanographic conditions (see section on Major Physical Influences, and Relative Productivity Level), components of the fauna (in particular) and the flora of this region are unlike the benthic biota in the rest of the Gulf. The benthic biota of far Northern Spencer Gulf contains a “relict tropical element” of species with tropical and subtropical affinities, as well as a number of endemic species (Shepherd 1983a, and S. Shepherd, SARDI, pers. comm., cited by Aquaculture Group - PISA Fisheries, 1996, Morelli and de Jong, 1995, Edyvane, 1999b, and DEH, 2000a).</p>
<p>5. Habitat Diversity</p>	<p>Habitat types include:</p> <ul style="list-style-type: none"> ♦ metamorphic headland and near-shore boulder reef, grading to gravel in some shallow subtidal areas (e.g. Lowly Point; Backy Point; Crag Point); ♦ near-shore calcareous (e.g. shelly) patch reefs; ♦ extensive supratidal and intertidal mudflats and sandflats*, extending more than 1km seaward in some areas. Some mudflats and sandflats are covered with algal mats; some with fine seagrass (<i>Zostera</i>); some are dissected by tidal channels; and some are connected to mangrove stands; ♦ supratidal and intertidal samphire / saltmarsh (covering tidal sand and mud flats in

	<p>some areas);</p> <ul style="list-style-type: none"> ♦ shingle and sand beaches in some less sheltered bays (e.g. Whyalla; Port Germein); ♦ extensive intertidal areas of mangrove <i>Avicennia marina</i>, up to several km wide in places; ♦ subtidal seagrass meadows (dominated by species of <i>Posidonia</i> in some areas, and mixed forms of seagrass in others); ♦ subtidal sandy, muddy and shelly habitats, including sandbanks, and deeper channel areas (to more than 20m) adjacent to banks. These deeper habitats are of various compositions (shell, sand, silt and mixtures of these) and forms (e.g. steep banks from the surface to the seafloor, and benthic sand-waves and “mega-ripples”); sandy and muddy habitats are in many places populated with various assemblages of attached invertebrates (Razorfish and other bivalve molluscs, gorgonian corals, soft corals, ascidians, sponges, bryozoa), and burrowing organisms. <p>*Various sandflats in Northern Spencer Gulf differ in dominant species composition. Kinhill Engineers (1987) described “broad sand flats”, dominated by bivalve molluscs, and “mangrove sand flats” of greater species richness and species density, dominated by polychaete worms and gastropod molluscs.</p> <p><u>General Habitat Notes</u></p> <p>Northern Spencer Gulf: The region is an inverse estuary containing shallow, warm saline waters. Northern Spencer Gulf occupies the Torrens Sunkland (Tertiary and Quaternary out-wash deposits), which lies between two horsts, the Flinders Ranges on the east and the Stuart Shelf to the west. The Torrens Sunkland is regarded as one of the most active seismic zones in Australia (Morelli and de Jong, 1995). The Northern Spencer Gulf region is characterised by shrublands on the supratidal shell ridges and sand dunes; samphire low shrubland on tidal flats; intertidal mangrove forests; supratidal and intertidal mud flats and sand flats (with authigenic minerals including gypsum and dolomite deposited in the supratidal evaporite flats – Harris and O’Brien, 1998); some areas of shingle and sandy beaches; salt flats / saltmarsh; tidal creeks; subtidal seagrass meadows; and subtidal coarse sand and shell channel areas (Morelli and de Jong, 1995). Some of the subtidal areas support species of benthic epifauna that are endemic to the region, and species of macroalgae that have tropical and sub-tropical affinities (as discussed in other sections of this table).</p> <p>The region includes mangrove and samphire areas such as Cowled’s Landing, Whyalla, Blanche Harbour, Port Augusta, Redcliff Point, Yatala Harbour, Port Germein, Port Pirie south to Port Davis Creek, Jarrold Point, and Fisherman Bay near Port Broughton.</p> <p>The mud flats are dissected by a network of tidal channels, some of which include Chinaman Creek, First to Seventh Creeks, Fisherman Creek and Port Davis Creek (Morelli and de Jong, 1995). The supratidal area consists mainly of bare carbonate sand flats (Gostin <i>et al.</i>, 1984, cited by Edyvane, 1995b), covering approximately 7% of the northern Spencer Gulf area. There are stranded sandy and shelly beach ridges indicating the position of former shorelines. The marine area, excluding the intertidal and supratidal sand, mud, and samphire area, is approximately 55,500 hectares in size (Aquaculture Group - PISA Fisheries, 1996). The far northern Spencer Gulf area has been described by Edyvane (1999b) as the <i>Winninowie Biounit</i>. Far Northern Spencer Gulf is a relatively sheltered, shallow area which experiences very low wave energy, high levels of evaporation, high salinities, and a large seasonal variation in sea surface temperature (see section above, on Major Physical Influences). The flora and fauna of this region are a separate major ecosystem to the rest of the Gulf, and contain a relict tropical element (Shepherd, 1983a, and Shepherd, pers. comm., cited by Aquaculture Group – PISA Fisheries, 1996). The region comprises extensive areas of supratidal and intertidal samphire, sandflats and mudflats, and intertidal mangroves. The mudflats of northern Spencer Gulf are dissected by a network of small tidal creeks and a number of major ones (e.g. Chinaman Creek). Seagrass beds (approximately 30% of the Winninowie Biounit’s marine coverage, according to mapping by CSIRO and SARDI,</p>
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cited by Edyvane, 1999b) are common in the intertidal and shallow subtidal areas. The seagrass beds grade into silt / mud and sand habitats at depths greater than 10 metres (McLaren and Wiltshire, 1984), and silt / mud and sand habitats reportedly comprise 70% of the Biounit's marine coverage, according to CSIRO and SARDI mapping (cited by Edyvane, 1999b). *Zostera mucronata* is prevalent on the intertidal sand flats in some areas. *Posidonia australis* and other *Posidonia* species (e.g. *P. sinuosa*) are the dominant subtidal seagrass species, with *Zostera (Heterozostera) tasmanica*, *Amphibolis antarctica*, and *Halophila ovalis* also present. These stands are prominent on the eastern side of the gulf, as well as on (and around) discrete offshore banks. Large bivalves such as Razorfish (*Pinna bicolor*), Hammer Oysters (*Malleus meridianus*), and other molluscs, crustaceans, ascidians and other bottom fauna are associated with this seagrass habitat (Shepherd, 1983a; McLaren and Wiltshire, 1984; SARDI S.A. Benthic Survey data, 1995; Edyvane and Baker, 1996c).

Specific Habitat Notes – Western Side

Cowled's Landing area: From Cowled's Landing, including **Eight Mile Creek**, north towards Whyalla, there is a narrow coastal strip of coastal clay pans, and stranded shelly and quartz sand ridges (i.e. part of the St Kilda Formation). Fronting that in places, are patches of shelly quartz sands, forming minor beaches areas, and clays from the drainage channels (Department of Mines and Energy, 1983). The main nearshore habitats include saltmarsh / samphire flats flushed by extreme high tides; intertidal mangrove areas with tidal channels; intertidal mudflats and sand flats (extending into Spencer Gulf), and subtidal seagrass meadows (Ivanovici, 1984; S.A. Department to Fisheries, 1993). The intertidal sand flats are broad in some areas (e.g. north and south of **Cowled's Landing**, where they extend seaward for at least 1 km). Out from Cowled's Landing is **Western Shoal**, a sandbank surrounded by shallow water (e.g. 1m - 2m on all sides), but descending to deeper waters south of the shoal. A survey during the early 2000s has shown that south of **Western Shoal**, between approximately 5m – 15m deep, there are (i) seagrass beds, particularly in the area directly south of Western Shoal, and comprising around 80% cover of *Posidonia*, and 15% of *Amphibolis*; (ii) an ascidian assemblage, comprising an average of 144 *Polycarpa* sp. ascidians per 35m², with minor cover of other ascidian species, and other invertebrates, such as gorgonian corals; (iii) patches of *Halophila* and *Posidonia* seagrass closer to shore, with mixed invertebrates including *Polycarpa* sp. ascidians, various sponges, soft corals and the Razorfish *Pinna* on sand, and (iv) at one sampled site, at around 15m, high abundance of the stalked bryozoan *Lanceopora* (around 1000 per 35m²), with *Halophila* seagrass (around 40% cover) and turf algae / drift (60% cover) (SARDI data, 2002). South of that area (i.e. several kilometres off the coast, south-east of **Cowled's Landing**), diverse assemblages of invertebrates occur on fine sand in deeper waters (15m-25m), including dense assemblages of mixed sessile invertebrates (containing solitary and colonial ascidians, bryozoa, sponges of various sizes and forms, soft corals, gorgonian corals, and the Razorfish *Pinna*). In waters deeper than 20m, gorgonian corals were the dominant cover on fine sand, with an average abundance of between 180 and 678 individuals per 35m², at the sites sampled, equivalent to around 20/m² in some areas. Ascidians were also abundant in some of the deeper waters dominated by gorgonians, with few other fauna (SARDI data, 2002).

Whyalla - False Bay - Point Lowly: The port area is located on a rocky promontory composed of Precambrian sedimentary rocks (Harris and O'Brien, 1998). Hails *et al.* (1984, cited by Harris and O'Brien, 1998) described the bottom sediments in the **Whyalla** area as a poorly sorted mixture of shell sand and gravel, quartzose sand and mud, with variable amounts of seagrass fibre. This sediment type forms a layer 0m - 1m thick near Whyalla, but may reach ~ 2m thickness in small patches in **False Bay**. These sediments overlie the "False Bay Formation" which is a mottled greyish yellow brown (oxidised red), laminated and gypsiferous clay, estimated to have been deposited ~80,000 years BP during a previous high sea level stand. The clay was sub-aerially exposed and weathered during the last glacial maximum (Hails *et al.*, 1984, cited by Harris and O'Brien, 1998). The **Whyalla** foreshore is part of a tidal flat approximately 1km across, bordered by a mangrove forest on the southern end and the Whyalla marina and jetty on the northern end. There is a large sand bar on the edge of the tidal flat, and further seaward, there are "mega-ripples" of sand in the

channel floor. There are strong tidal currents in the channel area (e.g. at 20m depth), which influence the type of marine biota found in this region. To the north is **False Bay**, which is shallow, with 2 to 4 km wide intertidal flats, and which has undergone ~ 5 km of Holocene progradation and in-filling (Gostin *et al.*, 1984, cited by Harris and O'Brien, 1998). To the south, the coastal habitats include intertidal sand and mud flats, mangroves, and salt flats (Burne and Colwell, 1982, cited by Harris and O'Brien, 1998). Major habitats in the **Whyalla** area and surrounds include samphire flats flushed by extreme high tides; intertidal mangroves; intertidal sandflats and mudflats; subtidal seagrass meadows; headland reef and near-shore patch reef, and subtidal sandy and muddy bottoms (which are dominated by sessile invertebrates). In the **Whyalla** area, Kinhill Stearns (1987) recorded *Posidonia australis* as the dominant seagrass in the near-shore waters (e.g. 2m), with minor amounts of *Zostera* (= *Heterozostera tasmanica*) and *Zostera mucronata*, and a mixed *P. australis* / *P. sinuosa* community at 4m – 5m. Sandy sediments in some parts of the Whyalla area are dominated by seagrasses *Amphibolis antarctica* in shallow waters and *Posidonia sinuosa* and *Posidonia angustifolia* in deeper water (Edyvane, 1995c; Aquaculture Group – PISA Fisheries, 1996). Dominant molluscs recorded in the **Whyalla** area included the Razorfish *Pinna bicolor*, Hammer Oysters (*Malleus* sp.), and various herbivorous gastropods including the Top Shells *Thalotia concia* and *Cantharidus irisodontes*, which feed on encrusting epiphytes on the seagrass leaves. Unvegetated areas contain a species of the Sand Cockle *Katelysia* (Kinhill Stearns, 1987). A benthic survey in 1995 recorded at 4m - 5m off **Lowly Point**, dense Hammer Oyster cover on the substrate (forming up to 100% cover in some areas) (Edyvane and Baker, 1996c and unpublished SARDI S.A. Benthic Survey Program data, 1995). The oyster cover supported a community of brown macroalgae (*Scaberia agardhii*, *Caulocystis* sp., three species of *Cystophora*, and *Sargassum linearifolium*). *Pinna bicolor* was also present, and the small turfing brown macroalga *Lobophora variegata* also occurred on the Hammer Oyster beds (Edyvane and Baker, 1996c, and unpublished SARDI S.A. Benthic Survey data, 1995). **Fairway Bank**, located offshore from the port of Whyalla, supports a large seagrass meadow. Below 6 m depth, the seabed is characterised by coarse gravelly sand and bedforms (Gostin *et al.*, 1984, cited by Harris and O'Brien, 1998). Some deeper (up to ~9 m), lower current energy areas away from the main tidal channels may support *Posidonia sinuosa* and *Zostera* (= *Heterozostera tasmanica*) seagrass communities (McLaren and Wiltshire, 1984, cited by Harris and O'Brien, 1998). Razorfish *Pinna bicolor* dominate the benthic community between 10m and 15m in the deeper water channels, and one survey showed that Razorfish in the areas occur at densities of up to 5 /m². This community also includes other molluscs, bryozoa, soft corals, ascidians and sponges (McLaren and Wiltshire, 1984, cited by Harris and O'Brien, 1998). *Pinna bicolor*, as well as a uniform cover of stalked bryozoa; orange "finger" sponges and ascidians (epizoic on *Pinna*) were also recorded during the 1995 survey, at a depth of 20m in the **Lowly Point** channel. Between **Whyalla** and Port Pirie, deeper central gulf waters also contain abundant sponges (see Carrick, 1997, Figure 7d). At the **Fairway Bank**, patches of the green macroalga *Caulerpa cactoides* and sparse beds of *Posidonia angustifolia* were recorded at 10m (Edyvane and Baker, 1996c and SARDI S.A. Benthic Survey data, 1995, unpublished).

Fitzgerald Bay area: The bay is partially sheltered by the **Backy Point** peninsula in the north, and by **Point Lowly** in the south. The bay is backed by a beach and ridge (Hails *et al.*, 1984). The beach is composed of sand and rock fragments, and there are areas of saltmarsh, mangroves, and tidal flats near shore (e.g. south-western corner). Rocky sections of the **Fitzgerald Bay** shoreline include the southern parts toward **Point Lowly**, and the north-eastern part between **Backy Point** and **Crag Point** (Parsons Brinckerhoff and SARDI, 2003, cited by PIRSA, 2004a). There are broad sand flats (dominated by bivalves) on the western shore (Kinhill Engineers, 1987). There is a sandbank in the south-western corner of the bay. Apart from the area in the vicinity of the sandbank, water depths within the bay vary from 10 to 20 metres (Aquaculture Group - PISA Fisheries, 1996). Further east into the gulf, the waters extend deeper than 20m (e.g. east of **Point Lowly Shoal** / seaward of **Point Lowly**, and east of **Backy Point** and **Crag Point**). In the shallow subtidal, species of *Posidonia* and *Zostera* (= *Heterozostera tasmanica*) have previously been recorded, extending to approximately 10m deep. In general, the cover on the subtidal soft sediments just outside of **Fitzgerald Bay** is reported to support a variety of ascidians, soft corals, bryozoans, cyanobacterial mats and sponges, as well as the razorfish, *Pinna bicolor*

(Parsons Brinckerhoff and SARDI, 2003, cited by PIRSA Aquaculture, 2004b). More specifically, various surveys have shown that the bottom of the bay consists of sandy sediment in depths greater than 12m, supporting a variety of invertebrates (particularly in deeper waters out from the central and southern sections of the bay), such as the Razorfish *Pinna*; sponges of various sizes and forms; soft corals (e.g. *Carijoa* sp.); the ascidian *Polycarpa*, the solitary ascidian *Phallusia* and other ascidians; polychaete worms, isopods and ascidians (P. Hone and S. Clarke, SARDI, pers. comm. 1996, cited by Aquaculture Group – PISA Fisheries, 1996; SARDI data, 2002). Some sites sampled in deeper waters out of **Fitzgerald Bay** also support dense patches of stalked bryozoa (*Lanceopora* sp.) and *Polycarpa* ascidians on sand (SARDI data, 2002). Between **Backy Point** and **Crag Point**, sand habitat in deeper waters (e.g. 20m) supports a sparse cover of *Phallusia* and *Polycarpa* ascidians, sponges and soft coral (*Carijoa* sp.), with low densities of *Pinna* razorfish, any few other visible benthic fauna (SARDI data, 2002). Cyanobacterial mats have been recorded to comprise between 2% and 5% of the benthic cover at some of the sites sampled in deeper waters (15m – 20m) out of **Fitzgerald Bay** (SARDI data, 2002).

Crag Point to Douglas Point region (North of Fitzgerald Bay): There are sparse mangrove stands, and a rocky shoreline in most parts of the area. *Hormosira banksii* reportedly occurs on rocky substrate in parts of the intertidal area, and the shallow subtidal is dominated by seagrass beds (mainly species of *Posidonia*), which are not continuous (Aquaculture Group - PISA Fisheries, 1996). During the 1970s, a survey in the **Crag Point** area (Shepherd, 1974) showed that the area was characterised by a shallow-water boulder zone, between the shore and approximately 3.5m deep. Metamorphic boulders colonised by mixed turfing red macroalgae occupied the shallows (2m), grading to a macroalgal community of the brown canopy taxa *Scaberia agardhii*, *Cystoseira trinodis* and *Sargassum* spp., with an understorey of the red *Botryocladia sonderi*, the turfing brown *Lobophora variegata*, and a species of the coralline *Jania*. The boulders supported a “large population” of the sea urchin *Heliocidaris erythrogramma*, which eat the lower stratum macroalgae. At **Crag Point**, the narrow sublittoral platform grades between 3.5 and 8m, and is covered with sediments grading from gravel to fine sand and silt in the lower depths. Dense seagrass beds, comprising patches of *Amphibolis antarctica* (to around 3m), species of *Posidonia* (from 2m to around 8m) and *Zostera* (= *Heterozostera tasmanica*) (between 7m - 9m) cover the platform. Below the seagrass zone is a channel basin, with a silty bottom, and a sparse assemblage of solitary ascidians and burrowing organisms. There are few macroalgae in the zone, but the brown *Sporochnus comosus* occurs below the seagrass zone, and mixed red algae (species of *Coelarthrum*, *Soliera*, *Champia* and *Spyridia*, amongst others) occur in deeper waters of the channel. Razorfish, Hammer Oysters, and a species of mussel are common in the area (in patches not covered with seagrass), and solitary attached ascidians of the *Polycarpa pedunculata* complex (which also includes *P. flava* and *P. viridis*), are also abundant, particularly between 8-12m (Shepherd, 1974).

Blanche Harbour, Two Hummock Point, Douglas Bank: The area includes intertidal mangroves, supratidal and intertidal sand and mudflats, subtidal seagrass meadows, coarse sand and shell channel areas (Ivanovici, 1984; S.A. Department of Fisheries, 1993). In the vicinity of the **Blanche Harbour - Douglas Bank** Aquatic Reserve, animal assemblages have been recognised to contain endemic fauna, and fauna with tropical affinities, in addition to the presence of sand waves and “mega-ripples” habitat, with a characteristic fauna that is unique to the upper Spencer Gulf region (Shepherd 1983a, 1983b; Shepherd and Hails, 1984). Within the **Blanche Harbour to Douglas Point** area, in the section between **Two Hummock Point** and **Mangrove Point**, recorded habitat types include supratidal and intertidal samphire, intertidal mangroves and sand flats, seagrass beds from low water mark to at least 7m deep, and deeper sandy, invertebrate-dominated channels and banks. Shepherd and Branden (1974) recorded seagrass in depth-zoned patches: *Posidonia australis* in the shallow subtidal to approximately 2m; *Amphibolis antarctica* to approximately 4m; narrow *Posidonia* (probably *P. sinuosa*) to 6m, and *Zostera* (= *Heterozostera tasmanica*) to around 7m. Deeper channel floor areas (10m - 15m) were characterised by migrating “sand waves” (more than 15m high) and “mega-ripples” (less than 1.5m high), with characteristic fauna that tolerate the mobile sediment (Shepherd, 1983b), as described below for **Redcliff Point** area. A SARDI survey in 1995 recorded *Posidonia sinuosa* beds at 8m

in the eastern channel area of **Two Hummock Point - Middle Bank**, with 5% - 20% cover of Razorfish *Pinna bicolor* and hammer oyster *Malleus meridianus*; 5% - 10% cover of mixed sponge species, and a sparse coverage of ascidians (Edyvane and Baker, 1996c, and unpublished data). At 8m - 9m depth, animal assemblages dominated the western side of the channel in the **Two Hummock Point – Middle Bank** area, composed principally of mixed sponges and ascidians (up to 50% cover) on a substrate covered with *Pinna* and *Malleus*. Species of the brown *Sargassum*, the green *Codium*, and turfing red macroalgae were also present, but overall coverage was minor. At the time of the 1995 survey, *Posidonia sinuosa* and *Posidonia australis* were recorded in the shallower sandy areas off **Two Hummock Point** (4m - 5m) (Edyvane and Baker, 1996c and unpublished data).

Specific Habitat Notes – Eastern Side

Point Jarrold to Germein Bay / Port Germein: The region is based on coastal clay pans and stranded shelly and quartz sand ridges (i.e. part of the St Kilda Formation), extending more than 5km inland, with minor salt pans in places (Department of Mines and Energy, 1983). There is a broad sand, mud and cobble beach at **Port Germein**. The coastal section from the **Point Jarrold** area northwards to **Germein Bay** comprises an extensive network of tidal creeks, such as **Deep Creek, Port Davis Creek, Fisherman Creek, Seventh, Sixth, Fifth, Fourth, Third, Second and First Creek**, some backed by swamplands. The major habitats include sandflats / mudflats / tidal saltmarsh, extensive mangrove areas, and shallow subtidal seagrass. At **Port Davis Creek, Third Creek, Second Creek and First Creek**, more than 75% of the original catchment area has been cleared, and a recent assessment as part of the National Land and Water Resources Audit classified all of these creeks as *severely modified* (see Bucher and Saenger, 1989; Barnett, 2001). **Fisherman Creek** and **Port Pirie** have also been classified as severely modified estuaries (Barnett, 2001). Bucher and Saenger (1989, cited by Edyvane, 1995b) mapped and described the remaining habitat at some of these creek areas, as follows:

Port Davis Creek: 12.07km² of intertidal sand/mudflats; 16.59 km² of mangroves; and 13.41km² of salt flats / saltmarsh.

Third Creek: 0.89km² of intertidal sand/mudflats; 1.93 km² of mangroves; and 9.80km² of salt flats / saltmarsh.

Second Creek: 2.3km² of intertidal sand/mudflats; 6.03 km² of mangroves; and 11.76km² of salt flats / saltmarsh.

First Creek: 8.04km² of intertidal sand/mudflats; 11.59 km² of mangroves; and 9.93km² of salt flats / saltmarsh.

Notes on the **Port Pirie** area, from Harris and O'Brien (1998): Hails *et al.* (1984) described the Holocene bottom sediments of **Germein Bay** as a poorly sorted mixture of shell sand and gravel, quartzose sand and mud, with variable amounts of seagrass fibre. The carbonate content exceeds 60% in the outer bay, decreasing southwards towards the port (mangrove swamp) area. This sediment type forms a uniform, ~2 m thick drape over the area surveyed in **Germein Bay**. The sediments overlie Pleistocene Mambrey Formation weathered clays with calcareous horizons that were sub-aerially exposed during the last glacial maximum (Hails *et al.*, 1984, cited by Harris and O'Brien, 1998). Intertidal and supratidal sedimentary facies were mapped by Depers (1974), who classified the channel bottom and floor of **Germein Bay** as "*Posidonia*-gastropod-foram skeletal packstone", which is a grey, poorly-sorted, muddy-gravelly sand containing 60% to 90% carbonate, and composed of 10-30% coralline algae fragments, 10-30% foraminifera, 15-20% gastropods and 5-15% undifferentiated skeletal debris. The terrigenous component is comprised of quartz sand and clay. Organic matter content was as high as 30%, and composed mainly of decaying *Posidonia* leaves and fibres. This subtidal facies is flanked along the channel margins by shallow subtidal to intertidal "*Zostera*-gastropod-foram skeletal packstone" (Depers, 1974), characterised by prolific growths of *Zostera* seagrass, and composed of sediment apparently transported landward from the subtidal facies described above. The coastal habitats adjacent to **Port Pirie** are predominantly the extensive intertidal mud flats (1 to 2 km wide) backed by mangrove swamps (2 to 4 km wide). The dredged shipping channel follows an ancient drainage channel which is flanked on both sides by mangrove swamps. Subtidal habitats include extensive *Posidonia* seagrass beds which are distributed over about 18% of the subtidal channel area to a depth of about 6 m (Gostin *et al.*, 1984).

Recorded density of fauna in the unvegetated intertidal flat area of **Germein Bay** was $>280 / m^2$ and was as great as $2,612 / m^2$ in the intertidal seagrass habitat (Hutchings *et al.*, 1993). In the subtidal channels, between 10m and 15 m, the Razorfish *Pinna bicolor* dominates the benthic community and occurs at densities of up to $5 / m^2$. This community includes other molluscs, bryozoa, soft corals, ascidians and sponges (McLaren and Wiltshire, 1984).

The **Fisherman Creek** tidal flat and creek area was mapped in 2000 as part of the National Land and Water Resources Audit, and the following statistics were calculated (see GeoScience Australia, 2001 - 2004):

- ♦ Flood/ebb delta (km²): 1.65
- ♦ Channel (km²): 0.53
- ♦ Intertidal flats (km²): 0.71
- ♦ Mangrove (km²): 3.12
- ♦ Saltmarsh / salt flat (km²): 25.20
- ♦ Water area (km²): 0.75
- ♦ Entrance width (km): 0.64
- ♦ Perimeter (km): 14.43
- ♦ Maximum length (km): 3.59
- ♦ Tidal range (m): 2.20

In contrast, the following statistics for **Fisherman Creek** were provided by the Australian Estuaries Database in 1998:

- ♦ Catchment area: 29 (km²)
- ♦ Open water area: 14.4 (km²)
- ♦ Intertidal flats area: 8.04 (km²)
- ♦ Mangrove area: 11.59 (km²)
- ♦ Saltmarsh area: 9.93 (km²)

Redcliff Point to Yatala Harbour area (including Winninowie Conservation Park). The coastal area adjacent to this park includes substantial areas of saltmarsh; supratidal and intertidal sandflats and mudflats; and intertidal mangroves on the mudflats, and bordering tidal creeks. Tidal inundation occurs over the low-lying samphires twice daily, while high areas are flooded two to three times per fortnight (Reilly, 1991, cited by DEH, 2000a). Some of the samphire areas are associated with cyanobacterial mats constructed by a number of different species of blue-green algae. Coastal marine sediments of salt marshes, mud flats and shell ridges contain highly saline gypseous "flour," gypseous clay and silty clay, and shell fragments, respectively (DEH, 2000a). Previous surveys have reported that the lower mud flats are covered by a low open samphire shrubland comprising *Suaeda australis*, *Sarcocornia quinqueflora*, *Sarcocornia blackiana* and *Halosarcia halocnemoides*. In the area between the upper mud flats and the alluvial plain, grows a supratidal samphire community, dominated by *Sclerostegia tenuis* and *Halosarcia* spp. (Morelli and de Jong, 1995; DEH, 2000a). Mangrove forests border the shorelines and tidal channels on the intertidal mud and sand flats. The mangroves on the western edge of **Redcliff Point** reduce sea currents and therefore help to control erosion (DEH, 2000a). The area of mangroves is intersected by over 60km of tidal creeks, and **Chinaman Creek** is the largest tidal creek in the reserve.

Winninowie Conservation Park includes 28km of Northern Spencer Gulf coastline and most of the reserve is low-lying coastal plain. The reserve is characterised by a system of tidal creeks, bordered by mangrove woodland extending into low lying playa lakes and samphire communities. Around 95 percent of the reserve is subject to tidal inundation during king tides. Since 1980 there appears to have been significant regeneration and colonisation within, and to the southern edge, of the mangrove woodland (DEH, 2000a).

An extensive stand of mangroves also borders the eastern and southern shoreline of the **Yatala Harbour** section of the reserve. These mangroves are contained within, and adjoin, the **Yatala Harbour Aquatic Reserve**. In **Yatala Harbour** several conditions of mangrove woodland occur ("colonising", "die-back" and "extinct"). **Yatala Harbour Aquatic Reserve** (south of, and adjoining Winninowie Conservation Park), on the eastern side of Spencer Gulf is characterised by its extremely high spring tides,

	<p>intertidal sand and mudflats, subtidal seagrass meadows, and coarse sand and shell channel areas (Ivanovici, 1984). On the southern side of Yatala Harbour channel, crescent-shaped scours have been observed approximately 20m-30m wide, and up to 2m deep.</p> <p>In the Redcliff Point – Yatala Harbour area, seaward of the mudflats and sandflats, there is a band of the intertidal fine seagrass <i>Zostera mucronata</i> (Shepherd, 1983a). Successive depth-related seagrass communities comprise meadows of <i>Posidonia australis</i>, <i>Posidonia sinuosa</i>, <i>Zostera</i> (= <i>Heterozostera tasmanica</i>), and/or <i>Halophila ovalis</i> (mixed in some areas). The subtidal area is characterised by seagrass communities (Shepherd, 1983a). During the 1970's, Shepherd and Branden (1974) recorded mixed beds of <i>Posidonia australis</i>, <i>P. sinuosa</i>, and <i>Amphibolis antarctica</i> (with <i>A. antarctica</i> mainly confined to the shallow areas, in less than 5m of water); <i>Zostera</i> (= <i>Heterozostera tasmanica</i>) in troughs, mainly below 5m; and <i>Halophila ovalis</i> between approximately 8m – 10m. McLaren and Wiltshire (1984) also described the distribution of seagrasses offshore from Redcliff in upper Spencer Gulf, which they considered to be representative of the upper gulf. They also recorded a succession of seagrass species with increasing depth and distance from the intertidal zone. The most extensive and widespread was <i>Posidonia australis</i> seagrass, beds of which were distributed over about 18% of the subtidal channel area to a depth of about 6 m (Gostin <i>et al.</i>, 1984 cited by Harris and O'Brien, 1998).</p> <p>A benthic survey in 1995 recorded both <i>Posidonia sinuosa</i> and <i>Posidonia angustifolia</i> at 6m to 7m in the Middle Bank area (SARDI S.A. Benthic Survey, unpublished data 1995; see also Edyvane and Baker, 1996c). The green macroalgae <i>Caulerpa cactoides</i> is also present in the subtidal area, on the edges of channels (Shepherd, 1983a; Morelli and de Jong, 1995; DEH, 2000A). The fauna in this region comprises mainly articulated bryozoa, sea pens, and solitary ascidians, which are usually found attached to shell fragments (see description for Two Hummock Point - Mangrove Point). In this bank and channel area, Shepherd (1983a) recorded a patchily distributed community of red macroalgae, mainly attached to shell fragments. Hard shelly substrates in the channels and banks area generally support mixed invertebrates, apart from the mixed red turfing macroalgae. At deeper depths, the Middle Bank grades into a sandy and shelly channel with sand waves and "mega-ripples". Shepherd and Hails (1984, cited by Harris and O'Brien, 1998) reported that the mega-ripples in the Middle Bank area of the Flinders Channel, comprised medium to coarse sand, 30-95% calcium carbonate. The mega-ripples are located on a sandy mid-channel area adjacent to one side of the Middle Bank sandbank, and range in size from smaller forms (20-30cm in height and 5-6m in wavelength), to larger forms (up to 3m height and 18m wavelength). The mega-ripples ("dunes") at several sampled locations differ in terms of cross-sectional profile, height, geometry, grain size and seasonal / annual migration rate. Mega-ripple (dune) crests were noted to migrate in a non-uniform manner, giving rise to curved dune crests, dune bifurcation and merging. Migration rates vary between summer and winter, with winter rates being up to 6 times larger than summer rates (Shepherd and Hails, 1984, cited by Harris and O'Brien, 1998).</p> <p>Animal assemblages recorded by Shepherd (1983a) in the channel / banks area include:</p> <ul style="list-style-type: none"> a sponge, gorgonian and soft coral community, on shell-rock surfaces covered with sediment, with many species of sponge; the soft coral <i>Telesto</i> (now called <i>Carijoa multiflora</i>); two species of gorgonians with tropical affinities (<i>Euplexaura</i> and <i>Echinogorgia</i> species), as well as bryozoa (e.g. species of <i>Celleporaria</i> and <i>Amanthia</i>), Hammer Oysters (<i>Malleus meridianus</i>) and solitary ascidians (e.g. <i>Polycarpa viridis</i> – formerly <i>P. pedunculata</i>, and <i>Halocynthia dumosa</i> – formerly <i>H. hispida</i>) being common components of the benthos; a solitary ascidian and gorgonian coral assemblage was recorded in the channel basin, between 10m - 20m, on shelly or sandy bottom, with sea pens, Hammer Oysters and echinoderms; and a "sandwave" community of invertebrates that can tolerate the mobile conditions, including the stalked bryozoan <i>Lanceopora obliqua</i>, the sea pen <i>Virgularia gustaviana</i>, and two species of solitary ascidian, as dominant components. <i>Virgularia gustaviana</i> is a tropical Indo-Pacific species, and its known occurrence within S.A. is restricted to upper Spencer Gulf, on silty bottom substrate (Utinomi and Shepherd, 1982).
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	<p>In the far northern Spencer Gulf area, aggregations of <i>Pinna bicolor</i> and <i>Malleus meridianus</i> are dominant features, recorded from the intertidal to 20m deep, and most commonly found on the edges of the channel basin from 8m to 15m. The brown macroalga <i>Hormosira banksii</i> is often found growing on intertidal aggregations of <i>P. bicolor</i> and <i>M. meridianus</i> in the region (Shepherd, 1983a).</p> <p><u>Specific Habitat Notes – Far Northern Area</u></p> <p>Further north, the bay south of Point Paterson, northwards to Snapper Point, is generally an area of low wave energy and low water circulation. The coastal habitats adjacent to Port Augusta include large intertidal sand and mud flats and low red cliffs composed of Pleistocene Hindmarsh Clay (Gostin <i>et al.</i>, 1984; Hails <i>et al.</i>, 1984, cited by Harris and O'Brien, 1998). There are mangroves lining the majority of the coast in this zone; sandy and shelly substrates (with invertebrate assemblages, particularly molluscs) in the central waters (including channels), and limited areas of seagrass (mainly <i>Posidonia</i> species). Hails <i>et al.</i> (1984, cited by Harris and O'Brien, 1998) described the bottom sediments as a poorly sorted mixture of shell sand and gravel, quartzose sand and mud, with variable amounts of seagrass fibre.</p> <p>This sediment type forms a layer up to 10 m thick near Point Paterson and is associated with the linear sandbanks which occupy the upper reaches of Spencer Gulf. Thicknesses in the inter-bank channels are of the order of 1m. These sediments overlie Pleistocene Mambrey Formation weathered clays with calcareous horizons that were sub-aerially exposed during the last glacial maximum (Hails <i>et al.</i>, 1984, cited by Harris and O'Brien, 1998). The estuarine area of Northern Spencer Gulf has been classified as <i>modified</i>, in a recent assessment by the National Land and Water Resources Audit (Barnett, 2001).</p>
<p>6. Taxonomic Diversity</p>	<p>Bony and Cartilaginous Fish</p> <p>A complete list of fish species is not available for this report, however well over 60 species are known to commonly occur in Northern Spencer Gulf. Apart from the common commercially and recreationally significant species that inhabit seagrass, reef, sand and mud habitats (see section below on Major Commercial and Recreational Fish), non-commercial species include various species of Weedy Whiting, Blue Rock Whiting, other Rock Whiting species, Pipefish (several species), Goby (several species), Cardinalfish species, Weedfish species, Wavy Grubfish, Soldierfish, Common Bullseye, Roughy, Toadfish, Common Stinkfish, Magpie Perch, Spiny Gurnard, Truncate Coralfish, Zebra Fish, Long-snouted Boarfish, Silverbelly, Yellow-tail Scad, and several Leatherjacket species (often in high abundance), such as Bridled Leatherjacket, Mosaic Leatherjacket, Velvet Leatherjacket, and Six-spined Leatherjacket (surveys by Branden <i>et al.</i>, 1994 and McDonald, 2000; and recreational diving records).</p> <p>Invertebrates</p> <p>Various sampling programs, including extensive infaunal surveys during the late 1980s, have reported a relatively high diversity of crustacean species in upper Spencer Gulf (e.g. data by Sergeev, cited by S. Shepherd, pers. comm., 2004). Kinhill Engineers (1987) recorded around 30 species of small crustacean from the intertidal sand and mangrove areas of upper Spencer Gulf. At least nine species of large decapod crustaceans are known to occur in upper Spencer Gulf, as well as several prawn species.</p> <p>More than 60 shelled and unshelled mollusc species have been recorded from intertidal sand and mangrove areas and shallow subtidal habitats in northern Spencer Gulf (Shepherd, 1983a and 1983b; Kinhill Engineers, 1987). The studies were not designed to achieve a complete inventory of taxa, hence the diversity of mollusc species in upper Spencer Gulf is likely to be higher.</p> <p>More than 30 species of polychaete worm have been recorded in the intertidal habitats of Upper Spencer Gulf (Kinhill Engineers, 1987).</p> <p>Hutchings <i>et al.</i> (1993) recorded 372 species of infauna from sandy and seagrass habitats in Germein Bay, northern Spencer Gulf, with high densities of fauna (up to 2612 animals per square metre) in intertidal <i>Zostera</i> seagrass habitat. The infauna was dominated by species of polychaete worms, molluscs and crustaceans.</p>

	<p>Estuarine, Coastal and Marine Birds Northern Spencer Gulf: Approximately 67 wading bird, other coastal bird, and sea bird species have been recorded, 19 of which are listed under international treaties (Morelli and de Jong, 1995).</p> <p>Intertidal and Supratidal Coastal Vegetation Winninowie Conservation Park: The area's large tidal range and extremes of water temperature have reportedly resulted in "the richest and most diverse coastal flora" in the state (DENR, 1995) and "remnant natural habitat of high biodiversity value" (DEH, 2000a).</p>
<p>7. Habitat for Endemic Taxa / Threatened Taxa / Rare or Uncommon Taxa</p>	<p>Marine and Coastal Plants Two large brown macroalgal species, <i>Hormophysa triquetra</i>, and <i>Sargassum decurrens</i>, which have tropical and subtropical affinities, have been recorded from Northern Spencer Gulf (Shepherd, 1983a). <i>H. triquetra</i> has been recorded from Port Broughton and Port Augusta, and may represent a relict population (Womersley, 1987). <i>S. decurrens</i> is found from Rottneest Island in W.A. northwards to northern Australia, and also New Caledonia. In South Australia it is known from Far Northern Spencer Gulf, and drift specimens have been recorded at Cowell, Wallaroo, and parts of Gulf St Vincent. The occurrence of the species in S.A. is considered to represent a relict tropical population, possibly in both gulfs (Womersley, 1987). Examples of other species from the area that are not common in South Australia include 4 algal epiphytes with tropical affinities, recorded from mangroves in upper Spencer Gulf (Beanland and Woekerling, 1982).</p> <p>Winninowie Conservation Park: The Grey Samphire <i>Halosarcia halocnemoides</i> ssp. <i>halocnemoides</i> has been identified as a species of conservation significance, and has been rated as uncommon within the Eyre Peninsula Botanical Region (DEH, 2000a, Table 1). The Beaded Samphire <i>Sarcocornia quinqueflora</i> has been identified as a species of conservation significance within the Flinders Botanical Region, and is awaiting full assessment of its status (DEH, 2000a, Table 1). The Winninowie area also contains a number of supratidal species of limited distribution (Morelli and de Jong, 1995, citing Reilly, undated and Chinnock, 1975), such as <i>Malacocera gracilis</i> (a chenopod that grows in saline clay soils or gypseus muds).</p> <p>Point Lowly: Recorded in the area is <i>Pterothamnion flexile</i>, a species of red macroalgae that reportedly has a limited range (Cheshire <i>et al.</i>, 2000; Turner, 2000).</p> <p>Bony and Cartilaginous Fish Great White Sharks (both large and small specimens) are regularly sighted around the Whyalla area at various times of the year (e.g. Merek's Tyre Reef; Mudbanks; the Leeton wreck; south of Western Shoal and other bank and channel areas out from Whyalla, Point Lowly and Whyalla foreshore area) (FishInternet Australia, 2001; Fishing South Australia, 2001). Visiting Great White Sharks eat large fish such as Snapper in the area. Great White Shark was listed in IUCN's Red List 2003 as <i>vulnerable</i> and <i>conservation dependent</i>, and is a protected species under both South Australian (<i>Fisheries Act 1982</i>) and Commonwealth (<i>EPBC Act 1999</i>) legislation.</p> <p>The deep-water Elephant Fish / Elephant Shark <i>Callorhynchus milii</i>, which migrates into shallow waters in S.A. during spawning season, is seasonally present in Northern Spencer Gulf. Elephant Fish is considered to be a potentially vulnerable species due to its very low fecundity, "boom and bust" recruitment levels, population dynamics, migratory behaviour, and researchers' poor knowledge of population sizes (D. Didier-Dagit, chimaeran species biologist, pers. comm., 1999; and see Baker, in press, for summary of the conservation status of this species in southern Australia).</p> <p>Several pipefish species are known from upper Spencer Gulf seagrass beds. Pipefish species are generally considered to be vulnerable due to their strong habitat association, and due to damaging processes that cause decline in the extent of their required habitats, particularly seagrass beds, upon which many pipefish species</p>

	<p>depend (Pogonoski et al., 2002; Baker, in press; Brown, 2004). All syngnathids (including pipefish) are now formally listed under the <i>Environment Protection and Biodiversity Conservation Act 1999</i>. Four examples of pipefish species in northern Spencer Gulf are :</p> <ul style="list-style-type: none"> ♦ the Tiger Pipefish (<i>Filicampus tigris</i>), a sub-tropical species which is more common recorded in warmer parts of Australia, such as Moreton Bay in Qld; Shark Bay, Port Hedland and Broome in WA; Sydney Harbour and other parts of NSW (Hutchins and Swainston; Kuitert, 1996 and 2000; Froese and Pauly, 2003). The species is usually found near the entrance of deeper estuarine areas, on rubble-sand or mud with sparse plant life (Kuitert, 1996b; Edgar, 2000). In South Australia, the species has been recorded from upper, mid, and lower Spencer Gulf (Kuitert, 2000; Froese and Pauly, 2003; B. MacDonald, DEH, pers. comm., 2003; records cited in Baker, 2004). ♦ The Deep-bodied (Deepbody) Pipefish <i>Kaupus costatus</i>, a species belonging to a monotypic, endemic Australian genus, known from isolated but locally abundant populations in Victoria, Flinders Island (Tasmania), and several places in South Australia (e.g. Spencer Gulf, upper Gulf St Vincent, and Kangaroo Island) (Kuitert, 1996b; Kuitert, 2000; B. MacDonald, unpublished survey data, 2000-2002; R. Browne, pers. comm., 2003; Browne, 2004). Deep-bodied Pipefish has specific habitat requirements, such as quiet (i.e. low energy) shallow (usually 3m or less, but see below) eelgrass beds in silty-bottomed yet clear-water environments. It is secretive and usually only seen when dragnet samples are taken. The species often occurs in small aggregations, in the intertidal zone (Kuitert, 1996b). Deep-bodied Pipefish has also been recorded in deeper seagrass beds in Spencer Gulf (B. MacDonald, unpublished survey data, 2000-2002) and over macroalgal stands, to around 10m (Dawson, 1985, cited by Froese and Pauly, 2003). ♦ Gales Pipefish <i>Campichthys galei</i>, which is known mainly from Western Australian waters (e.g. Shark Bay, Point Peron, Rottnest Island and Lucky Bay), but also recorded in South Australia – e.g. recorded in Spencer Gulf seagrass trawl samples (B. MacDonald, unpublished data, 2000-2002), and at Boston Island (lower Spencer Gulf) (Dawson, 1985; Kuitert, 1996a and 1996b; W.A. Museum records, cited in Baker, in press); and ♦ The Long-snout Pipefish <i>Vanacampus poecilolaemus</i>, reported from estuaries, shallow weedy bays, and shallow seagrass beds, often in quiet, silty-bottomed, clear-water habitats (Dawson, 1985; Kuitert 1996b). Long-snout Pipefish has been known mainly from Spencer Gulf, Gulf St Vincent and Kangaroo Island in South Australia. It is also recorded in Bass Strait / Victoria, Tasmania, and W.A., although populations in W.A. may represent a separate species (see Dawson, 1985; Kuitert, 1996a and 1996b and 2000). Recently, more than 250 specimens were recorded in beam trawls from seagrass sampling in Spencer Gulf (B. MacDonald, unpublished data, 2000 –2002). In Spencer Gulf, the species was found predominantly over <i>Posidonia</i>, but also occurred within intertidal <i>Zostera</i> meadows. Greatest numbers were taken at the most southerly extent of the study area, suggesting a possible preference for more exposed or cooler environments (McDonald, 2000-2002, unpublished data). Although the Long-snout Pipefish is not uncommon (e.g. survey data by B. MacDonald; and survey data cited in Browne, 2004), its restricted dispersal abilities, and reliance upon seagrass habitats, make it a species of potential conservation concern. <p>The Southern Potbelly / Pot-bellied Seahorse <i>Hippocampus bleekeri</i> is known to occur in the Blanche Harbour-Douglas Bank Aquatic Reserve (Pogonoski et al., 2002).</p> <p>Several fish and shark species, including some tropical species and some southern oceanic species, which are rarely recorded in South Australian coastal waters, are occasionally observed or caught in Northern Spencer Gulf waters. None of the following species are classified as rare or threatened, however their presence well away from their main range is of interest, hence their inclusion in this section. Examples include Dolphin Fish, Skipjack (Striped) Tuna, Broadbill Swordfish, and Thresher Shark (Morelli and de Jong, 1995; Aquaculture Group - PISA Fisheries, 1996; FishInternet Australia, 2001 and other recreational fishing reports).</p> <p>Fish species with western affinities, such as the Red-lipped Morwong <i>Cheilodactylus rubrolabiatus</i>, that do not commonly occur further east than the West Coast of S.A., are also reported on occasion in Northern Spencer Gulf. The little-known species</p>
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	<p>Orange-barred Pufferfish (<i>Polyspina piosae</i>), for which there are few published records in S.A., also occurs in Northern Spencer Gulf (survey data by P. Jennings, SARDI, cited in Baker, in press).</p> <p>The sub-tropical goby species <i>Bathygobius krefftii</i> (Frayed-Fin Goby / Krefft's Goby) has been reported from Northern Spencer Gulf, representing a disjunct population of the species, which occurs mainly in southern Queensland and New South Wales (Kuitert, 1993, 1996b; Gomon et al., 1994; Museum of Victoria record, 1997, cited by Baker, in press).</p> <p>Scarlet Cardinalfish (<i>Vincentia badia</i>) and Orange Cardinalfish (<i>V. punctata</i>), mouth-brooding fish species of potential conservation concern, have also been recorded in Northern Spencer Gulf (see Baker, in press, for summary).</p> <p>Invertebrates</p> <p>The "tropical relic" sea pen <i>Virgularia gustaviana</i>, found in the Indo-Pacific seas, has been recorded in southern Australia from the warm waters of Northern Spencer Gulf (Utinomi and Shepherd, 1982). The other <i>Virgularia</i> species, <i>V. mirabilis</i>, is also found in Victoria, and rarely recorded in South Australia. Utinomi and Shepherd (1982), reported that <i>V. mirabilis</i> had been recorded in S.A. only from upper Spencer Gulf. Shepherd (1983) considered <i>V. mirabilis</i> distribution in upper Spencer Gulf to be highly localised, with this mobile sea pen recorded only in the sandwave / mega-ripple field near Middle Bank. <i>Telestoa</i> (now called <i>Carijoa</i>) <i>multiflora</i>, a tropical soft coral species from the northern and western Australian coasts, is considered abundant in Northern Spencer Gulf, and is also found in mid Spencer Gulf (Utinomi and Shepherd, 1982; Morelli and de Jong, 1995).</p> <p>Shepherd (1983a) recorded the presence of relatively new and/or specifically undescribed taxa including a bryozoan, <i>Bugula</i> n.sp., a flatworm <i>Ancoratheca australiensis</i> and a nudibranch <i>Discodoris</i> n.sp. from the region. The uncommon brittle star <i>Amphiura trisacantha</i> is also found in Northern Spencer Gulf (Baker and Devaney, 1981, cited by Shepherd, 1983a), and in Victoria, this species has more recently been recommended for listing as threatened under the <i>Flora and Fauna Guarantee Act 1988</i> (O'Hara and Barmby, 2000). Several previously unrecorded species were discovered during the 1990s. One example is the two new species of intertidal barnacle that were recorded in wave-sheltered habitats of Spencer Gulf (Bayliss, 1994).</p> <p>The very small phylum of worm-like animals known as Phoronids ("Horseshoe Worms"), of which there are only around 12 species known world-wide (Shepherd, 1997a; Ponder et al., 2002), has representatives in Northern Spencer Gulf. The phoronids of tropical affinity, <i>Phoronis albomaculata</i> and <i>P. psammophila</i>, are known from sites in the Whyalla and Germein Bay area (Emig and Roldan, 1992).</p> <p>In Northern Spencer Gulf occurs an endemic species of Egg Cowrie, <i>Primovula cruenta</i>, that feeds on the gorgonian coral <i>Echinogorgia</i> (Gowlett-Holmes and Holmes, 1989; Wilson et al., 1993). Egg Cowries are mainly tropical, and few species occur in southern Australia (Wilson et al., 1993).</p> <p>The Point Lowly / Whyalla area supports a population of small specimens of the cowrie <i>Zoila friendii thersites</i> (Wilson and Clarkson, 2004), a species of conservation concern (see Section 9.2).</p> <p>A number of previously unrecorded polychaete worm species, including the first Australian records for one family of sand-dwelling polychaetes, have also been found in Northern Spencer Gulf (Hartmann-Schroder and Parker, 1990a and 1990b).</p> <p><i>Trochodota shepherdii</i>, a sea cucumber known from Spencer Gulf and Gulf St Vincent (Rowe, 1982) and one location in Victoria, is considered rare, and also vulnerable, particularly in areas of seagrass dieback (O'Hara and Barmby, 2000);</p> <p>The Lace Bottletail Squid <i>Sepiadarum</i> sp., is considered to be an uncommon species, and is known from the shallow seagrass beds in the gulfs of South Australia (Norman and Reid, 2000; Zeidler, pers. comm. to DEH, 2001).</p>
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A tropical mangrove and saltmarsh crab, *Sesarma erythroductyla*, which is found in Queensland and New South Wales (Jones and Morgan, 2002), is reported to also have isolated populations in parts of Victoria (e.g. see Morgan, 1986, cited by Plummer *et al.*, 2003), and in **Far Northern Spencer Gulf** (e.g. **Port Augusta**) (Davey, 1998).

A number of invertebrates, fish species and marine plants in the Northern Spencer Gulf area are endemic to southern Australia, but quantification is not possible for this report. Species in **Northern Spencer Gulf** which may be endemic within South Australia only, include the following:

- ♦ The South Australian endemic Sea Pen *Scytalium* sp., which has only been found in **Northern Spencer Gulf** at 10m depth on sandy or silty bottom (Shepherd and Thomas, 1982).
- ♦ The S.A. endemic gorgonian coral *Echinogorgia* sp. has been recorded from **Northern Spencer Gulf** (Grasshoff, 1982; Shepherd, 1983). The species, common in northern Spencer Gulf is similar to, but probably not identical with, a species of the tropical north-west Australian coast (Grasshoff, 1982).

Other species that may have a very limited distribution in southern Australia, and are known from the **Spencer Gulf** region, include the following:

- ♦ *Deltocyathus vincentinus*, solitary hard coral, previously abundant in both Spencer Gulf and Gulf St Vincent (Shepherd and Veron, 1982);
- ♦ *Edwardsia vivipara*, sea anemone, recorded from low energy coasts in the S.A. gulfs (Thomas and Shepherd, 1982).

A recent assessment by Museum of Victoria (O'Hara and Barmby, 2000) on the distribution of endemic taxa, recorded at least 12 decapod crustacean and echinoderm species whose range is restricted to the South Australian gulfs. The number of these species from Northern Spencer Gulf is not known for this report.

Marine Mammals *

Australian Sea Lions, which seasonally visit upper Spencer Gulf (Morelli and de Jong, 1995) to feed on cephalopods and fish, are regularly observed (particularly during winter and spring). There are no haul-out or breeding sites in the area. Australian Sea Lion is classified as *rare* under the S.A. *National Parks and Wildlife Act 1972*, and has also been considered by some researchers to be a threatened species (e.g. Gales, 1990; Gales *et al.*, 1994).

There are regular seasonal (winter) sightings of Southern Right Whales, both individuals and small groups, in Northern Spencer Gulf (e.g. **Yarraville Shoal**, **Western Shoal**, and other areas). Southern Right Whale was listed in the IUCN Red List 2003 as *conservation dependent*, and is a formally protected species under the Commonwealth's *EPBC Act 1999*, and in South Australia under the *National Parks and Wildlife Act 1972*.

Bottlenose Dolphins occur in Northern Spencer Gulf (e.g. small pods are occasionally observed at the mouth of **Chinaman Creek** (Morelli and de Jong, 1995; DEH, 2000a). Bottlenose Dolphin was listed as *Data Deficient* by the IUCN Red List 2003.

Several species of whale have been irregularly sighted in Northern Spencer Gulf (Morelli and de Jong, 1995; DEH, 2000a). Species include Bryde's Whale; Pygmy Sperm Whale (*rare* under S.A. *National Parks and Wildlife Act 1972*), and the Strap-toothed Whale. These sightings presumably represent stray individuals that travelled well away from their migratory path, since these species are rarely observed in South Australian waters.

Coastal and Marine Birds

Northern Spencer Gulf: Coastal birds listed as *rare* under *South Australian National*

	<p><i>Parks and Wildlife Act 1972</i> include Osprey, Eastern Reef Egret, Rock Parrot (which has a coastal association), and Australasian Shoveller (Matheson, 1976; Matthew, pers. comm. 1995, cited by Morelli and de Jong, 1995 and DEH, 2000a).</p> <p>Northern Spencer Gulf: A number of coastal and marine birds found in Northern Spencer Gulf are considered to be under threat. Examples include Orange-bellied Parrot (which feeds in intertidal areas, and is classed as <i>endangered</i> under the S.A. <i>National Parks and Wildlife Act 1972</i>, and the Commonwealth's <i>Environment Protection and Biodiversity Conservation Act 1999</i>). In 1992, seven sightings of the Orange-bellied Parrot were made at Chinaman Creek, amongst a flock of Blue-winged Parrots and several Rock Parrots. According to Morelli and de Jong (1995) and DEH (2000a), the sighting of Orange-bellied Parrots in the Chinaman Creek area in 1992 represented a significant extension of range for the species in South Australia. Other threatened species in the Northern Spencer Gulf region include Little Egret (which, although not formally listed, has been referred to as a <i>vulnerable</i> species - e.g. see Morelli and de Jong, 1995); Hooded Plover; White-bellied Sea Eagle; Eastern Curlew; Fairy Tern; and Samphire Thornbill, and all are classed under South Australian legislation as <i>vulnerable</i> species (Matheson, 1976; Morelli and de Jong, 1995; Matthew, pers. comm. 1995, cited by DEH, 2000a). Samphire Thornbill is also listed nationally as <i>vulnerable</i> (<i>EPBC Act 1999</i>). According to Copley (1996, cited by Edyvane, 1999b), the Little Tern, which is reported to occur at Ward Spit, could "realistically be regarded as endangered in South Australia". The Little Tern is classed as <i>vulnerable</i> under S.A. legislation.</p> <p>Marine Reptiles</p> <p>Northern Spencer Gulf: There have been seasonal reports of migratory turtles from more northerly parts of Australia (e.g. Hawksbill Turtle, Green Turtle and Loggerhead Turtle), visiting the Northern Spencer Gulf waters (Morelli and de Jong, 1995; Robinson <i>et al.</i>, 2000; DEH 2000a and 2003a). All turtle species recorded in South Australia are of conservation concern. Green Turtle was listed by IUCN Red List 2003 as <i>endangered</i>, and is also listed as <i>vulnerable</i> under the SA <i>National Parks and Wildlife Act 1972</i>, as well as the Commonwealth's <i>EPBC Act 1999</i>. Loggerhead Turtle was listed by IUCN Red List 2003 as <i>endangered</i>, and is also listed as an <i>endangered</i> species under S.A. legislation, as well as the Commonwealth's <i>EPBC Act 1999</i>. Hawksbill Turtle was listed by IUCN Red List 2003 as <i>critically endangered</i>, and is also listed as under the Commonwealth's <i>EPBC Act 1999</i> as <i>vulnerable</i>.</p>
<p>8. Other Important Taxa</p>	<p>Bony and Cartilaginous Fish</p> <p>There are abundant rays of several species in Far Northern Spencer Gulf, such as Smooth Stingray, Fiddler Ray, Eagle Ray and other species. Although surveys have not been undertaken, the regular capture of these species by recreational and commercial fishers in the area, indicates that Northern Spencer Gulf may be important habitat for ray species.</p> <p>Seasonal presence of Bronze Whalers (including pregnant and birthing females) and Hammerhead Sharks, which feed on fish in Northern Spencer Gulf (FishInternet Australia, 2001, and other recreational fishing reports).</p> <p>Seagrass meadows and unvegetated soft bottom habitats on the eastern side (e.g. Germein Bay area, between Baroota and Woods Point), and on the western side (e.g. between Murninnie Beach and Point Lowly, and between Point Lowly and Two Hummock Point), are reported to be used by one or more of the life stages of the following commercially and/or recreationally significant fish species: King George Whiting, Yellow-fin Whiting (Germein Bay, and Murninnie Beach to Point Lowly, unvegetated areas), Snapper, West Australian Salmon, Tommy Ruff, Yellow-eye Mullet (Germein Bay, unvegetated areas); Southern Sea Garfish, Red "Mullet", flathead species, flounder species (Germein Bay, and Murninnie Beach to Point Lowly, unvegetated areas), Trevally, Yellow-tail Kingfish, leatherjacket species (mainly in the seagrass), Snook, and Whaler Sharks (Bryars, 2003).</p> <p>Reef in the area between Black Point and Point Lowly is reported to be used by one or more of the life stages of King George Whiting, Snapper, West Australian Salmon,</p>

	<p>Tommy Ruff, Southern Sea Garfish, Yellow-eye Mullet, Trevally, Yellow-tail Kingfish, Leatherjacket species, Wrasse species, Snook, Silver Drummer, Gummy Sharks and Whaler Sharks (Bryars, 2003).</p> <p>Tidal flats on the eastern side (e.g. in the Germein Bay area between Baroota and Woods Point, including Ward Spit), and on the western side (e.g. between Murninnie Beach and Whyalla, and around False Bay and Port Bonython), and in Far Northern Spencer Gulf (i.e. Point Lowly to Port Augusta, then south to Baroota on the eastern side), are reported to be used by one or more of the life stages of King George Whiting and/or Yellow-fin Whiting, West Australian Salmon, Tommy Ruff, Southern Sea Garfish, Yellow-eye Mullet, Black Bream (eastern side), Mulloway, flathead species, flounder species, and Yellow-tail Kingfish (Bryars, 2003).</p> <p>Tidal creeks in the area (e.g. Ward Point, Port Germein, Port Pirie River, First to Seventh Creeks, Fisherman Creek, Eight Mile Creek and others between Murninnie Beach and Whyalla; False Bay; also between Two Hummock Point and Blanche Harbour; Yorkey Crossing; Curlew Point, Brown Point, False Creek, and Chinaman Creek, and from Miranda to Mambray Creek) are reported to provide habitat for most of the species (listed above) that also occur in tidal flat areas (Bryars, 2003).</p> <p>Mangrove forests in the area (e.g. Ward Point, Weeroona Island, Port Pirie River, First to Seventh Creeks, Murninnie Beach to Whyalla, False Bay, Fisherman Creek, Fitzgerald Bay, Backy Point to Douglas Point; Douglas Point to Blanche Harbour to Curlew Point to Yorkey Crossing to Point Paterson to Redcliff Point to Yatala Harbour) are reported to be used by one or more of the life stages of King George Whiting, Yellow-fin Whiting, West Australian Salmon, Tommy Ruff, Southern Sea Garfish, Yellow-eye Mullet, and Black Bream (the latter mainly on the eastern side, in the vicinity of the Port Pirie Creeks) (Bryars, 2003).</p> <p>Invertebrates</p> <p><i>Sarcoptilus grandis</i>, the largest Sea Pen in Australia, occurs in channels areas deeper than 10m, in Northern Spencer Gulf (e.g. Whyalla area).</p> <p>Soft corals (e.g. <i>Carijoa multiflora</i>, previously called <i>Telesto multiflora</i>); gorgonian corals (including genera with tropical affinities, such as <i>Euplexaura</i> and <i>Echinogorgia</i>, and a finely branched, strap-like gorgonian coral, <i>Clathraria</i> sp.); various solitary and compound ascidian species; sponges and bryozoa (both stalked and sessile) are abundant in some parts of upper Spencer Gulf (e.g. Middle Bank area; Whyalla / Fitzgerald Bay area; Cowleds Landing, and other locations in northern Spencer Gulf). Sand habitats dominated by sessile invertebrates such as these are not common in South Australia, particularly in the relatively shallow waters (15m – 25m) in which these assemblages occur in Spencer Gulf.</p> <p>Abundant Razorfish (<i>Pinna bicolor</i>) and Hammer Oysters (<i>Malleus meridianus</i>) occur in Northern Spencer Gulf, and these species are ecologically important because: (i) they are large filter-feeding molluscs, and thus may influence water quality in areas where they occur in dense beds; and (ii) Razorfish and Hammer Oysters provide additional hard substrate in areas where mainly soft sediments exist (sand, sandy mud, mud etc), thus providing a hard surface for the attachment of epibiota, including <i>Hormosira banksii</i>, <i>Scaberia agardhii</i>, <i>Caulocystis</i> sp., <i>Sargassum</i> spp., turfing red algae, and a variety of invertebrates, such as sponges, ascidians, mussels and other molluscs, and calcareous tube worms (Shepherd, 1974 and 1983a; J. Baker, pers. obs.). Cryptic species, such as small brittle stars also use dead <i>Pinna</i> shells as habitat (see Shepherd, 1974), and the presence of <i>Pinna</i> reportedly also promotes increased densities of sea urchins in northern Spencer Gulf. When shells of old Hammer Oysters and <i>Pinna</i> break into fragments, they provide a mobile substrate for stalked fauna (e.g. some bryozoan and ascidian species) that can withstand the strong currents of Northern Spencer Gulf, such as the mobile sandwaves / mega-ripples of the channel areas (Shepherd, 1983b).</p> <p>There are abundant solitary ascidians, principally species of the <i>Polycarpa pedunculata</i> / <i>P. viridis</i> complex (which also includes <i>P. flava</i>), in some parts of Northern Spencer Gulf (e.g. shallow seagrass beds) (Shepherd, 1974; Kott, in Australian Government Department of the Environment and Heritage, 2004b). Shepherd (1974) recorded densities of up to 20 – 40 / m² in the Crag Point area and sand wave / mega-ripple channel areas of Middle Bank, where this species can tolerate the mobility of sediments (Shepherd 1983b). Other ascidians of interest include <i>Sycozoa pedunculata</i>, a stalked ascidian found in southern States, which has a head</p>
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	<p>(sometimes two) that seasonally detaches, and another regenerates. <i>S. pedunculata</i> has been recorded in high densities in parts of Northern Spencer Gulf (Shepherd 1974; Shepherd, 1983b). The white solitary ascidian <i>Cnemidocarpa radicata</i> (formerly <i>C. etheridgii</i>) has also been recorded in high densities in some areas, such as the western side of Middle Bank (Two Hummock Point to Mangrove Point) (see Shepherd and Branden, 1974).</p> <p>Seagrass meadows and unvegetated soft bottoms on the eastern side (e.g. Germein Bay area, between Baroota and Woods Point), and on the western side (e.g. between Murninnie Beach and Point Lowly, and between Point Lowly and Two Hummock Point), are reported to be used by one or more of the life stages of the following commercially and/or recreationally significant invertebrates: Blue Swimmer Crab, Razorfish, Western King Prawn (Germein Bay, in the unvegetated areas), Southern Calamari; King Scallop and Queen Scallop (Bryars, 2003).</p> <p>Tidal flats on the eastern side (e.g. in the Germein Bay area between Baroota and Woods Point, including Ward Spit), and on the western side (e.g. between Murninnie Beach and Whyalla, and around False Bay and Port Bonython), and in Far Northern Spencer Gulf (i.e. Point Lowly to Port Augusta, then south to Baroota on the eastern side), are reported to be used by one or more of the life stages of Blue Swimmer Crab, Western King Prawn, Mud Cockle, Razorfish, and baitworm species (Bryars, 2003).</p> <p>Tidal creeks in the area (e.g. Ward Point, Port Germein, Port Pirie River, First to Seventh Creeks, Fisherman Creek; Eight Mile Creek and others between Murninnie Beach and Whyalla; False Bay; also between Two Hummock Point and Blanche Harbour; Yorkey Crossing; Curlew Point, Brown Point, False Creek, Chinaman Creek, and from Miranda to Mambray Creek) are reported to provide habitat for Blue Swimmer Crab, Western King Prawn and Razorfish (the latter mainly on the eastern side) (Bryars, 2003).</p> <p>Mangrove forests in the area (e.g. Ward Point, Weeroona Island, Port Pirie River, First to Seventh Creeks, Fisherman Creek, Murninnie Beach to Whyalla, False Bay, Fitzgerald Bay, Backy Point to Douglas Point; Douglas Point to Blanche Harbour to Curlew Point to Yorkey Crossing to Point Paterson to Redcliff Point to Yatala Harbour) are reported to be used by one or more of the life stages of Blue Swimmer Crab, Western King Prawn, Mud Cockles (mainly on the eastern side) and Baitworm species (Bryars, 2003).</p> <p>Marine Mammals Pods of Common Dolphins are occasionally observed feeding in Northern Spencer Gulf (Morelli and de Jong, 1995; DEH, 2000a).</p> <p>Coastal and Marine Birds In addition to rare, threatened and migratory species (see other sections of this table), other coastal marine bird species in the area include Black-faced Cormorant, Pied Cormorant and Red-capped Plover, all of which are the most numerous coastal bird species recorded in the region (Morelli and de Jong, 1995). Caspian Tern is reported to breed at Ward Spit (Edyvane, 1999b), and Spotted Crake also occurs in northern Spencer Gulf. Although Northern Spencer Gulf is not a breeding site or major habitat for Little Penguin, this species is also observed (usually during winter and spring) by fishers in the waters of the northern gulf (FishInternet Australia, 2001).</p>
<p>9. Notable Feeding, Breeding / Spawning and Nursery Areas</p>	<p>Bony and Cartilaginous Fish In general, the mangrove and seagrass habitats of Northern Spencer Gulf are important nursery areas for several commercial fish and crustacean species caught both locally, and in the southern areas of Spencer Gulf (Morelli and de Jong, 1995). Northern Spencer Gulf provides significant habitats for a number of large predatory fish, such as Snapper and Yellow-tail Kingfish. For example, the northern Spencer Gulf area is important for larval Snapper (which utilise fine muddy substrates in the area - Fowler and Jennings, 2002); juvenile Snapper, and larger, older Snapper ("mega-spawners"), the latter of which reside for long periods (up to several years, according to one government tagging study) at reef areas of northern Spencer Gulf, and aggregate on various reefs during spawning season (SADF, 1986; Jones, 1989). Adult Snapper, particularly larger Snapper, aggregate at habitat provided by natural patch reefs, and on artificial reefs (tyres, car bodies, shipwrecks, scrap metal), but are also found in the</p>

	<p>sandy channels and sandbank areas, and on muddy substrates. The larger, older Snapper are considered to have an important role in population spawning potential due to the large number of eggs produced (Jones <i>et al.</i>, 1990). Some of the major food sources for both small and large Snapper are abundant in Northern Spencer Gulf. Food items for large Snapper include large decapod crustaceans such as Blue Swimmer Crabs, several bivalve mollusc species, and echinoderms. Major food sources for small Snapper include young prawns, amphipods, polychaete worms and small rock crabs and molluscs (Jones, 1981).</p> <p>Schools of Yellow-tail Kingfish (up to 100 fish per school, in some cases), including very large individuals, also feed in Northern Spencer Gulf waters, on various fish and cephalopod species, and appear to seasonally aggregate at various Northern Spencer Gulf locations (including Port Augusta).</p> <p>Several commercially and recreationally significant fish species are also reported to <i>spawn</i> in Northern Spencer Gulf (Morelli and de Jong, 1995; DEH, 2000a). For example, Jones (1981) found Snapper in spawning condition in most parts of northern Spencer Gulf during spring to summer (October - February). Ferguson (1999, 2000) reported Yellow-fin Whiting in spawning condition in northern Spencer Gulf during October to January.</p> <p>Jones <i>et al.</i> (undated) reported that Spencer Gulf (including northern Spencer Gulf, according to Figures 6 and 7 in that report) is an important nursery area for the Australian Anchovy <i>Engraulis australis</i>. During a sampling period in 1986 and 1987 in both Spencer Gulf and Gulf St Vincent, highest larval densities were recorded from mid and northern Spencer Gulf, during summer. More recently, Dimmlich <i>et al.</i> (2004) reported that during a long term sampling program (1986 to 2001) of the densities of eggs and larvae of the Australian Anchovy in gulf and continental shelf waters across South Australia, the highest densities of eggs were found in northern Spencer Gulf and northern Gulf St Vincent, however larvae were more abundant further south of these areas, in shelf waters.</p> <p>False Bay, Fitzgerald Bay, Yatala Harbour, Blanche Harbour, Winninowie / Chinaman Creek, Port Pirie Creeks, Fisherman Creek, Port Davis Creek and other shallow coastal areas of Northern Spencer Gulf: The saltmarsh - mangrove - seagrass systems of the region provides key habitat for larval and juvenile fish, including many of the commercially and recreationally significant species. Aquaculture Group - PISA Fisheries (1996) reported that the nursery areas of northern Spencer Gulf support “the majority of commercial species” in the Gulf. A few examples of species that use the upper Spencer Gulf nursery areas include King George Whiting, Snapper, Yellow-fin Whiting, and Garfish. Nursery areas of northern Spencer Gulf contribute to the productivity of fish throughout the gulf (Bucher and Saenger, 1989).</p> <p>Seagrass meadows on the eastern side (e.g. Germein Bay area, between Baroota and Woods Point), and on the western side (e.g. between Murninnie Beach and Point Lowly, and between Point Lowly and Two Hummock Point), are reported to (i) be used by spawning adults of Southern Sea Garfish and Snook, and (ii) be a nursery area for juvenile King George Whiting, Snapper, West Australian Salmon; Tommy Ruff; Southern Sea Garfish; Red “Mullet”; flathead species; Trevally; Leatherjacket species, and Whaler Sharks (Bryars, 2003).</p> <p>Reef in the area between Black Point and Point Lowly is reported to be used by juvenile King George whiting, Snapper, West Australian Salmon, Tommy Ruff and Trevally (Bryars, 2003).</p> <p>Unvegetated soft bottom / sand habitats between Baroota and Woods Point (i.e. Germein Bay area), also between Murninnie Beach and Point Lowly, and in Far Northern Spencer Gulf (i.e. Point Lowly to Port Augusta, then south to Baroota) are reported to (i) be used by spawning adults of Yellow-fin Whiting and Snook, and (ii) be a nursery area for post-larval Yellow-fin Whiting, and for juvenile King George Whiting, Yellow-fin Whiting, Snapper, West Australian Salmon, Tommy Ruff, Yellow-eye Mullet, Red “Mullet”, flathead species, flounder species, Trevally, and Whaler Sharks (Bryars, 2003).</p> <p>Tidal flats on the eastern side (e.g. in the Germein Bay area between Baroota and Woods</p>
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	<p>Point, including Ward Spit), and on the western side (e.g. between Murninnie Beach and Whyalla, and around False Bay and Port Bonython), and in Far Northern Spencer Gulf (i.e. Point Lowly to Port Augusta, then south to Baroota on the eastern side), are reported to be a nursery area for post-larval and juvenile King George Whiting and Yellow-fin Whiting, and a nursery area for juvenile West Australian Salmon, Tommy Ruff, Southern Sea Garfish, Yellow-eye Mullet, Mulloway, flathead species and flounder species (Bryars, 2003).</p> <p>Tidal creeks in the area (e.g. Ward Point, Port Germein, Port Pirie River, First to Seventh Creeks, Fisherman Creek; Eight Mile Creek and others between Murninnie Beach and Whyalla; False Bay; also between Two Hummock Point and Blanche Harbour; Yorkey Crossing; Curlew Point, Brown Point, False Creek, Chinaman Creek, and from Miranda to Mambray Creek) are reported to be nursery areas for the species (listed above) that also occur in tidal flat areas (Bryars, 2003).</p> <p>Mangrove forests in the area (e.g. Ward Point, Weeroona Island, Port Pirie River, First to Seventh Creeks, Fisherman Creek, Murninnie Beach to Whyalla, False Bay, Fitzgerald Bay, Backy Point to Douglas Point; Douglas Point to Blanche Harbour to Curlew Point to Yorkey Crossing to Point Paterson to Redcliff Point to Yatala Harbour) are reported to be a nursery area for post-larval and juvenile King George Whiting, and a nursery area for juvenile King George Whiting (in mangroves in the western and far northern sides of the gulf), Yellow-fin Whiting, West Australian Salmon, Tommy Ruff, Southern Sea Garfish, Yellow-eye Mullet (mangroves are also a spawning area for this species), and Black Bream (the latter mainly on the eastern side, in the vicinity of the Port Pirie Creeks) (Bryars, 2003).</p> <p>Invertebrates</p> <p>False Bay and Blanche Harbour have been identified as major prawn nursery areas (Carrick, SARDI, pers. comm., cited by PISA Fisheries – Aquaculture Group, 1996; Carrick and Williams, 2001; Carrick, 2003). Record large settlement of post-larval prawns occurred at False Bay in April 2000, compared with several other sampling periods during 3 sampling years between 1993 and 2000 (Carrick and Williams, 2001). Other shallow coastal areas of Northern Spencer Gulf (e.g. Fitzgerald Bay, Yatala Harbour, Winninowie / Chinaman Creek also provide important habitat for larval and juvenile prawns. Carrick (2003, figure 16) showed in the waters between Whyalla and Port Pirie, the abundance of prawn larvae was higher than that in any other part of Spencer Gulf sampled during 1993 and 1994. Correspondingly, False Bay on the western side and the Port Pirie area on the eastern side, are major nursery areas (Carrick, 2003, Figure 17).</p> <p>False Bay / Lowly Point / Black Point / Fitzgerald Bay area: One of the largest regular spawning aggregations of Giant Cuttlefish known to exist in the world, occurs in this area (M. Norman, University of Melbourne, cited by Hummock Hill Communications 1999, and Whyalla Sports Divers Club, 2000). p.178. Enormous aggregations of spawning cuttlefish occur in few other areas of the world, such as waters off West Africa (S. Shepherd, pers. comm., 2004). Giant Cuttlefish is the largest cuttlefish known, and is found only in southern Australian waters. Headland reef and nearshore patch reef in the area are used for egg laying (Norman undated, cited by Whyalla Sports Divers Club, 2000; Hall, 1999).</p> <p>Reef in the area between Black Point and Point Lowly is also reported to be a spawning area for Southern Calamari, and to provide habitat for all life stages of the Purple Sea Urchin (Bryars, 2003).</p> <p>Northern Spencer Gulf: For several decapod crustacean species, the seagrass, sand and mud habitats of Northern Spencer Gulf are important habitats, for feeding, shelter and reproduction (Ivanovici, 1984; Bucher and Saenger, 1989, cited by Edyvane, 1995b), and the upper gulf is also a major nursery area for some crustaceans. Examples of crustaceans that are abundant in the area include Blue Swimmer Crab <i>Portunus pelagicus</i> and Mud Crab <i>Helograpsus haswellianus</i> (Morelli and de Jong, 1995), and northern Spencer Gulf is at the end of the eastern and south-eastern Australian range of the latter species (see Australian Government Department of the Environment and</p>
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Heritage, undated). Commercial and recreational catch data, and prawn bycatch data, show that the deeper central waters of the Northern Spencer Gulf (such as the area between Whyalla and Port Pirie) are a major habitat for the Blue Swimmer Crab, which occurs in high densities in the area (e.g. see Carrick, 2003, Appendix 1). Several other species of decapod crustacean are commonly recorded in the Northern Spencer Gulf area. For example, a number of crab species occur in the tidal creeks of Winninowie Conservation Park (DEH, 2000a). The upper Gulf is both a major feeding and nursery area for some species of decapod crustaceans.

Seagrass meadows on the eastern side (e.g. **Germein Bay** area, between Baroota and Woods Point), and on the western side (e.g. between **Murninnie Beach** and **Point Lowly**, and between **Point Lowly** and **Two Hummock Point**), are reported to (i) be used by the spawning adults of Blue Swimmer Crab, Razorfish, Southern Calamari, and King and Queen Scallop, and (ii) provide habitat for larvae or post-larvae of some of these species (Bryars, 2003). Unvegetated sand habitats in these areas, as well as in **Far Northern Spencer Gulf** (i.e. Point Lowly to Port Augusta, then south to Baroota) are reported to provide similar functions, in addition to being a nursery area for the forementioned taxa, and Western King Prawns (Bryars, 2003).

Tidal flats on the eastern side (e.g. in the **Germein Bay** area between Baroota and Woods Point, including **Ward Spit**), and on the western side (e.g. between **Murninnie Beach** and **Whyalla**, and around **False Bay** and **Port Bonython**), and in **Far Northern Spencer Gulf** (i.e. Point Lowly to Port Augusta, then south to Baroota on the eastern side), are reported to provide habitat for post-larval and/or juvenile Western King Prawns, Blue Swimmer Crabs (also spawning areas, as well as nursery areas), Mud Cockles, Razorfish and baitworm species (Bryars, 2003).

Tidal creeks in the area (e.g. **Ward Point, Port Germein, Port Pirie River, First to Seventh Creeks, Fisherman Creek; Eight Mile Creek** and others between Murninnie Beach and Whyalla; **False Bay**; also between **Two Hummock Point** and **Blanche Harbour; Yorkey Crossing; Curlew Point, Brown Point, False Creek, Chinaman Creek**, and from **Miranda** to **Mambray Creek**, are reported to be nursery areas for juvenile Western King Prawns, Blue Swimmer Crabs, and Razorfish (the latter mainly on the eastern side) (Bryars, 2003).

Mangrove forests on the eastern side (e.g. **Ward Point, Weeroona Island, Port Pirie River, First to Seventh Creeks, Fisherman Creek** are reported to be (i) used by the spawning adults and post-larvae of Mud Cockles, and (ii) a nursery area for juvenile Blue Swimmer Crabs, Western King Prawns, and Mud Cockles (Bryars, 2003). Mangrove forests on the western side to the head of the gulf (e.g. **Murninnie Beach** to **Whyalla**, and **False Bay, Fitzgerald Bay, Backy Point** to **Douglas Point; Douglas Point** to **Blanche Harbour** to **Curlew Point** to **Yorkey Crossing** to **Point Paterson** to **Redcliff Point** to **Yatala Harbour**) are reported to provide habitat for both adult and juvenile baitworms, and are nursery areas for juvenile Blue Swimmer Crabs and Western King Prawns (Bryars, 2003).

Coastal and Marine Birds

The samphire flats and small tidal creeks in the **Northern Spencer Gulf** region provide important habitat for wading birds, and most wetland areas on both sides of the upper gulf are important in this regard. Specific examples include **Winninowie Conservation Park** and the **Whyalla - False Bay** area. When exposed, **Ward Spit** and **Cockle Spit** also provide important seabird roosting areas and wading bird habitat. The mangrove area around **Point Paterson** is considered to provide important bird habitat, and a number of bird species are protected under the Japan-Australia Migratory Bird Agreement (JAMBA) occur there. In years of high rainfall in the interior, migratory marine birds use the North / South configuration of Spencer Gulf as a wetland corridor (Morelli and de Jong, 1995; Edyvane, 1995b; Dougherty, DENR pers. comm. and J. Cannon, pers. comm., cited by PISA Fisheries – Aquaculture Group, 1996; Reilly, 1991, cited by DEH, 2000a).

Northern Spencer Gulf is inferred to be an important breeding and feeding habitat for Black-faced Cormorant, Pied Cormorant (e.g. breeding populations at **Winninowie / Chinaman Creek**, and at **Weeroona Island**), Caspian Tern and Little Tern (N.B. **Ward Spit** is reported to be a significant area for this species), Pied and Sooty Oystercatcher, and Red-capped Plover (Morelli and de Jong, 1995; DEH, 2000a).

<p>10. Shipwrecks and Artificial Reefs</p>	<p>There are several major artificial reefs in the area, such as those at Whyalla, Fitzgerald Bay (two reefs), Blanche Harbour, Port Augusta, and two artificial reefs in the waters adjacent Port Pirie - Germein Bay area. There are also a number of other objects that have been dumped and serve as fish-aggregating devices in the region. Apart from providing additional hard substrate for attached invertebrates (sponges, ascidians, molluscs, etc), these artificial reefs also attract numerous reef fish species, some of interest to fishers and divers (see section on Taxonomic Diversity). One survey (Branden <i>et al.</i>, 1994) recorded up to 28 fish species using the artificial reef habitats in the Whyalla area. Snapper, particularly large fish, are known to aggregate and use reef area as habitat, including artificial reefs made of tyres, car bodies and other objects (see Jones, 1979; McGlennon and Jones, 1997).</p> <p>A number of shipwrecks in the area (e.g. Illusion, Leeton, and others) provide additional hard substrate, and attract Snapper, Whiting, Leatherjacket species, and Sharks, amongst others (see Notes on Social and Economic Values and Uses).</p>
<p>11. Popular Dive Sites</p>	<p>Ecological and biological features of popular dive sites in the Whyalla area include the following (see Christopher, 1988; DIASA, undated; Hummock Hill Communications, 1999, 2001, 2002; Dive Oz, 2002):</p> <ul style="list-style-type: none"> ♦ the regular mass aggregation of Giant Cuttlefish in the Point Lowly - Black Point area; ♦ the variety of macro-crustaceans (at least 9 species of crabs and other decapod crustaceans), most of which are also abundant in the Northern Spencer Gulf area; ♦ the abundant invertebrates of some major groups (e.g. solitary ascidians, sea stars, molluscs such as Razorfish and Scallops etc), and the large sessile invertebrates in the deeper channel areas (e.g. large sea pens, gorgonian corals, sponges, amongst others); ♦ the abundance of bottom-dwelling fish and elasmobranchs (flathead and flounder species, Eagle Ray and other ray species); ♦ the abundance of reef fish in some areas (particularly at artificial reefs – see above). ♦ The jetty pylon community of attached invertebrates at the iron ore jetty at Whyalla is also recognised for its abundance and diversity of attached invertebrates (soft corals such as <i>Carijoa multiflora</i>, bryozoa, sponges, compound ascidians, and other groups). The jetty is also reported to attract Snapper, Magpie Perch, Moonlighters, leatherjackets, and many other reef fish of interest to divers.
<p>12. National and/or International Importance</p>	<p>Northern Spencer Gulf is distinctive due to its physical and oceanographic properties being a major “inverse estuary” (Bailey, 1975; Nunes and Lennon, 1986). Also, carbonate sediment production in the area is high (Burne and Colwell, 1982), and the area is reported to globally significant in this regard (Lewis <i>et al.</i>, 1998).</p> <p>In addition to the geological and geo-morphological significance of the entire northern Spencer Gulf, specific examples of areas of conservation significance in this regard include the northern section of Fitzgerald Bay, where geologically significant shell ridges are located (Aquaculture Group - PISA Fisheries, 1996).</p> <p>The distinctive “relict tropical” element in the flora and fauna (Shepherd 1983a) of Northern Spencer Gulf is nationally recognised in the classification of the area by the Commonwealth (IMCRA Technical Group, 1998) as the Northern Spencer Gulf Bioregion, which has features not present in other bioregions in southern Australia.</p> <p>The larger Northern Spencer Gulf wetland area (of which Winninowie Conservation Park forms one part) is listed in the national <i>Directory of Important Wetlands</i> (Morelli and de Jong, 1995; Environment Australia, 2001b). The Northern Spencer Gulf area is considered to conserve mangrove, samphire, and seagrass communities of State and National conservation value (Harbison and Wiltshire, 1993). Within the Northern Spencer Gulf area, wetlands that are part of the <i>Directory of Important Wetlands</i></p>

	<p>listing include the samphire, mangrove, and shallow intertidal habitats from the region that encompasses Whyalla, Blanche Harbour, Port Augusta, Redcliff Point and Winninowie, Yatala Harbour, Port Germein, Port Pirie south to Jarrold Point, Fisherman Bay and Port Broughton.</p> <p>According to DEH (2000a), the Winninowie Conservation Park conserves extensive intertidal marine communities and wildlife species of State and National conservation value. The park, of which around 95% is subject to inundation by sea water during king tides, was declared to conserve examples of several coastal and marine systems, some of which have sub-tropical affinities. The park includes significant stands of the grey mangrove <i>Avicennia marina</i>, samphire salt marsh and seagrass communities, and over 60 kilometres of tidal creeks. The park's large tidal range and extremes of water temperature reportedly make this area unique in southern Australia (DEH 2000a). Winninowie Conservation Park is also considered to be of international significance in its conservation of geo-morphological processes, and the extensive seagrass communities within the reserve provide a "world class record" of sea level changes and sedimentary processes. The area has been listed on the <i>State Heritage Register</i>. Morelli and de Jong (1995) and DEH (2000a) stated that the mangrove forests in the area (e.g. Chinaman Creek) are considered to be one of the largest undisturbed stands of mangroves remaining in South Australia.</p> <p>The Redcliff region (within Winninowie Conservation Park) is reported to be "one of the finest examples of a sub-tropical marine and coastal ecosystem in the southern hemisphere, containing the richest and most diversified coastal flora in South Australia" (Morelli and de Jong, 1995).</p> <p>Redcliff Point, a designated place of geological significance, is on the <i>State Heritage Register</i> and the <i>Register of National Estate</i>.</p> <p>Northern Spencer Gulf is a migration stop-over for around 19 species of shorebird listed under international treaties JAMBA and/or CAMBA, including the Marsh Sandpiper, Sharp-tailed Sandpiper; Curlew Sandpiper, Greenshank, Red-necked Stint, Red Knot, Sanderling, Grey Plover, Pacific Golden Plover, Grey-tailed Tattler, Bar-tailed Godwit and Ruddy Turnstone (Morelli and de Jong, 1995; DEH, 2000a).</p> <p>Winninowie Conservation Park: Identified as an area of international and national importance for shorebirds by Watkins (1993, cited by Morelli and de Jong, 1995).</p> <p>Northern Spencer Gulf was listed during the early 1990s on the <i>Register of the National Estate</i> as an <i>Indicative Place</i>, meaning that it is to be assessed for potential inclusion in the National Heritage Register. The site was nominated for its significance as a "biogenic reef", particularly the accumulation of carbonate sediments (from seagrasses) for over 1 million years, reportedly extending to depths of 30m. Other features in the Statement of Significance included the sub-tropical element and uniqueness of flora and fauna in Northern Spencer Gulf.</p>
<p>Major Commercial and Recreational Fish, Sharks, Molluscs and Crustaceans</p>	<p>Some of the fish, shark and invertebrate species caught commercially and / or recreationally in northern Spencer Gulf include:</p> <p><i>Fish</i>: Snapper, Garfish, Yellow-fin Whiting, King George Whiting, Sand Whiting, Tommy Ruff (Australian Herring); Snook, Yellow-eye Mullet, Australian Salmon, Yellow-tail Kingfish, Mulloway, Striped Trumpeter, several Leatherjacket species, Redfish (Red "Snapper"), Silver Drummer, Silver Trevally, Dusky Morwong, Southern Blue Morwong, Red "Mullet", Magpie Perch, Red-lipped Morwong (irregularly observed and sometimes caught in northern Spencer Gulf), and several species of Flathead and Flounder.</p> <p><i>Sharks and Rays</i>: Smooth Stingray, Fiddler Ray, Eagle Ray and other ray species; Bronze Whaler and/or Black Whaler Shark, Whiskery Shark, Gummy Shark, School Shark and other shark species.</p> <p><i>Invertebrates</i>: Blue Swimmer Crab (a major commercial and recreational species); Western King Prawn; Giant Cuttlefish; Southern Calamari, Razorfish, Octopus, Oysters, Mud Crabs.</p>

8.11 South-Eastern Spencer Gulf (Spencer Gulf Bioregion)

Figure 13 depicts the location of this area.



Figure 13: South-Eastern Spencer Gulf

<p>1. Biogeographic Significance</p>	<p>No areas of outstanding biogeographic significance are known for the area, according to the definition of the criterion used in this report.</p>
<p>2. Major Physical Influences, and Relative Productivity Level</p>	<p>Other than the strong currents in the Tiparra area (see below), no other unusual or outstanding oceanographic features are recorded for the area, however the following information on physical influences is provided, as background.</p> <p>Physical Influences</p> <p>The mid-eastern and south-eastern Spencer Gulf region experiences much variation in the strength of swells, waves and currents, therefore it is not likely that any one of these oceanographic factors influences the entire region in the same way. Some of the physical influences are listed below for various sections of the coast described in the table.</p> <ul style="list-style-type: none"> ♦ The mid-eastern part of the coastal marine area described here (e.g. Port Rickaby – Parsons Beach area), generally experiences predominantly moderate wave energy, however in the south, wave energy varies from low near Point Turton to moderately high from Point Souttar to Corny Point. Wave energy is moderate to high on the western coast of Wardang Island, and moderate on the east coast. The Port Minlacowie area experiences moderate wave action, and the Corny Point area experiences high wave exposure on occasion, with waves over 3m (Edyvane, 1995b; Aquaculture Group – PISA Fisheries, 1996). ♦ Currents in the much of the northern area are relatively strong. For example, 50cm – 75cm per second in the Tiparra area, possibly reaching 2 knots (100cm per second) adjacent to Tiparra Reef, and in Tiparra Bay (Petrusevics <i>et al.</i>, 1998). There are gyres in the area (e.g. clockwise in the Wallaroo area, north of Tiparra; anticlockwise south of Wallaroo) (Petrusevics <i>et al.</i>, 1998). In the south-eastern part of the gulf, currents are also relatively strong in some areas (e.g. 60cm per second reported for the vicinity of Balgowan; the western side of Wardang Island, and the area between Corny Point and the north-eastern extent of the shoal in Hardwicke Bay) (Petrusevics <i>et al.</i>, 1998), however weaker currents have been recorded in central Hardwicke Bay. ♦ Hardwicke Bay is a large, open, shallow bay with broad depth contours. The bay experiences high water temperatures and still water conditions during summer (Aquaculture Group – PISA Fisheries, 1996). Due to its shallowness (5m-15m in most parts), the bay cools and warms relatively quickly compared with deeper gulf waters, and during summer, southern Hardwicke Bay may be subject to stratification (e.g. during periods when there is little water movement – dodge tide, low wind conditions) (Petrusevics <i>et al.</i>, 1998). ♦ In contrast to much of mid-eastern and south-eastern Spencer Gulf, the coastal waters north and west of Corny Point have steep depth gradients close to the coast (S.A. Coast and Marine Atlas data, 2001), and current speeds are also stronger in this area, compared with central Hardwicke Bay. <p>Relative Productivity</p> <p>Little information is available about the relative productivity for most areas of the region described in this table, however the following notes are provided for specific locations:</p> <p>Bird Islands / Warburto Point area: The tidal mudflats are rich in organic matter, and provide a highly productive food supply for organisms that utilise the saltmarsh, mangrove and mudflat environment of the area. The nutrient levels of the tidal mudflats are reflected in the densities of invertebrates that thrive in the “ooze”. There are annual “swarms” of blood worms in the Bird Islands area (Harris, 2003), which are ecologically important in terms of their role as food for fish and some bird species, and nutrient recycling. This abundant food supply, combined with the shelter and protection offered by the mangroves, also provides a refuge for larvae and small juveniles of various fish and crustacean species, which in turn provide important food sources for the local bird fauna (Robinson <i>et al.</i>, 1996).</p> <p>Tiparra area: The strong currents in the area (see above) and other oceanographic</p>

	<p>features create conditions that provide abundant suspended, drift and attached food sources. For example, the area is highly productive for macroalgal epiphytes, which form dense blooms on the seagrass, particularly during late winter to spring (Shepherd, 1973). The algal food sources are utilised by many invertebrates (with Greenlip Abalone being of particular note) and some of the fish species. Greenlip Abalone in the Tiparra Reef area have very high fecundity and fast growth rates, compared with Greenlip Abalone in most other parts of South Australia (see Shepherd and Baker, 1998). The strong current in the area also provides favourable conditions for numerous sessile invertebrates, such as bryozoa, ascidians, and sponges.</p> <p>Port Victoria Bay / Lee side of Wardang Island: The shallow, sheltered waters of the bay provide a productive area for sediment-dwelling invertebrates, which in turn provide important food sources for larval and juvenile fish and crustaceans. A high abundance of small fish has been observed in this nursery area.</p>
<p>3. Habitat Representativeness</p>	<p>Parts of the area described in this table contain some of the coastal and marine habitats and features that are characteristic of the Spencer Gulf Bioregion (IMCRA Technical Group, 1998). These include:</p> <ul style="list-style-type: none"> ♦ Precambrian crystalline rock (i.e. metamorphic) headlands*; ♦ Cainozoic outwash sediments forming low cliffs; ♦ Holocene beaches, dunes, and estuarine deposits; ♦ Fine <i>Zostera</i> sp., and <i>Zostera</i> (= <i>Heterozostera</i>) <i>tasmanica</i> seagrass in the intertidal area; ♦ the grey mangrove <i>Avicennia marina</i> in sheltered intertidal flats; ♦ subtidal seagrasses, including extensive meadows of <i>Posidonia</i> species, and <i>Amphibolis</i> species in deeper waters; ♦ reef communities, some dominated by the large browns <i>Scaberia agardhii</i> (particularly in shallower waters), species of <i>Cystophora</i> and <i>Sargassum</i>, with mixed red macroalgae and smaller turfing brown macroalgae (e.g. <i>Lobophora variegata</i>) in the understorey. <p>* (Note that IMCRA Technical Group, 1998, did not include calcareous reefs as being characteristic of the Spencer Gulf bioregion, however calcareous reefs are prevalent in various sections of the gulf, including part of the region described in this table.</p>
<p>4. Habitat Rarity</p>	<p>The nearshore patch reefs in mid-eastern Spencer Gulf have diverse assemblages of invertebrates (some also highly abundant) and dense macroalgal cover in some areas. Other patch reefs are interspersed with sandy areas supporting a variety of seagrasses and sessile invertebrates. Such reefs are an uncommon feature on the eastern side of Spencer Gulf.</p> <p>The minor areas of saltmarsh / samphire in mid-eastern Spencer Gulf (described below) are an uncommon feature in central Spencer Gulf.</p>
<p>5. Habitat Diversity</p>	<p>Marine habitat types in the mid-eastern and south-eastern section of Spencer Gulf, between Bird Islands and Corny Point include:</p> <ul style="list-style-type: none"> ♦ areas of samphire / saltmarsh (minor extent); ♦ intertidal mangrove areas (minor extent); ♦ beach habitats, varying from low to high wave exposure, with extensive backing dunes in some areas; ♦ supratidal and intertidal sediment beds (i.e. mudflats and sandflats exposed to low wave energy); ♦ intertidal and shallow subtidal seagrasses (<i>Zostera</i> / <i>Heterozostera</i>); ♦ benthic seagrass meadows, including dense beds of species of <i>Amphibolis</i> and <i>Posidonia</i>, and stands of <i>Halophila</i> in some areas; ♦ benthic sand habitat (including some areas with invertebrates such as stalked bryozoa and sponges, other areas with solitary ascidians, and some areas with no

	<p>visible cover);</p> <ul style="list-style-type: none"> ◆ intertidal/nearshore reefs of various compositions (mainly Precambrian metamorphic, but also including Permian deposits, and younger calcareous reef) and forms (platforms, ledges, cliffs, boulders), including those associated with islands - mainly metamorphic boulders and calcareous blocks and rubble eroded from land). In some areas, nearshore reefs are covered with mixed brown, red and green macroalgae, sponges, bryozoa, molluscs, ascidians and various other invertebrates. The species-rich nearshore reefs of mid-eastern Spencer Gulf are an uncommon feature along the eastern side of Spencer Gulf; ◆ benthic reefs (e.g. mainly calcareous platform, ledge and patch reef), subject to various levels of wave exposure, and covered in some areas with mixed brown canopy-forming macroalgae, with mixed red species and turfing browns in the understory. In deeper waters, in the northern part of this region, some reefs are dominated by mixed invertebrates, such as ascidians and sponges; ◆ Razorfish (<i>Pinna</i>) beds (often in patches, and interspersed with seagrass or sand); ◆ mixed habitats that includes brown macroalgal-dominated patch and platform reef, mixed seagrasses, and sand habitat. <p>Selected Habitat Notes (from Shepherd, 1973; Edyvane and Baker, 1996c and SARDI S.A. Benthic Survey data, unpublished; Robinson <i>et al.</i>, 1996; Aquaculture Group – PISA Fisheries, 1996; Petrusevics <i>et al.</i>, 1998, S.A. Coast and Marine Atlas data, 2001, and SARDI survey data, 2002, unless otherwise specified).</p> <p>Generally, over much of the mid-eastern and south-eastern Spencer Gulf area, subtidal reef is dominated by species of <i>Sargassum</i>, <i>Cystophora</i> and <i>Scaberia agardhii</i>, and minor quantities of red understory macroalgae such as <i>Botryocladia sonderi</i>, turfing brown macroalgae (e.g. <i>Lobophora variegata</i>), sponges, and bare rocky substrate. Species of the seagrasses <i>Posidonia</i> and <i>Amphibolis</i> are prevalent on subtidal sandy substrates.</p> <p>Bird Islands and Bird Reef: Bird Islands are the remnant of a low land prominence that was submerged recently (i.e. around 6000 years ago). The amount of land exposed varies greatly with the tide. The island group consists mainly of two vegetated islands and a bare reef that dries on low tide. The reef marks the outer limit of the shallows, around 2.5km from the mainland (Robinson <i>et al.</i>, 1996). The base rock appears to be Precambrian volcanic rock, and only on the outer reef is this core rock exposed (Robinson <i>et al.</i>, 1996). DEH's supratidal and intertidal mapping program (see S.A. Coast and Marine Atlas, 2001) mapped "bare" reef platform on the western and southern sides of West Bird Island. Tidal deposits of sand and fine silt fringe the shallows of the inner islets, blanketing the reef outcrops with low sand dunes and mudflats, the latter of which are regularly inundated by tides. Mangrove (<i>Avicennia marina</i>) stands surround the entire West Bird Island, except for the north-western tip. There is also intact samphire (mainly the Grey Samphire <i>Halosarcia halocnemoides</i>) around West Bird Island, in the supratidal (Australian Heritage Commission, undated; Robinson <i>et al.</i>, 1996; S.A. Coast and Marine Atlas, 2001), and on the coast east and south-east of the Bird Islands (PIRSA, SARDI and DEH map, in Bryars, 2003). On West Bird Island, the samphire surrounds a thin strip of vegetated beach ridge / chenier in the middle and eastern sides of the island. The south-western shorelines of the Bird Islands face the prevailing winds and waves of mid Spencer Gulf, however because the waves are diminished by the surrounding shallows, they do not scour away the mud and sand to bare rock, but instead deposit coarse and shellgrit that is graded into a central dune ridge by the wind (Robinson <i>et al.</i>, 1996). The smaller East Bird Island comprises a small central vegetated dune ridge, surrounded by samphire, and mangrove. Patchy intertidal seagrass surrounds both West and East Bird Island, and there is a line of bare sand running north-east to south-west of East Bird Island (S.A. Coast and Marine Atlas, 2001). In 1995, CSIRO and SARDI (see map in Edyvane, 1999b) mapped dense seagrass in the subtidal around Bird Islands. In the coastal vicinity of Bird Islands, there are coastal cliffs with sandflats at the base. Sand ridges and vegetated coastal dunes are north of the Bird Islands, but are shallow in height (less than 10m ASL).</p>
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Warburto Point: There are mangroves and intact samphire / saltmarsh around the **Warburto Point** headland, with the mangrove stand at the south-western end covering the largest area, and extending into the gulf, south-westerly from the point. There are strips of bare sand, shingle deposits, and bare intertidal platform reef on the western, south-western and southern sides. At the south-western end, a strip of bare intertidal sand is sandwiched between the intertidal reef and the vegetated beach ridge on higher land (S.A. Coast and Marine Atlas, 2001). Patchy seagrass dominates the shallow subtidal around **Warburto Point**, according to DEH's mapping program for intertidal habitats (see S.A. Coast and Marine Atlas, 2001). CSIRO and SARDI (1995, see map in Edyvane, 1999b) mapped dense seagrass in the subtidal around **Warburto Point**.

The area described as **Tiparra Bay** in general, also includes **Port Hughes** and **Moonta Bay**. At the far northern end of **Moonta Bay**, south of **Warburto Point**, there is a section of patchy intertidal seagrass seaward of the beach, however the intertidal of the far northern side of the bay has been mapped as mainly bare sand (S.A. Coast and Marine Atlas, 2001). The intertidal area at **Port Hughes** consists of both sand and extensive exposures of conglomerate (a flat-lying, coarse sandstone imbedded with quartz pebbles), reported to be the oldest rock sedimentary rock exposures on Yorke Peninsula (Field Geology Club of South Australia, 1997). The conglomerate overlies the metamorphic basement rock, and forming a wide, boulder-strewn shore platform. In the shallow subtidal (e.g. 3m – 5+m) of the **Port Hughes** area, the bottom contains sand patches and seagrass (reported to be dense throughout most of the bay, according to CSIRO and SARDI map in 1995 – see Edyvane, 1999b), however patch reef also occurs in the nearshore area. A more recent survey in the area by SARDI, has shown that habitat cover at 12m – 20m in the area **west of Port Hughes**, and north-west of the **Bird Islands**, comprises, in the deeper eastern waters, mainly *Halophila* seagrass and bare sand, with *Posidonia* seagrass (both sparse and dense stands) in the more southerly, shallower waters, **north-west of the Bird Islands** and **west of Port Hughes**. Stalked bryozoa were the dominant benthic cover at some sampled sites both north and north-west of Bird Islands. An assemblage of *Pinna* Razorfish and stalked ascidian (*Pyura* sp.) on sand, and an assemblage of invertebrates on reef (including various ascidian species) were recorded in deeper waters, **west-north-west of the Bird Islands** (SARDI data, 2002).

Further north at Point Riley, a benthic survey in 1995 (see Edyvane and Baker, 1996c) recorded on the nearshore reefs brown macroalgae such as species of *Sargassum* (*S. linearifolium*, *S. podacanthum*) and *Scaberia agardhii* ("corkweed"), with various sponges; the turfing brown *Lobophora variegata*; and mixed red macroalgae (e.g. *Botryocladia sonderi*, and species of *Rhabdonia*, *Echinothamnion*, and *Jeannerettia*) on rock reef surfaces. Given the similarity of substrates and oceanographic conditions further south of Point Riley, in the **Moonta Bay / Port Hughes** area, similar macroalgal species to those recorded at Point Riley may be expected to occur in this area. The coast between **Port Hughes** and **Cape Elizabeth** comprises a long sand beach with backing dunes. In the southern part of **Tiparra Bay**, towards Cape Elizabeth, seagrass dominates the shallows close to shore in the south of the bay (DEH mapping, in S.A. Coast and Marine Atlas, 2001), and there is patchy dissected reef in the subtidal (referred to by fishers as "broken bottom") amongst the sand and seagrass.

According to a map in Bryars (2003), seagrass and unvegetated soft bottom / sand occurs along the entire coast between **Cape Elizabeth** and **Port Victoria**, seaward of the reef outcrops and the tidal flats that occur in the nearshore area along various sections of that coast. Tidal flats are also widespread in the area, particularly between **Point Warrenne** and **Reef Point**; from **Reef Point** to **Point Pearce**; around **Rocky Island**, and the eastern side of **Wardang Island – Bird Point**). Saltmarshes are present just south of **Reef Point**; along the eastern side of **Wardang Island** and around **Bird Point**, and in the **Port Victoria** area (PIRSA, SARDI and DEH map, in Bryars, 2003).

Tiparra Reef: Shepherd (1973) surveyed the Tiparra Reef area and recorded the following: High relief calcareous reef, with isolated calcareous outcrops / blocks at the

edge of the main reef strip, interspersed amongst sand with sparse *Heterozostera* (= *Zostera*) cover; and seagrass communities of *Amphibolis* and *Posidonia* species to the west of the main reef strip. *Amphibolis* beds in the area were covered with naturally abundant epiphytes, particularly species of red macroalgae, which colonise the *Amphibolis* in prolific quantities during in late winter to spring, such as *Jeannerettia pedicellata*, *Wollastoniella myriophylloides*, species of *Jania*, *Polysiphonia*, *Spyridia*, and others). *Ecklonia*, and species of *Cystophora* (e.g. *C. moniliformis* and *C. monilifera*), and species of *Sargassum* were recorded as the dominant canopy taxa on limestone reef in the area. Encrusting and articulated coralline red algae, and turfing species of brown macroalgae, are common on reef surfaces in the area. The reefs in the areas have many small caves, crevices and overhangs, creating micro-habitats for shade-dwelling taxa (particularly sessile invertebrates, and reef molluscs such as abalone and various gastropods). Similarly, a more recent benthic survey in 1995 recorded *Amphibolis antarctica* and *Posidonia sinuosa* as dominant on sand at 5m deep, with bare sand patches and various sponge species in the understorey. As was observed during the 1970 survey, the *Amphibolis* was noted in 1995 to be heavily covered with various naturally-occurring red epiphytes, such as *Jeannerettia pedicellata*, species of *Wrangelia*, and *Plocamium mertensii*, amongst others (Edyvane and Baker, 1996c).

Along the coast between **Cape Elizabeth** and the bay on the north side of **Reef Point**, there is an extensive sand beach system with calcareous backing dunes (S.A. Department of Mines, 1975). Part of this dune system includes the area between **Balgowan** and **The Gap**, approximately 8km long by 0.25 – 0.5km wide, that has been listed under the *Register of the National Estate* (Australian Heritage Commission, undated). Nearshore reef and unvegetated soft bottom (sand habitat) occurs along the coast between **Cape Elizabeth** and **Tiparra Rocks**, including “**The Gap**” (PIRSA, SARDI and DEH map, in Bryars, 2003). In the subtidal off **Cape Elizabeth**, there is dissected patch reef in the shallow subtidal (e.g. 4m), and sand with vegetated patches further seaward (e.g. around 10m). Coastal rock in the area is varied, comprising Precambrian gneisses, schist and calc-silicate rocks (intruded by granites and other plutonic rocks), and overlaid with Cambrian limestone, which outcrops as cliffs in the **Balgowan** area. There are also Permian deposits (till and boulder erratics) in the **Balgowan** area. Younger deposits include Quaternary aeolianites, shelly limestone, sand dunes and back shore dunes, raised beaches, beach dune ridges and beach sand, alluvial clays, saline swamps, and salt flats (Geological Survey of South Australia, Maitland sheet). Nearshore rocky reefs occur at the base of headlands in the area between **Balgowan** and **Island Point**. Offshore from **Balgowan**, there are dense *Posidonia* seagrass beds with filamentous algae in the shallow subtidal (several metres seep), grading to mixed invertebrates (e.g. bryozoa, *Polycarpa* ascidians, sponges), macroalgae (e.g. *Cystophora* and *Sargassum* species, with *Osmundaria* and other red macroalgae), broken reef and patches of *Amphibolis* and *Posidonia* seagrass in deeper waters (e.g. 10m – 15). A dense stand of *Cystophora* was also recorded in this area, during a recent survey (SARDI data, 2002). Between 15m and 20m, patches of bare reef were recorded, with sand areas supporting a sparse cover of invertebrates (*Polycarpa* sp. and other ascidians, sponges, and low densities of Razorfish), seagrass (sparse patches of *Halophila* and *Posidonia*) and macroalgae (e.g. the red *Osmundaria*) (SARDI data, 2002).

South of **Balgowan**, on the bay side of **Reef Point**, there is a small area of samphire, backed by bare stranded tidal deposits that extend inland (DEH map, in S.A. Coast and Marine Atlas, 2001). Between **Reef Point** and **Island Point** the shore is predominantly sandy (Department of Mines, 1975). From **Island Point** around the headland of the **Point Pearce Peninsula**, the shoreline is rocky, comprising metamorphosed basement rock that extends into the subtidal. **Island Point** is barely separated from the mainland, and connected at low tide by a rocky reef (Robinson *et al.*, 1996). The basement rock of the islet is capped with calcarenite, calcrete and soil. The more exposed coastline has weathered the metamorphic base rock to a broad shelf of jointed rock, dissected into piles of loose boulders. The supratidal rocks are covered with orange lichen, as occurs on those at **Green Island** (Robinson *et al.*, 1996). In the subtidal area between **Reef Point** and **Beatrice Rock**, a recent survey recorded, on reef, a benthic cover of mixed invertebrates (e.g. bryozoa,

Polycarpa ascidians, and sponges), patches of macroalgae (*Cystophora* sp., with lesser cover of *Sargassum* species, and red macroalgae). Patch of seagrass (*Amphibolis* and *Posidonia*) and broken reef also occurred in the area (SARDI data, 2002).

From the **Island Point** area, south-westwards to **Goose Island** and **Green Island**, and the northern and eastern sides of **Wardang Island**, there are dense and medium density beds of *Posidonia* seagrass with filamentous algae in the shallow subtidal (e.g. to around 5m) (SARDI data, 2002).

Goose Island, Little Goose Island, White Rocks and Seal Rocks, Green Island, Rocky Island: All are metamorphic basement reef islands, surrounded by metamorphic reef platforms and boulders, and scattered calcareous reef eroded from the island covering above water level. **Rocky Island**, around 1.4km south of **Point Pearce**, rises above a shallow bank of reefs and sandbars between the Point and **Wardang Island**. **Rocky Island** has been eroded into a pile of fragmented boulders, and the southern rock spit is subject to tide and wave inundation. There are small sandy beaches in some parts of the island group (e.g. at **Goose Island** and **Green Island**), and a seagrass-covered sand spit joining **Green Island** to the mainland (Robinson *et al.*, 1996). The waters surrounding **Goose Island** to the south, east and north support beds of seagrass (species of *Posidonia* and *Amphibolis*). A previous survey reported that reef areas to the west and north-west of **Goose Island** are dominated by brown macroalgae, such as species of *Cystophora* and *Sargassum* (Ivanovici, 1984; Johnson, 1988a).

Precambrian metamorphosed volcanic rocks outcrop in the **Port Victoria** shore area, on the beach and in low cliffs, and the metamorphic reef outcrops extend south past **Point Gawler**. There are numerous dissected reef areas in the subtidal, to at least 12m, around **Port Victoria** and **Wardang Island**, interspersed with seagrass, bare sand patches, and cobble bottom. North-east of **Point Pearce**, in the **Port Victoria** bay, there is a broad stretch of samphire at the head of the bay, interspersed with vegetated ridges, with a bare intertidal sand flat further south, towards the Port Victoria township (DEH map, in S.A. Coast and Marine Atlas, 2001). Within the bay itself, there is dense seagrass in the shallow subtidal beyond the sand line (CSIRO and SARDI map, 1995, in S.A. Coast and Marine Atlas, 2001). Generally, *Hormosira banksii* ("sea grapes") is abundant on the reefs of the intertidal area in mid-eastern Spencer Gulf (e.g. **Port Victoria** area), with *Zostera* (= *Heterozostera tasmanica*) seagrass occurring on the sandy areas. In deeper water, species of *Posidonia* are dominant, and large brown macroalgae such as *Scaberia agardhii*, *Caulocystis* sp., *Cystoseira trinodis* and *Sargassum* species occur on reef (S. Clarke, SARDI, pers. comm. to PISA, cited by Aquaculture Group – PISA Fisheries, 1996).

Wardang Island: The island, approximately 8.4km long and 2.4km wide, lies around 11km off **Port Victoria**. Nearshore habitats on the eastern side include areas of fringing saltmarsh, sandy beaches, and intertidal sandbars. *Posidonia* seagrass beds occur on the eastern side of **Wardang Island**. In slightly deeper waters (e.g. 10m-15m), in the north-eastern sector of **Wardang Island**, a recent survey recorded mainly reef habitat, with invertebrates (e.g. *Polycarpa* and *Pyura* ascidians, sponges, bryozoa), sparse macroalgae (e.g. species of the browns *Sargassum* and *Encyothalia*, with *Osmundaria* and other red macroalgae), and patches of *Amphibolis* and *Posidonia* seagrass on sand, amongst the rock / broken reef, rubble and invertebrates (SARDI data, 2002). Around the south and west of the island, low cliffs, rock platforms, outcrops and small sandy and rocky beaches dominate the nearshore area. The Precambrian metamorphosed volcanic basement rock (mainly rhyodacite, according to Robinson *et al.*, 1996) outcrops as exposed intertidal reefs, headlands and platforms on the western and southern sides (Robinson *et al.*, 1996). The intertidal area of the south-eastern coast also contains glacially deposited sediments from the Permian (clay, sand, gravel and boulders), and the boulders (called "erratics") deposited by ice during the Permian, also occur on beaches on the east coast of the island. Overlying the basement rock is a layer of fossil-rich, Tertiary sandstone, visible as a prominent layer around 4m thick, in the cliffs at the southern end of the island (Robinson *et al.*, 1996). Pleistocene calcarenite and calcrete also occurs in the coastal area. Calcareous reef has been recorded also in the subtidal,

on the western and south-western sides, as well as sparse seagrass patches. The patch reef is dominated by mixed species of brown macroalgae, red macroalgae, and invertebrates. At the time of a 1995 survey, calcareous reef at 10m on the western side, was dominated by species of *Cystophora* (such as *C. expansa*, *C. monilifera*, *C. moniliformis*), with lesser cover of *C. brownii* and *Sargassum* species such as *S. sonderi* and *S. spinuligerum*; the large red macroalga *Osmundaria prolifera*, and the turfing brown *Lobophora variegata* common in the understory, with various invertebrates (e.g. ascidians). "Bare" calcareous rock was also recorded in some areas at 10m. On the south-western side of the island is a small bay, with patchy reef offshore. Towards the south and east, on shallower reef (5m), dominant flora recorded in 1995 included *Sargassum heteromorphum*, *S. linearifolium* and *Cystophora expansa*, with *Scaberia agardhii* ("corkweed") and the large red *Osmundaria prolifera* in patches. Few understory species were recorded, other than crustose corallines on the reef, and the red *Cladurus elatus*, with minor cover of the turfing brown *Cladostephus spongiosus* (Edyvane and Baker, 1996c and SARDI S.A. Benthic Survey data, 1995, unpublished). South-east of **Wardang Island**, in waters 10m – 15m, sand habitat supports a sparse cover of invertebrates (*Polycarpa* sp. and other ascidians, sponges and low densities of Razorfish), seagrass (sparse patches of *Halophila* and *Posidonia*), and macroalgae (e.g. the red *Osmundaria* on sand, and dense patches of *Cystophora* on reef patches) (SARDI data, 2002).

The metamorphic basement rock that outcrops in the Port Victoria area extends south to **Point Gawler, Rifle Butts Beach, and Renowden Rocks**. At **Rifle Butts Beach** there is a basement rocky shoreline interspersed with a small sandy beach.

Further south on the "shin" of Yorke Peninsula, there is an extensive beach system with backing dunes, with a continuous section that stretches from **Wauraltee to Port Rickaby**, and includes a number of named beaches (**Kemps, The Bamboos, The Bushes**). At **Wauraltee**, the nearshore benthic environment is mainly sand out to around 5 metres, with seagrass and limestone reef at around 10+m (MLSSA dive report, 1998). Low eroding Tertiary cliffs along this stretch of coast are the remains of raised beaches, with various fossil deposits imbedded (e.g. at **Brown Point and Port Rickaby**) (Crocker, 1946; Field Geology Club of S.A., 1997). On the coast at **Port Rickaby** there is an exposure of a Tertiary sandstone with abundant pelycopod fossils, and south of the town, towards the intertidal platform at **Barker Rocks**, Permian boulder till with erratics, occurs on the beach (S.A. Department of Mines, 1975). In the shallow subtidal of the **Port Rickaby and Barker Rocks** area, there are dissected reefs and broad areas of sand bottom. South of **Barker Rocks**, the **Bluff Beach** is a small sheltered bay with a backing cliff (**The Bluff**). There is intertidal reef north and south of the bay at Bluff Beach.

From **Brown Point to Port Minlacowie and Point Turton**, there is a long expanse of coastal beach with backing dunes, and coastal cliffs in a number of areas, such as Port Minlacowie and near the township of Hardwicke Bay. Permian deposits (of boulder till with erratics) outcrop in the area. The beach strips in Hardwicke Bay include **Parsons Beach, Watsons Beach and Cockle Beach**.

Between **Port Minlacowie and Hardwicke Bay**, there is a samphire strip along the coast, fronted by bare intertidal sand (DEH map, in S.A. Coast and Marine Atlas, 2001); seagrass in the shallow subtidal (e.g. 2m); and reef and sand further out in the bay (e.g. 5m) (according to CSIRO and SARDI map from 1995, in S.A. Coast and Marine Atlas, 2001). In the shallow water (e.g. 4m) off **Port Minlacowie**, species of the seagrasses *Posidonia* and *Amphibolis* dominate sandy and pebbly substrate. There are dissected reefs with ledges (and isolated reef outcrops) in the shallow subtidal. At the time of a benthic survey in 1995, the broken, crevassed calcareous reefs in the area were dominated by mixed brown canopy macroalgae (*Scaberia agardhii*, and species of *Cystophora* and *Sargassum*) and the large red macroalga *Osmundaria prolifera*, with an understory of mixed red and brown macroalgae (e.g. *Cladurus* sp., *Lobophora variegata*) (Edyvane and Baker, 1996c). Examples of larger invertebrates that are common in the area include several species of sea star, and various nudibranchs. More recent surveys by SARDI, in shallow bay areas of Hardwicke Bay, between **Port Minlacowie and Point Turton**, have shown that habitat cover between 0.5m and 2m comprises (i) in the intertidal and shallow

subtidal near the **Hardwicke Bay** township, mainly low profile broken reef, covered with a diverse mix of brown, red and green macroalgae, and various invertebrates, and interspersed with *Posidonia* and *Amphibolis* seagrass patches; bare sand was recorded seaward of the broken reef, at around 2m; and (ii) south of the **Hardwicke Bay** township, around the base of the bay, to **Point Turton**, mainly sand at the shore, grading to dense *Posidonia* seagrass in the shallow subtidal (SARDI data, 2002). In deeper water, recent surveys by SARDI have shown that habitat cover at 10m in the section of **Hardwicke Bay** from south of **Brown Point**, to the **Hardwicke Bay** settlement, is dominated by mainly sparse assemblages of mixed invertebrates on sand (particularly the ascidians *Polycarpa viridis* and a species of *Phallusia*, as well as sponges, and the Razorfish *Pinna*), sparse seagrass (*Posidonia*, *Zostera / Heterozostera* and *Halophila*), and mixed species of red macroalgae (SARDI data, 2002). Bare sand and a sparse assemblage of invertebrates (comprising low densities of sponges, ascidians and Razorfish) were recorded in the deeper central areas of **Hardwicke Bay** (e.g. 12m – 15m). Sparse and medium-density stands of *Posidonia* seagrass (with ascidians and sponges) are also scattered throughout the bay in waters deeper than 10m, along with patches of *Pinna* Razorfish (SARDI data, 2002).

Hardwicke Bay: The bay faces north-west, and is sheltered from westerly and south-westerly winds. Precambrian basement rocks (e.g. gneisses, schists, and calc-silicate rocks intruded by granites, pegmatite and aplite) outcrop at **Point Souttar** along the beach, forming rocky reefs. Permian deposits of boulder till with erratics overlie the Precambrian rocks, and there are low cliffs of Tertiary limestone (1:250 000 Geological Survey of South Australia Map Sheet, Maitland). Between **Point Souttar** and **Point Turton** is a small bay with low profile platform reef (covered with mixed brown, red and green macroalgae) close to shore, grading to dense *Posidonia* seagrass beds within 100m of the shore. The Permian deposits outcrop along the shoreline near **Point Turton**, and there are raised shelly limestone beaches in the most southern part of **Hardwicke Bay**, near **Point Turton** (S.A. Department of Mines, 1975). Most of the bay is fringed by extensive sandy beaches and sand flats, vegetated sand dunes, and there are low coastal cliffs of limestone and dune sand in some areas. Behind the dunes, there are areas of saline swamp, occasionally subject to flooding (e.g. **Peesey Swamp**). There is a large rock / reef pool at the southern end of the bay. Seaward of the beaches, there are broad expanses of sand throughout the bay, with sparse seagrass also in the subtidal, and reefs are scattered throughout the intertidal and shallow subtidal area (e.g. see reef descriptions for **Port Minlacowie**). At a depth of 10m the sandy sediments in some areas are dominated by species of *Posidonia* (on sand ridges) and *Amphibolis* (in depressions between ridges). Most of the bay is between 5m and 15m deep.

Peesey Swamp is inland, but abuts the coast at **Hardwicke Bay** and contains samphire saltmarsh flats, extending from Hardwicke Bay to Sturt Bay. Low ridges of kunkarised shells and shell sand of marine origin extend parallel to the swamp, discontinuously on either side. Similar stranded ridges occur throughout the swamp. Vegetation on lower flats consists of samphire species, and saltbush. Pockets of the wetland Swamp Paperbark *Melaleuca halmaturorum* are scattered throughout the swamp (Australian Heritage Commission, undated). Peesey Swamp was originally a strait, that dissected the eastern and western part of the peninsula. Sand dunes built up at each end barring the sea from entering. Much of this area is still below sea level (District Council of Yorke Peninsula, 2002).

In the **Point Turton – Fish Point** area, there is an outcrop of the fossiliferous Point Turton limestone in the coastal area (Department of Mines S.A., 1975). The limestone is around 18m thick in the coastal area, and contains bryozoa, amongst other fossils (Field Geology Club of S.A., 1997). The limestone rests on a Permian clay and boulder till bed, which is exposed at low tide in the cliff on the western side of **Magazine Bay** (Field Geology Club of S.A., 1997). There is also boulder till at the base of the cliffs in the **Point Turton** area, evidence of the Permian glacial period (around 200 – 234 million years ago). The till is composed of boulders and stones, about 1.2 metres thick (District Council of Yorke Peninsula, 2002), and extends inland to the Warooka area, to the south-east of Point Turton. Around 500m west of **Fish Point**, there are calcreted cliffs, including the remains of raised beaches of

	<p>shelly sand (Field Geology Club of S.A., 1997). In the nearshore area, coastal reef has been mapped between Point Turton and Burners Beach (near Galway Bay) (PIRSA, SARDI and DEH map, in Bryars, 2003).</p> <p>Along the coast between Point Turton and Corny Point, there are sand beaches backed by dunes and coastal scrub (e.g. the area includes Burners Beach, Leven's Beach and The Pines).</p> <p>In the vicinity of The Pines, an extensive suite of late Holocene regressive frontal dunes forms a 2-3 km wide coastal plain (von der Borch, 1993). The area is unstable in terms of sand movement, and progressive sand accretion from east-flowing nearshore currents has built the coastline out to the proximity of an offshore shoal in one area, and resulted in erosion of the beach in the vicinity of The Pines settlement (von der Borch <i>et al.</i>, 1993). Seaward of the beach, there are shallow subtidal sand and seagrass beds (CSIRO and SARDI map, 1995, in Edyvane, 1999b, and S.A. Coast and Marine Atlas, 2001).</p> <p>Corny Point: Waters off Corny Point are relatively deep (e.g. 10m – 40+m), and the area is exposed to swells coming through the mouth of Spencer Gulf. There are Pleistocene calcarenite and Tertiary sandstone cliffs, underlaid and fronted by exposed Precambrian gneissic platforms and headland reef (ledges / sheets, and blocks) at the Point. To the east of the point, there is a sandy beach strip, backed by dunes in some areas, with dense seagrass beds in the shallow subtidal (e.g. 1m – 2+m). (S.A. Topographic Map Series, Corny Point; SARDI data, 2002). In the shallow subtidal around Corny Point, there are dissected reefs (including ledges and reef “patches”), coarse sand, and nearshore seagrass beds (Field Geology Club of S.A., 1997; CSIRO and SARDI map, 1995, in S.A. Coast and Marine Atlas, 2001; Shepherd and Brook, 2002). The macroalgal community present on the reefs is composed of species characteristic of higher wave energy conditions, such as the brown macroalga <i>Scytothalia dorycarpa</i>. The kelp <i>Ecklonia radiata</i>, and other canopy species of brown macroalgae, are also present. In shallow reef areas (e.g. to 2m), <i>Cystophora subfarinata</i> and <i>C. monilifera</i> are present (Shepherd and Brook, 2002). Common red macroalgae in the understory include taxa such as species of <i>Plocamium</i>, <i>Phacelocarpus</i> and the encrusting <i>Peyssonnelia</i>, and crustose corallines. Similarly, a more recent survey in the area by SARDI, has shown that off Corny Point, between 10m and 20m, the area seaward of the point is dominated by brown macroalgae in the Sirococcaceae, with some <i>Ecklonia</i> also present. At that depth (i.e. 10m – 20m), to the north-east of Corny Point, are patches of rocky reef and “broken bottom” (i.e. scattered rock and debris) interspersed with sand, with some ascidians and the Razorfish <i>Pinna</i> also present in the area. Seaward of the brown macroalgal stands and the rocky reefs, in deeper waters (30m – 40+m) off Corny Point, the habitat is predominantly sand, with a sparse cover of invertebrates, including solitary and colonial ascidians, stalked and sessile bryozoa, sponges, gorgonian corals, the “sea pen” <i>Sarcoptilus</i>, and the Razorfish <i>Pinna</i>. This sandy habitat with sparse invertebrate cover also extends north-east of Corny Point, into the deeper waters of Hardwicke Bay (SARDI data, 2002).</p>
<p>6. Taxonomic Diversity</p>	<p>Marine Plants Wardang Island: Edyvane (1995b) described the subtidal areas of Wardang island as having “considerably large and diverse communities of algae and seagrass”, but no details were provided.</p> <p>Bony and Cartilaginous Fish The range of oceanographic conditions, and the variety of habitat types in the area (including sheltered muddy shallows, wave-exposed headland reefs, benthic seagrass beds, sandbanks, extensive dissected platform reef, and wrecks, amongst others), results in a high diversity of fish species utilising the mid-eastern and south-eastern Spencer Gulf area. Many seagrass-dwelling, reef-dwelling and sand-dwelling species of fish, as well as more mobile pelagic fish species, are all abundant in the area. A complete species list of fish is not available for the area, however available records from fishing, diving, and bycatch survey show that well over 60 species of fish have been commonly recorded in the area, and at least 30 of these are</p>

	<p>commercially and/or recreationally fished (as target species, or bycatch from line fishing or netting). It is likely that a complete fish species inventory of the eastern gulf would show the diversity to be high.</p> <p>Mid-Eastern and South-Eastern Spencer Gulf: A comparatively large number (i.e. at least 20) of species of shark, ray and skate have been reported in the area, and it is likely that the variety of habitat types, the abundant fish and large invertebrates as prey, as well as the oceanographic features of the area, support a high diversity of elasmobranch species. According to fishing records from commercial, recreational and prawn bycatch, examples of elasmobranch species found in the mid-eastern and south-eastern Spencer Gulf area include Bronze Whaler, Black Whaler, Smooth Hammerhead, Great White Shark, School Shark and Gummy Shark, Whiskery Shark, Angel Shark, Piked Dogfish, Port Jackson Shark, Spotted Wobbegong, Cobbler Carpetshark, Rusty Catshark, Fiddler Ray, Black Ray, Eagle Ray, Shovelnose Ray, Short-tail Torpedo Ray (a continental shelf and slope species not commonly observed in coastal waters, according to Compagno and Last, 1999, but has been observed in prawn bycatch sampling in Spencer Gulf during the 1990s – see Carrick 1997); Sparsely-Spotted Stingaree (Dixon’s Stingaree); at least two other Stingaree species, and White-Spotted Skate. Also, Elephant “Shark” (which is a chimera, i.e. neither a shark nor a fish) is also found in the area. There are reports from fishers that some of the shark and ray species listed above are abundant in the region (e.g. Hardwicke Bay and other locations).</p> <p>Invertebrates Possibly due to the influence of the currents in the area, and the consequent abundant food supply, a number of areas in mid-eastern Spencer Gulf support a variety of species of soft corals, sponges, ascidians, nudibranchs and other invertebrates (e.g. see section on Popular Dive Sites), however information on relative diversity and/or abundance, compared with other locations, is not known for this report.</p> <p>Barker Rocks: The intertidal platforms are described as supporting “a wide variety of intertidal life” (Edyvane, 1999b).</p>
<p>7. Habitat for Endemic Taxa / Threatened Taxa / Rare or Uncommon Taxa</p>	<p>Marine Plants Mid-Eastern Spencer Gulf: The uncommon macroalgal species <i>Champia parvula</i>, is found in the area. It is considered to have a large range, which extends to the Tasmanian coast, but it is a species that is not commonly found (Turner, 2000; Cheshire <i>et al.</i>, 2000). It has two known varieties, one of which (<i>C. parvula</i> var. <i>amphibolis</i>), has been found only growing epiphytically on <i>Amphibolis</i> sp., on Tiparra Reef in the Spencer Gulf (Womersley, 1996).</p> <p>Marine Mammals Haul out sites for a small number of Australian Sea Lions at Goose Island and White Rocks. Australian Sea Lion is classified as <i>rare</i> under S.A. legislation. Colony numbers have varied over time: for example, around 35 animals in 1978 (Robinson and Dennis, 1988); around 24 animals in 1990 (Gales, 1990); and less than 10 in more recent years (according to S.A. Coast and Marine Atlas, 2001). The species is also considered to be a threatened species (e.g. Gales, 1990; Gales <i>et al.</i>, 1994; Shaughnessy, 1999).</p> <p>Bony and Cartilaginous Fish Both <i>Leafy and Weedy Seadragons</i> have been reported from the Moonta / Port Hughes / Tiparra area; the Port Victoria / Wardang area, and from a number of sites in the Hardwicke Bay to Corny Point area (Dragon Search Community-Based Monitoring Program, and see Baker, 2003a and 2003b, for details). Leafy Seadragon is a protected species in South Australia, and is also listed under the Commonwealth’s <i>EPBC Act 1999</i>. Both Leafy and Weedy Seadragons were listed as <i>Data Deficient</i> in the IUCN Red List 2003.</p> <p>The little known Gulf Pipefish <i>Stigmatopora</i> nov. sp. (<i>Stigmatopora nasospatulata</i>) has also been recorded in the Port Victoria area, and possibly further south in other parts of south-eastern Spencer Gulf. The species may be endemic to the gulfs region of South Australia (Browne, 2004). Other pipefish species that are known from the</p>

mid-eastern Spencer Gulf area include the Javelin Pipefish *Lissocampus runa* (e.g. recorded in the **Tiparra** area) (records cited in Baker, in press).

The Spotted Snake-blenny, *Ophiclinops pardalis*, a small fish species that may be endemic within South Australia, has been recorded in the **Port Victoria** area, and a few other locations in S.A. (such as Kangaroo Island) (see Baker, in press, for synopsis on this species).

Adults and juveniles of *Western Blue Groper*, *Blue-throated Wrasse* and other Wrasse species are found in the **Corny Point** area (Shepherd and Brook, 2002; Bryars, 2003). Other reef fish species of potential conservation concern recorded in the area include *Banded Morwong* (a species that is less common in S.A. compared with its distribution in south-eastern Australia and Tasmania), and the *Western Foxfish* (a species more common in southern W.A. and far western S.A. and known from few locations in the S.A. gulfs) Further information on the conservation status of these species is provided in section 9.2 of this report, and in Baker (in press).

Whiskery Shark: Caught commercially in small numbers, in deeper waters of **south-eastern Spencer Gulf** (SARDI data, unpublished). No information on trawl bycatch of this species is available. The extent of recreational fishing for this species is not known for this report. Classified as *Lower Risk, but Conservation Dependent* in the IUCN Red List 2000 and 2002, but not included in the 2003 IUCN Red List.

Dog Shark: Dog sharks are caught commercially and recreationally in small numbers, in deeper waters of mid-eastern and south-eastern Spencer Gulf. In South Australia, Dog Shark catches are not separated by species, but most refer to Spurdog or Spiny Dogfish (*Squalus acanthias*). Piked Dogfish *S. megalops*, a deeper water species, has also been recorded in Spencer Gulf (see Carrick, 1997). IUCN Red List 2003 recorded the conservation status of Spiny Dogfish as *Lower Risk – Near Threatened*, and status of Piked Dogfish as *Data Deficient*, stating that there is inadequate information to assess the species status of *S. megalops*, particularly regionally in southern Australia. The species conservation status of Spiny and Piked Dogfish were reviewed in 2003 by the IUCN Shark Specialist Group, and both were still considered to be of conservation concern due to fishing-induced risks to population sustainability, and, in the case of the latter species, uncertainty in the taxonomy (i.e. *S. megalops* may be an Australian endemic, but this requires further study). The status of dogfish species, and an overview of the fisheries in southern Australian waters, is provided in Section 9.2. Dogfish species have population and reproductive dynamics that may make them vulnerable to over-exploitation (i.e. long-lived; aggregative behaviour when feeding; spatial segregation by size and sex; delayed maturation - from 10 to 25 years in some species; inshore breeding of some species in bays and estuaries; long gestation period; large pregnant females of some species occurring in shallow waters; few young per litter; and schooling behaviour in young – e.g. see Compagno, 1984; Gomon *et al.*, 1994; Last and Stevens, 1994). The annual rate of population increase for *Squalus acanthias* is near the lowest for any known vertebrate, averaging 2-3% per year (Camhi *et al.*, 1998). Growth is also slow – about 4cm per year up to sexual maturity (Last and Stevens, 1994).

See section **Issues for Risk and Impact Assessment**, for more information about bony and cartilaginous fish species of conservation concern in the region.

Invertebrates

South-eastern Spencer Gulf: Habitat for the unusual pelagic octopus *Argonauta nodosa* (see Zeidler and Norris, 1989), which produces the decorative egg cases known as “paper nautilus”, made from arm secretions of the female. Over the years, “many” paper nautilus cases have been collected from areas such as **Parsons Beach** (SYP Tourism and Promotions Committee, 2002).

Tiparra Reef: *Leptoclinides* sp.1, a colonial ascidian of limited known distribution, occurs at Tiparra Reef and the Investigator Group Islands, and may be endemic to S.A. (Kott, 1997).

Point Turton: the rarely recorded tropical nudibranch *Crosslandia viridis* has been reported in the area (Hutchison, in Rudman, 2003)

Port Hughes: The nudibranch *Hypselodoris saintvincentius* has been recorded from the

	<p>area, and also on southern Yorke Peninsula, and may be endemic to South Australia (Rudman, 2002b).</p> <p>Coastal and Marine Birds Bird Islands: Habitat for Rock Parrot (which has a coastal association and sometimes nests in the spray zone), and Musk Duck. Both species are classified as <i>rare</i> under S.A. <i>National Parks and Wildlife Act 1972</i>). Goose Islands: Habitat for migratory Great Knot, described as “scarce to rare” in southern States of Australia (Pizzey, 1988), though not formally listed under S.A. legislation. Also habitat for Rock Parrot (Robinson <i>et al.</i>, 1996), which is known to nest in the spray zone of islands in S.A., and is listed as <i>vulnerable</i> under South Australian legislation. Habitat for Fairy Tern and Hooded Plover (Robinson <i>et al.</i>, 1996), both listed as <i>vulnerable</i> under South Australian legislation.</p> <p>Various species of macroalgae, invertebrates and fish that occur in the mid-eastern and south-eastern Spencer Gulf region, are endemic to southern Australia. Quantification of these marine species is not possible for this report.</p>
<p>8. Other Important Taxa</p>	<p>Bony and Cartilaginous Fish South-eastern Spencer Gulf: Spawning area for Port Jackson Shark, according to divers’ reports of aggregations of live eggs on some of the reefs in this area. The Wardang Island area is recognised for the high abundance of some fish species, particularly reef fish species (e.g. schools of Snapper, Old Wife, Silver Drummer, sweep species, leatherjacket species, which are attracted to the “maze” of dissected reefs and the shipwrecks in the area (see sections below on Popular Dive Sites, and Shipwrecks and Artificial Reefs).</p> <p>The seagrass beds in mid-eastern Spencer Gulf provide habitat for one or more of the life stages of the following commercially and/or recreationally significant species: King George Whiting, Snapper, West Australian Salmon, Tommy Ruff, Southern Sea Garfish, Red “Mullet”, flathead species, Trevally, Yellow-tail Kingfish, leatherjacket species, Snook, and Whaler sharks (Bryars, 2003).</p> <p>Nearshore reefs in the mid-Spencer Gulf area (e.g. Cape Elizabeth to Tiparra Rocks; Reef Point to Point Pearce, parts of Goose Island, and the northern, western and southern sides of Wardang Island) and Hardwicke Bay area (e.g. Point Gawler, Point Turton to Burners Beach, and Corny Point) are reported to provide habitat for one or more of the life stages of the following commercially and/or recreationally significant species: King George Whiting, Snapper, West Australian Salmon, Tommy Ruff, Southern Sea Garfish, Yellow-eye Mullet, Trevally, Sea Sweep, Silver Drummer, leatherjacket species, Snook, wrasse species, Gummy Shark and Whaler sharks (Bryars, 2003). Most of these species (except Leatherjackets, Sweep and Drummer, and Gummy Sharks) are also reported to occur on unvegetated soft bottom habitat in the Cape Elizabeth to Point Gawler area, along with Yellow-fin Whiting, School Whiting, Red “Mullet”, Yellow-tail Kingfish and species of flathead and flounder (Bryars, 2003). Further south, unvegetated soft bottom habitat in the Point Gawler to Corny Point area, provides habitat for one or more of the life stages of King George Whiting, Snapper, West Australian Salmon, Tommy Ruff, Southern Sea Garfish, Red “Mullet”, flathead species, Yellow-tail Kingfish, Trevally, leatherjacket species, Snook, and Whaler sharks (Bryars, 2003).</p> <p>Invertebrates Mid-eastern and south-eastern Spencer Gulf are important habitats for adult Southern Calamari. The abundance of Calamari in this area is reflected in the commercial catches by jig and haul net in recent years (see Notes on Social and Economic Values and Uses in this report, and Triantafillos and Fowler, 2000). Spencer Gulf as a whole contains the largest known population of Western King Prawns in the world (PIRSA, 2003d). The seagrass beds and/or unvegetated soft bottom habitats in mid-eastern Spencer Gulf provide habitat for one or more of the life stages of the following commercially and/or recreationally significant species: Blue Swimmer Crabs, Sand Crabs (mainly in sand habitat), Southern Calamari, Razorfish, Western King Prawns (mainly in sand habitat), and King and Queen Scallops (Bryars, 2003). Further south, unvegetated soft bottom habitat in the Point Gawler to Corny Point area, provides habitat for one</p>

	<p>or more of the life stages of Sand Crab, Southern Calamari, Razorfish, and King and Queen Scallops (Bryars, 2003). Seagrass beds in south-eastern Spencer Gulf provide habitat for Razorfish, Southern Calamari, and King and Queen Scallops (Bryars, 2003).</p> <p>Sheltered beach habitats along the mid-eastern Spencer Gulf coast and around associated islands, support Sand Crabs and baitworm species (Bryars, 2003). Baitworms are also abundant in the tidal flats (e.g Point Warrenne to Reef Point; from Reef Point to Point Pearce; around Rocky Island, and the eastern side of Wardang Island).</p> <p>Nearshore reefs in the mid-Spencer Gulf area (e.g. Cape Elizabeth to Tiparra Rocks; Reef Point to Point Pearce, parts of Goose Island, and the northern, western and southern sides of Wardang Island) and Hardwicke Bay area (e.g. Point Gawler, Point Turton to Burners Beach) are reported to provide habitat for one or more of the life stages of the following commercially and/or recreationally significant species: Southern Calamari, Giant Cuttlefish (mid-eastern Spencer Gulf), Greenlip Abalone (mid-eastern Spencer Gulf), and Purple Sea Urchin (Bryars, 2003). Blacklip and Greenlip Abalone, Southern Rock Lobster, Purple Sea Urchin and Maori Octopus utilise reef habitat in south-eastern Spencer Gulf (e.g. Point Gawler, Point Turton to Burners Beach, and Corny Point) (Bryars, 2003).</p> <p>There are also abundant sessile invertebrates, such as solitary and colonial ascidian species and sponges, on patch reefs in mid-eastern and south-eastern Spencer Gulf (SARDI data, 2002).</p> <p>The abundant calcareous organisms (small bivalves and gastropods, foraminifera, bryozoa etc) in the waters of mid-eastern and south-eastern Spencer Gulf, have contributed in the past to the formation of extensive beach and dune systems, and fossil-rich dune rock cliffs.</p> <p>Coastal and Marine Birds</p> <p>In addition to rare, vulnerable and migratory species, and breeding areas for particular species, some of the other coastal and marine birds observed in parts of the region are as follows:</p> <p>Bird Islands: Other species that have been observed utilising the island areas include Sacred Kingfisher, Black-Fronted Dotterel, Pied Cormorants, Black Cormorants, Black-faced Cormorants, Australian Pelicans, Crested Terns and Silver Gulls (Robinson <i>et al.</i>, 1996) (see also Breeding Areas, below).</p> <p>Wardang Island: Habitat for Little Penguin, Masked Plover, Pacific Gull, Australian Pelican, Black Cormorant, Little Black Cormorant, Little Pied Cormorant, Caspian Tern, and Crested Tern (Robinson <i>et al.</i>, 1996; S.A. Marine and Coast and Marine Atlas, 2001).</p> <p>Goose Islands: Habitat for White-faced Heron, Pied Oystercatcher, Pacific Gull, Fairy Tern, Black-faced Cormorant, Black Cormorant, Little Black Cormorant, Pied Cormorant, Rock Parrot, Black Swan, Swamp Harrier, Australian Pelican.</p> <p>Little Goose Island: Habitat for Black-faced Cormorant, Crested Tern and Silver Gull.</p> <p>White Rocks: Habitat for Pacific Gull and Silver Gull (Robinson <i>et al.</i>, 1996).</p> <p>Rocky Island: Breeding and/or nesting area for the Crested Tern and Caspian Tern (Robinson <i>et al.</i>, 1996).</p> <p>Green Island: Nesting area for migratory Caspian Tern, and also habitat for Pied Oystercatcher, Pied Cormorant, Crested Tern and Silver Gull (Robinson <i>et al.</i>, 1996).</p> <p>Seal Rocks: Habitat for Pied Cormorant (Robinson <i>et al.</i>, 1996).</p>
<p>9. Notable Feeding, Breeding / Spawning and Nursery Areas</p>	<p>Invertebrates</p> <p>Tiparra Reef area: A highly productive area for Abalone, particularly Greenlip (see Part 2 of this table), although 3 other Abalone species are also common in the area. There is abundant food for Greenlip Abalone in the Tiparra Reef area, which therefore have fast growth rates and high fecundity (Shepherd and Baker, 1998), and Greenlip Abalone are therefore large and abundant in the area. Abalone feed on a variety of small macroalgae in the region, particularly epiphytes on seagrass, and drift macroalgae, such as various species of filamentous reds (e.g. see Shepherd, 1973). In addition to Greenlip Abalone (see above), nearshore reefs in the mid-eastern Spencer Gulf area (e.g. Cape Elizabeth to Tiparra Rocks area; Reef Point to Point Pearce, Goose Island, and reef near the northern, western and southern sides of Wardang</p>

Island) are reported to provide habitat for all life stages of the Purple Sea Urchin, and a habitat for the spawning adults of Southern Calamari (Bryars, 2003). Nearshore reefs in the **Hardwicke Bay** area are reported to provide spawning areas for Southern Calamari (e.g. **Point Gawler**, and from **Point Turton** to **Burners Beach**), and habitat for all life stages of the Purple Sea Urchin (e.g. **Point Gawler** area; and from **Point Turton** to **Burners Beach**; and **Corny Point**). Bryars (2003) reported that Southern Rock Lobster, Maori Octopus, and Greenlip and Blacklip Abalone all reproduce in the **Corny Point** area.

Mid-eastern Spencer Gulf: The seagrass beds and unvegetated soft bottom habitats provide feeding, spawning and nursery areas for Blue Swimmer Crabs and Razorfish; egg-deposition areas for Southern Calamari, and habitat for post-larval and juvenile King and Queen Scallops (Bryars, 2003). Juvenile Sand Crabs and Western King Prawns also utilise the unvegetated sand habitats (Bryars, 2003).

Further south, unvegetated soft bottom habitat in the **Point Gawler** to **Corny Point** area, provide habitat for spawning adults of Razorfish, Southern Calamari, and King and Queen Scallops, and the post-larvae juveniles of the sedentary species (Razorfish and Scallops) are reported to settle locally in the area (Bryars, 2003). Seagrass beds in **south-eastern Spencer Gulf** are reported to be utilised by spawning adult Southern Calamari, and provide a nursery area for juvenile Razorfish and King and Queen Scallops (Bryars, 2003).

Tidal flats in the area (e.g. around **Bird Island**, **Warburto Point**, **Moonta Bay**; and southwards between **Port Hughes** and **Cape Elizabeth**) provide habitat for spawning Blue Swimmer Crabs and Razorfish, and for post-larval and juvenile Razorfish and baitworm species (Bryars, 2003). Tidal flats in the **Port Victoria** area are reported to provide a habitat for juvenile Sand Crabs, and post-larval and juvenile Razorfish, and baitworm species, the latter also occurring in tidal flats in south-eastern Spencer Gulf (e.g. **Kemps**, **Bushes**, **Bluff** and **Parsons Beaches**) (Bryars, 2003). Juvenile Sand Crabs and baitworms are also reported to occur in the tidal flats in **Hardwicke Bay** (Bryars, 2003).

The shallows of the **Wardang** area, and further north at **Warburto Point**, are also nursery areas for Western King Prawns (Carrick, 2003, Figure 17).

Mangrove forest in the area (e.g. **Bird Island** / **Warburto Point**) provides habitat for juvenile Blue Swimmer Crabs and Western King Prawns (Bryars, 2003).

Sheltered beach habitat in south-eastern Spencer Gulf (e.g. **Rifle Butts Beach**, **Second Beach**, **Wauraltee Beach**, **Kemps Beach**, **Bluff Beach**, and the beach east of **Corny Point**) are reported to provide a nursery area for juvenile Sand Crabs, and a habitat for both adults and juveniles of baitworm species (Bryars, 2003).

The **outer Hardwicke Bay** area, north of **Corny Point**, is a habitat for adult Western King Prawns that migrate from the centre of the gulf (Carrick, 2003, Figure 18).

Bony and Cartilaginous Fish

Known spawning areas for King George Whiting, north of **Corny Point**, and west of **Wardang Island** (Fowler and McGarvey, 1997, 1999).

Nearshore reefs in the **Cape Elizabeth** to **Tiparra Rocks** area, and from **Reef Point** to **Point Pearce**, are reported to provide habitat for juvenile King George Whiting, Snapper, West Australian Salmon, Tommy Ruff and Trevally (Bryars, 2003). Reef around **Goose Island**, and near the northern, western and southern sides of **Wardang Island**) is reported to provide habitat for spawning adults, and juveniles, of Sea Sweep (Bryars, 2003). Nearshore reefs in the **Hardwicke Bay** area are reported to provide nursery habitat for juvenile King George whiting, West Australian Salmon, Tommy Ruff, Trevally and Sea Sweep (all in the **Point Gawler** area, and from **Point Turton** to **Burners**) (Bryars, 2003). Spawning areas and nursery areas for Sea Sweep and Western Blue Groper, are reported in the **Corny Point** area (Bryars, 2003).

Mid-eastern Spencer Gulf: The seagrass beds and unvegetated soft bottom habitats provide feeding, spawning and nursery areas for Southern Sea Garfish (Bryars, 2003). Juvenile King George Whiting, Snapper, West Australian Salmon, Tommy Ruff, Trevally, Red "Mullet", flathead species, and leatherjacket species, also utilise the seagrass habitats (Bryars, 2003). Divers have observed large numbers of juvenile fish in the area between **Wardang Island** and the **Port Victoria** coast, and consider the shallow seagrass habitat in the area to provide a significant nursery for fish (e.g. see Bellchambers, 1998).

Unvegetated soft bottom habitats in **mid-eastern Spencer Gulf** reportedly support larval

	<p>Southern Sea Garfish, post-larval Yellow-fin Whiting, and juvenile King George and Yellow-fin Whiting, Snapper, West Australian Salmon, Tommy Ruff, Yellow-eye Mullet, Red "Mullet", Trevally, flathead species and flounder species (Bryars, 2003). Further south, unvegetated soft bottom habitat in the Point Gawler to Corny Point area, is reported to provide habitat for spawning adults of Snook, and be a nursery area for juvenile King George Whiting, West Australian Salmon, Tommy Ruff, Southern Sea Garfish, Red "Mullet", Trevally, flathead species and leatherjacket species (Bryars, 2003).</p> <p>Tidal flats in the area include Bird Island, Warburto Point, Moonta Bay; southwards between Port Hughes and Cape Elizabeth; south of Cape Elizabeth; Point Warrenne to Reef Point; from Reef Point to Point Pearce; around Port Victoria, and southwards throughout Hardwicke Bay to the Burners Beach area, and these areas are reported to provide habitat for spawning Yellow-fin Whiting, and nursery areas for juvenile King George Whiting and/or School Whiting, West Australian Salmon, Tommy Ruff, Southern Sea Garfish, Yellow-eye Mullet, and species of flathead and flounder (Bryars, 2003).</p> <p>Sheltered beach habitats along the mid-eastern and south-eastern Spencer Gulf coast and around associated islands, reportedly support spawning adult Yellow-fin Whiting (mid-eastern areas) and Yellow-eye Mullet (both mid-eastern and south-eastern areas), and also juvenile King George and School Whiting, West Australian Salmon, Tommy Ruff, Yellow-eye Mullet, and juveniles of flathead and flounder species (Bryars, 2003).</p> <p>Mangrove forest in the area (e.g. Bird Island / Warburto Point) provides a feeding / sheltering area for Yellow-eye Mullet, and habitat for post-larval and juvenile King George Whiting, and juvenile West Australian Salmon, Tommy Ruff, Southern Sea Garfish, and Yellow-eye Mullet (Bryars, 2003).</p> <p>Coastal and Marine Birds Bird Islands, Moonta Bay, Cape Elizabeth, Port Victoria and Port Rickaby are amongst a list of key areas in South Australia for wading birds (Wilson 2000, cited by DEH, 2003a). The latter three areas reportedly support between 1000 and 2000 wading birds (DEH, 2003a, Figure 9).</p> <p>Bird Islands: Breeding area for Silver Gull, Sooty Oystercatcher, Caspian Tern, Crested Tern, Pied Cormorant and Little Pied Cormorant (Australian Heritage Commission, undated), and regionally important area for White-faced Herons, which nest in the mangroves. More than 20 herons were observed during a previous survey, and such relatively high numbers of this species in one locality is considered unusual for islands in S.A. (Robinson <i>et al.</i>, 1996).</p> <p>Goose Islands: Habitat for large numbers of breeding Crested Terns and Silver Gulls (Robinson <i>et al.</i>, 1996). According to a map in the S.A. Coast and Marine Atlas (2001), there are more than 600 Crested Terns breeding on Goose Island. The Goose Islands are also a refuge for international migratory species (see National and/or International Significance), and also contain small breeding populations of Little Penguin (50 – 100 penguins, according to one previous count) and Pacific Gull (Robinson <i>et al.</i>, 1996; S.A. Coast and Marine Atlas, 2001). Little Goose Island is a breeding area for Pied Cormorant, Pacific Gull and Silver Gull (Robinson <i>et al.</i>, 1996; S.A. Coast and Marine Atlas, 2001). White Rocks is reported to be a breeding area for Crested Tern and Black-faced Cormorant (S.A. Coast and Marine Atlas, 2001).</p> <p>Rocky Island: Breeding area for Crested Tern and Black-faced Cormorant (around 600 black-faced cormorants were recorded in a previous survey – see Robinson <i>et al.</i>, 1996), and Caspian Terns have also been reported nesting there.</p> <p>Wardang Island: Breeding area for Caspian Tern (Copley, 1995 and 1996) and Silver Gull (Robinson <i>et al.</i>, 1996).</p>
<p>10. Shipwrecks and Artificial Reefs</p>	<p>The shipwrecks of the Port Victoria and Wardang Island area have a significant function as artificial reefs. Dive promotion materials report that the shipwrecks in the area support extensive fish populations, and the shipwrecks are listed amongst the best dive sites in South Australia (Christopher, 1988; DIASA, undated; Aquanaut,</p>

	<p>undated). Wrecks such as the “<i>Songvaar</i>”, “<i>Australian</i>” and the “<i>Investigator</i>” are recognised to attract schools of fish such as Old Wives, Magpie Perch, and Silver Drummer, Zebra Fish and many others. Cuttlefish are also common in the area. Commercially and recreationally significant fish such as Snapper are also attracted to wrecks in the area, according to Yorke Peninsula tourism materials. Tourism and diving promotion materials describe the <i>Songvaar</i> wreck as having the function of an artificial reef, providing habitat for many species of reef fish, with abundant Snapper and Cuttlefish of particular note. The “<i>Australian</i>” serves a similar function, and although it provides limited support for attached biota, schools of fish are attracted to the structure, with notable species including Sweep, Drummer, and leatherjacket species, amongst others. Other features of the wreck sites are the clear shallow water; the relative abundance of benthic sharks (Port Jackson and Wobbegong); and the presence of Sea Lions, from the nearby White Rocks colony. Further details of the shipwrecks are described in Notes on Social and Economic Values and Uses for this area.</p>
<p>11. Popular Dive Sites</p>	<ul style="list-style-type: none"> ♦ Some of the biotic features of interest to divers at Tiparra Reef include various reef fish; the topography of the high relief limestone reef and adjacent outcrops, which provides numerous surfaces for attachment of invertebrates (e.g. sponges); abundant abalone, and a variety of gastropods and other molluscs. ♦ Port Hughes jetty and other mid-eastern Spencer Gulf jetties provide additional habitat for a variety of soft corals (promoted as one of the prime attractions for divers at Port Hughes jetty), bryozoa, sponges, ascidians, and anemones growing on the pylons, and attracts numerous fish species, including schooling species (e.g. Whiting, Tommy Ruff, Trevally, Yellow-tail Kingfish, Snook); various species of leatherjacket (including Rough, Pygmy and Mosaic Leatherjacket); reef fish species (e.g. Bullseye species, Magpie Perch, Dusky Morwong, Old Wife, Moonlighter, Western Talma (Squareback Butterfly Fish), Victorian Scalyfin, Hulafish, Globe Fish, Shaw’s Cowfish and Ornate Cowfish – males, females, adults and juvenile Cowfish of both species have all been observed in the area); benthic fish species (e.g. Stargazers, flathead species, Grubfish, Catfish); syngnathids (various species of Pipefish, and Seahorses); Wrasse species (e.g. Castelnau’s); other fish species such as Black-banded Sea Perch, Little Weed Whiting, Red “mullet”, Ringed Toadfish, and Cardinalfish species. Other biota in the area that attracts divers includes sharks such as Wobbegong and Port Jackson sharks, abundant rays (e.g. Fiddler Ray, and various other ray, stingray and stingaree species) and skates, cuttlefish, calamari, abundant Blue Swimmer Crabs, nudibranchs (including large colourful species such as <i>Ceratosoma brevicaudatum</i>), jellyfish, comb jellies, flatworms, sea spiders, hermit crabs, and shrimps (Christopher, 1988; Aquanaut, undated; Brown, undated; MLSSA dive reports, 1999, 2000 and 2003; Dive Oz web site, 2003). ♦ Apart from the shipwrecks in the area, the Port Victoria jetty is recognised for its variety of fish and the invertebrate growth on the pylons. Other features commonly observed at Port Victoria jetty include rays, octopus, Giant Cuttlefish, as well as nudibranchs, sea stars, various shrimp species, and less commonly observed benthic fish species, such as anglerfish (Dive Oz, 2003). The natural reefs around Wardang Island and the Port Victoria area and southwards (e.g. Rifle Butts Beach) are also recognised for diving and snorkelling, with some of the features of interest to divers including the high water clarity; the various reef fish species (examples from the Wardang area include Magpie Perch, Dusky Morwong, Blue Morwong, Western Blue Devil, Snapper, Zebra Fish, Old Wife, Silver Drummer and many others); other fish (Puffer Fish, Weedy Whiting, King George Whiting, Garfish, and many other species); Abalone; Calamari; and sharks such as Bronze Whalers (Brown, undated; MLSSA reports, 1997-1999). ♦ Goose Island and White Rocks are also recognised by divers and snorkellers for the presence of the small population of Australian Sea Lions (Christopher, 1988; DIASA, undated). ♦ Point Turton jetty is known for its “healthy pylon growth” (Brown, undated), abundant colourful sponges, “large variety of nudibranchs” (Christopher, 1988; Brown, undated), dumpling squid, cuttlefish, slipper lobsters, and a variety of marine worms (Brown, undated), and schooling fish (Dive Oz, 2003) amongst other features. The Point Turton jetty has been described as supporting “a large array of marine life”

	<p>(DIASA, undated). The rocky reefs west of the jetty at Point Turton are also recognised by divers. Soft corals are also found in the area, with abundant marine flatworms.</p> <ul style="list-style-type: none"> ♦ Reefs in the Port Rickaby, Port Minlacowie area, Hardwicke Bay area and off Corny Point are also recognised diving spots. Examples of biotic features of interest include the various reef fish species; Port Jackson sharks (also shark eggs); Spider Crabs; nudibranchs; various sea star species, and other invertebrates (Christopher, 1988; MLSSA dive trip records, 1988 and 1999; DIASA, undated).
<p>12. National and/or International Importance</p>	<ul style="list-style-type: none"> ♦ Bird Islands Conservation Park: Listed on the <i>Register of the National Estate</i>. The area comprises two islands near Warburto Point, and less than 1km offshore, declared as a Conservation Park primarily to protect the breeding habitat of sea birds, and the mangrove swamp fringing the islands. Limited access and virtual absence of introduced species has ensured preservation of habitat (Australian Heritage Commission, undated), and protection of bird species, as evidenced by the presence of ground-nesting birds such as Crested Terns (Robinson <i>et al.</i>, 1996). ♦ Bird Islands: contains habitat for at least one species (Great Egret – Robinson <i>et al.</i>, 1996) listed under an international treaty for migratory birds (CAMBA agreement – see Department of Foreign Affairs, 1988). ♦ Balgowan Sand Dunes: Listed on the <i>Register of the National Estate</i> because the area supports an open heath / scrub coastal plant association that is poorly conserved in other parts of Yorke Peninsula. The area is also recognised for its size, near pristine condition, diverse bird population and scientific value as a marker area representative of the type of vegetation (habitat) which used to occur more widely on Yorke Peninsula (Australian Heritage commission, undated). ♦ Wardang Island: Listed on the <i>Register of the National Estate</i> in recognition of the well preserved exposure of a wide variety of geologic and geomorphological features, including a variety of rock types of various ages, including pre-Cambrian acid volcanics and basic intrusives, Permian glaciogene sediments with numerous erratics, Pliocene fossiliferous limestone with rich fauna in ten distinct horizons. A Permian / Pliocene unconformity surface is also preserved. The island's south-western coastline contains good evidence of Permian ice age sediments (glacial till – clay, sand, gravel and boulders deposited by moving ice), erratic boulders and glacial scour marks (Robinson <i>et al.</i>, 1996). Also registered in recognition of the Recent stranded beach ridges, wave cut platforms and calcrete horizons, and salt marshes and barrier dunes forming a “classic pro-grading beach couplet” (Australian Heritage Commission, undated). ♦ Goose Island Conservation Park: Listed on the <i>Register of the National Estate</i>. The conservation park comprises of several small islands, declared in recognition of the breeding colonies of Black-faced Cormorant, Pied Cormorant, Hooded Dotterel and Silver Gull; and the use of the islands by a wide diversity of sea and land birds (Australian Heritage Commission, undated). ♦ Goose Islands and Wardang Island provide habitat for at least five species of migratory coastal birds that are listed under international migratory bird treaties JAMBA and/or CAMBA. Species include Sharp-tailed Sandpiper, Ruddy Turnstone, Red-Necked Stint, Great Knot and Caspian Tern (Robinson <i>et al.</i>, 1996; Environment Australia, 2000). Green Island is also a nesting area for Caspian Tern (listed under the international CAMBA agreement for migratory birds – see Department of Foreign Affairs, 1988). ♦ The coastal dune area between Port Rickaby and Barker Rocks has been listed as an <i>Indicative Place</i> on the <i>Register of the National Estate</i>, in recognition of (i) the consolidated dunes representing “some of their best type and character on the western coastline of Yorke Peninsula”, (ii) such dune systems of the type and condition not being common in S.A. (iii) the existence of a number of coastal plant species of limited known distribution, and (iv) the integrity and undisturbed nature of the dune plant communities, including the diverse understorey (Kraehenbuehl, Dept Environment and Planning S.A. pers. comm. to Australian Heritage Commission, 1992). ♦ Peeseey Swamp: Listed on the <i>Register of the National Estate</i>, in recognition of the

	<p>area of marshy saline flats of mid-Recent high sea level extending from Hardwicke Bay to Sturt Bay. Low ridges of kunkarised shells and shell sand of marine origin extend parallel to the swamp, discontinuously on either side. Similar stranded ridges occur throughout the swamp (Australian Heritage Commission, undated).</p> <ul style="list-style-type: none"> ♦ The South Australian Division of the Geological Society of Australia with partner groups (e.g. Australian Heritage Commission, South Australian Museum, and other organisations) has classified a number of geological monuments in the area, including Corny Point (unconformity, of gneissic basement rock of around 1700 ma, underlying fossiliferous limestone of around 26ma); Point Turton (unconformity, Permian glacial sediments, and type locality for Point Turton fossiliferous limestone); The Bluff area south of Barker Rocks; Port Victoria (Precambrian volcanic basement rock foreshore); Cliff Point on the eastern side of Wardang Island; the Balgowan Cliffs; and part of Moonta Bay. ♦ The Spencer Gulf region in general has been identified as an area of international importance for shorebirds, by Watkins (1993, cited by Morelli and de Jong, 1995).
<p>13. Major Commercial and Recreational Fish, Sharks, Molluscs and Crustaceans</p>	<p>Some of the main fish, shark and invertebrate species caught commercially and / or recreationally in the waters off mid-eastern and south-eastern Spencer Gulf include:</p> <p><u>Fish</u>: King George Whiting, Snapper, Southern Sea Garfish, Tommy Ruff, Snook, Yellow-eye Mullet, Yellow-fin Whiting, School Whiting, West Australian Salmon, various leatherjacket species, Trevally, flathead species, Silver Drummer, Red "Mullet", various wrasse species, Striped Perch, Blue Morwong, Yellow-tail Kingfish, Weedy Whiting, boarfish species, Sweep, gurnard perch and rockfish species.</p> <p><u>Sharks and Rays</u>: Gummy Shark, School Shark, Bronze Whaler and/or Black Whaler, Eagle Ray and other ray species, skate species.</p> <p><u>Invertebrates</u>: Greenlip Abalone (a major part of the commercial fishery operates in the mid-eastern Spencer Gulf area), Blacklip Abalone, Western King Prawns (commercial only, in waters deeper than 10m), Southern Calamari, Cuttlefish, Razorfish, Blue Swimmer Crabs, Sand Crabs, Octopus species, Velvet Crab, King and Queen Scallops, Southern Rock Lobster (southern areas).</p>

8.12 Western Investigator Strait (between the “Toe” of Yorke Peninsula and Northern Kangaroo Island) (Eyre/Gulf St Vincent Bioregions Boundary)

Figure 14 depicts the location of this area.



Figure 14: Western Investigator Strait

1. Biogeographic Significance	Cool-water upwelling and associated productivity in the area is regionally significant (see below), however features of outstanding biogeographic significance at State and national scales are not known for this area, for this report.
2. Major Physical Influences, and Relative Productivity Level	<p>Major Physical Influences</p> <p>The following are characteristic oceanographic features of the area encompassing South-Western Yorke Peninsula / mouth of Spencer Gulf, Althorpe Islands, Western Investigator Strait and North-Western Kangaroo Island (see Bye, 1976; Shepherd and Sprigg, 1976; Bruce and Short, 1992; Petrusevics, 1993; Edyvane, 1999b; S.A. Coast and Marine Atlas, 2001; Ward <i>et al.</i>, 2000; Shepherd and Brook, 2002; Butler <i>et al.</i>, 2002; PIRSA, 2003d, Figure 8).</p> <ul style="list-style-type: none"> ♦ Moderate to strong wave energy exposure (especially on the headland areas of South-Western Yorke Peninsula, the exposed sides of islands in the vicinity); ♦ Strong bottom currents in deeper waters (particularly in western and central Investigator Strait); ♦ Storm waves; ♦ Local scale eddies/gyres (e.g. Royston Head); ♦ Minimal tidal range; ♦ Strong prevailing south-westerly swells (south-western Yorke Peninsula); ♦ Strong currents in the centre of Investigator Strait; ♦ Steep depth gradients close to the coast, in some areas (e.g. south of Corny Point) ♦ Frontal systems that form seasonally in between Eyre end Yorke Peninsulas. The Althorpe Islands area is at the boundary of the seasonal sea surface temperature fronts, in which warmer gulf waters and cooler deeper waters from western SA meet, causing strong benthic temperature and salinity differentials (Bruce and Short, 1992; Petrusevics, 1993); ♦ Edge of a colder water upwelling zone, that is most evident along southern Eyre Peninsula and North-Western and Western Kangaroo Island during summer and autumn, but extends into the mouth of Spencer Gulf; ♦ The entire South-Western Yorke Peninsula coast is also subject to strong erosive action due to the oceanographic conditions. <p>Relative Productivity Level</p> <p>The oceanographic features that characterise south-western Yorke Peninsula (in particular, the sea surface temperature fronts, nutrient-rich upwelling of southern Eyre Peninsula, currents, and local-scale eddies and gyres) may be responsible for:</p> <ul style="list-style-type: none"> ♦ the relatively high abundance and concentration of pilchard eggs (see Ward <i>et al.</i>, 2001) and larvae in the area west of the “toes” of Yorke Peninsula (see figures in Jones <i>et al.</i>, 1995; Ward <i>et al.</i>, 2000); ♦ the relatively high abundance of zooplankton on the eastern side of the Spencer Gulf mouth; i.e. off the “toes” of Yorke Peninsula (see Ward <i>et al.</i>, 2001); ♦ the macroalgal diversity of the area, for example the abundance and diversity of species of brown canopy dominants and encrusting corallines in the south-western part of Yorke Peninsula (Edyvane and Baker, 1996c and 1998a); ♦ the use of areas of high current flow / eddies by spawning aggregations of benthic sharks, such as Wobbegong and Port Jackson (see section 9 of this table).
3. Bioregional Representativeness of Habitats	<p>The Western Investigator Strait / South-Western Yorke Peninsula area lies in the boundaries of Gulf St Vincent and Eyre Bioregions as classified by IMCRA Technical Group (1998).</p> <p>Features, within the area discussed here, that are characteristic of the Gulf St Vincent Bioregion include:</p> <ul style="list-style-type: none"> ♦ moderate wave energy coastline;

	<ul style="list-style-type: none"> ♦ Tertiary sedimentary cliffs*; ♦ beaches; ♦ shore-fringing macroalgal communities on reefs, including the shallow water brown macroalga <i>Hormosira banksii</i>; ♦ <i>Scaberia agardhii</i>, <i>Sargassum</i> species, <i>Cystophora</i> species, <i>Seirococcus axillaris</i> and/or <i>Ecklonia radiata</i> in the macroalgal canopy on subtidal reefs; ♦ Benthic seagrass beds (mainly species of <i>Posidonia</i> and <i>Amphibolis</i>); ♦ Sparse <i>Zostera</i> (= <i>Heterozostera</i>) <i>tasmanica</i> seagrass beds in deeper waters (e.g. mainly 25+m). ♦ Features, within the area that are characteristic of the Eyre Bioregion include: ♦ moderate to high deepwater wave energy coastline; ♦ calcarenite cliffs, headlands and platforms*; ♦ <i>Cystophora</i> species and <i>Ecklonia radiata</i> in the macroalgal canopy on reefs; ♦ green (mainly <i>Caulerpa</i> species) and red (e.g. <i>Plocamium</i> species) macroalgal assemblages; ♦ high macroalgal species diversity (particularly red species); ♦ subtidal seagrass communities in more sheltered areas; ♦ breeding colonies of Australian Sea Lion and/or New Zealand Fur Seal, particularly on islands. <p>* Note that the <i>granite headlands, reefs and islands</i> that underlie the calcareous capping in the region, and are a major feature of the south-western Yorke Peninsula region, were not listed by IMCRA as being characteristic of either Bioregion in which parts of the described area are situated.</p>
<p>4. Habitat Rarity</p>	<p>South-west of Althorpe Islands Two basement “highs” (knolls) occur approx. 20-25km south-west of Althorpe Islands (Rankin <i>et al.</i>, 1991). Such topographic features of the sea floor are generally considered to be ecologically significant, due to their differences in structure and depth, compared with the adjacent waters.</p> <p>Innes National Park Small mound-like stromatolite constructions occur in a shallow salt lagoon near Ethel Beach (Reynolds, 1999; NPWSA, 2002). Stromatolites are considered to be very rare in South Australia, and globally (NPWSA, 2002).</p>
<p>5. Habitat Diversity</p>	<p>South-Western Yorke Peninsula The habitat diversity in the area includes:</p> <ul style="list-style-type: none"> ♦ sandy beaches, on moderately exposed coast, and in smaller more sheltered bays; ♦ extensive intertidal reefs of various forms and compositions (e.g. calcareous platform reefs and blocks; granitic boulder and sheet reefs) and cliff / headland reefs; ♦ benthic reefs (granitic and calcareous) off the mainland and islands, with a diversity of micro-habitats (caves / caverns, reef “walls”, crevasses, gutters, overhangs, dissected platforms, reef outcrops / boulders, “pinnacles”), with a variety of benthic cover compositions (see notes below). Aeolianite reef occurs from Stenhouse Bay to the western side of Marion Bay, and as patches in the deeper waters of Investigator Strait; ♦ mixed habitats, such as sand / boulder reef habitat (e.g. southern side of Innes, in parts of Stenhouse Bay near eastern and western headlands), and mixed seagrass / cobble / sand habitat; ♦ subtidal seagrass beds (e.g. parts of Stenhouse Bay, Cable Hut Bay, West Bay, Groper Bay, the bay between Rhino Head and Penguin Point, amongst others); ♦ benthic sand habitat. <p>(Savarton <i>et al.</i>, 1987; Edyvane and Baker, 1998a and SARDI S.A. Benthic Survey data</p>

1993, unpublished; Shepherd and Brook, 2002).

Althorpe Islands, Haystack Island, Seal Island

The habitat diversity in the area includes:

- ♦ near-shore benthic granitic basement reefs with diversity of forms (platforms, ledges, boulders, caves, chasms and crevasses, overhangs, vertical reef (rock “walls”), isolated reef outcrops and near-shore fringing reef patches of broken calcarenite blocks and rubble);
- ♦ areas of small sandy beaches (e.g. north-east coast of Althorpe Island);
- ♦ mixed sand / granite reef / calcarenite block / rubble reef habitats;
- ♦ subtidal seagrass beds (e.g. Haystack Island);
- ♦ benthic sand habitat.

(Robinson *et al.*, 1996; Edyvane and Baker, 1998a and SARDI S.A. Benthic Survey data 1993, unpublished)

Cape Forbin to Cape Dutton (including Western River Cove)

The habitat diversity in the area includes:

- ♦ estuaries (e.g. Western River Cove);
- ♦ mudflats (e.g. Snelling Beach lagoonal area);
- ♦ sand beaches/bays and pebble beaches;
- ♦ metamorphic (e.g. schistose) cliff reefs, nearshore platform reefs and subtidal reefs;
- ♦ subtidal seagrass beds;
- ♦ benthic sand habitat.

Western Investigator Strait

The habitat diversity in the area includes:

- ♦ benthic seagrass beds of various forms (*see habitat descriptions below*) e.g. sparse beds of the fine *Zostera* (= *Heterozostera*) *tasmanica* seagrass and mixed sand-dwelling invertebrate assemblages in deeper waters to approximately 35m, and *Posidonia*-dominated seagrass meadows (with lesser cover of *Amphibolis antarctica*) in shallower waters less than 20m;
- ♦ calcareous patch reefs (in deeper waters of the western Strait: 20m - 40+m), including aeolianite reefs and calccreted shell beds of variable topography (N.B. calcareous algae is abundant in the area);
- ♦ benthic sand habitat, including deeper water sand ripples.

Selected Habitat Notes

(Savarton *et al.*, 1987; SARDI S.A. Benthic Survey data, 1993, unpublished; Robinson *et al.*, 1996; Edyvane and Baker, 1996c and 1998a; Collings and Cheshire, 1998; Shepherd and Brook, 2002; Shepherd *et al.*, 2002).

South-western Yorke Peninsula

The area is generally exposed to the forces of wind, waves and swells, and the elements have sculpted rocky headlands, wavecut platforms and sandy beaches throughout the south-western foot of the peninsula. In general, intertidal and shallow subtidal calcareous platforms in some parts of south-western Yorke Peninsula are dominated by *Hormosira banksii*, *Sargassum* species, smaller red, green and brown macroalgae (foliose and turfing species), and abundant invertebrates, particularly molluscs, echinoderms, anemones and polychaetes (Savarton *et al.*, 1987). In addition to the abundant nearshore reefs (discussed below), seagrasses such as *Posidonia* species (e.g. *P. sinuosa*; *P. angustifolia*) and/or *Amphibolis* (mainly *A. antarctica*) occur throughout the region, to at least 20m, but are more prevalent in the shallower parts of some south-western Yorke Peninsula bays. Dense seagrass beds occur in Marion Bay, to the east of the area discussed here. Seagrass beds are also present in parts of **Stenhouse Bay, Cable Hut Bay**, and smaller bays around the foot of Yorke Peninsula (e.g. **West Bay, Pandalowie Bay, Groper Bay, Dolphin Bay**, and the bay between Rhino Head and Penguin Point, amongst others). *Halophila australis* and *Zostera* (= *Heterozostera*) *tasmanica* seagrasses are also present in the region (e.g. **West Bay**, and part of **Stenhouse Bay**,

amongst other locations). In some areas, such as **West Bay**, *Posidonia* and *Amphibolis* are heavily encrusted (naturally) with a diverse array of large red and brown macro-algal epiphytes (Edyvane and Baker, 1998a).

Shepherd and Sprigg (1976) recorded aeolianite reef in the region from **Stenhouse Bay** to the western side of **Marion Bay**. The authors considered the area to be rich in macroalgae (see descriptions below), as well as sponges, crinoids, reef molluscs, Rock Lobsters and other benthos, and supporting a varied fish population. More recent surveys in the area by SARDI, have shown that habitat at the western end of **Marion Bay**, between 10m and 30m, comprise a mix of sparse seagrass, macroalgae and invertebrate cover; a sponge and ascidian assemblage (covering a small proportion of the surveyed area, particularly in the western side of Marion Bay), and beds of medium density *Posidonia* seagrass (western end of **Marion Bay**) (SARDI data, 2002).

In more exposed areas on the southern side of **Innes** (including parts of **Stenhouse Bay** near the eastern and western headlands, and **Rhino Head**, among others), some of the shallow reefs (e.g. around 5m) comprise mixed sand and boulder/broken calcarenite rock habitat. The calcareous reef is covered with a mixed macroalgal community which includes *Scaberia agardhii*, several *Cystophora* and *Sargassum* species, the small red *Botryocladia sonderi*, the large leathery red *Osmundaria prolifera*, green macroalgae such as *Caulerpa* (e.g. *C. flexilis*) and *Dictyosphaeria sericea*, and turfing brown macroalgae (e.g. *Lobophora variegata* and other species) (Edyvane and Baker, 1998a and SARDI S.A. Benthic Survey data, unpublished). Gorgonian corals also occur in shaded parts of reefs at **Stenhouse Bay** (Savarton *et al.*, 1987). Brown canopy species *Caulocystis* sp., *Cystophora monilifera*, and *Scaberia* are common on dissected calcareous reef in the shallows (e.g. 1m- 2m) at **Stenhouse Bay**. Collings and Cheshire (1998) recorded species of *Cystophora* and *Sargassum* as the principal reef macroalgae in the **Stenhouse Bay** area (e.g. on patch reefs at 9m), with *Cystophora* species dominating the shallower sites (5m). Shepherd and Brook (2002) recorded *Ecklonia*, *C. siliquosa*, *C. subfarcinata*, *C. monilifera* and *C. retorta* as the reef dominants between 5m – 10m in **Stenhouse Bay**.

In addition to the reef, sparse to medium density beds of *Posidonia* and *Amphibolis* occur throughout much of **Stenhouse Bay**. A survey during the mid 1980s (Savarton *et al.*, 1987) also recorded seagrass from approximately 3m to at least 10m in the bay, and 1:10 000 aerial photos indicate that much of **Stenhouse Bay** is covered with seagrass. Shepherd and Brook (2002) also recorded seagrass in the shallows of **Stenhouse Bay** (e.g. 1m – 2m).

On the deeper, more exposed reefs on the southern side of Innes (e.g. **Cape Spencer** and **Cable Hut Bay** at 5m to 10m), several species of brown macroalgae dominate the canopy, including *Cystophora* spp. (e.g. *C. siliquosa*), *Sargassum* spp. (e.g. *S. fallax*), *Carpoglossum confluens*, *Acrocarpia paniculata* and *Ecklonia radiata*, with understory flora comprised of a dense cover of green macroalgal species (e.g. particularly *Caulerpa* spp. on reefs around 10m), mixed red algae such as species of *Plocamium*, *Areschougia*, and *Phacelocarpus*, and dense and abundant cover of encrusting and articulated coralline red species (Edyvane and Baker, 1998a and SARDI S.A. Benthic Survey data, 1993, unpublished).

Chinaman's Hat Island is a small calcarenite islet west of Stenhouse Bay, around 350m offshore. The coastal perimeter rises abruptly as a rim of broken cliffs to a broad platform, and an arc of submerged reef connects the islet to a nearby headland to the west, and extends east of the islet (Robinson *et al.*, 1996). Westward from **Chinaman's Hat Island**, there is deeply dissected calcarenite reef of high relief (around 3m), and rocky outcrops near the western point. Dominant reef cover recorded between 3m and 7m includes *Ecklonia*, with lesser amounts of *Acrocarpia paniculata*, and various *Cystophora* species (*C. moniliformis*, *C. monilifera* etc). In the channel area between the island and the coast, dissected calcarenite reef in the shallows is dominated by *Cystophora* species such as *C. moniliformis* and *C. siliquosa*, with *Amphibolis* seagrass patches on the sand near the shore. There is also high relief calcarenite reef on the seaward side of **Chinaman's Hat Island**, dominated by *Ecklonia*, with lesser cover of *Cystophora* species (e.g. at 6m – 9m). East of the island (towards the wreck of the *Marion*), *Ecklonia* is

sparser on the high relief calcarenite reef, and dominant reef cover recorded between 2m and 7m includes *C. retorta*, other *Cystophora* species, and species of *Sargassum* (Shepherd and Brook, 2002).

Granite blocks (around 2m high) high occur in the nearshore area on the western side of **Howling Cave Bay** (near **The Gap**). Between 1m – 5m, Shepherd and Brook (2002) recorded mainly *Cystophora* species, with lesser cover of *Ecklonia*. On the eastern side, there are steep mainland cliffs, with undercuts forming caves. Between 3m - 5m, Shepherd and Brook (2002) reported sparse coverage of *Ecklonia* and species of *Cystophora*, with articulated coralline algal turf.

Shallow bays on the western side of the foot of Yorke Peninsula (e.g. **Pondalowie**; **Dolphin Bay**) comprise a variety of mixed habitats including calcarenite patch reefs (covered mainly with *Cystophora* spp.), bare sand, and seagrass (mainly *Amphibolis antarctica*). Shepherd and Brook (2002) reported mainly *C. moniliformis* in the shallow reef area (e.g. 1m) on the western side of **Pondalowie Bay**. Out from the centre of **Pondalowie Bay** is **Middle Islet**, separated from the mainland by a channel reef. The islet is composed of granite, with a calcarenite capping and dunes, and there is also a small semi-submerged reef around 740m west (Robinson *et al.*, 1996). There is also a small islet at the southern end of **Pondalowie Bay**, called **South Islet**, which is connected to the mainland by a “neck” of semi-submerged reef and sand. The islet has a granite base, capped with eroded and undercut calcarenite, which has formed sheer cliffs on the exposed western and northern coasts (Robinson *et al.*, 1996).

Savarton *et al.* (1987) recorded *Ecklonia* and species of *Cystophora* (e.g. *C. retorta*) in the shallow subtidal reef areas of **Groper Bay** to 6m, with *Hormosira* and various green macroalgae closer to shore (e.g. 0+m – 2m), and *Amphibolis* and *Zostera* seagrass in the sandy areas. There are many calcareous boulders that have eroded from the cliffs and fallen into Groper Bay (Savarton *et al.*, 1987). In the shallow (0.5m – 2m) back reef channel in **Groper Bay**, Shepherd and Brook (2002) also recorded mainly *Ecklonia* on the calcarenite reef, with lesser cover of *Cystophora moniliformis*, and *Caulerpa* species in the understorey. At the headland **north of Groper Bay**, Shepherd and Brook (2002) recorded, on calcarenite reef of high relief (2m – 3m) between 2m – 10m depth, mainly *Ecklonia*, with lesser cover of mixed *Cystophora* species (e.g. *C. siliquosa*, *C. moniliformis*, *C. racemosa*, *C. retorta*), and *Caulerpa* species in the understorey.

On the **western side of Innes** (e.g. **Royston Head**), shallow reefs (e.g. 5m) are dominated by a large number of species of brown macroalgae, including *Seirococcus axillaris*, *Scytothalia dorycarpa*, *Cystophora* and *Sargassum* species, and *Ecklonia radiata*. Mixed coralline red and green macroalgae (e.g. species of *Caulerpa*) dominate the understorey. The reef at **Royston Head** at 10m has dominant cover that is similar to that on the coastal and island reefs of southern Eyre Peninsula, dominated by several *Sargassum* species and *Myriodesma integrifolium*, with a dense and diverse understorey of mixed red algal taxa, such as species of *Micropeuce*, *Areschougia*, *Polysiphonia* and many others. (Note: A local scale eddy/gyre is evident from aerial photos in the Royston Head area).

There is an island (**North Islet** or **Royston Island**) close to **Royston Head**, the northernmost extremity of Pondalowie Bay, and a shallow, partially drying reef connects the two (Robinson *et al.*, 1996). The island is composed of granite, with an eroded calcarenite capping. Waves and surge have scoured much of the slope area, to form smooth, deeply incised ramps. There are dislocated boulders in the fringe area, beyond the reach of normal swells, and rounded granitic detritus is mixed with the jagged fragments of calcarenite (Robinson *et al.*, 1996).

Deeper reefs on the western side of Innes (e.g. **West Cape** at 15m) are dominated by *Seirococcus axillaris*, *Carpoglossum confluens*, *Ecklonia radiata*, with an understorey of red macroalgae including species of *Phacelocarpus*, *Callophycus* and *Callophyllis* (Edyvane and Baker, 1998a).

There is calcarenite reef in the lagoon at the northern end of **Browns Beach**, sheltered by a fringing reef. Creviced calcarenite platform in the shallows is covered with species such as *Cystophora moniliformis* and *C. siliquosa*, with the seagrass *Amphibolis* on

adjacent sand areas. The southern part of Browns Beach contains granite reef at the shore, with *Ecklonia*, *C. siliquosa*, and *C. moniliformis* in the shallows (e.g. to 2m), and *Amphibolis antarctica* on sand (Shepherd and Brook, 2002). South of Browns Beach, part of the **Shell Beach** area comprises sand habitat and smooth granite blocks up to 2m high, with a mixed community of brown macroalgae between around 1m and 10m in the reef areas, comprising *Ecklonia*, mixed species of *Cystophora* including *C. racemosa* and *C. retorta*, *Carpoglossum confluens*, *Acrocarpia paniculata*, *Sargassum fallax* and *S. linearifolium*, and other species (Baker, pers. obs., 2002; Shepherd and Brook, 2002).

Further north on the “toes” of Yorke Peninsula, shallow (to 3m) calcarenite reef in the **Formby Bay** area supports various species of *Cystophora*, and *Ecklonia radiata*. The granitic shore reef in the **Gleasons Landing** area has *Scaberia agardhii*, species of *Cystophora*, and *Ecklonia* as dominant reef cover between 2m – 6m (Shepherd and Brook, 2002).

There is a granite islet off **Daly Head**, the westernmost extremity of a submerged reef extending from **Daly Head** (Robinson *et al.*, 1996). On the exposed reef at **Daly Head**, *Carpoglossum confluens*, *Ecklonia radiata* and *Acrocarpia paniculata* have been recorded in the canopy, with lesser cover of *Cystophora grevillei* and *C. platylobium*, and understory comprising red macroalgae such as species of *Callophyllis*, *Callophycus* and *Cladurus elatus*; articulated corallines such as *Haliptilon roseum* and species of *Amphiroa*, *Metagoniolithon*, and *Cheilosporum*; turfing browns such as *Homoeostrichus sinclairii*, and a dense cover of crustose coralline algae on the reef surfaces (Edyvane and Baker, 1996c).

Western Investigator Strait

In deeper waters away from the coast (approximately 25m to 35m), Shepherd and Sprigg (1976) recorded the *Heterozostera* seagrass / *Lunulites* (button bryozoan) assemblage as occurring in much of the southern Investigator Strait area, dominated by sparse beds of *Heterozostera tasmanica* (now reinstated into the *Zostera* genus – see Soros-Pottruff and Posluszny, 1995, and Kuo, 2004). Dominant benthic fauna include *Lunulites* bryozoan and unattached brachiopods, and species that can tolerate the high tidal flow environment (e.g. the fan bryozoan *Parmularia* sp., the stalked ascidians *Pyura australis* and *Pyura spinifera*, and the sea pen *Sarcoptilus grandis*). The deeper waters off the north coast of Kangaroo Island (e.g. north of Snug Cove, deeper than 30m) also contain patches of consolidated calcareous sand dunes (i.e. as “aeolianite reef” – see Shepherd and Sprigg, 1976). This geology provides a hilly, rough bottom topography, covered with a variety of algae, sponges, crinoids, molluscs and other benthos, a varied fish population, and high densities of Snapper and Rock Lobsters (Shepherd and Sprigg, 1976). In western Investigator Strait, Shepherd and Sprigg (1976) also recorded patches of consolidated shell bed reef of low relief in the waters of southern Yorke Peninsula, off the toe of Yorke Peninsula, to 25m.

Note that there is currently a paucity of benthic survey information for the deeper waters of Investigator Strait.

Althorpe Islands

The Althorpe Islands consist of 3 main islands and 5 small islets. **Althorpe Island**, is the southernmost and largest (96 ha, and 93m high). To the north-east, and closer to the coast, are **Seal Island**, and **Haystack Island** (43m high). The five small islets (the **Western Islets** or **Little Althorpe**) are off the western side of **Althorpe**. The small islets formed from erosion of a granite rise along a series of joints or dykes, forming deep crevasses that segmented the outcrop into the five islets (Robinson *et al.*, 1996).

Islands in the Althorpe group contain sub-tidal granite basement reefs, and calcarenite is present in the nearshore area some places, where it has eroded from the island “capping” above. On **Althorpe Island**, jointing in the massive granite humps has resulted in gaping, many-branched crevasses and chasms along the coastline, that alternate with long fingers of rock, in turn dissected into segmented chains of islets. There is a large sandy bay, bounded by cliffs, on the north-eastern side of **Althorpe Island** (Robinson *et al.*, 1996).

Seal Island is composed of granitic gneiss, intruded by amphibolite dykes. The lines of

weakness in the gneiss have been exaggerated into deep grooves, that eventually “slough off” large slabs of rock. The broadest joints and dykes have been worn to deep indentations, or completely penetrated, to form the segmented islets off the western tip of **Seal Island** (Robinson *et al.*, 1996).

Haystack Island rises as a narrow wall of sheer calcarenite cliffs, undermined and indented by rock falls from active erosion. The granite ridge of the island is mainly below sea level (Robinson *et al.*, 1996).

According to a survey in 1993 (see Edyvane and Baker, 1998a), reefs at the Althorpes are dominated by species that are characteristic of the parts of Gulf St Vincent Bioregion where relatively high wave energy conditions occur i.e. *Ecklonia radiata*, with lesser cover of *Acrocarpia paniculata*, *Cystophora* species (e.g. *C. moniliformis*), *Seirococcus axillaris* and *Sargassum* species. The understorey on these reefs (especially reefs below 5m) comprises an abundant number of red macroalgal taxa (e.g. species of *Plocamium*, *Phacelocarpus*, *Pterocladia*, *Ballia*, and *Sonderopelta coriacea*), including coralline reds (e.g. *Metagoniolithon* sp., *Halptilon roseum*), and green algae (e.g. species of *Caulerpa* and *Codium*). At the time of the survey reefs around Haystack Is were dominated by mixed sps of *Sargassum* (e.g. 6 species recorded) and *Cystophora* in the shallower areas (5m) and *Seirococcus axillaris* on the deeper reefs (eg 15m), with less cover of *Ecklonia radiata*. The understorey composition on reefs at Haystack Island is both very diverse and abundant in macroalgal red species, including species that are considered to be uncommon as understorey species at a State-wide scale. Green macroalgae (*Caulerpa* and *Codium* species) are also abundant on these reefs. A sheltered sandy bay occurs on the north-east side of Althorpe island. All of the four major genera of Southern Australian subtidal seagrasses were recorded at 10m in this bay (mainly *Posidonia* spp., but also present were *Halophila australis*, *Zostera* (= *Heterozostera*) *tasmanica*, and *Amphibolis antarctica*) with mixed red and brown macroalgal epiphytes, and sponges in the understorey. *Posidonia* / *Amphibolis* / *Halophila* seagrass beds with mixed macroalgal epiphytes and sponges in the understorey were also recorded on sandy substrates around Haystack Is. On the SE side of **Althorpe Island**, the community in the sheltered cove at a depth of 5m is regionally unusual, comprising predominantly green macroalgae (*Caulerpa flexilis* and *Caulerpa obscura*) in the benthic cover. Also present were the brown macroalgae *Ecklonia radiata*, *Cystophora moniliformis* and *Cystophora monilifera*, and mixed red macroalgae (e.g. species of *Gigartina*, amongst others) (Edyvane and Baker, 1998a and unpublished SARDI benthic survey data, 1993).

Within a few km of the islands there are numerous other shoals of granite (**South-west Rock, Brook Shoal, Emmes Reef**) (S. Shepherd, pers. comm., 2003).

Some 20-25 km to the south-west of Althorpe Island there are two submerged knolls or sea mounts (Rankin *et al.*, 1991). Information about the benthic cover of these knolls is not available for this report.

Cape Dutton to Cape Forbin

Shallow, exposed metamorphic rock reefs occur along much of the northern coast, interspersed with small sand and pebble beaches (e.g. at **Kangaroo Cove, Snug Cove, Western River Cove, Snelling Beach** and **King George Beach** (Baker, pers. obs. 1993; Edyvane and Baker, 1996b; Shepherd *et al.*, 2002; PIRSA, SARDI and DEH map, in Bryars, 2003). At **Snug Cove**, there is nearshore reef with abundant fissures and crevices (Shepherd *et al.*, 2002). In 2002, a survey on reef in the shallow subtidal recorded *Ecklonia* (30% cover), *Cystophora siliquosa* (25%), *C. moniliformis* (10%), *Acrocarpia* (30%) and species of *Caulerpa* (5%) (Shepherd *et al.*, 2002). A benthic survey in 1994 showed that inshore sites in the area, from 5m to 10m deep, are dominated by metamorphic reefs covered with a variety of large brown macroalgae. For example, at 5m, recorded taxa include *Acrocarpia paniculata*, *Seirococcus axillaris*, mixed *Cystophora* and *Sargassum* species with an understorey of articulated corallines and brown turfing species (e.g. *Zonaria* spp., *Cladostephus spongiosus*); at 10m, *Ecklonia radiata*, *Seirococcus axillaris* and *Scytothalia dorycarpa*, *Carpoglossum confluens* and mixed *Cystophora* and *Sargassum* species, with mainly large reds such as species of *Plocamium*, and species from the family *Dasyaceae* (Edyvane and Baker, 1996b, and SARDI S.A. Benthic Survey data, 1994, unpublished). A number of different sponge

	<p>species are also present in the understory, amongst other sessile invertebrate groups. Seagrass is present seaward of the reef in this area (including the Snug Cove to Western River Cove area). Shepherd and Sprigg (1976) reported that the southern Investigator Strait area contains <i>Posidonia</i> seagrass beds to a depth of 20m. A benthic survey in 1994 reported that in waters 15m to 18m deep, sparse seagrass beds occur, comprised of <i>Posidonia</i>, <i>Amphibolis</i> and <i>Halophila</i> species (SARDI S.A. Benthic survey data, 1994, unpublished).</p>
<p>6. Taxonomic Diversity</p>	<p>Marine Plants Althorpe Islands, Haystack Island, Seal Island High species diversity of red macroalgae, particularly around Haystack Island. On a State-wide scale, the diversity of macroalgae recorded off the coast of Yorke Peninsula during a 1993 SARDI benthic survey was comparable with the diverse nutrient rich upwelling regions such as those found in the south east of the state, with more than 100 main understory species recorded (Edyvane and Baker, 1998a, and unpublished benthic survey data). High species diversity of dominant canopy species of brown macroalgae in some parts of this area (Edyvane and Baker, 1998, and unpublished data).</p> <p>Daly Head to Penguin Point High species diversity and abundance of coralline red macroalgal species, and high abundance of encrusting coralline species. High species diversity of brown canopy macroalgae in some parts of this area compared with 12 of 13 other sampled locations on southern Yorke Peninsula (Edyvane and Baker, 1998a, and SARDI S.A. Benthic Survey data, 1993, unpublished).</p> <p>Bony and Cartilaginous Fish Although the south-western Yorke Peninsula has not been comprehensively surveyed to count all fish species from reef, seagrass and sand habitats, Savarton <i>et al.</i> (1987) recorded around 50 fish species collectively from 5 survey sites (which included reef, seagrass and sand habitats) along south-western Yorke Peninsula. Many of the reef fish species observed during the 1980s survey were also recorded at south-western Yorke Peninsula sites during a Reefwatch survey in 2002, as well as a number of other reef fish species not listed in the survey by Savarton <i>et al.</i> (1987). Although survey information for all areas is not available, there is anecdotal evidence for high species diversity of fish (particularly reef fish), according to divers' reports, tourism promotion materials, and popular articles, for south-western Yorke Peninsula in general, such as the following areas: Royston Head to Penguin Point / South-Western Yorke Peninsula and nearshore islands; Althorpe Islands, Haystack Island, Seal Island. The variety of habitats (e.g. seagrass, sand, calcareous reef platforms, and granite reef boulders, ledges etc) in the numerous bays and headland areas, promotes the fish species diversity in the area. Savarton <i>et al.</i> (1987) recorded 8 species of rays, stingarees and their relatives (i.e. Fiddler Ray, Black Ray, Eagle Ray, Smooth Stingray, 3 species of Stingaree, and Melbourne Skate) collectively from 5 survey sites along south-western Yorke Peninsula.</p> <p>Cape Forbin to Cape Dutton (including Snug Cove and Western River Cove): No specific information for the area is available for this report, other than the fish species listed in other sections of this table, however a total of more than 230 fish species have been recorded from Kangaroo Island (Glover, 1979), and many of these, particularly the reef and pelagic species, occur along the northern and north-western coast.</p> <p>Invertebrates South-western Yorke Peninsula: Survey information is not available, however there is anecdotal evidence (according to divers' reports, tourism promotion materials, and popular articles) of "high diversity" (presumably both phyletic and species level) of marine invertebrates on reefs, including sponges, soft corals, gorgonian corals, crinoids and other echinoderms, and reef molluscs, amongst others. North-Western Kangaroo Island: Survey information is not available, however, divers report an abundance of sponges, soft corals and gorgonian corals, bryozoa, echinoderms, gastropods, nudibranchs and other shell-less molluscs, and other</p>

	<p>invertebrates, and it is likely that some of the groups in the area are species-rich.</p> <p>Coastal and Marine Birds South-western Yorke Peninsula: More than 20 coastal and seabird species have been recorded in the area around Innes (e.g. Little Penguin, Black-faced Cormorant, Pied Cormorant, Little Pied Cormorant, Eastern Reef Heron, Pied Oystercatcher, Sooty Oystercatcher, Banded Stilt, Grey Plover, Banded Plover, Hooded Plover, Red-necked Stint, Black-winged Stilt, Pacific Gull, Silver Gull, Caspian Tern, Crested Tern, Little Tern, Shy Albatross, amongst others) (Copley, 1995 and 1996).</p>
<p>7. Habitat for Endemic Taxa / Threatened Taxa / Rare or Uncommon Taxa</p>	<p>Marine Plants Royston Head: <i>Ptilophora prolifera</i>. A red macroalgal species which is uncommonly recorded, but has a large range (Turner, 2000; Cheshire <i>et al.</i>, 2000); Cape Spencer, Cable Hut Bay and Althorpe Island: The uncommon coralline red algal species <i>Amphiroa gracilis</i> (Womersley, 1996) is found in the area (Edyvane and Baker, 1998a).</p> <p>Bony and Cartilaginous Fish North-western Kangaroo Island: Habitat for some reef fish species that are rarely observed in the central and southern parts of South Australia, such as the Western Foxfish, which has been recorded by divers in the area (e.g. Muirhead, MLSSA, 1999b). In general, reef areas along Northern Kangaroo Island and south-western Yorke Peninsula are reported to provide spawning and nursery areas for Western Blue Groper (Bryars, 2003). The south-Western “toe” of Yorke Peninsula (i.e. Innes area) is a nursery area for juvenile Western Blue Groper, particularly creviced calcareous reefs in shallow bays (see Shepherd and Brook, 2002). The Sculptured Seamothe <i>Pegasus lancifer</i>, a species of potential conservation concern (see Pogonoski <i>et al.</i>, 2002) occurs in the northern Kangaroo Island area. South-Western “Toe” of Yorke Peninsula (i.e. Innes area): Presence of a number of species of potential conservation concern. For example, Western Blue Groper and Blue-throated Wrasse are known from the area (e.g. Shepherd and Brook, 2002), particularly the western side of the foot of Yorke Peninsula; and Harlequin Fish are present on a number of reefs in the area, according to reports by divers. Also recorded in the area is the Banded Morwong, a species that is less common in S.A. compared with south-eastern Australia and Tasmania. Section 9.2 discusses the reported status of (and potential risks to populations of) Western Blue Groper, Harlequin Fish, Blue-Throated Wrasse, and other strongly site-associated reef fish species. Several species of pipefish have been recorded in shallow bay east of Royston Head (Savarton <i>et al.</i>, 1987). Leafy Seadragons have been recorded from at least 6 locations in the surrounding region and Weedy Seadragons recorded from at least 3 locations (Dragon Search Community Monitoring Program data 1996-2002; Baker 2003a). Seahorse species are known to occur at sites along southern Yorke Peninsula (Savarton <i>et al.</i>, 1987, and divers’ reports). Short-headed Seahorse and Leafy and Weedy Seadragons were listed by IUCN Red List 2003 as <i>Data Deficient</i>. Southern Pot-Bellied Seahorse was recommended by Pogonoski (2002) for listing as <i>Lower Risk but Conservation Dependent</i>. Many pipefish species, including those in South Australia, are considered to be of conservation concern due to their strong site association and consequent vulnerability to localised impacts (see Pogonoski <i>et al.</i>, 2002; IUCN Red List, 2003, Baker, in press; Brown, in prep.). The Robust Pipehorse (<i>Solegnathus robustus</i>), another syngnathid species of conservation concern, has also previously been found in the area (SA Museum record, cited by Baker, in press). Althorpe Islands, Haystack Island, Seal Island: Presence of species of potential conservation concern, such as Leafy Seadragon, Western Blue Groper (including large individuals), Blue-Throated Wrasse and other Wrasse species, and Harlequin Fish (see Section 9.2). Harlequin Fish are known to be fished recreationally around the Althorpe Islands, according to charter fishing reports. Cape Forbin – Cape Dutton (including Western River Cove): Presence of species of potential conservation concern (Weedy and Leafy Seadragons, Western Blue Devil, Harlequin Fish, Western Blue Groper, Blue-throated Wrasse, several other Wrasse species, and other reef fish species, such as the uncommonly recorded Gunn’s Leatherjacket). The reported status of these species, and potential risks to their various populations, are discussed in section 9.2, and in Baker (in press). The cave-</p>

dwelling Western Upsidedown Pipefish *Heraldia nocturna* has also been recorded off northern Kangaroo Island (records cited in Baker, in press).

Invertebrates

Althorpe Islands: Presence of a phototrophic sponge *Cymbastela* sp., which has been considered rare in Southern Australia (Cheshire *et al.*, 1995).

Investigator Strait: Examples of species that may be uncommon within South Australia, include the following: *Paracyathus vittatus*, a low cylindrical stony coral, recorded from Investigator Strait, and the colonial dendroid stony coral *Dendrophylla atrata* (Shepherd and Veron, 1982). Ascidian species that may be either endemic to S.A. or uncommon in S.A. and have been found in the **Investigator Strait** area, amongst a limited number of other locations in S.A., include *Leptoclinides* sp. 3; *Eudistoma constrictum* (recorded at **Chinaman's Hat Island**, and other sites in **Investigator Strait**); *Polycitor obeliscus* (recorded to date only in **Investigator Strait**); and *Aplidium pronum* (also known only from the type specimen) (Kott, 1997; P. Kott, Queensland Museum, pers. comm., 2004).

Investigator Strait: Deeper water habitat in the area (e.g. 40+m) supports a colony of the rare cowrie *Umbilia armeniaca* (Wilson and Clarkson, 2004).

Marine Mammals

Althorpe Islands, Haystack Island, Seal Island, Western Islets: Haul-out sites (Althorpe, Little Althorpe North and South, Seal Island, Haystack Island, Western Islets) for the Australian Sea Lion (Robinson and Dennis, 1988; Gales *et al.*, 1994). Australian Sea Lion is classified as *rare* in South Australia and considered by some researchers to be threatened (see Gales, 1990; Gales *et al.*, 1994; Dennis and Shaughnessy, 1996 for population summaries). Sea Lions also utilise waters off north-western Kangaroo Island (**Cape Forbin** to **Cape Dutton**, including **Western River Cove**).

South-western Yorke Peninsula (e.g. **Cape Spencer**): Southern Right Whales occur seasonally in the area, close to shore near the cliffs. IUCN Red List 2003 classified Southern Right Whale as *conservation dependent*; the species is listed under South Australian legislation as *vulnerable*, and is also listed under the Commonwealth's *EPBC Act 1999* as a threatened species.

South-western Yorke Peninsula: Bottlenose Dolphins are regularly present in the area. IUCN Red List 2003 classified Bottlenose Dolphin as *Data Deficient*.

Coastal and Marine Birds

North-western Kangaroo Island: Important breeding sites for Peregrine Falcon, Osprey, White-bellied Sea Eagle and Little Penguin have been located in coastal areas (Gilliland, 1996). Peregrine Falcon and Osprey are listed as *rare* under the *National Parks and Wildlife Act 1972*. White-bellied Sea Eagle is listed as *vulnerable* under the *National Parks and Wildlife Act 1972*.

Western River Wilderness Protection Area: Breeding sites for White-bellied Sea Eagle are present in the area (Gilliland, 1996)

South-Western Yorke Peninsula / Innes: Habitat for the Eastern Reef Egret / Heron (Copley, 1996), which is listed as *rare* under the *National Parks and Wildlife Act 1972*. Breeding and/or feeding areas for potentially threatened coastal and marine bird species (e.g. Little Tern, Fairy Tern, Hooded Plover, Shy Albatross, amongst others) (Copley, 1995 and 1996; Robinson *et al.*, 1996; Rogers, 2002). The Little Tern, Fairy Tern, Hooded Plover and Shy Albatross are listed as *vulnerable* under *National Parks and Wildlife Act 1972*. Rock Parrots (classified as *rare* in S.A.), which have a coastal association, use **Middle Islet**, and have been recorded nesting on **Royston Island** (Robinson *et al.*, 1996). White-bellied Sea Eagle (classified *vulnerable* in S.A.) and Osprey (classified *rare* in S.A.) also occur in Innes National Park (Robinson *et al.*, 1996; NPWSA, 2002). Ospreys nest on previously nested on **South Islet** in the park, however Robinson *et al.* (1996) reported that increased interference in recent years has resulted in unsuccessful nesting.

Gleeson's Landing: Rock Parrots (*rare* in S.A.) have been sighted feeding in the dunes, and Hooded Plovers (*vulnerable* in S.A., and nationally) have been sighted feeding on the beach (e.g. Birds Australia, 2002). **Daly Head Island:** Habitat for Osprey (SARLAC, 1998), listed as *rare* under S.A. legislation.

	<p>Althorpe Islands, Haystack Island, Seal Island: A number of sea bird colonies are found in the region, including potentially threatened species such as Fairy Tern (breeding colonies on Seal Island), White-bellied Sea Eagle (nesting areas), and Rock Parrot (breeding on Seal Island, and also found on all other islands in the group) (Robinson <i>et al.</i>, 1996).</p> <p>A large number of invertebrates and macroalgae, and a smaller number of fish species, that occur in the area described in this table are endemic to southern Australia, but quantification is not possible for this report.</p>
<p>8. Other Important Taxa</p>	<p>Marine Plants</p> <p>South-Western Yorke Peninsula: Abundance of coralline red macroalgae in some parts of this area (e.g. Cable Hut Bay) (Edyvane and Baker, 1998a), which forms an important habitat for some fish and invertebrate groups (e.g. for abalone, see Shepherd and Daume, 1996 and Daume <i>et al.</i>, 1997)</p> <p>Bony and Cartilaginous Fish</p> <p>South-western “Toe” of Yorke Peninsula: Eggs and larvae of Pilchards and other clupeoid fishes (see Jones <i>et al.</i>, 1995, and Ward <i>et al.</i>, 2000) concentrate in the area due to oceanographic conditions, such as the frontal systems at the mouth of Spencer Gulf (Bruce and Short, 1992; Petrushevics, 1993).</p> <p>Beach habitats along Northern Kangaroo Island / Western Investigator Strait / “Toe” of Yorke Peninsula are reported to provide habitat for one or more of the life stages of King George Whiting and/or School Whiting, West Australian Salmon, Tommy Ruff, Yellow-eye Mullet, flathead species, flounder species and Whaler sharks (Bryars, 2003). All of these species, as well as Trevally and Snook, are reported to also utilise the subtidal sand habitats in the area (Bryars, 2003).</p> <p>Reef areas along Northern Kangaroo Island and the south-western side of Yorke Peninsula (i.e. the “Toe” of the Peninsula) and the Althorpe Islands are reported to provide habitat for one or more of the life stages of King George Whiting, Snapper, West Australian Salmon, Southern Sea Garfish, Tommy Ruff, Yellow-eye Mullet, Trevally, Leatherjacket species, Western Blue Groper, Blue-throated Wrasse and other wrasse species, Snook, Sea Sweep, Silver Drummer, flathead species, flounder species, Gummy Sharks, and Whaler Sharks (Bryars, 2003).</p> <p>Seagrass meadows in Marion Bay are reported to provide habitat for one or more of the life stages of King George Whiting, West Australian Salmon, Southern Sea Garfish, Tommy Ruff, Trevally, Snook, Leatherjacket species, flathead species and Whaler Sharks (Bryars, 2003). Most of these species are also reported to utilise seagrass habitat around Pondalowie Bay, and Althorpe Island, Haystack Island and Seal Island (Bryars, 2003).</p> <p>Invertebrates</p> <p>South-Western Yorke Peninsula and islands (Althorpe Islands, Haystack Island, Seal Island): Locally abundant gorgonian corals, especially at Haystack Island, and anecdotal evidence from divers and dive associations of high abundance of some benthic invertebrate taxa (e.g. sponges, ascidians, bryozoa) at island reef locations (e.g. Christopher, 1988; DIASA undated).</p> <p>Western Investigator Strait: Abundance of sponges, ascidians, reef molluscs, crinoids and some crustacean species (including Southern Rock Lobster) on the deeper calcareous reefs (Shepherd and Sprigg, 1976). The reefs in the area also provide habitat for abalone.</p> <p>Cape Forbin to Cape Dutton (including Western River Cove): Anecdotal evidence (e.g. from divers) of abundance of reef invertebrates, including a variety of different sponge species.</p> <p>South-Western Investigator Strait: An abundance of various invertebrates associated with the sparse <i>Zostera</i> (= <i>Heterozostera</i>) <i>tasmanica</i> beds, including the button bryozoan <i>Lunulites</i> sp., the unattached brachiopod <i>Anakinetica cumingi</i>, the sea pen <i>Sarcoptilus grandis</i>, stalked fan bryozoan <i>Parmularia</i> sp. and two stalked ascidian species (<i>Pyura australis</i> and <i>P. spinifera</i> (see Shepherd and Sprigg, 1976 for species list). Also, abundance of sponges, ascidians, reef molluscs and crinoids on the reef outcrops found in western Investigator Strait (Shepherd and Sprigg, 1976).</p> <p>Reef areas along Northern Kangaroo Island and south-western Yorke Peninsula are</p>

	<p>reported to provide habitat for one or more of the life stages of Southern Rock Lobster, Southern Calamari, Giant Cuttlefish, Maori Octopus, Greenlip Abalone, Blacklip Abalone, and Purple Sea Urchin (Bryars, 2003).</p> <p>Beach habitats along Northern Kangaroo Island / Western Investigator Strait are reported to provide habitat for Sand Crabs and baitworm species, subtidal sand also provides habitat for Sand Crabs, and is utilised by Southern Calamari (Bryars, 2003).</p> <p>Marine Mammals</p> <p>South-western Yorke Peninsula, and islands (Althorpe Islands, Haystack Island, Seal Island): Common Dolphins regularly present.</p> <p>Althorpe Islands, Haystack Island, Seal Island: Colonies of New Zealand Fur Seals occur at Althorpe, Little Althorpe South, and Seal Island (Shaughnessy <i>et al.</i>, 1994). North-western Kangaroo Island (Cape Forbin to Cape Dutton, including Western River Cove) is also a habitat, including occasional haul out sites. The New Zealand Fur Seal was previously classified in the IUCN Red List 2000 as <i>Lower Risk, but Conservation Dependent</i>, but was not included in the IUCN Red List 2003.</p> <p>Cape Forbin to Cape Dutton (including Western River Cove): Western River Cove/Snug Cove area is recognised as a site for the regular presence of Bottlenose Dolphins. IUCN Red List 2003 classified Bottlenose Dolphin as <i>Data Deficient</i>.</p> <p>Coastal and Marine Birds</p> <p>South-western Yorke Peninsula: In addition to the bird species that are listed as rare or vulnerable (see section above), the region provides habitat for Pied Oystercatcher, Sooty Oystercatcher (e.g. Royston Island, Middle Islet, Chinaman's Hat Island), Banded Stilt (which is an Australian endemic) and Pied Stilt, Grey Plover, Red-capped Plover (Daly Head Island), Banded Plover, Hooded Plover, Red-necked Stint, Pacific Gull (e.g. Middle Islet, South Islet), Silver Gull (breeding areas on Daly Head Island and Haystack Island), Caspian Tern (e.g. Middle Islet), Crested Tern (e.g. large colony on Daly Head islet), Little Penguin, White-faced Heron (e.g. Royston Island), Black-faced Cormorant (e.g. Middle Islet) amongst others (Copley 1996; Robinson <i>et al.</i>, 1996; NPWSA, 2002). Some of these species are seasonal migrants from various locations in the Northern Hemisphere (see section 12 of this table).</p> <p>Althorpe Islands (Haystack, Seal, Western Islets): Habitat for White-faced Heron; Ruddy Turnstone; Sooty Oystercatcher; Masked Plover; Pacific Gull (including feeding areas on Haystack Island, where middens are present, indicating generations of Pacific Gulls use the area for cracking open molluscs taken from intertidal pools, with molluscs being a primary food source); Silver Gull (breeding recorded on Haystack); Black-faced Cormorant; Pied Cormorant (N.B. breeding, roosting and/or feeding areas for several cormorant species have been recorded on Seal Island); Crested Tern (breeding recorded on Althorpe Island) (Copley, 1996; Robinson <i>et al.</i>, 1996).</p> <p>Middle River / Snelling Beach (on north-western Kangaroo Island): Various wading bird species use the mudflats and lagoon area (Edyvane, 1999b), and local residents report Little Penguins in the area.</p>
<p>9. Notable Feeding, Breeding/Spawning and Nursery Areas</p>	<p>Bony and Cartilaginous Fish</p> <p>Investigator Strait: Previously, important habitat for Snapper, supporting abundant fish (e.g. described as “excellent Snapper grounds” by Shepherd and Sprigg, 1976) prior to population decline during the late 20th century (see section on Issues for risk and Impact Assessment).</p> <p>Further east of Cape Dutton, on northern Kangaroo Island, one of the few spawning known areas for large adult King George Whiting has been recorded (Fowler and McGarvey, 1997). (N.B. The northern Kangaroo Island spawning area is not within the geographic range of the area described in this table).</p> <p>Beach habitats along Northern Kangaroo Island / Western Investigator Strait are reported to provide spawning areas for Yellow-eye Mullet, and nursery habitat for juvenile School Whiting, West Australian Salmon, Tommy Ruff, Yellow-eye Mullet, and species of flathead and flounder (Bryars, 2003).</p> <p>Seagrass meadows in Marion Bay are reported to be nursery areas for King George Whiting, West Australian Salmon and Tommy Ruff (Bryars, 2003).</p>

	<p>Western River and Middle River are reported to be spawning, feeding and nursery areas for Black Bream, and nursery areas for West Australian Salmon and Yellow-eye Mullet (Bryars, 2003).</p> <p>South-western Yorke Peninsula: Anecdotal reports from divers and fishers of an abundance of several shark species (e.g. Wobbegong and Port Jackson shark) including breeding and nursery areas for Port Jackson shark in the bays on the south-western “toe” area of Yorke Peninsula (Muirhead, 1999a; and unpublished reports from divers).</p> <p>Invertebrates</p> <p>Western Investigator Strait: Feeding and sheltering habitat for Southern Rock Lobster, particularly on calcareous reefs in the deeper waters of the Strait (Shepherd and Sprigg, 1976).</p> <p>In addition to habitat for Rock Lobster, reef areas along northern Kangaroo Island and south-western Yorke Peninsula are used as feeding, spawning, and/or nursery areas by Maori Octopus (spawning and egg deposition areas), Greenlip Abalone, Blacklip Abalone, and Purple Sea Urchin (Bryars, 2003).</p> <p>Southern Calamari utilise the seagrass habitats in the south-western Yorke Peninsula areas (e.g. Marion Bay) (Bryars, 2003).</p> <p>There are nursery areas for Western King Prawns on the northern side of Kangaroo Island (Boxshall et al., 1999, cited by PIRSA, 2003d).</p> <p>Coastal and Marine Birds</p> <p>The Althorpe Islands contain regionally and/or locally significant breeding and feeding areas for various seabird species. Examples include:</p> <p>Althorpe Island (a survey reported in Robinson <i>et al.</i>, 1996, recorded a population of approximately 22,428 Short-tailed Shearwaters). Althorpe Island and Western Islets also contain breeding populations of Crested Tern.</p> <p>Haystack Island has, according to a previous survey reported by Robinson <i>et al.</i> (1996), a population of approximately 650 White-faced Storm Petrels, although in terms of petrel numbers, Haystack Island is not one of the major breeding areas in South Australia;</p> <p>Collectively the south-western Yorke Peninsula islands are important habitat for Little Penguin, with breeding colonies reported from Roysten Island, Middle Islet, Chinaman’s Hat Island, Seal Island and Althorpe Island (Robinson <i>et al.</i>, 1996).</p>
<p>10. Shipwrecks and Artificial Reefs</p>	<p>South-Western Yorke Peninsula</p> <p>The steel barque shipwreck <i>Hougomont</i> at Stenhouse Bay and the relatively intact wreck of the steel steamship <i>Willyama</i> near Rhino Head are recognised dive sites (Christopher, 1988, and Yorke Peninsula tourism promotion materials), and provide additional habitat for fish, sessile and motile invertebrates and marine plants in the area. A number of other historic/protected shipwrecks exist in the area (see table on Notes on Social and Economic Values and Uses), but not all have been found. Buried or extensively broken up wrecks are not included in this section as additional habitat.</p>
<p>11. Popular Dive Sites</p>	<p>Althorpe Island Group (e.g. Althorpe Island and Seal Cove, Haystack Island, Seal Island): Althorpe Islands are recognised among the best diving sites in South Australia (DIASA, undated; Christopher, 1988; Aquanaut, undated; Dive Oz 1998-2003), due to the variety of reef topography and associated micro-habitats (e.g. a long reef “wall”, caves and “overhangs”, “swim-throughs”, ledges / “drop-offs”, “bommies”); prolific reef fish (including large Western Blue Groper, and Western Blue Devil) and other fish (particularly large Yellow-tail Kingfish, and large schools of Redfish, Sweep, Boarfish, Bullseyes); presence of numerous species of colourful sponges, gorgonians and soft corals and other sessile invertebrates; abundant Rock Lobster; large rays, and abundant Fur Seals (which interact with divers). “CD’s Bommie”, off Althorpe Island, is around 500m diameter, and 20m high (i.e. from 32m depth up to 12m), and is promoted for its density and species diversity of reef fish, (including popular species such as Western Blue Groper, Western Blue Devil, various species of Bullseye, Redfish, Snapper, Boarfish), as well as abalone, Rock Lobster, soft corals, gorgonian corals, and sponges.</p> <p>South-Western Yorke Peninsula: Stenhouse Bay, Cable Hut Bay, Chinaman’s Hat Island, Crystal Bay - Reef Head area, The Gap, Pandalowie Bay, Browns Beach, Penguin Point, and Cape Spencer, amongst other southern and south-western Yorke</p>

	<p>sites, are recognised for diving and snorkelling, due primarily to their abundance and/or high species diversity of fish, invertebrates and large colourful marine flora (marine plant diversity described in other parts of this table). All of the above sites have been listed in DIASA's (undated) guide to the best dive sites in South Australia, Christopher's (1988) Divers Guide to South Australia, and more recently in a dive guide by Aquanaut (undated). Regionally, ecological and biological features of areas around south-western Yorke Peninsula that are listed as popular dive sites include micro-habitat variety ("drop-offs", caves/caverns, crevasses, "massive" rock outcrops, "walls", large overhangs and ledges, "gutters" etc); large Western Blue Groper (up to around 25kg), Kingfish and Redfish and other pelagic fish species; diversity of reef fish species; abundance of sponges, and soft corals, and gorgonian corals in shaded areas; Rock Lobster; Abalone; Wobbegong sharks; and Fur Seal colonies. Reef fish in the area include Western Blue Groper, Western Blue Devil, Ornate Cowfish, Western Talma, Senator Wrasse, Blue-throated Wrasse, Brown-spotted Wrasse and other Wrasse species, Harlequin Fish, Herring Cale, Zebra Fish, Redfish, sweep, Victorian Scalyfin, Moonlighter, Boarfish, Rock Cod, several species of Leatherjackets, amongst many others.</p> <p>The Stenhouse Bay jetty is listed in various diving guides to S.A. (e.g. Christopher, 1988; Aquanaut, undated; Brown, undated), due to its abundance of sponge and other sessile invertebrate taxa on the pylons, basket stars, gorgonian corals, abalone on the adjacent sea bed, and diversity and abundance of fish species, amongst other features.</p> <p>North-Western Kangaroo Island contains a number of recognised dive spots (including Western River Cove, Pissy Boy Rock, The Arch, The Amphitheatre, and others). Sites in the area, particularly the near-shore reefs, are recognised for the near-shore reef topography; diversity of brown, red and green macroalgae; large Western Blue Groper; Western Blue Devil; Harlequin Fish; abundant Wrasse and Leatherjackets of various species; abundance and diversity of other reef fish (more than 230 species have been recorded from the Kangaroo Island region, and many of these are found along the northern coast); also, presence of uncommon reef fish with western affinities that are not usually observed in other popular dive locations in S.A. (such as Western Foxfish); abundant and colourful sponges, hydroids, soft corals, gorgonians of various forms and colours, ascidians, anemones, echinoderms (e.g. feather stars, basket stars, sea stars, biscuit stars), gastropod molluscs, nudibranchs (including <i>Ceratosoma brevicaudatum</i>, and <i>Tambja verconis</i>, amongst others), and many other reef invertebrates; and the presence of Leafy and Weedy Seadragons; Fur Seals, Australian Sea Lions, Wobbegongs and other sharks (DIASA, undated; Kangaroo Island regional tourism promotion materials, and divers reports) (see also North-Western, Western and South-Western Kangaroo Island table of this report).</p>
<p>12. National and/or International Importance</p>	<p>Althorpe Islands Conservation Park (e.g. Althorpe, Haystack, Seal Islands and Western Islets) is listed on the <i>Register of the National Estate</i>, primarily to preserve breeding habitat for seabirds, that is considered to be in good condition due to the absence of predators and competitors (Australian Heritage Commission, undated). The Conservation Park is also considered to include "important haul out sites for the Australian Sea Lion (Berggy, 1996).</p> <p>The coastal Innes National Park is listed on the <i>Register of the National Estate</i>, however the primary features for listing are not marine, apart from the formal protection of "a variety of coastal environments, such as cliffs, dunes and salt lakes" (Berggy, 1996).</p> <p>Inneston Lake Geological Site is listed on the <i>Register of the National Estate</i>, in recognition of stromatolites, which are ancient life forms, and uncommon at State, national and international levels. Inneston Lake has a marine origin, and is one of a chain of lakes in a swamp depression in the south-western Yorke Peninsula coastal zone (Innes National Park). The lake also contains two types of pure gypsum. Present salinity levels in the lake are extreme (>100,000 ppm) (Australian Heritage Commission, undated). (N.B. Inneston Lake and Deep Lake Geological Sites are also on the <i>State Heritage Register</i>, as designated places of geological and palaeontological significance (DEH, 2003g)).</p> <p>South-Western Yorke Peninsula and Islands: Habitat for migratory birds, listed under</p>

	<p>international treaties (such as JAMBA and CAMBA). Examples include Eastern Reef Egret, Grey Plover, Ruddy Turnstone, Red-necked Stint, Caspian Tern, Crested Tern, Little Tern, and White-bellied Sea Eagle (Department of Foreign Affairs, 1981 and 1988; Copley, 1996; Robinson <i>et al.</i>, 1996).</p>
<p>13. Major Commercial and Recreational Fish, Sharks, Molluscs and Crustaceans</p>	<p>Some of the commercially and/or recreationally fished species that occur in parts of the area that collectively encompass the Foot of Yorke Peninsula, and Investigator Strait, include:</p> <p><i>Fish</i>: Australian Salmon, King George Whiting, Garfish, Snapper, Yellow-eye Mullet, Tommy Ruff, Trevally, Snook, various species of Leatherjacket, Mulloway, Southern Blue Morwong, Western Blue Groper and other Wrasse species, Boarfish, Harlequin Fish, Dusky Morwong, Swallowtail, Red “Mullet”, gurnard perch species, and Ling.</p> <p><i>Sharks and Rays</i>: Gummy Sharks, School Sharks, Bronze Whaler and/or Black Whaler and various ray and skate species</p> <p><i>Invertebrates</i>: Southern Calamari, Rock Lobster, Octopus, Abalone, Sand Crabs.</p> <p>Some of the commercially and/or recreationally fished species that occur in parts of the area that collectively encompass the deeper waters of Western Investigator Strait (e.g. north-western Kangaroo Island), include:</p> <p><i>Fish</i>: Ocean Leatherjacket; reef fish such as Redfish (Red “Snapper”), Blue Morwong, King George Whiting, Garfish, Australian Salmon, Western Blue Groper and other Wrasse species, various Leatherjacket species, Ling, Conger Eel, Boarfish, Red “Mullet”, Snook, Swallowtail.</p> <p><i>Sharks and Rays</i>: School Shark and Gummy Shark, Bronze Whaler and/or Black Whaler, Saw Shark, Whiskery Shark, Wobbegong and other shark species.</p> <p><i>Invertebrates</i>: Greenlip and Blacklip Abalone, Southern Rock Lobster, Southern Calamari, Octopus.</p>

8.13 North-Western, Western and South-Western Kangaroo Island (Eyre Bioregion)

Figure 15 shows the location of this area.



Figure 15: North-Western, Western and South-Western Kangaroo Island

<p>1. Biogeographic Significance</p>	<ul style="list-style-type: none"> ♦ Significant breeding sites for New Zealand Fur Seal at Cape du Couedic and Casuarina Islets. The coastal and island areas of south-western and western Kangaroo Island represent the one of the top 3 breeding areas for New Zealand Fur Seal in South Australia (see Shaughnessy, 2002). The New Zealand Fur Seal was classified in the IUCN Red List 2000 as <i>Lower Risk, but Conservation Dependent</i>, however the species was not included in the 2003 Red List. ♦ According to Bannister <i>et al.</i> (1996), high productivity upwelling zones in deeper waters off Southern and Western Kangaroo Island (see following section on Major Physical Influences) may be part of the required habitat for migratory cetaceans, such as Sperm Whales (listed as <i>vulnerable</i> in the IUCN Red List 2003; and <i>rare</i> under S.A. legislation), with the deeper waters of south and western Kangaroo Island being considered a key area for this species; Pygmy Sperm Whale and Dwarf Sperm Whale (<i>rare</i> in S.A.); Pygmy Right Whales (<i>rare</i> in S.A.); some species of Beaked Whales (most of which are listed as <i>data deficient</i> in the IUCN Red List 2003, and <i>rare</i> in S.A.); Risso's Dolphin (<i>data deficient</i> under IUCN Red List 2003; <i>rare</i> in S.A.); False Killer Whale (<i>rare</i> in S.A.) and the two Pilot Whale species (Short-Finned Pilot Whale <i>rare</i> in S.A.), with both Pilot Whale species being known to strand along southern Kangaroo Island, according to Kemper and Ling (1991). The very narrow continental shelf in the western and south-western part of Kangaroo Island, in addition to the fact that the very deep submarine canyon areas south of Kangaroo Island (see von der Borch, 1979) are significant feeding areas for whales (see Bannister <i>et al.</i>, 1996), may also be contributing factors to the prevalence of various whale species occurring relatively close to the coast in the Kangaroo Island area. ♦ The following feature largely pertains to the terrestrial part of the coastal environment, but is included in this section because two of the following rivers have coastal outlets in the area described here. According to Morelli (DENR, 1995), in a description of the coastal river systems in the western Kangaroo Island area, the North West River, Rocky River, Breakneck River and Larrikin Lagoon in combination represent "a unique ecosystem in South Australia, and are the best examples of pristine river systems and plateau swamps in South Australia". The catchments of Rocky River and Breakneck River are considered to be the amongst the only undisturbed river catchments in South Australia (see National and Water Resources Audit assessments, in GeoScience Australia, 2001).
<p>2. Major Physical Influences, and Relative Productivity Level</p>	<p>Major Physical Influences</p> <p>Western and Southern Kangaroo Island are influenced seasonally by strong winds that produce conditions favourable for upwelling of deeper, nutrient-rich waters. Water temperatures are relatively low during these upwelling periods (e.g. 11^o C - 15^o C along parts of the Eyre coast during summer – autumn (Wenju <i>et al.</i>, 1990, CSIRO SST imagery 1995 and 1998, Ward and McLeay, 1998; Ward <i>et al.</i>, 2000).</p> <p>Western and South-western Kangaroo Island are subject to high wave energy and swells. Most of this coastal region is fully exposed, almost year round, to strong prevailing winds and the Southern Ocean, which result in moderate to high wave energy, with strong south-west to westerly swells. Areas along the more exposed regions of this coast (eg. Cape du Couedic and Cape Borda), show a persistent year round south-west to westerly swell of 2-4 m for approximately 50% of the year (Edyvane and Baker, 1996b). The extreme oceanographic conditions close to the coast influence the type of benthic biota that can exist in the area.</p> <p>North-Western, Western and South-Western Kangaroo Island have very steep depth gradients close to the coast, particularly at the north-western end of the island. According to interpolated depth contours in the S.A. Coast and Marine Atlas (DTUP, 2001), waters are as deep as 30m within 100m of the coast at some points on north-western Kangaroo Island (e.g. Harvey's Return area, and grade sharply to 65m-70+m, within 1km of the coast. Similarly on the west coast (e.g. West Bay) and south-west coast (e.g. Cape du Couedic), waters grade steeply to around 75m – 80m, within 5 to 6km of the coast. The continental shelf is very narrow in this area. Sand covers extensive platform reef on southern Kangaroo Island, and the action of the strong ocean swell mobilises the sand and provides constantly unstable benthic conditions (J. Baker, pers. obs., 1994; Edyvane and Baker, 1996b).</p>

	<p>Relative Productivity</p> <p>Seasonal upwelling of nutrient-rich cold water close to the coast on western and southern Kangaroo Island (Wenju <i>et al.</i>, 1990; Butler <i>et al.</i>, 2002) results in:</p> <ul style="list-style-type: none"> ♦ High phytoplankton concentrations (see Ward <i>et al.</i>, 2000); ♦ High biomass and concentrations of zooplankton, particularly krill (Mackie, PIRSA, 1995; Ward <i>et al.</i>, 2000; Butler <i>et al.</i>, 2002); ♦ This productivity strongly influences the food chain in the area, providing conditions conducive to the production of high biomass of pilchards and other bait fish (Jones <i>et al.</i>, 1995; Ward <i>et al.</i>, 2000 and 2001), and significant feeding areas for sea birds, predatory fish species such as Australian Salmon (Dimmlich and Jones, 1997); whales (both krill-eating species and species that eat fish and cephalopods), and fur seals.
<p>3. Bioregional Representativeness of Habitats</p>	<p>Parts of the area described in this table contain some of the features that are considered representative of the Eyre bioregion, according to IMCRA Technical Group (1998), namely:</p> <ul style="list-style-type: none"> ♦ influence of localised nutrient rich upwellings; ♦ moderate to high deepwater wave energy coastline; ♦ meta-sedimentary (i.e. metamorphic rock) and calcarenite cliffs, headlands and platforms; ♦ <i>Cystophora</i> species and <i>Ecklonia radiata</i> in the macroalgal canopy on reefs; ♦ green (mainly species of <i>Caulerpa</i>) and red (e.g. <i>Osmundaria prolifera</i> and <i>Plocamium</i> species) macroalgal assemblages; ♦ high macroalgal species diversity (particularly red species); ♦ subtidal seagrass communities in more sheltered areas; ♦ important breeding colonies of Australian Sea Lion and/or New Zealand Fur Seal, particularly on islands; ♦ coastal wetlands / river outlets of national importance (e.g. Rocky River, Breakneck River, South West River). <p>The northern part of the area discussed here (Cape Torrens westwards to Cape Borda) is classified as part of the edge of the Gulf St Vincent Bioregion (IMCRA Technical Group, 1998), and contains several of the features considered characteristic of that bioregion:</p> <ul style="list-style-type: none"> ♦ moderate wave energy coastline; ♦ meta-sedimentary (i.e. metamorphic rock) headlands; ♦ shore-fringing macroalgal communities and isolated reefs; ♦ seagrass beds (mainly <i>Posidonia</i> spp.); ♦ sparse seagrass beds in deeper waters; ♦ <i>Sargassum</i> species, <i>Cystophora</i> species, <i>Seirococcus axillaris</i> and/or <i>Ecklonia radiata</i> in the macroalgal canopy.
<p>4. Habitat Rarity</p>	<p>Not known for this report.</p>
<p>5. Habitat Diversity</p>	<p>Habitat types include:</p> <ul style="list-style-type: none"> ♦ coastal river mouths/ "estuarine" habitats e.g. De Mole River estuary; North West / Ravine des Casoars, Breakneck, Sandy and Rocky Rivers, South West River; ♦ sandy beaches (particularly along the west coast of Kangaroo Island); ♦ pebble beaches e.g. north-western coast; ♦ near-shore metamorphic fringing reef (extensive along the west and south-west coasts) and granitic fringing reefs;

- ◆ near-shore coastal cave habitats;
- ◆ near-shore seagrass beds (e.g. parts of the north-western and western coast);
- ◆ deeper water beds of fine seagrass, *Zostera* (= *Heterozostera tasmanica* (western Investigator Strait off north-west coast));
- ◆ extensive benthic sand habitats (particularly southern Kangaroo Island);
- ◆ variety of shallow benthic reef types (meta-sedimentary, granite and calcareous) and forms/orientations which include: benthic boulder reefs, rubble reefs, block and patch reefs, platform reefs, ledges, caves, crevices, holes etc;
- ◆ mixed habitats e.g. metamorphic basement rock reef and calcareous reef, interspersed with sand;
- ◆ deeper calcareous reefs (to approx. 100+m).

Selected Habitat Notes

(Notes on geology and geomorphology from Daily *et al.* (1979); geology maps from the former Department of Mines and Energy and other sources, 1:25 000 aerial photographs; J. Baker (pers. obs., 1993, 1994), and Shepherd *et al.* (2002). Notes on macroflora from Edyvane and Baker (1996b); Gilliland (1996a); SARDI S.A. Benthic Survey data, 1994, unpublished; J. Baker (pers. obs., 1993, 1994), and Shepherd *et al.* (2002).

Coastal cliffs, islands and near-shore reefs are mainly meta-sedimentary (i.e. hard, metamorphosed rocks, previously sandstone beds), covered with eroded calcarenite.

Interspersed with the coastal reefs, there are numerous, small, sandy, surf beaches along the west coast of Kangaroo Island (e.g. **Maupertuis Bay, Rocky River Mouth, Sandy Beach, Knapman's Creek mouth, Breakneck Creek mouth, Ravine des Casoars mouth, and West Bay**) (PIRSA, SARDI and DEH map, in Bryars, 2003).

Cape Borda

The nearshore area comprises metamorphic schistose fringing reef, pebbly beaches, small sandy beaches, benthic reef and sand habitats. In 1994, a benthic survey on shallower reef (e.g. 10m), reported the benthic cover to be dominated by a variety of forms and taxa of brown macroalgae (*Carpoglossum confluens*, *Acrocarpia paniculata*, *Scytothalia dorycarpa*, and species of *Sargassum* and *Cystophora*). Mixed species of the green *Caulerpa* were also present, with a variety of red macroalgae in the understory (e.g. species of *Plocamium*, *Phacelocarpus*, *Trigenia*, amongst others). Deeper reefs (15m – 20m) were dominated by mixed red taxa (e.g. species of *Plocamium*, *Callophyllis*, *Ptilocladia*); brown macroalgae *Scytothalia dorycarpa*, *Cystophora platylobium*, *Carpoglossum confluens*, and species of the green *Caulerpa* (Edyvane and Baker, 1996b; SARDI S.A. Benthic Survey data, 1994, unpublished).

Cape Torrens - Harvey's Return

In the nearshore area at Harvey's Return, there are layers and sheets of folded meta-sedimentary rock (Shepherd *et al.*, 2002). In 2002, a survey in the shallow subtidal at Harvey's Return recorded a cover of *Ecklonia* (30%), *Cystophora siliquosa* (30%), *C. moniliformis* (10%), and turfing species (Shepherd *et al.*, 2002). Inshore metamorphic reef areas from 5m to 10m are covered with a variety of large macroalgal flora, particularly brown and red taxa, and sessile invertebrates. In 1994, a benthic survey at 5m recorded large brown macroalgae, including *Sargassum* spp., *Ecklonia radiata* (especially dominant in shallow waters near the headland), *Seirococcus axillaris*, *Xiphophora chondrophylla* and a number of *Cystophora* species. The mixed understory includes green algae (particularly *Caulerpa* species), large reds such as species of *Melanthalia* and *Plocamium*, turfing brown species (species of *Halopteris*, and *Cladostephus spongiosus* etc); encrusting reds (e.g. *Sonderopelta coriacea*) and animals such as ascidians and sponges. At 15m - 20m, were recorded large mixed canopy forming browns dominate, such as *Scytothalia dorycarpa* and *Seirococcus axillaris*, *Ecklonia radiata*, *Sargassum* spp., with mainly large red algae in the understory (*Osmundaria prolifera*, mixed large *Plocamium* species etc) (Edyvane and Baker, 1996b, and SARDI S.A. Benthic Survey data, 1994, unpublished).

North-Western Coast (seaward of coastal reefs)

Seagrass and bare sand habitat are also present in this area, seaward of the coastal fringing reefs such as those described above. Note that Shepherd and Sprigg (1976) classified the southern Investigator Strait area as containing *Posidonia* seagrass beds to about 20m. In deeper waters (25m to 35m), Shepherd and Sprigg (1976) recorded the “*Heterozostera - Lunulites*” assemblage as occurring in much of the southern Investigator Strait area, dominated by sparse beds of *Heterozostera tasmanica* (now reinstated into the *Zostera* genus – see Soros-Pottruff and Posluszny, 1995 and Kuo, 2004). Dominant benthic fauna in that assemblage reportedly include *Lunulites* the button bryozoan and unattached brachiopods, and species that can tolerate the high tidal flow environment (e.g. the fan bryozoan *Parmularia*, the stalked ascidians *Pyura australis* and *P. spinifera*, and the seapen *Sarcoptilus*). Rocky outcrops in the sand are covered with mixed sponges, ascidians, crinoids, reef molluscs, and red macroalgae.

West Bay - Vennachar Point: There are gneissic sheets and blocks forming the exposed coastal reef and shallow subtidal reef in the **West Bay** area. A survey in 2002, in the shallow subtidal on the southern side of **West Bay**, recorded mixed *Cystophora* species (e.g. *C. siliquosa* 35%, *C. subfarcinata* 10%, *C. moniliformis* 25%) as the dominant cover on reefs (Shepherd *et al.*, 2002). In 1994, SARDI's S.A. Benthic Survey program recorded the following benthic composition on reef at 5m, off the north shore of **West Bay**: a dense cover of canopy-forming *Cystophora* species, with an abundance of different species of *Caulerpa*. The understory was composed of a mixture of red algal species (e.g. *Osmundaria prolifera*, and species of *Phacelocarpus*, *Laurencia* and *Plocamium*). At the time of the 1994 survey, rugged broken reefs (meta-sandstone) at 15m were densely covered with several *Caulerpa* species, *Ecklonia radiata*, mixed large red alga (mainly species of *Plocamium*, *Melanthalia* and *Phacelocarpus*), with a dense understory of mixed calcareous red species. Canopy-forming brown macroalgae were not dominant at that depth.

West Bay Islet (Paisley Islet) is connected to the southern end of **West Bay** at low tide, and is exposed to strong sea conditions from the south-west. The island is composed of meta-sandstone, worn into a series of parallel grooves, and the central (highest) part of the island is capped by calcarenite and calcrete (Robinson *et al.*, 1996).

South-Western Kangaroo Island

There are shoreline reefs along the southern and western coasts of Kangaroo Island (see below for brief descriptions). In the bays, the substrate consists mainly of sand and there is patch reef of various compositions (see below). Bare sand occurs along much of the south-western coast of the island, dominating in some areas from 0-20m (i.e. **Rocky River** coast). Fringing reefs occur at around 5-6m, or as patch reefs in sand. Large expanses of sand occur at 30+m, covering an extensive reef platform, which spans across most of the southern coast of the island. The sand overlying this platform is “mobile” due to the strong swells, hence it is difficult for benthic biota to establish in this environment (Edyvane and Baker, 1996b). Below about 40m, the platform reefs drop gradually to the continental shelf break, where the continental profile drops sharply as a result of the extensive, deep water Murray Canyons (Von der Borch, 1979, cited by Edyvane and Baker, 1996b).

Cape Bedout - West Bay

Nearshore area is coastal meta-sedimentary reef, and benthos between approximately 5m – 10m is mainly bare sand. Seagrass patches also present.

Maupertuis Bay: Nearshore area is mainly coastal meta-sedimentary reef. Benthic sandy habitat and patches of seagrass also present.

Cape du Couedic: The near-shore area is mainly coastal meta-sedimentary reef and sand. There is a sheet of eroded calcarenite over the metamorphic base (Robinson *et al.*, 1996).

North and South Casuarina Islets: The north islet is around 370m from **Cape du Couedic**, and the south islet 2.3km south-west of the Cape. **North Casuarina Islet**, around 2ha, is a rounded hump of meta-sandstone, and the calcarenite cap (similar to that at Cape du Couedic) has mostly been eroded by the sea, except for a section on

	<p>the more protected eastern side. South Casuarina Islet is similar to the northern island, also 2ha, and also composed of a hump of eroded, biotite-rich meta-sandstone, with amphibolite dykes. The deeper, more exposed waters have scoured all calcarenite from above the metamorphic rock. Both islets are both subject to strong storm waves (Robinson <i>et al.</i>, 1996).</p> <p>Kirkpatrick Point – Cape Younghusband: Granite outcrops at water level, which extends into the shallow subtidal area as reef.</p> <p>Sanderson Bay and Weir Cove bay areas are mainly sandy bottomed, with small patches of calcareous reef. Reef patches are heavily covered with fauna and flora. Patches of seagrass are also present.</p> <p>Hanson Bay: Contains coastal fringing reefs, coarse sandy beaches, benthic reef and benthic sand habitat. Contains an example of a regionally unusual plant assemblage in mixed habitat (mixed sand, calcareous platform reef and basement rock boulder reef). In 1994, a survey at 5m (on boulders overlying platform reef) recorded 40% to 100% of the benthic cover as comprising mixed species of the green macroalga <i>Caulerpa</i>. On some boulders, mixed red and large brown (e.g. <i>Sargassum</i>) species were also present. On deeper reefs in Hanson Bay (15m), low profile platform calcareous reefs and bare sand habitats occur. At the time of the 1994 survey, reefs were covered mainly with the brown macroalgae <i>Scytothalia dorycarpa</i>, the large red <i>Osmundaria prolifera</i>, mixed macroalgal red taxa (species of <i>Callophyllis</i>, <i>Phacelocarpus</i>, <i>Areschougia</i> etc), green <i>Caulerpa</i> species, and smaller brown turfing species (Edyvane and Baker, 1996b, and SARDI S.A. Benthic Survey data, 1994, unpublished).</p> <p>Cape Bouguer: A densely covered meta-sedimentary coastal reef occurs, with a flat platform reef (calcareous) positioned seaward of the coastal fringing reef.</p> <p>Deeper waters of Western and South-western Kangaroo Island: Large expanses of mobile bare sand, overlying bare platform reef, spans much of southern Kangaroo Island, from approximately 10m to at least 30m deep. Daily <i>et al.</i> (1979) described deeper water aeolianite (fossil dune-rock) reefs as occurring along western and southern Kangaroo Island, to 100+m.</p>
<p>6. Taxonomic Diversity</p>	<p>Marine Plants High biodiversity of benthic macroalgae (particularly canopy-forming large brown species, and red understory species) on near-shore reefs in part of the nominated area e.g. Cape Borda to Cape Torrens and other areas on the far North-west Coast (Edyvane and Baker, 1996c, and unpublished SARDI S.A. Benthic Survey data, 1994).</p> <p>Western and South-western Coasts: High species diversity of red and green macroalgae on some reefs in the area (Womersley and Edmonds, 1979; Womersley, 1990; Edyvane and Baker, 1996c).</p> <p>Bony and Cartilaginous Fish High species diversity of fish (particularly reef associated fish, but also including other groups) on the north-west coast of Kangaroo Island (which includes Cape Borda and Cape Torrens area), however quantitative information is not available for this area.</p> <p>Invertebrates Anecdotal evidence (e.g. from divers and diving organisations) of high species diversity of sessile marine invertebrates, such as sponges and ascidians on the north-west coast of Kangaroo island (e.g. Cape Borda and Cape Torrens area).</p>
<p>7. Habitat for Endemic Taxa / Threatened Taxa / Rare or Uncommon Taxa</p>	<p>Marine Plants Cape du Couedic: Presence of red macroalgae <i>Anotrichium towinna</i> and <i>Leptoklonion fastigiatum</i> with nationally recognised limited range (Cheshire <i>et al.</i>, 2000; Turner, 2000).</p> <p>South-west River: Presence of brown macroalgal species (<i>Strepsithalia aemula</i>) with nationally recognised limited range (Cheshire <i>et al.</i>, 2000; Turner, 2000).</p>

Presence of macroalgal assemblages dominated by mixed red and green taxa (Edyvane and Baker, 1996c, and SARDI S.A. Benthic Survey data, 1994, unpublished). For example, in some parts of **Hanson Bay**, dense beds of green *Caulerpa* species occur, forming between 40% to 100% of the benthic cover in some areas. Part of **West Bay** reef are dominated by mixed green *Caulerpa* species and large red macroalgae (mainly species of *Plocamium*, *Melanthalia* and *Phacelocarpus*), with a dense understorey of mixed species of calcareous red macroalgae. Canopy-forming brown taxa are not dominant on reefs in the area. These type of marine plant assemblages are not commonly recorded in most parts of S.A., apart from several other sites on southern Kangaroo Island, and limited areas of the upper South-East of S.A..

Invertebrates

A number of South Australian endemic ascidian species (mainly colonial, but also including a solitary stalked form) occur in the **Investigator Strait** area (see Kott, 1997), but it is not known for this report whether such species occur specifically in area of far north-western Kangaroo Island discussed in this report. Uncommon stony corals of limited known distribution also occur in **Investigator Strait**.

A number of specimen shells of conservation concern, such as *Zoila marginata orientalis*, occur on sandy reef / sponge habitat on northern Kangaroo Island (see Wilson and Clarkson, 2004).

Bony and Cartilaginous Fish

North-Western, Western and / or South-Western Kangaroo Island: Presence of fish and shark species of potential conservation concern, at some locations within the area: examples include Leafy and Weedy Seadragons (Dragon Search Community Monitoring Program, and see Baker, 2003a and b); Western Blue Groper (including large individuals) and other Wrasse species; Harlequin Fish, and other site-associated reef fish species; Bronze Whaler; Spurdog; and other shark species. The reported status of, and potential threats to, these species are discussed in Section 9.2.

Migratory pelagic species such as schools of Southern Bluefin Tuna occur in the waters off **southern Kangaroo Island**. Southern Bluefin Tuna is recognised internationally (by IUCN) and nationally (Commonwealth *EPBC Act 1999*) as a threatened species, and is a species of conservation concern in southern Australian states (see Pogonoski et al., 2002; Baker, in press).

The Lagoon Goby *Tasmanogobius lasti*, an eastern Australian species that is not recorded in most parts of South Australia, occurs in rivers (and near river mouths) around **Kangaroo Island** (Higham et al., 2002; Australian Museum records, SA Museum records, cited in Baker, in press).

Marine Mammals

Southern Kangaroo Island is part of the regular migration path for threatened Southern Right Whale. Southern Right Whales occur periodically in the area. For example, in 2002, a mother and calf remained in the **Cape du Coeddic** area between Admiral's Arch and North Casuarina Islet, for more than 2 weeks (NPWSA, 2002b). IUCN Red List 2003 classified Southern Right Whale as *conservation dependent*.

Deeper waters in the vicinity of the area discussed here are recognised for the periodic presence of several migratory whale species (Kemper and Ling, 1991; Ling, S.A. Museum, pers. comm. to S.A. Department of Fisheries, 1992), including species that rarely occur in South Australian waters. Some of these species are listed under South Australian legislation as *rare*, and/or are listed as threatened species under the IUCN Red List, including the following: Sperm Whale (*vulnerable* in the IUCN Red List 2003; *rare* under S.A. legislation), with the deeper waters off southern and western Kangaroo Island being considered a key area for this species; Pygmy Sperm Whales and Dwarf Sperm Whales (*rare* in S.A.); Pygmy Right Whale (*rare* in S.A.); some species of Beaked Whales (most of which are listed as *data deficient* in the IUCN Red List 2003, and *rare* in S.A.); Risso's Dolphin (*data deficient* in the IUCN Red List 2003; *rare* in S.A.); False Killer Whale (*rare* in S.A.) and the two Pilot Whale species (Short-Finned Pilot Whale *rare* in S.A.), with both Pilot Whale species being known to strand along southern Kangaroo Island, according to

Kemper and Ling (1991). Pygmy Blue whales, which feed in the South-East of South Australia (see Gill, 2002 and Butler *et al.*, 2002), also enter southern Kangaroo Islands during the summer-autumn upwelling period, in which feeding occurs. All whale species entering S.A. waters are protected under South Australian legislation. High productivity upwelling zones in deeper (Commonwealth-managed) waters off southern and western Kangaroo Island may be part of the required habitat for many of the migratory cetaceans.

A pod of Southern Right Whale Dolphins *Lissodelphis peronii*, an Antarctic species rarely recorded in Australia, has been observed off **southern Kangaroo Island**, surfacing 92 nautical miles south of Cape Gantheame (Clarke, 2000). This is one of very few records of the species in South Australian waters. At least two records are known from the Kangaroo Island area (see section 8.17), and may indicate that the waters off southern Kangaroo Island provide important seasonal habitat for this species.

There are breeding sites for Australian Sea Lion at **Cave Point** and **Cape Bouguer**. Haul out sites for Australian Sea Lion occur at **Cave Point, Cape Bouguer, Cape du Couedic, North Casuarina** and **South Casuarina Islet, Paisley Islet (West Bay Islet)** and **Cape Borda**. According to a survey by Robinson *et al.* (1996), **West Bay Islet** always contains a small number of bull male sea lions, and a large number of Sea Lion bones, and the authors speculated that this islet may be a place where old male Sea Lions from other colonies go to die. Australian Sea Lion classified as *rare* under S.A. legislation), and considered by some researchers to be threatened (e.g. see Gales, 1990; Gales *et al.*, 1994, Dennis and Shaughnessy, 1996).

Breeding and haul-out sites for the New Zealand Fur Seal are discussed below in section 9, on **Notable Feeding, Breeding and Nursery Areas**. The New Zealand Fur Seal was classified in the IUCN Red List 2000 as *Lower Risk, Conservation Dependent*, but the species was not included in the IUCN Red List 2003.

The coast of south-western Kangaroo Island (e.g. **Cape Bouguer**) is a haul out site for the Australian Fur Seal *Arctocephalus pusillus* (Robinson, DEHAA, pers. comm. 1997, cited by Lewis *et al.*, 1998), although it has not been recorded as breeding in South Australia. The Australian Fur Seal was classified in the IUCN Red List 2000 as *Lower Risk, but Conservation Dependent*, however it was not included in the IUCN Red List 2003. The Australian Fur Seal has been described as “the world’s fourth rarest sea species” (Parks and Wildlife, DPIWE, 2003).

Coastal and Marine Birds

The area described in this table provides habitats (including breeding sites, in some cases) for birds with a coastal association, that are classified as *rare* under S.A. legislation. These include: Osprey, Cape Barren Goose, Musk Duck, Eastern Reef Egret and Rock Parrot (which is known to nest in the spray zone, particularly on coastal islands), amongst other bird species (Morelli and de Jong, 1995; Copley 1995 and 1996; Robinson *et al.*, 1996; Edyvane, 1999b).

The coastal area (including **Flinders Chase National Park**), provides habitat for birds of conservation concern that have a coastal association, including breeding sites for some of the following: Hooded Plover (*vulnerable* in S.A. and also considered threatened nationally), White-bellied Sea Eagle (*vulnerable* in S.A.), Osprey (*rare*) (found in coastal areas of **Flinders Chase National Park**, for example); *vulnerable* Fairy Tern (at **Paisley Islet / West Bay Islet**); Cape Barren Goose, Musk Duck and Eastern Reef Egret (all 3 species classified as *rare* in S.A.) (Morelli and de Jong, 1995; Copley, 1995 and 1996; Robinson *et al.*, 1996; Edyvane, 1999b; DEH, 2001c). Other species of conservation concern within **Flinders Chase National Park** include the wetland species Lewin’s Rail and Latham’s Snipe (both *vulnerable* in S.A.), and the Rock Parrot (*rare* in S.A.) (DEH, 2001c). The *rare* Fleshy-footed Shearwater has also been recorded in the area (DEH, 2001c).

There are feeding and stopover areas for migratory oceanic birds, along the **North-**

	<p>west, West, and South-west Coasts of Kangaroo Island. The migratory Southern Giant-Petrel (nationally <i>endangered</i>; globally <i>vulnerable</i>) has been recorded in Flinders Chase National Park and surrounds, and migratory albatross species of conservation concern that have been recorded in the area include Wandering Albatross, Shy Albatross, Black-browed Albatross, and Yellow-nosed Albatross (DEH, 2001c). According to a National Oceans Office map (2002, citing Brothers <i>et al.</i>, 1997), south-western Kangaroo Island is one of approximately 20 areas within South-Eastern South Australia, in which “higher occurrence” records of the at-sea distribution of the Shy Albatross are recorded, based on marked bird surveys. Shy Albatross is listed as <i>vulnerable</i> under S.A. and Commonwealth legislation. The IUCN Red List 2003 recorded it as a <i>near threatened</i> species. Wandering, Black-browed and Yellow-nosed Albatrosses are all listed as <i>vulnerable</i> species, according to State and/or national legislation, and are listed in the IUCN Red List 2003 as threatened species.</p> <p><i>An unknown number of invertebrates, fish species and marine plants in the area described here are endemic to southern Australia, but could not be quantified for this report.</i></p>
<p>8. Other Important Taxa</p>	<p>Marine Mammals Cape Bouguer is a minor breeding site for New Zealand Fur Seal (Shaughnessy, 2002; Shaughnessy and Dennis, 2002).</p> <p>Bony and Cartilaginous Fish Commercially significant demersal species such as Blue-eye Trevalla, Hapuku, and Blue Warehou (amongst others) occur in deeper waters off southern Kangaroo Island (AFMA, 1999a; Bruce <i>et al.</i>, 2001; Baker, in press). Larvae of the commercially significant Blue Warehou occur off southern Kangaroo Island, which are considered to be the product of a discrete spawning stock (Bruce <i>et al.</i>, 2001). According to commercial and recreational fishing records, examples of some of the commercially and/or recreationally significant fish species that utilise reefs and/or sand habitats along the western, north-western and/or south-western sides of Kangaroo Island include Snapper, West Australian Salmon, Trevally, flathead species, Ocean Leatherjacket and other Leatherjacket species, Snook, Western Blue Groper, Blue-throated Wrasse and other Wrasse species, Sea Sweep, Blue Morwong, Redfish, Silver Drummer; Blue-eye Trevalla (in deeper waters), Gummy Shark and Whaler Sharks. Surf beaches along Kangaroo Island's west coast (e.g. Maupertuis Bay, Rocky River Mouth, Sandy Beach, Knapman's Creek mouth, Breakneck Creek mouth, Ravine des Casoars mouth, and West Bay) and south-west coast (Cape Kersaint, Stun'sail Boom River Mouth, Hanson Bay and between Kirkpatrick Point and Weirs Cove) are reported to provide habitat for one or more of the life stages of School Whiting, West Australian Salmon, Tommy Ruff, Yellow-eye Mullet, flathead species and Whaler sharks (Bryars, 2003). All of these species, as well as King George whiting, Snapper, Mulloway, Trevally, Snook, flounder species and Whaler Sharks, are reported to utilise the unvegetated soft bottom (i.e. sand) habitats along south-western Kangaroo Island (Bryars, 2003).</p> <p>Invertebrates Reef habitats along western and southern Kangaroo Island are important to the life cycle of Southern Rock Lobster and Blacklip Abalone (see section below). In addition to these species, other commercially significant invertebrates that utilise reefs in the western, north-western and south-western sides of Kangaroo Island include Maori Octopus, Greenlip Abalone, and Purple Sea Urchin (Bryars, 2003).</p> <p>Coastal and Marine Birds Flinder's Chase National Park coastal river systems and estuaries: migratory waders that are present in the area include the Common Greenshank, Latham's Snipe, Painted Snipe, Sharp-tailed Sandpiper, Red-necked Stint, Ruddy Turnstone and Curlew Sandpiper (Raines, 1994, cited by Morelli and de Jong, 1995; DEH, 2001c) Other birds that occur in the park include wading birds / wetland birds (such as White-faced Heron, Rufous Night Heron, Australian White Ibis, Yellow-billed</p>

	<p>Spoonbill, Australian Spotted Crake, Purple Swamphen, Dusky Moorhen, Black-tailed Native Hen, and Eurasian Coot); waterfowl (Black Swan, Australasian Shelduck, Australian Wood Duck, Pacific Black Duck, Grey Teal, Chestnut Teal, and Australasian Grebe), as well as coastal / shorebirds (such as Sooty Oystercatcher, Red-capped Plover / Dotterel, Black-fronted Dotterel, and Masked Lapwing), and sea birds such as Australasian (Australian) Gannet, Little Penguin, Pacific Gull, Silver Gull, Crested Tern and Whiskered Tern, White-faced Storm-Petrel, Little Pied Cormorant, Pied Cormorant, Little Black Cormorant, Black Cormorant, Cape Petrel, Fluttering Shearwater and Short-tailed Shearwater (DEH, 2001c).</p> <p>West Bay Islet provides habitat for bird species such as the Red-capped Dotterel (Robinson <i>et al.</i>, 1996).</p> <p>Flinders Chase National Park (including the cave at Ravine des Casoars, and other locations) and Hanson Bay provides habitat for the Little Penguin (Australian Heritage Commission, undated, and Kangaroo Island tourism promotion materials).</p> <p>Casuarina Islets provide habitat for bird species such as the Sooty Oystercatcher, Red-capped Dotterel, Crested Tern and Silver Gull, Antarctic Tern, which is not common in S.A., has also been recorded (dead specimen) in the area (Robinson <i>et al.</i>, 1996).</p> <p>Habitats for breeding birds are listed under Notable Feeding, Breeding/Spawning and Nursery Areas.</p>
<p>9. Notable Feeding, Breeding/Spawning and Nursery Areas</p>	<p>Marine Mammals</p> <p>Significant breeding sites for New Zealand Fur Seal on Cape du Couedic and Casuarina Islets. Population numbers estimated during the past decade include 2166 seals (and 442 pups) at North Casuarina Islet, and 2337 seals (and 477 pups) at Cape du Couedic (Robinson and Dennis 1988, Shaughnessy <i>et al.</i>, 1994). More recently, the pup production number at Cape du Couedic and North Casuarina Islet have been ranked 4th and 6th respectively, of 17 sites in S.A. where pup production is recorded (Shaughnessy, 2002). Around 1680 pups were recorded at Cape du Couedic in 2001 (Shaughnessy and Dennis, 2002), and 499 pups were recorded at North Casuarina Islet in the 1995 breeding season (Shaughnessy, 1997). Nautilus Rock and Nautilus North, at Cape du Couedic, have stable colonies of New Zealand Fur Seals, now carrying 170 and 630 pups (Shaughnessy, 2001a). Nautilus North pup production has increased at 15.6% per annum since 1989, but is not considered stable due to lack of space limiting colony growth. A new colony was discovered in 1995, in and nearby cave (Libke Cave). This cave colony has been rapidly increasing at 65% per annum (and now contains 340 pups), assumed to be receiving immigrants from nearby colonies (Shaughnessy, CSIRO, 2001a). Other important colonies include those at Berris Point, with 109 pups counted in 2001 (Shaughnessy and Dennis, 2002), and (further east of the area discussed in this table) Cape Gantheaume, an area with the second largest production of New Zealand Fur Seal pups in South Australia (Shaughnessy, 2002). There is a smaller breeding colony at Cave Point, with production in 2001 estimated to be 9 pups (Shaughnessy and Dennis, 2002). There are also haul out sites for New Zealand Fur Seals at Cape Borda, Paisley Islet (West Bay Islet) and Cape Bouguer. The chasm on the eastern coast of South Casuarina Islet is also a haul out site for fur seals.</p> <p>There is a minor breeding site for Australian Sea Lion at Cape Bouguer (Shaughnessy, 2002), and Cave Point has been previously recorded as a minor area for breeding. The deeper water off southern and western Kangaroo Island may be an important feeding area for migratory cetaceans, as well as South Australian pinnipeds (Ling, pers. comm. to South Australian Department of Fisheries, 1992; Bannister <i>et al.</i>, 1996).</p> <p>Bony and Cartilaginous Fish</p> <p>Surf beaches along Kangaroo Island's west coast (e.g. Maupertuis Bay, Rocky River Mouth, Sandy Beach, Knapman's Creek mouth, Breakneck Creek mouth, Ravine des Casoars mouth, and West Bay) are reported to provide habitat for juvenile School Whiting, and surf beaches along the south-west coast (Cape Kersaint, Stun'sail Boom River Mouth, Hanson Bay and between Kirkpatrick Point and Weirs Cove) are reported to provide habitat for juvenile West Australian Salmon (Bryars, 2003).</p>

	<p>The more sheltered beach at Hanson Bay (South West River Mouth) is reported to provide habitat for juvenile West Australian Salmon, Tommy Ruff, Yellow-eye Mullet and species of flathead and flounder (Bryars, 2003).</p> <p>Estuarine areas such as the mouths of the South West River and Stun'sail Boom River are reported to provide habitat for all life stages of Black Bream and Yellow-eye Mullet, including spawning and nursery areas for Black Bream (Bryars, 2003).</p> <p>Invertebrates</p> <p>The north-western, western and south-western coasts of Kangaroo Island provide important reef habitats and associated food sources for Southern Rock Lobster. Aeolianite (consolidated fossil dune-rock) reef on southern Kangaroo Island occurs in deeper water (to 100m, according to Daily <i>et al.</i>, 1979), and is considered to provide an important sheltering area for Southern Rock Lobster (Daily <i>et al.</i>, 1979). The significance of the area for Southern Rock Lobster is also reflected in the commercial fishing yields from the area (see <i>Notes on Social and Economic Values and Uses</i>).</p> <p>Parts of western and south-western Kangaroo Island provide important habitat for Blacklip Abalone, as indicated by commercial fishing yields from the area (see <i>Notes on Social and Economic Values and Uses</i> section), and the reported significance of the region for abalone fishers (Gilliland, 1996a).</p> <p>Coastal and Marine Birds</p> <p>Cape Torrens Wilderness Protection Area: An important breeding site for White-bellied Sea Eagles is located within the park boundaries (Gilliland, 1996a).</p> <p>North-western Coast of Kangaroo Island: Important breeding sites for Peregrine Falcon, White-bellied Sea Eagle, Osprey and Little Penguin (Gilliland, 1996a).</p> <p>Coastal River Systems of North-western, Western and/or South-western Kangaroo Island: Breeding areas for Cape Barren Goose, White-bellied Sea Eagle, Australian Wood Duck, Baillon's Crake, Masked Lapwing and Red-capped Plover (Raines 1994, cited by Morelli and de Jong, 1995).</p> <p>West Bay Islet provides a breeding area for Pacific Gull and Crested Tern, and Sooty Oystercatcher (Robinson <i>et al.</i>, 1996).</p> <p>North Casuarina Islet: Breeding area for Pacific Gull, Silver Gull, Crested Tern and Rock Parrot (Robinson <i>et al.</i>, 1996).</p> <p>South Casuarina Islet: Breeding area for Pacific Gull, Ruddy Turnstone and Sooty Oystercatcher (Robinson <i>et al.</i>, 1996).</p>
<p>10. Shipwrecks and Artificial Reefs</p>	<p>Wreck sites on north-western Kangaroo Island are recognised for the variety of reef fish, macroalgae, as well as crustaceans, sponges and other invertebrates that occur. Dive sites on western and south-western Kangaroo Island are mainly restricted to wreck sites, due to general inaccessibility of the area and dangerous diving conditions. Some of these wreck sites on western and south-western Kangaroo Island contain parts of the ship and associated artefacts, but their significance as artificial reefs and fish-attracting devices is not known for this report.</p>
<p>11. Popular Dive Sites</p>	<ul style="list-style-type: none"> ♦ No information specific to the Cape Borda – Cape Torrens area is available for this report. In general, however diving areas on the north-west coast of Kangaroo Island, particularly the near-shore reefs, are recognised for the near-shore reef topography; diversity of brown, red and green macroalgae; large Western Blue Groper; Western Blue Devil; Harlequin Fish; abundant wrasse and leatherjackets of various species; abundance and diversity of other reef fish (more than 230 species have been recorded from the Kangaroo Island region, and many of these are found along the northern coast); also, presence of uncommon reef fish with western affinities that are not usually observed in other popular dive locations in S.A., such as Western Foxfish; abundant and colourful sponges, hydroids, soft corals, gorgonians of various forms and colours, ascidians, anemones, echinoderms (e.g. feather stars, basket stars, sea stars, biscuit stars), gastropod molluscs, nudibranchs, and many other reef invertebrates; and the presence of Leafy and Weedy Seadragons; fur seals, Australian Sea Lions, Wobbegong species, Bronze Whalers, and other sharks (DIASA, undated; Kangaroo Island regional tourism promotion materials, and divers reports). (see also table above, on Western Investigator Strait).

	<ul style="list-style-type: none"> ♦ There are very few sites dived on the western and south-western coast of Kangaroo Island, due to dangerous diving conditions and the inaccessibility of most areas.
<p>12. National and/or International Importance</p>	<ul style="list-style-type: none"> ♦ The coastal river systems of north-western, western and south-western Kangaroo Island provide habitat for migratory waders with a coastal association, that are listed under international treaties JAMBA and/or CAMBA. Species include the Common Greenshank, Sharp-tailed Sandpiper, Curlew Sandpiper, Red-necked Stint, Latham's Snipe, and Painted Snipe (Raines, 1994, cited by Morelli and de Jong, 1995). The offshore islands also provide habitat for species listed under international treaties, including Ruddy Turnstone (Robinson <i>et al.</i>, 1996). ♦ The following conservation areas are listed on the <i>Register of the National Estate</i> due to their natural values: Flinders Chase National Park (including the Casuarina Islets), Tandanya Natural Area (adjacent to the eastern border of Flinders Chase), Kelly Hill Conservation Park (now part of Cape Bouguer Wilderness Protection Area), and Cape Torrens Conservation Park (now Wilderness Protection Area). ♦ The Kangaroo Island coastline is listed by the Australian Heritage Commission as an Indicative Place (i.e. under consideration for inclusion on the <i>Register of the National Estate</i>), due to its significance as part of the migratory route of the Southern Right Whale.
<p>13. Major Commercial and Recreational Fish, Sharks, Molluscs and Crustaceans</p>	<p>Some of the main fish, shark and invertebrate species caught commercially (and some also caught recreationally) in the waters off North-Western and Western Kangaroo Island (including deeper Commonwealth waters) include:</p> <p><i>Fish:</i> Ocean Leatherjacket, reef fish such as Redfish, Southern Blue Morwong, Western Blue Groper and other Wrasse species; also King George Whiting, Garfish, Australian Salmon, various Leatherjacket species, Rock Ling, Conger Eel, Boarfish, Red "Mullet", Snook, Swallowtail and several other species. Additionally, Hapuku, Pink Ling, Blue-eye Trevalla and Warehou species (e.g. Blue Warehou) are some of the main species caught by Commonwealth fisheries in the western Kangaroo Island area.</p> <p><i>Sharks and Rays:</i> School Shark, Gummy Shark (the two main sharks species taken in the area (mainly in Commonwealth waters), Bronze Whaler and/or Black Whaler and other shark species (including Saw Shark, Whiskery Shark and Wobbegong) also occur, but are fished in far less quantity than School and Gummy Shark. Elephant "Shark" (Elephant Fish) is also fished in the area.</p> <p><i>Invertebrates:</i> Southern Rock Lobster, Greenlip and Blacklip Abalone, Southern Calamari.</p> <p>Some of the main fish, shark and invertebrate species caught commercially (and some also caught recreationally) in the in the deeper waters off South-Western Kangaroo Island include:</p> <p><i>Fish:</i> Ocean Leatherjackets, Blue-eye Trevalla, Redfish, Hapuku, Southern Blue Morwong, Western Blue Groper and other Wrasse species, King George Whiting, Australian Salmon, Rock Ling, Knifejaw, Boarfish, Sweep, Rock Ling and Conger Eel, Black Bream and Mullet (at river outlets). In addition to Blue-eye Trevalla, some of the other main species caught by Commonwealth fisheries in deeper waters, include Hapuku, Pink Ling, and Warehou species (e.g. Blue Warehou). Southern Bluefin Tuna also occur in deeper waters.</p> <p><i>Sharks and Rays:</i> School Shark and Gummy Shark (the major species caught in the area, particularly in Commonwealth waters). Dog Sharks, Bronze Whaler and/or Black Whaler, Saw Sharks and other sharks also occur in the area, and are caught commercially, but not in large quantities, compared with School and Gummy sharks. Wobbegong sharks and various skate and ray species are also caught in the south-western Kangaroo Island area.</p> <p><i>Invertebrates:</i> Arrow Squid, Southern Rock Lobster, Greenlip and Blacklip Abalone.</p>

<p>1. Biogeographic Significance</p>	<ul style="list-style-type: none"> ♦ Southern Eyre Peninsula (e.g. Coffin Bay National Park, Avoid Bay, Avoid Bay Isles, Cape Carnot, Cape Wiles, Fishery Bay and waters further East): Seasonal, cold water nutrient rich upwelling, occurs close to the coast, extending from Point Sir Isaac on the Coffin Bay Peninsula to north-western and western Kangaroo island, resulting in summer sea surface temperatures along the inshore region of the southern Eyre coast being as low as 11^oC during some summer-autumn periods (Wenju <i>et al.</i>, 1990, Ward and McLeay, 1998). The southern Eyre Peninsula area is one of the major areas influenced by a nutrient rich upwelling (apart from parts of the South East coast) along the South Australian coastline, characterised by surface waters of relatively low temperature and high zooplankton biomass (Mackie, 1995; Ward <i>et al.</i>, 2000). ♦ Southern Eyre Peninsula Islands: Nationally significant breeding and haul out site for New Zealand Fur Seals, at Liguanea Island. In 2002, the fur seal colony at Liguanea Island was ranked 5th in South Australia, terms of its pup production (Shaughnessy, 2002). ♦ The waters of the Coffin Bay system (Coffin Bay, Port Douglas, Mount Dutton Bay and Kellidie Bay) constitute the largest estuarine area on the Eyre Peninsula coast, and the second largest in South Australia.
<p>2. Major Physical Influences, and Relative Productivity Level</p>	<p>Major Physical Influences</p> <ul style="list-style-type: none"> ♦ The southern Eyre Peninsula is subject to seasonal cold water upwellings in summer and autumn, with relatively low water temperatures during these upwelling periods (e.g. 11^oC - 15^oC along parts of the Eyre coast during summer – autumn (Wenju <i>et al.</i>, 1990, CSIRO SST imagery, 1995 and 1998; Ward and McLeay, 1998; Ward <i>et al.</i>, 2000). ♦ Much of the southern Eyre Peninsula coast has steep depth gradients close to shore. For example, according to interpolated depth contours in the SA Coast and Marine Atlas (DTUP, 2001), waters are around 70m deep within 1.5km of the coast of the Four Hummocks; 60m – 65m deep within 1.5km of the coast in the West Point area; and around 50m deep around 1km south of Williams Island. ♦ The easterly extent of warm water masses that influence the western Eyre Peninsula / eastern Great Australian Bight area, particularly the warm water mass that is generated in the Bight (Herzfeld, 1997; Herzfeld and Tomczak, 1997), may periodically extend to southern Eyre Peninsula (see Griffin <i>et al.</i>, 1997; Herzfeld, 2000). ♦ The south-western Eyre Peninsula coastline, from Point Sir Isaac to Cape Catastrophe, is exposed to high wave energy, and is one of the highest wave energy shorelines in South Australia, comparable to Canunda in the South-East (Short and Hesp, 1984 and Short <i>et al.</i>, 1986, cited by Edyvane and Nias, undated). ♦ The waters of the inner Coffin Bay system (e.g. Port Douglas, Little Douglas, Mount Dutton Bay, Kellidie Bay, Yangie Bay) are protected by the Coffin Bay Peninsula to the south and west, and by a series of points, sand spits and narrow peninsulas on the lee side, and also by extensions of the convoluted Coffin Bay coastline on the eastern side. As well as being the largest system of shallow protected bays on the West Coast, the unusual geomorphological configuration of the Coffin Bay waterways system makes the area unique within South Australia. <p>Relative Productivity Level</p> <ul style="list-style-type: none"> ♦ Nutrient-rich upwelling along southern Eyre Peninsula is responsible for high production of phytoplankton, particularly along the western end of Southern Eyre Peninsula / Coffin Bay National Park area (e.g. see Figure 16 in Ward <i>et al.</i>, 2000). ♦ Southern Eyre Peninsula (e.g. Coffin Bay National Park, Avoid Bay, Avoid Bay Isles, Cape Carnot, Cape Wiles, Fishery Bay and waters further East): Due to the influence of nutrient rich upwelling and phytoplankton production, the area supports high abundance of zooplankton and bait fish that eat the zooplankton. Pilchards are a highly abundant baitfish species in the area, and also a significant species in marine

	<p>food webs, forming the major part of the diet of a number of marine mammal, predatory fish, and seabird species (e.g. see Dimmlich and Jones, 1997; Ward and McLeay 1998; Ward <i>et al.</i>, 2000). Baitfish are an important part of the diet of predatory fish (e.g. Australian Salmon and Snook), seabird species (e.g. Little Penguin, Shearwaters and many others), and some cetaceans and pinnipeds. The fish that eat Pilchards are also an important part of the diet of some marine mammals and sharks (e.g. Bronze Whalers). Also the food web of which Pilchards are part extends to top predators – for example, Great White Sharks (for which southern Eyre Peninsula is an important habitat), eat tuna, Salmon, Snapper and other predatory fish, young pinnipeds and dolphins, and even sea birds and Pilchards.</p> <ul style="list-style-type: none"> ♦ There is a high abundance of zooplankton in the southern Eyre Peninsula area, due to the upwelling, and zooplankton is a major food source for numerous marine species, notable ones being baitfish (eg. pilchards, anchovies), and some whale species that periodically visit the area. ♦ The sheltered waters, and the high productivity of phytoplankton and zooplankton in the Coffin Bay system, makes the area of great importance for sand-dwelling fauna such as bivalve molluscs.
<p>3. Bioregional Representativeness of Habitats</p>	<p>Features of the area that are representative of the Eyre Bioregion (see IMCRA Technical Group, 1998) include:</p> <ul style="list-style-type: none"> ♦ “moderate to high deepwater wave energy coastline”; ♦ cold, nutrient-rich coastal upwellings; ♦ rocky coast, with numerous headlands; ♦ Precambrian meta-sedimentary cliffs and Pleistocene dune rock cliffs, headlands and shore platforms,* interspersed with Holocene dune barrier beaches; ♦ numerous offshore islands; ♦ marine flora and fauna typical of Flindersian Province; ♦ high species diversity amongst marine plants, particularly the red algae; ♦ species of <i>Cystophora</i>, <i>Plocamium</i>, the large red <i>Osmundaria prolifera</i> and the green <i>Caulerpa</i> as dominant or sub-dominant components of the benthic flora on reefs in some areas; and ♦ colonies of New Zealand Fur Seal and Australian Sea Lion on the islands (N.B. mainly haul-out sites, in this region). <p>* Note: There are granite islands and reefs along southern Eyre Peninsula, which should also be considered as characteristic features of the Eyre Bioregion, but have not been included by IMCRA Technical Group (1998) in bioregion descriptions.</p>
<p>4. Habitat Rarity</p>	<p>Sleaford Mere: A saline lake behind dunes of Sleaford Bay, containing stromatolite mounds (Australian Heritage Commission, undated; Reynolds, 1999; Edyvane, 1999b). Although this is not a marine habitat, Sleaford Mere was formerly connected to Sleaford Bay (Reynolds, 1999). Stromatolites are considered to be very rare in South Australia, and globally (NPWSA, 2002).</p>
<p>5. Habitat Diversity</p>	<p>Coffin Bay National Park / Coffin Bay Peninsula to Jussieu Peninsula / Lincoln National Park:</p> <ul style="list-style-type: none"> ♦ Calcareous coastal fringing and nearshore island reefs, such as Point Avoid, much of Golden Island, Black Rocks and parts of Perforated Island (the calcarenite reef in this area is the eroded remains of a more extensive calcareous reef that once blanketed much of the near-shore part of the Coffin Bay Peninsula and associated islands, according to Robinson <i>et al.</i>, 1996, and still overlays the granite on many of the Southern Eyre islands). Calcareous reefs have a variety of forms and orientations (platforms, cliffs, crevices, “holes”, sea caves, overhangs, and blocky/rubble reefs from eroded calcarenite, particularly around some of the islands); ♦ Calcareous cliffs and headlands, overlying granite and geissic basement rock, which outcrops as headland points and shelves along parts of the coast;

- ♦ Granitic, gneissic and meta-sedimentary headland reefs, extending offshore to include island reefs. Examples include the granitic **Sudden Jerk Island**, the **Four Hummocks**, **Rocky Island South**, **Greenly Island**, **Liguanea Island**, and the deeper benthic reefs and partially-exposed rocks between some of these islands. Part of **Price Island**, and part of **Golden Island's** coastline and the nearshore area are composed of resistant metamorphic silt-stones. Granite or metamorphic reef around most of these islands forms cliff faces, platforms, crevices, holes, sea caves, overhangs, and boulder / rubble reefs.
- ♦ Exposed sand beach habitats e.g. nearshore **Avoid Bay**, **Gunyah Beach**, **Sleaford Bay**;
- ♦ Benthic sand habitat;
- ♦ Seagrass beds (e.g. parts of **Avoid Bay**). Aquaculture Group - PISA Fisheries (1997) reported that seagrass beds are found in sandy, less exposed parts of the area between **West Point** and **Shoal Point (Sleaford Bay and surrounds)**, at less than 20m, and provide substrate for seasonal blooms of large red macroalgal epiphytes (e.g. *Asparagopsis armata*, *Laurencia* spp. and *Jeannerettia pedicellata*).
- ♦ Large and extensive calcareous dune systems (e.g. **Coffin Bay Peninsula**, and **Wanna Dunes** on the **Jussieu Peninsula**)
- ♦ There are also a small seasonal creeks in the area, opening to the sea (e.g. **Fishery Bay**)
- ♦ Paperbark swamps (near the coast, **Coffin Bay Peninsula**)
- ♦ Saltmarsh / samphire swamps
- ♦ Saline coastal lake (**Sleaford Mere**)

Coffin Bay waterways system:

- ♦ Calcareous headland reefs, and calcareous block and rubble reef within bays;
- ♦ Calcareous islands and sand islands;
- ♦ Shallow, seagrass-lined bays, with sand and shell substrate;
- ♦ Numerous sand bars and sand banks;
- ♦ Shallow, sandy channels;
- ♦ Mud habitats (in the innermost bays, and parts of the inner islands);
- ♦ Saltmarsh / Saline swamps;
- ♦ Mangroves

Habitat Notes

(Sources: SARDI S.A. Benthic Survey data, 1994 and 1995, unpublished; Morelli and de Jong, 1995; Robinson et al., 1996; Aquaculture Group - PISA Fisheries, 1997; Petrusevics et al., 1998; Edyvane and Baker, 1998b and 1999b; DEH, 2000c; GeoScience Australia, 2001 - 2004).

South-Western Side

In general terms, the **Coffin Bay** system comprises intricately interlocking marine lagoons, vegetated peninsulas, sandy dunes, sheltered beaches and ocean beaches, limestone cliffs, islands and sandbanks (Australian Heritage Commission, undated).

The **Coffin Bay Peninsula** separates the exposed beaches and islands of the oceanic side, from the sheltered waters of Coffin Bay system (described below). The northern tip of **Coffin Bay Peninsula** lies within the Sleaford Complex, consisting of a series of contorted gneisses of late Archaean to early Proterozoic age (c. 2700-2300 m. years). In other parts of peninsula, these gneisses are overlain by a sequence of iron-bearing sediments of the Hutchinson Group (Morelli and de Jong, 1995). On the oceanic side are high windswept cliffs (crumbling and undercut in places), massive dunes, and wave-exposed surf beaches. Away from the coast there are sand dunes and limestone pavements, patches of Sheoak and low-lying samphire swamps (DEH, 2000c). One of

the largest components of the **Coffin Bay National Park** (on the **Coffin Bay Peninsula**) is the dune fields of whitish calcareous sands, which comprise about 68% of the total area of the park. About two thirds of the dunes are vegetated by Coast Beard Heath (*Leucopogon parviflorus*) and the Coast Daisy Bush (*Olearis axillaris*), and open heath. Other areas in the Coffin Bay National Park include undulating calcarenite with a shallow sandy soil layer, a lake (Lake Damascus) and other small ephemeral lakes and soaks. The calcarenite supports dryland teatree, low woodland / open scrub, Drooping Sheoak woodland, mallee open scrub and low open heath. **Lake Damascus** is surrounded by Swamp Paperbark (*Melaleuca halmaturorum*) and *Gahnia* tussock sedgeland in areas where the water remains in summer. The other ephemeral lakes and soaks support samphire (*Sarcocornia blackiana*) communities (Australian Heritage Commission, undated).

The **Coffin Bay** coastal system encompasses the coastline of **Coffin Bay Peninsula**, including **Avoid Bay** and islands offshore from that bay (**Black Rocks**, **Sudden Jerk Island**), **Gunyah Beach** and **Seven Mile Beach**, and the waters that bound **Kellidie Bay**, **Mount Dutton Bay**, **Yangie Bay**, **Port Douglas Bay**; and eight inner bay islands (including **Yangie Bay Island**, **Goat Island** and the **Mt Dutton Bay Islands (North, South-West and South-East)**, **Rabbit Island**, and **The Brothers Island**) (Morelli and de Jong, 1995).

Outer Coffin Bay is bounded to the north by **Point Sir Isaac** on the peninsula, and **Frenchman Bluff** on the coast. **Frenchman Bluff** has low cliffs to the shoreline, and the convoluted coast in the area forms a series of very small bays and headlands, all of which lead into the outer Coffin Bay waters. The benthos includes patches of seagrass, bare sand, and patch reef with dense macroalgae. Along the Coffin Bay Peninsula from the northern tip at **Point Sir Isaac** to the southern tip at **Point Whidbey**, there are heavy coastal reefs, exposed to the west and south-west. **Outer Coffin Bay** is protected from the predominantly southerly winds, however, strong northerly winds in summer increase the wave energy on the southern beaches and the eastern cliffs. The western and southern coasts are characterised by relatively protected, shallow sandy beaches. Generally, from 0.5m to 20m depth, **Coffin Bay** is characterised by dense seagrass communities, dominated by *Posidonia* species, and large banks of dead seagrass accumulate on the beaches (CSIRO and SARDI data, 1995, unpublished; PISA Fisheries – Aquaculture Group, 1997). On the rocky coasts, macroalgal assemblages are considered to be typical of the high energy communities found along the southern coast of the Eyre Peninsula (Womersley, 1984 and 1990), comprising *Cystophora*-dominated communities in the sub-littoral fringe to upper-sublittoral zone, grading to an *Ecklonia*-dominated community in deeper coastal waters, with a diverse understory of red macroalgae. A benthic survey in 1995 (SARDI S.A. Benthic Survey data, unpublished) recorded on reef at 8m, off the coast at **Greenly Beach**, just north of the entrance to Coffin Bay, a mixed canopy of *Ecklonia* and *Scytothalia dorycarpa*, with a species-rich understory of mixed brown and red macroalgae, sponges, ascidians, and encrusting coralline algae on the reef. Red macroalgae included species of *Rhodomenia*, *Callophyllis*, *Halymenia*, and *Gloiosaccion*), and brown macroalgae in the understory included *Dictyota naevosa*, *Glossophora nigricans*, and a *Sporochnus* species (SARDI SA Benthic Survey data, unpublished). Generally across south-western Eyre Peninsula, the brown canopy macroalgae such as *Ecklonia* become more sparse with depth, and red macroalgae tend to dominate the lower zone, where the rock gives way to sand. Seagrasses are found in the more protected regions in depths less than 20m, and are important in providing a substrate for natural, seasonal blooms of red macroalgae, in particular *Asparagopsis*, *Laurencia* and *Jeannerettia* (Womersley, 1984 and 1990, cited by PISA Fisheries – Aquaculture Group, 1997).

In the **Farm Beach** area, on the eastern side of outer **Coffin Bay**, a benthic survey recorded bare sand at 2m on the northern side, and dense beds of *Posidonia* (possibly *P. angustifolia*) at 3m – 4m deep, near Farm Beach. South of **Farm Beach**, sparse coverage of both *Posidonia* and *Halophila* was recorded, on shelly sand at 2.5m deep. Adjacent to the entrance to **Port Douglas Bay**, sparse patches of *Zostera / Heterozostera* were recorded in the shallow subtidal – less than 1m deep (CSIRO and SARDI data, 1995, unpublished).

Outer Coffin Bay is separated from **Port Douglas Bay** by a narrow channel (adjacent to **Point Longnose**). There is strong water movement through the channel on a regular basis, and the “rip” of water dislodges seagrass and sand in the vicinity of the **Point Longnose channel**. The channel enters **Port Douglas Bay**, a large bay bounded by **Point Longnose** in the north, and **The Brothers Islands** in the south. Generally, sandy areas in the shallow subtidal of **Port Douglas Bay** support *Posidonia* and *Heterozostera* (*Zostera*) species,. Just south of **Point Longnose**, there are sandbanks, and clumps of seagrass, scattered over a predominantly bare sand substrate (CSIRO and SARDI data, 1995, unpublished; PISA Fisheries – Aquaculture Group, 1997). A survey in 1995 recorded near the channel at **Point Longnose**: mainly bare sand, and also present were shell beds, with the brown alga *Colpomenia*, and small patches of *Posidonia angustifolia* seagrass, with *P. coriacea* seagrass at the edges of the *P. angustifolia* stands (CSIRO and SARDI data, 1995, unpublished). **Point Longnose** is sandy, and the sand extends into the subtidal. A benthic survey recorded bare sand at 2m in the vicinity of Point Longnose, and a bed of *Posidonia angustifolia* at 3m. The *Posidonia* stretches to shore in some places on the north-western side of **Port Douglas Bay**, just south of Point Longnose (CSIRO and SARDI data, 1995, unpublished). In deeper waters (7m) on the **north-western** side of **Mt Dutton Bay**, mud was recorded, with around 20% cover of the green macroalga *Caulerpa cactoides*. A similar substrate was recorded on the north-eastern side, at 4m (CSIRO and SARDI data, 1995, unpublished).

On the eastern side of **Port Douglas Bay (Horse Peninsula)**, there is an area of sandbanks just south of the mouth of Port Douglas and the channel into **Little Douglas**, extending southwards along the **Horse Peninsula**. Portions of the coast dry at low tide in this area. At 3.5m on the eastern side, a survey recorded rubble bottom with ascidians, and little cover of seagrass (CSIRO and SARDI data, 1995, unpublished). South of Little Douglas, dense patches of *Posidonia* occur in the shallow subtidal (e.g. 2m – 3m), with *Heterozostera* (*Zostera*) in the shallowest waters (less than 1m). A benthic survey in 1995 recorded bare sand, and large patches of *Posidonia angustifolia* (with associated seagrass fauna) in the shallow subtidal in **eastern Port Douglas Bay**, off the **Horse Peninsula** (CSIRO and SARDI data, unpublished, 1995). At the northern end of **Port Douglas Bay** is **Little Douglas**, a very small, almost enclosed bay, which is reported to contain dense *Heterozostera* (*Zostera*) seagrass (CSIRO and SARDI data, unpublished, 1995).

At the bottom of **Port Douglas Bay** are **The Brothers Islands**, lying between the **Horse Peninsula** and **Keely Point**. The calcarenite islands (capped with harder calcrete) have been reduced in size due to the action of tides and waves, and are weathered and undercut around the sides. The larger island (“Big Brother”) is tear-shaped, and about 250m long and 100m wide. “Little Brother”, almost 100m long and only 20m-30m wide, lies in the wake of the larger island, separated by a narrow channel and reef (the remains of a previous land bridge) (Robinson et al., 1996).

In the southern part of **Port Douglas Bay**, a benthic survey (CSIRO and SARDI data, 1995, unpublished) recorded sand and shelly bottom with filamentous algae at 2m, adjacent to **The Brothers Islands**. Opposite **The Brothers**, medium density patches of *Heterozostera* were recorded at 1.5m, dense *Heterozostera* at 4m, and a community of dense *Halophila australis* (paddleweed), sponges and scallops was recorded at 7.5m. Medium to dense coverage of *Heterozostera* seagrass was also recorded at 2m – 3m at “**Shag Point**”, grading to dense *Halophila* seagrass at 4m deep, offshore from “Shag Point” (CSIRO and SARDI data, 1995, unpublished).

During the mapping of the tide-dominated **Port Douglas Bay – Coffin Bay** area as part of the National Land and Water Resources Audit (NLWRA), the following statistics were recorded (see GeoScience Australia, 2001 - 2004):

Water area (km²) 117.59
 Central Basin (km²) 94.27
 Barrier / Back Barrier (km²) 1.31
 Channel (km²) 3.00
 Tidal sandbanks (km²) 11.4
 Bedrock perimeter (km) 41.09
 Bedrock (km²) 0.21
 Flood / Ebb delta (km²) 25.51
 Floodplain (km²) 0.36

Intertidal flats (km²) 2.5
 Mangrove (km²) 0.04
 Saltmarsh / salt flat (km²) 3.49
 Seagrass (km²) 86.2
 Rocky Reef (km²) 0.68
 Entrance width (km) 2.04
 Perimeter (km) 131.65
 Maximum length (km) 23.53
 Maximum width (km) 8.33

It is noted that the spatial extent of mangroves reported in the above-mentioned assessment is less than the 3.12km² of mangroves recorded in **Port Douglas** area (including **Mt Dutton Bay** and **Kellidie Bay**) by Bucher and Saenger (1989, cited by Edyvane and Nias, undated).

Within **Coffin Bay** and adjoining bays, the main coastal vegetation comprises Swamp Paperbark *Melaleuca halimifolium* scrub and tussock sedgeland along the coastline; samphire low shrubland on frequently inundated areas; and the sandy areas fringing the coastal swamp support several sedges (Morelli and de Jong, 1995). **Kellidie Bay** is surrounded by small, narrow beaches of sand and shellgrit, with calcareous ledges jutting into the bay. Further inland in **Kellidie Bay**, are vegetated limestone ridges, and flat, swampy, low-lying areas (Australian Heritage Commission, undated). A closed shrub of *M. halimifolium* occurs along the **Port Douglas** and **Kellidie Bay** coastline, growing on calcareous ledges at the water's edge, and in low-lying areas which are regularly inundated by the sea. This vegetation zone is adjoined by *Gahnia filum* tussock sedgeland, and in damper areas grades into a samphire low shrubland of *Sarcocornia blackiana*, *S. quinqueflora* and *Halosarcia* species. Sandy areas which fringe the coastal swamp support the sedges *Baumea juncea*, *Isolepis nodosa* and *Juncus kraussii*; the sandy beaches are dominated by scattered clumps of *Cakile maritima* and *Isolepis nodosa*. The inner bay islands are mainly vegetated with a low shrubland of both native and introduced species (Preece, 1985, cited by Morelli and de Jong, 1995).

Mt Dutton Bay comprises a north / south elongated bay to the north of Coffin Bay township. The bay has relatively deep waters to the south and east which taper to shallow waters at the northern end (PISA Fisheries Aquaculture group, 1997). **Lavender Bay** is at the southern end of **Horse Peninsula**, near the entrance to **Mt Dutton Bay**.

Within the sheltered waters of the Coffin Bay system (including **Mt Dutton Bay** and **Kellidie Bay**), there are eight, small, calcarenite islands, and in the shallow tidal waters of **Yangie Bay**, is a larger sand and mudflat island (**Yangie Bay Island**). The cover of all the calcarenite islands has been substantially modified due to grazing and guano mining (Robinson et al., 1996). Islands within the Coffin Bay system include: **Mt Dutton North Island** (also known as **Jetty Island**), a small calcarenite rise about 500m from shore, fringed by the shallow waters of Mount Dutton Bay. **Jetty Island** has a calcareous cap that has been worn away to form a maze of overhangs, crevasses, caves and solution tubes. The coastal rim rises sharply as a perforated, undercut ledge, with rubble in areas where caves and "lips" have collapsed (Robinson et al., 1996). The calcarenite has been etched into sharp blade-like and needle-like shapes by the wind and waves. The inner part of the island is unstable and undermined, and the surge penetrates under a surface pitted with sinkholes. In the shallow subtidal of **northern Mt Dutton Bay**, a benthic survey in 1995 recorded dense *Halophila* seagrass between 2m and 4m deep, including the area near the jetty. In **northern Mt Dutton Bay**, *Heterozostera* (= *Zostera*) patches were also recorded in the shallow subtidal. Also in this area, near **Jetty Island**, at 2m depth were dense patches of *Zostera*, and a dense cover of the green macroalga *Caulerpa cactoides* in places (CSIRO and SARDI data, 1995, unpublished).

Inside the mouth of **Mt Dutton Bay** are two unnamed islets and a bare rock. The small mounds of calcarenite and sand lie a short distance from a minor headland protruding near the southern tip of **Horse Peninsula** (Robinson et al., 1996). The three named islets in this area are **North**, **South-East** and **South-West Mt Dutton Bay Islands**. Connecting rock between the small islands has been eroded, possibly reformed into the sandbars that

connect the islets' rocky cores, and radiate along the tidal flows in this broad, shallow basin. **South-West Island** has a rocky shoreline on the northern side, and there are sand flats around the island that are utilised by shore birds. Coastal vegetation includes Grey Samphire on the pockets of shellgrit and saline soil (Robinson et al., 1996).

In 1995, a benthic survey recorded, on the western side of **central Mt Dutton Bay**, at 1.6m: patches of *Zostera / Heterozostera* and patches of *Halophila* seagrasses, with *Giffordia* epiphyte; at 2m: dense *Zostera / Heterozostera*. Further towards the middle of **central Mt Dutton Bay**, at 4m dense *Halophila* seagrass and the green macroalga *Caulerpa cactoides* were recorded, with some *Heterozostera* (= *Zostera*) seagrass. Towards the eastern side of **central Mt Dutton Bay**, dense *Heterozostera* was recorded at 2.5m (CSIRO and SARDI data, 1995, unpublished).

A survey in **southern Mt Dutton Bay** recorded *Zostera* (*Heterozostera*) and *Halophila* seagrasses on sand, between 1m and 3m (CSIRO and SARDI data, 1995, unpublished). Also recorded, at 2m deep, was shell bed with lots of overgrowing algae, and *Zostera* (*Heterozostera*), near the entrance to **Mt Dutton Bay**. South of Mt Dutton Bay is **Rabbit Island**, adjacent to **Long Beach**. The calcrete-capped calcarenite island, about 4ha in area and 10m high, lies on a shallow shoal a little over 1km from the southern coast of Port Douglas. The surrounding shallows reduce wave impact, hence the island perimeter is not undercut, although it is steep (Robinson et al., 1996). There is a crumbling talus slope of calcarenite on the exposed side facing Port Douglas, with some boulders of calcrete, and the eastern side is more sheltered, and sandy. Sandbars and calcareous reef surround **Rabbit Island** (Robinson et al., 1996).

Goat Island is a small outcrop in the channel that feeds **Kellidie Bay**. Goat Island is composed of calcarenite and calcrete, and rises from a small surrounding shoal, with a sandbar trailing to the east. There is a deep channel that forks either side, to the west (Robinson et al., 1996).

Kellidie Bay, one of the two innermost bays in the Coffin Bay system is a shallow sandy bay, with bare sand channels and intertidal sand banks, shell beds, and patches of calcareous rock / rubble. A benthic survey in 1995 reported a lot of seagrass and algal detritus at 1m – 2m in western **Kellidie Bay** (e.g. floating leaves of *Halophila* and *Zostera*, floating macroalgae, and macroalgae on the sand and calcareous bottom). There are dense patches of *Heterozostera* (= *Zostera*) throughout Kellidie Bay. In the eastern side of **Kellidie Bay**, *Heterozostera* (*Zostera*) seagrass was recorded at 1m, with patches of calcareous, algae-covered rock (CSIRO and SARDI data, 1995, unpublished).

Yangie Bay (the smaller of the innermost bays in the Coffin Bay system) is a quiet, protected bay, surrounding by saline marshes that support Grey Samphire, regularly inundated by the tide. The bottom of the shallow bay is sandy and muddy, with abundant mussels. There is a small island in the southern curve of the bay: **Yangie Bay Island** is described as a 5ha mosaic of dry rock, meandering channels, and regularly inundated mud and sand. There is a larger channel that separates this "island" from the mainland. The main elements of the island are calcarenite, fringed by sediment deposits connecting each outcrop (Robinson et al., 1996).

Southern Side

On the southern of the **Coffin Bay Peninsula**, there are exposed rocky headlands (e.g. **Point Whidbey** and **Point Avoid**), broad sandy beaches between the headlands (e.g. **Sensation Beach**, **Avoid Bay**, **Gunyah Beach**), and numerous nearshore and offshore islands, some of which can be seen from the broad beaches. The **Avoid Bay** offshore islands are steeply sloping and eroded into many crevices and caves (Morelli and de Jong, 1995).

Whidbey Isles: Within Avoid Bay is **Avoid Island (Sudden Jerk Island)** and **Black Rocks**, and to the south and south-west of the bay out of the bay is a string of widely-scattered islands south-west of **Point Avoid**, including **Golden Island**, **Price Island**, **Perforated Island**, **Unnamed Rock**, and **Four Hummocks** islands. **Price** and **Perforated Islands** have a calcarenite cover over their granite bases. These islands are mainly flat,

with rugged cliffed coastlines. Further seaward, the calcarenite cover has eroded away, leaving rounded, granite inselbergs (i.e. **The Four Hummocks**, which are some of the most seaward islands of the group, and the **Unnamed Rock** west of Perforated Island) (Australian Heritage Commission, undated; Robinson et al., 1996).

Close to the coast, **Avoid Island** rises a few hundred metres from a small headland, projecting into the northern curve of **Avoid Bay**. The island is a low granite dome, with a calcarenite mantle that rises abruptly on the 23m high summit. On the island there is a semi-fresh, 2m deep pool in a granite cleft, used by sea birds to wash (Robinson et al., 1996). There is an unnamed islet close to shore (about 500m off **Misery Bay**) (Australian Heritage Commission, undated). Also close to the coast, **Black Rocks** is a broken chain of islets, reefs and other rocks, positioned about 1km off a small point on south-central Avoid Bay. **Black Rocks** are composed of calcarenite, broken into scattered fragments. The largest islet is about 47m high, and rises steeply from the sea, particularly on the most exposed faces, to a flatter platform. The island is composed of separated layers of softer calcarenite (eroded to form caves and overhangs), and harder calccrete. On the larger islets in the **Avoid Bay** group, remnants of layered calcareous beds rise above a lower platform (Robinson et al., 1996). The smallest islet in the group is almost submerged at high tide.

Golden Island, a rugged island about 1km south of Point Avoid, is composed mainly of thick calcarenite, of the Bridgewater Formation, visible as sharp cliffs, and steep slopes of jagged boulders and pulverised rock (Robinson et al., 1996). The gently undulating upper platform slopes gradually from the tallest cliffs on the north-west side, to the lower south-east corner. On the steeper cliff, and at the base, there is abundant, freshly eroded calcarenite. Two central sand hills are the highest points on the upper platform of the island, about 55m above sea level (Robinson et al., 1996). Calcarenite once blanketed much of the Coffin Bay Peninsula and the surrounding continental shelf, but most sections not immediately submerged by the rising sea were quickly eroded, and the retreat of the calcarenite bed that once covered Golden Island and joined it to nearby Point Avoid, is marked by a submerged reef connecting the two. Golden Island remains due to the presence of surf-exposed but resilient, metamorphosed sediments of the Hutchinson Group (Robinson et al., 1996).

Price Island is described as a dome of Hutchinson Group meta-siltstone, rising 64m above sea level (Robinson et al., 1996). There is much erosion at the base of the dome, forming a sharp rim of cliffs, with jumbled black rock scree meeting the surf at the base. The Bridgewater Formation calcarenite that once extended over the island is now eroded, and remains only on the apex of the dome. There is a large crevasse and sea cave on the exposed south-western tip of **Price Island**, that fills with a wall of water that slams into the rock. Also, a reef extends for about 400m from the northern point of the island (Robinson et al., 1996). A benthic survey in 1995 (SARDI, unpublished data) recorded boulders and pebble reef at 5m depth around **Price Island**. At that depth, the benthic cover was dominated by the brown canopy species *Cystophora siliquosa* and *Ecklonia radiata*, with minor quantities of other *Cystophora* species (e.g. *C. moniliformis* and *C. platylobium*), and an understory of branching red macroalgae (e.g. species of *Callophyllis*, *Areschougia*, *Rhodophyllis*, *Pterocladia*), flat encrusting red macroalgae (*Sonderopelta* and *Peyssonnelia* sp.), articulated coralline algae (*Haliptilon roseum*) and flat, calcareous red algae on the boulders.

Perforated Island is a long, irregular-shaped island that lies about 12.4km west-south-west of Point Avoid, and is the most seaward of the isles that still support a cover of thick calcarenite of the Whidbey Group (Robinson et al., 1996). The coast of the island is deformed into deep bays. There are "towering walls" of calcarenite perched on a confined ridge of granite, visible as a 3m – 5m wide table that does not rise above the waterline. The deep water swells around the island form a continuous fringe of white water that erodes the cliffs, which are undercut at the waterline, forming many sea caves and overhangs. The largest cave is about 10m – 15m wide, and 30m – 40m high, and opens on the north-western face of the northern tip (Robinson et al., 1996). A hole has been eroded through Perforated Island, forming a limestone "bridge" about 400m from the northern point of the island. A tall stack of rock has also been severed from the northern tip of the island (Robinson et al., 1996). Deep water surrounds the entire island, however there is a reef extending from just off the southern point for 1.6km west, and also many reefs lie to the south of **Perforated Island** (Robinson et al., 1996).

“**Unnamed Rock**” lies about 7km south-west of Perforated Island, and comprises a bare, salt-crusted dome of rock about 23m high, that is exposed to the surge. This is the first visible part of an inselberg range, part of the 2,350 million year old Sleaford Complex, that also includes the **Four Hummocks**, **South Rocky Island**, and **Greenly Island** (Robinson et al., 1996).

Four Hummocks Islands: The inselberg that forms these granitic islands first rises about 27km west-south-west of Point Avoid, and the two middle islands of the group lie 1km south-south-west (Robinson et al., 1996). Once a single unit, a deep, water-filled crevasse now separates the two domes. The northern summit is about 88m high. A 400m gap separates the southernmost island, with an intervening rock that rises about 15m above sea level. The southern, cone-shaped island is about 110m high. There are few loose boulders around the islands, which erode very slowly. Much of the islands’ surface is bare granite, and there are thin layers of calcarenite on the tops of 3 of the islands (Robinson et al., 1996).

To the north-west of the main islands in the Whidbey group is **Greenly Island**, a rugged granite Island divided into two sections, the main southern section rising to a height of 230m (Australian Heritage Commission, undated). East-south-east of the main Whidbey group is **South Rocky Island (Rocky Island South)**, one of the most remote islands off the South Australian coast (Robinson et al., 1996).

Greenly Island is an inselberg of Whidbey Granite (of the ancient Sleaford Complex), lying in deep water, about 30km west-south-west of Point Whidbey. The island is about 230m high, and the north-western tip drops steeply to a deep chasm (“The Channel”) that channels a torrent of surge, separating the northern lobe (Robinson et al., 1996). A small islet (Seal Rock) about 61m above sea level lies almost 1km off the east coast. Remnants of a calcarenite cap occur on the main island, and deposits of windblown sand also form beds on the main island (Robinson et al., 1996).

South Rocky Island (= Rocky Island South), composed of Whidbey Granite, is the remaining summit of a range, and the present continental shelf is about 90m below the island. South Rocky Island rises from deep water on all but the western side of the southern point, where a reef extends for about 400m, and a submerged rock lies 2km west of the northern point (Robinson et al., 1996). Rocky Island South has probably existed as an ocean-locked island for at least 12,000 years (Robinson et al., 1996). The island, which is about 68m high, has steep, rounded flanks of resistant granite, cut by a few deep crevasses. Grey Saltbush grows on the island, which is constantly exposed to strong, salt-laden winds.

There is little information about the benthic cover on reefs off the **southern tip of Eyre Peninsula**, however sampling by SARDI in 1994 and 1995 showed that there were few dominant brown canopy macroalgae in the near-shore reef area of the southern Eyre, although species of *Cystophora* occurred in low density, particularly on shallow coastal fringing reefs, with mixed red and coralline algae understory, in some areas mixed with *Ecklonia radiata*, on reefs around 10m (such as **Point Whidbey**, on the **Coffin Bay Peninsula**). The brown macroalgae *Ecklonia radiata* and *Acrocarpia paniculata* occur on some reefs (at 10m and deeper), particularly those closer to south-eastern Eyre Peninsula (see **Liguanea Island**). The predominant cover on many reefs in the southern Eyre region is a variety of red macroalgal species (up to 60% cover, at some sites, particularly mixed reefs and habitats, including the large red leathery macroalgae *Osmundaria prolifera*, and species of *Plocamium*, *Phacelocarpus* and *Melanthalia*, flat encrusting forms such as *Sonderopelta coriacea* and species of *Peyssonnelia*, articulated corallines such as *Haliptilon roseum*, and encrusting corallines) (Edyvane and Baker, 1998b, 1999b and SARDI SA Benthic Survey data, unpublished). Petrushevics *et al.* (1998) also reported red macroalgae as the dominant benthos in the south-western Eyre area. Encrusting corallines are common in the area, covering many of the boulder reefs. Green macroalgae (*Caulerpa* spp.) formed around 5% of the cover at some sites. Mixed red species on coralline covered rock also dominate reef at **Point Whidbey** (Coffin Bay Peninsula).

South-Eastern Side

There is a long, almost straight stretch of coast extending south-east from Point Avoid, through to **D’Anville Bay** and **Cape Carnot**. **Cape Carnot** consists of two spectacular rocky promontories; the more westerly ends in a small Peninsula, roughly circular in shape, which contains some of the most significant exposures of early Proterozoic/ Archaean gneisses in Australia (Australian Heritage Commission, undated). To the east is **Cape Wiles**, at the entrance to **Fishery Bay** and **Sleaford Bay**, on the southern side of the **Jussieu Peninsula (Lincoln National Park)**. **Cape Carnot** and **Cape Wiles** are separated by **Groper Bay**.

Sleaford Bay comprises a number of small rocky inlets and long, exposed, sandy beaches, backed in places by calcareous cliffs and large sand dunes (e.g. the **Wanna Dunes**).

Sleaford Mere is an enclosed shallow salt lake, separated from the head of Sleaford Bay by about 100 metres of sand dunes (Australian Heritage Commission, undated; Lincoln Marine Science Centre, 1998). **Sleaford Mere** is the eastern boundary of the Lincoln National Park.

The topography and geomorphology of the southern coast of **Jussieu Peninsula (Lincoln National Park)** are highly variable. Along the coast are smooth, crescentic “pocket” beaches; broad surf beaches exposed to the Southern Ocean; rugged, granite headlands; deep rocky coves, and steep, abrupt cliffs. In some places, weathering of the coastal rocks has produced blowholes, crevasses, and caves (Robinson et al., 1996; Lincoln Science Centre, 1998). Rugged headlands and steep cliffs dominate the southeastern coastline from **Wanna** to **Cape Catastrophe**, and a large and spectacular unconsolidated dune field stretches from **Sleaford Mere** to **Wanna** (DEH, 2004b).

Wanna comprises steep cliffs, low-energy and high-energy bays and shores, and long expanses of sandy beaches and dunes (Lincoln Marine Science Centre, 1998). Further towards the tip of the Jussieu Peninsula is **Jussieu Bay**. Islands in the area include **Cape Rock**, **Liguanea Island**, **Curta Rocks** (near **Cape Tournefort**, eastern end of **Sleaford Bay**), and **Wanna Stacks** (close to the coast, on the eastern side of **Sleaford Bay**). At the southern tip of the Jussieu Peninsula are **West Point** and **Cape Catastrophe**, and **Williams Island** lies south of **West Point** (see section 8.5).

Cape Rock lies about 8km west-north-west of **Cape Carnot**. It rises about 6m high in calm weather, but is almost completely covered by water during moderate to rough swells. The rock is composed of Sleaford Complex granite or gneiss (Robinson et al., 1996).

About 3.2km south of Cape Carnot is **Liguanea Island**, an elongated island of 202ha, composed of Sleaford Complex gneiss. The sea has penetrated weaker layers and fractured joints, forming a jagged coastline of alternating crevasses and rocky spits (Robinson et al., 1996). This gneissic base is covered in part by a low dome of calcarenite that rises to a flat platform, 39m at the southern end of the island. There is a coastal fringe of Nitre-bush and Marsh Saltbush, particularly on the most exposed southern and western sides. The waters surrounding the island are comparatively shallow. A low outcrop of gneiss extends from the southern end of the island for about 600m, and is mostly submerged (Robinson et al., 1996).

Curta Rocks, perhaps the remains of a fragmented promontory, is a chain of islets extending more than 3.5km south-south-west from the cliffed beaches east of **Cape Tournefort**. The main supporting structure of **Curta Rocks** is Lincoln Complex granite (between 1580 and 1800 million years old, and therefore younger than the rocks outcropping further west) (Robinson et al., 1996). Where the granite ridge rises far enough above the water, there is a crest of Bridgewater Formation calcarenite, reaching 37m above sea level at the highest point. The main igneous platform, and the associated outcrops, are frequently scoured and submerged by heavy swells, and salt spray drifts over the entire rock mass (Robinson et al., 1996). Nitre-bush, Marsh Saltbush, and Grey Saltbush occur on the two largest rock masses.

Wanna Stacks: To the west of **Cape Tournefort**, the rapid erosion of a thick calcarenite bed has stranded two humps of granitic / gneissic rock as small, nearshore islets. The larger islet, 55m high, rises on a dome of granite or gneiss, about 370m from the nearby tall

	<p>cliffs. There is calcarenite on the leeward side of the dome, and the islet's remnant has been carved into a flat-topped "stack". There are salt-tolerant samphires and saltbushes, and other coastal species, on the larger islet. The smaller islet (8m high) also has remnant calcarenite on the leeward side. It lies about 108m off the south-eastern end of a sandy beach. Both main islets in Wanna Stacks are the remains of fragmented headland that survives as a chain of exposed rock and a submerged reef in the separating channel. Swells break and diffract heavily around the shores of both islands, which are largely inaccessible (Robinson et al., 1996).</p> <p>There is little benthic survey information recorded for the south-eastern tip of Eyre Peninsula. The brown macroalgae <i>Ecklonia radiata</i> and <i>Acrocarpia paniculata</i> were reported to be the dominant canopy taxa on reefs at 10m around Liguanea Island (Edyvane and Baker, 1998b, 1999b, and SARDI S.A. Benthic Survey data, 1994-1995, unpublished).</p> <p>In some areas, habitats contain a variety of both macroalgae and invertebrate species as dominant benthic cover. For example, reef at 10m in western Sleaford Bay is dominated by <i>Cystophora</i> species and <i>Ecklonia radiata</i>, with a dense understorey of mixed sponge and ascidian species, green macroalgae (several <i>Caulerpa</i> spp. and <i>Codium</i> spp.), red macroalgae (species of <i>Peyssonnelia</i>, <i>Dictyomenia</i>, <i>Lenormandia</i>, <i>Wrangelia</i> and other taxa), articulated coralline macroalgae (e.g. <i>Haliptilon roseum</i>), and smaller brown macroalgae (e.g. <i>Homoeostrichus sinclairii</i> and species of <i>Dictyota</i>). Similarly at Liguanea Island, under the <i>Ecklonia radiata</i> and <i>Acrocarpia paniculata</i> canopy (10m), mixed hydroids and ascidians are highly dominant in the benthic cover, along with articulated and encrusting coralline algae, and turfing brown macroalgal species (Edyvane and Baker, 1998b, 1999b, and SARDI S.A. Benthic Survey data, 1994-1995, unpublished).</p>
<p>6. Taxonomic Diversity</p>	<p>Marine Plants Southern Eyre Peninsula: Little quantitative information on marine plant biodiversity is available for this area, however, SARDI's Statewide Benthic Survey program showed that the southern Eyre region was one of the three most diverse regions sampled in S.A. in terms of red macroalgal species, which formed a major part of the benthic cover (e.g. see Edyvane and Baker, 1999a). It is also evident that many of the major groups and forms of marine macroalgae are present in the area (i.e. diverse at several taxonomic levels). Examples include a variety of furoid species and other large brown macroalgae; small brown macroalgae; turfing red macroalgae (including encrusting forms both calcareous and non-calcareous), articulated corallines, and many species of erect red macroalgae, with a wide variety of habits/morphology (Edyvane and Baker, 1998b, 1999b, and SARDI S.A. Benthic Survey data, 1994 and 1995, unpublished).</p> <p>Bony and Cartilaginous Fish (Sources: Christopher, 1988; Wyschnja, 2000; Aquanaut, undated, and various dive records and dive promotion materials). Coffin Bay National Park, Avoid Bay, Avoid Bay Isles: Anecdotal evidence from divers of high abundance and diversity of reef fish (e.g. Point Sir Isaac). Fishery Bay, Cape Wiles, Groper Bay, Cape Carnot, D'Anville Bay, Liguanea Island: Unquantified diversity of reef fish. Some of the many examples include Seaperch species, Swallowtail, Victorian Scalyfin, Silver Drummer, Bullseye species, Harlequin Fish, Western Blue Devil, Western Foxfish, Western Blue Groper and Blue-throated Wrasse and various other Wrasse species, Zebra Fish, Boarfish, Sea Sweep, Dusky Morwong, Redfish, amongst other species).</p> <p>Invertebrates (Sources: Christopher, 1988; SARDI S.A. Benthic Survey data, 1995, unpublished; Edyvane and Baker, 1999b; Wyschnja, 2000; Shepherd, pers. comm., 2004; and various dive records and dive promotion materials). Fishery Bay, Cape Wiles, Groper Bay, Cape Carnot, D'Anville Bay, Liguanea Island: Diversity of phyla, and abundance of various sessile invertebrates in cave and ledge habitats (gorgonian corals, sponges, ascidians, crinoids, nudibranchs, reef gastropods and other molluscs). Sponges and ascidians also abundant on macroalgal-dominated reef habitats in Fishery Bay, and in parts of Sleaford Bay</p>

	<p>(these invertebrates form up to 25 - 40% of the understorey in some locations – Edyvane and Baker, 1999b and unpublished SARDI S.A. Benthic Survey data). A dense understorey of mixed hydroids and ascidians also occur on reefs at Liguanea Island.</p> <p>The islands of Avoid Bay (including Golden Island) have a very high diversity of ascidian species. There is an “extraordinarily rich” ascidian fauna in the caves around the islands (S. Shepherd, SARDI, pers. comm., 2004)</p> <p>Marine Mammals Coffin Bay National Park, Avoid Bay, Avoid Bay Isles: DEHAA (1999) reported 12 marine mammal species in the Coffin Bay National Park area, with at least six species of whale, two species of dolphins, and two species of pinniped are regularly recorded in the area.</p> <p>Estuarine, Coastal and Marine Birds Coffin Bay National Park and offshore islands: According to DEHAA (1999) and species lists in DEH (2004a), around 37 species of coastal and marine birds (including ocean-going seabirds and coastal wading birds) occur in the Coffin Bay National Park area. At least 16 coastal and seabird species have been recorded on the Avoid Bay islands, Whidbey group and Four Hummocks Islands (Robinson <i>et al.</i>, 1996). Seabird species have been described as “prolific” in the area (ATN, 2003).</p>
<p>7. Habitat for Endemic Taxa / Threatened Taxa / Rare or Uncommon Taxa</p>	<p>Bony and Cartilaginous Fish Southern Foot of Eyre Peninsula: Important area for Great White Sharks. Great White Shark was listed in IUCN’s Red List 2003 as <i>vulnerable</i> and <i>conservation dependent</i>, and is a protected species under South Australian and Commonwealth legislation.</p> <p>Coffin Bay National Park, Avoid Bay, Avoid Bay Isles (e.g. Golden I., Black Rocks); Four Hummocks Is., Price I., Perforated I., Greenly I., South Rocky I.: Presence of species of conservation concern (e.g. Leafy and Weedy Seadragons, Western Blue Groper, including large individuals, Blue-throated Wrasse and other Wrasse species; and Western Blue Devil). The reported status of, and potential threats to, these species are outlined in Section 9.2.</p> <p>Southern Eyre Peninsula: the south-western Australian anglerfish species <i>Allenichthys glauerti</i> has been found in the area. The species has rarely been recorded in South Australia (Baker, in press).</p> <p>Fishery Bay, Cape Wiles, Groper Bay, Cape Carnot, D’Anville Bay, Liguanea Island, southern coastal part of Lincoln National Park: Presence of fish species of conservation concern, such as: Leafy and Weedy Seadragons, Western Blue Groper, Blue-throated Wrasse and other Wrasse species, and Harlequin Fish (see section 9.2). Examples of locations where adult (including spawners) and juvenile Western Blue Groper are reported to occur, include reef between Point Sir Isaac and Altmona Beach; reef in the area from Shoal Point to Cape Catastrophe (e.g. Cape Rock, Cape Carnot, Liguanea Island, Cape Wiles, Wanna Stack, Cape Tournefort, Curta Rocks), and reef at Greenly Island, South Rocky Island, Four Hummocks Islands and Perforated Island (Bryars, 2003).</p> <p>The Knife-snout Pipefish <i>Hypselognathus rostratus</i> has been recorded in the area (e.g. Whidbey Islands) (museum records, cited in Baker, in press).</p> <p>Coffin Bay: The Javelin Pipefish <i>Lissocampus runa</i> has been found in the area (Australian Museum record, cited in Baker, in press). The species is not commonly recorded in South Australia, possibly due to lack of targeted searches in suitable habitat (Browne, 2004).</p> <p>Migratory pelagic species such as schools of Southern Bluefin Tuna occur in the waters off southern Eyre Peninsula. Southern Bluefin Tuna is recognised internationally (IUCN) and nationally (Commonwealth <i>EPBC Act 1999</i>) as a threatened species, and is a species of conservation concern in southern Australian states (see Pogonoski <i>et al.</i>, 2002; Baker, in press).</p> <p>Invertebrates Examples of taxa that may be endemic and/or limited in distribution within South Australia are provided below.</p>

- ♦ *Patiriella parvivipara*, the smallest sea-star in the world, also live bearing, was recorded from shallow pools on granite substrate, on western and **southern Eyre Peninsula (D'Anville Bay)** (Keough and Dartnall, 1978; Thomas, 1982). The sea-star has no planktonic larval stage, and narrow habitat limits, and is considered vulnerable to pollutants, especially hydrocarbons (Environment Australia, 1998).
- ♦ The nudibranch *Sclerodoris trenberthi* (a small species which grows to 4.5cm, and is golden red colour with pale spots) is considered *rare*, and is found only along **Southern Eyre Peninsula** (from Tumby Bay around to Elliston) (Burn, 1989).
- ♦ Ascidian species such as the colonial *Polyzoa nodosa*, the flat colonial *Distaplia tokioka*, and *Aplidiopsis sabulosa* (all three recorded from **Price Island**); *Ritterella papillata* and *R. cornuta* (both also known only from the type specimens, taken at **Price Island**), and *Ritterella compacta* (from Flinders Island, **Price Island** and southern Spencer Gulf) (Kott, 1997; Australian Government Department of the Environment and Heritage, 2004b).

Marine Mammals

Coffin Bay National Park and Islands, Avoid Bay and Islands, Four Hummocks

Islands, Lincoln National Park Islands: Haul out sites for Australian Sea Lions at Greenly I., Rocky I. South, Four Hummocks Is. South and Central, Four Hummocks Little North East, Four Hummocks North, Golden I., Cape Rock, Low Rock, Price I., East I., Point Avoid and Avoid Bay Isles, Sudden Jerk I. and Black Rocks, and Liguanea Island. Breeding colonies of Australian Sea Lion at Four Hummocks North, Price I. and Liguanea I. (Gales et al., 1994; Robinson et al., 1996; Shaughnessy et al., 1997; S.A. Coast and Marine Atlas, 2001; Shaughnessy, 2002). In 1996, Shaughnessy et al. (1997) estimated pup production to be around 25 animals at **Price Island**, and 11 at **Four Hummocks North**. In 1990, Gales et al. (1994) estimated pup production to be 23 pups at **Liguanea Island**. Collectively, the islands off southern Eyre Peninsula are an important breeding region for this species. Australian Sea Lion is listed as *rare* (S.A. *National Parks and Wildlife Act*), and considered by some researchers to be threatened (e.g. Gales, 1990; Gales et al., 1994). Australian Sea Lion populations are not increasing in SA; the species does not breed annually (unlike other pinnipeds), and pup mortality rates can be high in some areas (CSIRO media releases, 1998 and 2000b; Shaughnessy, 2001b).

Coffin Bay National Park, Avoid Bay, Avoid Bay Isles, Sleaford Bay and other parts of the Lower Eyre Peninsula:

Presence of Southern Right Whale, particularly during winter, as they migrate to breeding grounds at the head of the Great Australian Bight (DEHAA, 1999). **Sleaford Bay**, and the waters approximately 5km east and west of the bay, comprise a particularly significant area for this species during breeding season (Burnell and McCulloch, 2001). There are regular reports of Southern Right Whales (often cow with calf) passing **Coffin Bay Peninsula** and offshore islands between August and December (Preece, 1985, cited by Morelli and de Jong, 1995). The Southern Right Whale was listed in the IUCN Red List (2003) as *conservation dependent*; it is listed as *vulnerable* under S.A. legislation; and is also listed under the Commonwealth's *EPBC Act 1999*, as a threatened species.

The lower Eyre Peninsula is considered to be seasonally used by a high number of cetaceans. Thirteen species are known to occur in the region, some seasonally (such as Southern Right Whales, Humpback Whales, Minke Whales), some year-round (Bottlenose and Common Dolphins, possibly Pygmy Right Whales), and some from records only (Kemper, S.A. Museum, pers. comm., cited by Aquaculture Group – PISA Fisheries, 1997). Humpback Whale was listed in the IUCN Red List 2003 as *vulnerable*, and is also listed under South Australian and Commonwealth legislation as *vulnerable*. Minke Whale is listed by the IUCN Red List 2003 as *near threatened*. Pygmy Right Whale is listed as *rare* under S.A. legislation. Examples of whale species recorded (mainly from beach strandings) along the **Coffin Bay Peninsula** and other parts of southern Eyre Peninsula include Southern Bottlenose Whale *Hyperoodon planifrons* (*Rare* under S.A. legislation), Strap-toothed Whale *Mesoplodon layardii* and Long-finned Pilot Whale *Globicephala melas* (Kemper and Ling, 1991; Morelli and de Jong, 1996). Examples of areas along southern Eyre Peninsula where frequent sightings of whales have been made include **Sleaford Bay** and **Coffin Bay** (Kemper, S.A. Museum, pers. comm., cited by Aquaculture Group – PISA Fisheries, 1997), and the Coffin Bay Peninsula in general (DEHAA 1999b, 1999c). Irregular strandings include species listed as *rare* under South

Australian legislation, such as Sperm Whale, Pygmy Sperm Whale and Minke Whale (Kemper and Ling, 1991), all of which are also included in the IUCN Red List as threatened or potentially threatened species. Reports during the 1830s of 'a great number of whales' in the Sleaford Bay area led to a short-lived whaling industry in the area (Hosking, 1973, cited by Staniforth, 1999).

Fishery Bay, Cape Wiles, Groper Bay, Cape Carnot, D'Anville Bay, Liguanea

Island: Presence of threatened Southern Right Whale (Groper Bay, Fishery Bay, Sleaford Bay) (DEHAA, 1999; S.A. Museum reports, and regional tourism promotion materials). Southern Right Whale was listed in the IUCN Red List 2003 as *Conservation Dependent*, and is classified as a threatened species under both South Australian and Commonwealth legislation.

Coffin Bay Peninsula: The Leopard Seal *Hydrurga leptonyx* has occasionally been recorded (Morelli and de Jong, 1995). The species occurs mainly in Antarctic waters and sightings in S.A. represent stray individuals. *H. leptonyx* is listed as Rare under S.A. legislation.

Coastal and Marine Birds

Coffin Bay National Park, Avoid Bay, Southern Eyre Peninsula coastline and

offshore islands: Bird species that are considered to be "rare or threatened either locally or more widespread" (DEHAA, 1999b, 1999c) and recorded along southern Eyre Peninsula and islands (Robinson *et al.*, 1996; DEHAA, 1999b, 1999c) include:

- ♦ Swamp Harrier;
- ♦ Peregrine Falcon (*rare* under S.A. legislation);
- ♦ White-bellied Sea Eagle (*vulnerable* under S.A. legislation); and Osprey (*rare* under S.A. legislation). White-bellied Sea Eagle and Osprey are considered to be "generally uncommon" in South Australia, but moderately common in the southern Eyre Peninsula area (DEHAA, 1999b and 1999c; ATN, 2003). Both are considered vulnerable to human disturbance, and are considered to be potentially threatened species. The **Coffin Bay Peninsula** provides breeding and nesting areas for both White-bellied Sea Eagle and Osprey. Both species have also been reported at the **Whidbey Isles Conservation Park**, and in **Kellidie Bay Conservation Park** (Australian Heritage Commission, undated). White-bellied Sea Eagles also breed at **Greenly Island**, and are found at the **Four Hummocks** islands. **Perforated Island** and **Wanna Stacks** are both known breeding areas for Osprey (Robinson *et al.*, 1996). The availability of undisturbed coastal cliff habitats and rocky islands offshore makes the **Coffin Bay Peninsula** an important breeding refuge for these species (DEHAA, 1999b and c; Australian Heritage Commission, undated).
- ♦ Rock Parrots (which have a coastal association, and often nest in the spray zone) are found at **Liguanea Island** and **Wanna Stacks**, and also the inner (e.g. **Golden Island**), middle (e.g. **Perforated Island**) and outer **Whidbey Group** isles. Also breed at **The Brothers (Coffin Bay)**. The Rock Parrot is listed as *rare* under S.A. legislation.
- ♦ The Cape Barren Goose breeds on some of the **Southern Eyre Peninsula islands**, (e.g. all of the **Four Hummocks**, and **Liguanea Island**), and is also found within parts of **Coffin Bay** (e.g. **Kellidie Bay**, and **The Brothers**). South Australian populations of Cape Barren Goose have been severely depleted last century due to hunting, and island locations are now a refuge for restoring population numbers. The Cape Barren Goose has been described as the *second rarest goose species in the world* (Australian Heritage Commission, undated), and is listed as *rare* under S.A. legislation.
- ♦ Hooded Plover: There are breeding sites along the beaches of the **Coffin Bay Peninsula**, such as **Seven Mile Beach** (Australian Heritage Commission, undated; DEH, 2000c). Hooded Plover is listed under S.A. legislation as a *vulnerable* species
- ♦ Fairy Tern: A large colony breeds on **Seal Rock**, off **Greenly Island**. Fairy Tern is listed as *vulnerable* under S.A. legislation;
- ♦ Latham's Snipe: (*vulnerable* under S.A. legislation);
- ♦ Musk Duck: in the Coffin Bay system (*rare*, under S.A. legislation);
- ♦ Banded Land Rail (Banded Rail, Buff-banded Rail): found in parts of the **Coffin Bay Peninsula**, and also nests / breeds at the **Brothers Islands, Rabbit Island**, and

	<p>North Island (Mt Dutton Bay). Generally uncommon in S.A., according to the Australian Heritage Commission (undated).</p> <ul style="list-style-type: none"> ♦ Eastern Reef Egret: breeds at The Brothers and Rabbit Island, and also found on Goat Island, in small limestone caves or ledges which are screened by vegetation (Morelli and de Jong, 1995; Robinson et al., 1996). Eastern Reef Egret is listed as <i>rare</i> under South Australian legislation. ♦ Albatrosses and Petrels are described as a “common sight” along the coast of the Coffin Bay National Park (ATN, 2003). Albatross and Petrel species are highly migratory, and some are listed by the Commonwealth (under the <i>EPBC Act 1999</i>), and in the IUCN Red List 2003, as threatened species. <p>Lincoln National Park and Islands: Breeding colonies of rare and/or threatened seabirds at coast and island sites e.g. White-bellied Sea Eagle – <i>vulnerable</i> under S.A. legislation; Osprey - <i>rare</i>.</p> <p>Whidbey Group Islands: There is a suspected breeding population of the migratory Flesh-footed Shearwater, which is listed as <i>rare</i> under South Australian legislation. The evidence is based upon characteristic burrows likely to belong to Flesh-footed Shearwaters (e.g. on Perforated Island), however breeding birds have not yet been found during irregular surveys of the islands (Robinson <i>et al.</i>, 1996).</p> <p>Marine Reptiles Leathery Turtles (LeatherbackTurtles) are seen regularly in Port Douglas and Mount Dutton Bay in late summer (Morelli and de Jong, 1995). Leatherback Turtle was listed under the IUCN Red List 2003 as <i>critically endangered</i>, and is also listed under Commonwealth and South Australian legislation, as <i>vulnerable</i>.</p> <p>Other Sleaford Mere: Presence of coastal stromatolite mounds (uncommon in South Australia) at Sleaford Mere, an enclosed, shallow salt lake, separated from Sleaford Bay by an approximate 100m wide stretch of sand dunes (Australian Heritage Commission, undated; Reynolds, 1999; Edyvane and Nias, undated, cited in Edyvane, 1999b). A large number of invertebrates and macroalgae, and a smaller number of fish species, that occur in the Southern Eyre Peninsula region are endemic to southern Australia, but quantification is not possible for this report.</p>
<p>8. Other Important Taxa</p>	<p>Marine Plants Coffin Bay National Park, Avoid Bay, Avoid Bay Isles: Abundant coralline red macroalgal cover which has been hypothesised to be important habitat for larval abalone (Shepherd and Daume, 1996; Daume <i>et al.</i>, 1997).</p> <p>Bony and Cartilaginous Fish Reef between Point Sir Isaac and Altmona Beach; reef in the area from Shoal Point to Cape Catastrophe (e.g. Cape Rock, Cape Carnot, Liguanea Island, Cape Wiles, Wanna Stack, Cape Tournefort, Curta Rocks, West Point, Williams Island), and reef at Greenly Island, South Rocky Island, Four Hummocks Islands and Perforated Island: The areas are used by one or more of the life stages of the following commercially and/or recreationally significant fish species: King George Whiting, Snapper, West Australian Salmon, Tommy Ruff, Yellow-eye Mullet, Trevally, Yellow-tail Kingfish, Leatherjacket species, Snook, Western Blue Groper, Blue-throated Wrasse and other Wrasse species, Sea Sweep, Silver Drummer; Gummy Shark and Whaler Sharks (Bryars, 2003).</p> <p>Surf beaches between Point Sir Isaac and Point Whidbey; Avoid Bay; Altmona Beach / Gunyah Beach; at Shoal Point, and in Sleaford Bay: The areas are reported to be used by one or more of the life stages of the following commercially and/or recreationally significant fish species: School Whiting, West Australian Salmon; Tommy Ruff, Yellow-eye Mullet, flathead species, School Shark and Gummy Shark (Avoid Bay and Altmona Beach area) and Whaler Sharks (Bryars, 2003).</p> <p>Unvegetated soft bottom habitats between Point Sir Isaac and Altmona Beach, (including Black Rocks, Golden Island, Price Island); at Shoal Point, and at Greenly Island, South Rocky Island, Four Hummocks Islands and Perforated Island: The areas are used by one or more of the life stages of the following</p>

	<p>commercially and/or recreationally significant fish species: King George Whiting, School Whiting, Snapper, West Australian Salmon; Tommy Ruff, Yellow-eye Mullet, flathead species, Trevally, Snook, School Shark and Gummy Shark (mainly inshore - Point Sir Isaac to Altmona Beach area) and Whaler Sharks (Bryars, 2003).</p> <p>Sheltered beach habitats (e.g. Seasick Bay and Avoid Bay area): The areas are used by one or more of the life stages of the following commercially and/or recreationally significant fish species: King George Whiting, School Whiting, West Australian Salmon; Tommy Ruff, Yellow-eye Mullet, flathead species, flounder species, and Whaler sharks (Bryars, 2003).</p> <p>Coffin Bay: The shallow, sheltered habitats of the the Coffin Bay system are important habitats for juveniles and adults of various fish species, such as King George Whiting, young Australian salmon (Salmon "Trout"), Sand Whiting, Tommy Ruff, Snook, Garfish, flathead species, and flounder species. The area also provides habitat for sharks (e.g. Gummy Shark, Whaler sharks) and rays (e.g. Eagle Ray and Fiddler Ray).</p> <p>It is noted that there is a museum record of a dead Blue Shark (2.5m long) with 23 pups, found on a samphire swamp in Yangie Bay, a shallow estuary connected with Coffin Bay (S.A. Museum data, 1991, cited in Baker, in press). Blue Sharks are oceanic, and rarely come in to shallow waters in South Australia.</p> <p>Invertebrates</p> <p>Coffin Bay: The significance of the bay for macro-invertebrates such as Sand Crabs, octopus and Scallops, is discussed in the following section, on Notable Feeding, Breeding / Spawning and Nursery Areas. It is noted that previously, during the late 1800s and early 1900s, the area was also a significant habitat for Native Oysters, populations of which declined by about 1930, due to over-fishing, and dredging of the bay for transport etc.</p> <p>Reef between Point Sir Isaac and Altmona Beach; reef in the area from Shoal Point to Cape Catastrophe (e.g. Cape Rock, Cape Carnot, Liguanea Island, Cape Wiles, Wanna Stack, Cape Tournefort, Curta Rocks, West Point, Williams Island), and reef at Greenly Island, South Rocky Island, Four Hummocks Islands and Perforated Island: The areas are reported to be used by one or more of the life stages of the following commercially and/or recreationally significant invertebrate species: Southern Rock Lobster, Southern Calamari, Giant Cuttlefish, Maori Octopus, Greenlip and Blacklip Abalone, and Purple Sea Urchin (Bryars, 2003).</p> <p>Surf beaches between Point Sir Isaac and Point Whidbey, and at Avoid Bay, Shoal Point and Sleaford Bay, are reported to provide habitat for Sand Crabs and bait worm species (Bryars, 2003). These species are also listed as occurring in the Altmona Beach / Gunyah Beach area, which also reportedly provides habitat for Goolwa Cockles (Bryars, 2003). Sheltered beach areas (e.g. Seasick Bay, Avoid Bay area, Fishery Bay and Williams Island) also are also reported to be used by Sand Crabs and bait worm species (Bryars, 2003).</p> <p>Unvegetated soft bottom / sand habitats between Point Sir Isaac and Altmona Beach, (including Black Rocks, Golden Island, Price Island); at Shoal Point; Sleaford Bay; Cape Catastrophe, Greenly Island, South Rocky Island, Four Hummocks Islands, and Perforated Island, are reported to provide habitat for Sand Crabs and Southern Calamari (Bryars, 2003).</p> <p>Sleaford Mere Conservation Park: "Land-locked population of skates" (Australian Heritage Commission, undated), which reportedly reside in the shallow salty waters of Sleaford Mere, behind the Sleaford Bay dunes.</p> <p>Coffin Bay National Park, Avoid Bay, Avoid Bay Isles, Liguanea Island: Relative abundance of hydroid species (Edyvane and Baker, 1999b; SARDI S.A. Benthic Survey data, 1994 and 1995).</p> <p>Point Avoid and associated islands, Fishery Bay and Groper Bay Areas: Previous (1970's and 1980s) existence of high abundance of Greenlip Abalone (Shepherd and Rodda, 2001; Shepherd <i>et al.</i>, 2001; S. Shepherd, pers. comm., 2000).</p> <p>Marine Mammals</p> <p>Southern Eyre Peninsula Islands: Haul-out sites for New Zealand Fur Seals at Greenly Island, Rocky Island South, Little Hummock Island, Four Hummocks Islands North and South, Cape Rock, Cape Wiles and Liguanea Island. Also, haul-out sites for the New Zealand Fur Seal along some parts of Coffin Bay National Park coast (e.g. Point</p>
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	<p>Avoid (Robinson <i>et al.</i>, 1996; Shaughnessy <i>et al.</i>, 1997; Aquaculture Group - PISA Fisheries, 1997; DEHAA, 1999b, 1999c; S.A. Coast and Marine Atlas, 2001; Shaughnessy, 2002). The New Zealand Fur Seal was classified in the IUCN Red List 2000 as <i>Lower Risk, but Conservation Dependent</i>, but was not included in the IUCN Red List 2003.</p> <p>Coffin Bay system (also including Port Douglas, Mount Dutton Bay, Kellidie Bay, Yangie Bay, Avoid Bay, Avoid Bay Isles and other parts of Southern Eyre Peninsula): Common Dolphins and Bottlenose Dolphins are regularly recorded in waters off the Coffin Bay Peninsula, and Bottlenose Dolphins also utilise the sheltered waterways of Coffin Bay and the associated inner bays (Kemper and Ling, 1991; ANCA, 1996; J. Baker, pers. obs., 1995; Aquaculture Group – PISA Fisheries, 1997; DEHAA 1999b, 1999c). IUCN Red List 2003 classified the Bottlenose Dolphin as <i>Data Deficient</i>.</p> <p>Coastal and Marine Birds</p> <p>Coffin Bay National Park, Avoid Bay, Avoid Bay Isles: Breeding and stopover sites for coastal and marine birds, including the White-faced Storm Petrel, Little Penguin, Short-tailed Shearwater, Silver Gull and Pacific Gull, Crested Tern, Red Capped Plover, Hooded Plover, Sooty Oystercatcher, White-faced Heron, and Brown Falcon (Robinson <i>et al.</i>, 1996). Pied Oystercatcher, Hooded Plover and Red-capped Plover breed on the beaches of southern Eyre in summer (DEHAA 1999b, 1999c). Australian Shelduck also seasonally visit the coastal waterholes of the park.</p> <p>Many of the forementioned species, including Short-tailed Shearwater, Pacific Gull, Silver Gull, and Sooty Oystercatchers are also found the Four Hummocks</p> <p>Rocks north of North Curta Rock: A breeding site for the Crested Tern.</p> <p>Greenly Island: A breeding site for Pacific Gull, White-faced Heron and Short-tailed Shearwater.</p> <p>South-East Island (Mt Dutton Bay): Roosting area for seabirds, including a flock of about 200 Pied Cormorants (Robinson <i>et al.</i>, 1996).</p> <p>South-West Island (Mt Dutton Bay): Nesting / roosting area for coastal birds and seabirds, including Pied Oystercatchers and Sooty Oystercatchers, Little Pied Cormorants, and Sacred Kingfisher; and feeding area for Red-capped Plovers, Red-necked Stints and Grey Plovers (Robinson <i>et al.</i>, 1996).</p> <p>Lincoln National Park / Sleaford Mere: presence of coastal wading birds in this region (e.g. Sleaford Mere Conservation Park) (Australian Heritage Commission, undated).</p> <p>Southern Area of Lincoln National Park and associated islands: Nesting sites for the Osprey, White-bellied Sea Eagle, Short-tailed Shearwater and Cape Barren Goose. Sooty Oystercatchers, White-faced Herons, Silver Gulls, Pacific Gulls and Crested Terns also occur in the area (e.g. Liguanea Island, and Wanna Stacks) (Australian Heritage Commission, undated; Copley, 1995 and 19996; Robinson <i>et al.</i>, 1996).</p> <p>Other</p> <p>Perforated Island (Whidbey Group) and Greenly Island (both northern and southern sections) and Liguanea Island support colonies of Native Bush Rats, which have a coastal association, and have been recorded feeding (and possibly nesting) in piles of cast-up macroalgae and other marine debris, on other South Australian islands (Robinson <i>et al.</i>, 1996).</p> <p>Yangie Bay: At high tide, Western Grey Kangaroos swim across the relatively deep channel from Yangie Bay to Yangie Bay Island (Robinson <i>et al.</i>, 1996).</p>
<p>9. Notable Feeding, Breeding / Spawning and Nursery Areas</p>	<p>Marine Mammals</p> <p>Coffin Bay National Park and Islands, Avoid Bay, Lincoln National Park Islands: Nationally and/or locally significant breeding and haul out sites for Australian Sea Lions at: Greenly Island, Rocky Island South, Four Hummocks Island South and Central, Four Hummocks North and Liguanea Island (Gales, 1990; Gales <i>et al.</i>, 1994; Edyvane, 1999b; S.A. Coast and Marine Atlas, 2001; Shaughnessy, 2002). This area also contains foraging sites for New Zealand Fur Seals (Shaughnessy, 1990, 1997, 2002; Shaughnessy <i>et al.</i>, 1994).</p> <p>Breeding colonies of New Zealand Fur Seals at Greenly Island, Rocky Island South, Little Hummock Island and Liguanea Island (Robinson <i>et al.</i>, 1996; Shaughnessy <i>et al.</i>, 1997; Shaughnessy, 2002).</p>

Coffin Bay waterways: Feeding, breeding, calving and nursery area for Bottlenose Dolphins (Australian Heritage Commission, undated).

Bony and Cartilaginous Fish

Southern Eyre Peninsula coastline: High abundance of Pilchards (that are a significant food chain / food web species) associated with nutrient-rich upwelling (Ward and McLeay, 1998; Ward *et al.*, 2000). Pilchards are a major food source for predatory fish such as Australian Salmon, which feed outside the major surf beaches of southern Eyre Peninsula. The importance of Pilchards in the marine food web of southern Eyre Peninsula is discussed above (see section on **Relative Productivity**).

Reefs along **southern Eyre Peninsula** and associated islands, are reported to provide nursery areas for juvenile Sea Sweep and Western Blue Groper, and surf beaches in the area are reported to be nursery areas for juvenile School Whiting (Bryars, 2003).

Southern Eyre Peninsula bays (e.g. **West Point to Cape Wiles**, including **Sleaford Bay**): Habitat for pregnant female School Sharks, and School Shark pups, and also a breeding area for Gummy Sharks (AFMA, 2002).

Several sites in **Coffin Bay** provide nursery areas for scalefish species such as King George Whiting (Jones *et al.*, 1990; Morelli and de Jong, 1995) and young flathead (e.g. **Port Douglas Bay**)

Invertebrates

Coffin Bay National Park, Avoid Bay, Avoid Bay Isles: An important habitat for Rock Lobster, Greenlip and Blacklip Abalone (Aquaculture Group – PISA Fisheries, 1997, and also evident in catch data from the area - see **Notes on Social and Economic Values and Uses**). Examples include the **Coffin Bay Peninsula**, and **Whidbey Isles** for Abalone (Aquaculture Group - PISA Fisheries, 1997), and the **Cape Carnot, Cape Wiles, Fishery Bay** area for Greenlip Abalone in particular. **Avoid Bay** previously contained a large population of Greenlip Abalone (the collapse of which was described by Shepherd *et al.*, 2001). Areas in the vicinity of **Coffin Bay National Park, Avoid Bay, Avoid Bay Isles** contain abundant coralline red algal cover (Edyvane and Baker, 1999b; SARDI S.A. Benthic Survey data, 1994 and 1995), which has been hypothesised to be important habitat for larval abalone (Shepherd and Daume, 1996; Daume *et al.*, 1997). Important Rock Lobster habitats (as evidenced by fishing effort concentration) include the **Coffin Bay Peninsula**, the **Whidbey Isles**, **Rocky Island**, **Greenly Island**, and **Cape Carnot** (Aquaculture Group - PISA Fisheries, 1997).

Coffin Bay is a nursery area for Western King Prawns. Deeper waters **out of Coffin Bay**, between Reef Point and Drummond Point, are important habitat for adult Western King Prawns (as shown by recent catch data – see Svane and Barnett, 2004). It is noted that prawns from further north-west (i.e. Ceduna area) also migrate southwards into the Coffin Bay prawn grounds, as evidenced by a recent tagging study (reported in Svane and Barnett, 2004).

Coffin Bay: The shallow sand and seagrass habitats in the Coffin Bay system provide important nursery and feeding habitat for Sand Crabs, Mud Cockles, and species of Scallop. Although Sand Crabs are widespread throughout South Australia, **Coffin Bay** is one of the most important areas in South Australia for this species, in terms of abundance (e.g. see Westlake and Jones, 1999; Westlake *et al.*, 2002). Scallops (*Pecten*, *Equichlamys* and/or *Mimachlamys*) were previously abundant in **Coffin Bay**, however the populations have been much reduced, due to excess fishing and micro-algal blooms problems in the bay (see section **9.2**). Mud Cockles were previously abundant in **Coffin Bay**, however the population collapsed during the 1990s, considered with high likelihood to be caused by over-fishing (Fowler and Jones, 1997).

Deeper waters out of Coffin Bay: An important breeding area for Sand Crabs. According to Westlake and Jones (1999), a breeder index as high as 68% was recorded for crabs in offshore waters in 1998/99.

Coffin Bay: An important habitat for octopus species, which appear to be abundant in the area, according to commercial catch records.

Coastal and Marine Birds

	<p>Southern Eyre Peninsula coast: Major feeding area for seabirds, which utilise baitfish such as Pilchards as a major food source. According to Mackie (PISA, 1995), seabirds such as Crested Terns, Little Penguins and Australian Gannets are known to feed on Pilchards, as a major dietary item.</p> <p>Coffin Bay National Park and Southern Eyre Peninsula coastline: The sandy beaches of the Coffin Bay Peninsula are considered to be important summering sites for migratory Sanderlings <i>Calidris alba</i> (Morelli and de Jong, 1995). Also, Pied Oystercatcher, Hooded Plover and Red-capped Dotterel all breed on the beaches of the Coffin Bay Peninsula and southern Eyre coast in summer (DEHAA, 1999b, 1999c).</p> <p>Coffin Bay National Park, Avoid Bay, southern Eyre Peninsula coastline and offshore islands: The availability of undisturbed coastal cliff habitats and rocky islands offshore makes the Coffin Bay Peninsula a significant breeding refuge for the White-bellied Sea Eagle and Osprey (Morelli and de Jong, 1995; Australian Heritage Commission, undated; DEHAA, 1999b, 1999c).</p> <p>South and North Curta Rocks, North, Central and South Four Hummocks Islands, Perforated Island, Golden Island, Price Island, Liguanea Island, Greenly Island, Avoid Island; Black Rocks (Whidbey Group): Breeding sites for the Short-tailed Shearwater, with significant populations recorded by NPWSA survey during the 1980s, at some islands i.e. Liguanea (21,330 birds), Perforated (14,220 birds), Price (8532 birds), Curta Rocks (4642 birds), and lesser numbers on other southern Eyre islands (Robinson <i>et al.</i>, 1996).</p> <p>South and North Curta Rocks, South Four Hummocks Island, Price Island, Avoid Island, Black Rocks (Whidbey Group): Breeding populations of the White-faced Storm Petrels: Curta Rocks (6700 birds), Price Island (3900 birds) (SA Coast and Marine Atlas, 2000; Robinson <i>et al.</i>, 1996).</p> <p>The Brothers Islands (Coffin Bay): considered to be a major local breeding area for Crested Terns, Caspian Terns, Pacific Gulls and Silver Gulls (Robinson <i>et al.</i>, 1996). There are breeding areas for Little Penguins at Rabbit Island (Coffin Bay), Liguanea, North Curta and South Curta Rock, Greenly Island, Avoid Island, Black Rocks (Whidbey Group) (Robinson <i>et al.</i>, 1996).</p> <p>Lincoln National Park and Islands: Breeding colonies of seabirds at coast and island sites (e.g. Short-tailed Shearwater, White-faced Storm Petrel).</p> <p>Sleaford Mere: Breeding area for Chestnut Teal (Australian Heritage Commission, undated).</p>
<p>10. Shipwrecks and Artificial Reefs</p>	<p>There are few shipwrecks that have been found along the southern Eyre coast (see section on Social and Economic Values). Due to the rough nature of this coast, it is likely that most of the known shipwrecks have broken up, and therefore their significance as additional habitat in this area is likely to be low. Artificial reefs are not recorded as occurring in this area.</p>
<p>11. Popular Dive Sites</p>	<p>The few accessible dive sites along the southern Eyre Peninsula are noted for their variable topography (sheltered coastal lagoons surrounded by cliffs, sea caves, crevices, “grottos”, overhangs, “rocky cavernous bottom” with lots of “holes” etc), variety of reef fish (large Western Blue Groper, Seaperch species, Swallowtail, Scalyfin, Harlequin Fish, Dusky Morwong, Western Blue Devil, Western Foxfish, Redfish, Wrasses, Zebra Fish, Blue Morwong, amongst others), fur seals, abundant sessile invertebrates (particularly ascidians, gorgonian corals, sponges, crinoids), nudibranchs, reef molluscs and Rock Lobster. Examples of dive sites with some or all of these features include Wanna, Redbanks (and other sites around Whalers Way), “The Swimming Pool”, Cape Wiles (where there is a protected “lagoon” surrounded by cliffs), Fishery Bay, Liguanea Island, and Groper Bay (Christopher, 1988; DIASA, undated; Wyschnja, 2000; Aquanaut, undated).</p>
<p>12. National and/or International Importance</p>	<p>Whidbey Islands and Greenly Island Conservation Parks are on the <i>Register of the National Estate</i>. The Whidbey Islands are noted on this Register for their “diverse seabird community” including breeding populations of Short-tailed Shearwaters, Fairy Penguins, and Rock Parrrots; habitat for threatened species such as White-bellied Sea Eagle and Osprey; breeding populations of New Zealand Fur Seal and Australian Sea Lion. The islands are also recognised for their pristine condition, and high scenic value. The Whidbey Islands Conservation Park contains Golden Island, Price Island, Perforated Island and</p>

	<p>three of the four islands in the Four Hummocks Islands group (the southernmost is a lighthouse reserve, and is not included in the park). Similar marine values apply to the high Greenly Island, which supports seabird colonies, and colonies of Australian Sea Lion and New Zealand Fur Seal. Greenly Island and Perforated Island also support colonies of Native Bush Rats. The Island is also recognised for its spectacular form, although the cover of Greenly Island has been degraded, the island is not considered pristine (Australian Heritage Commission, undated).</p> <p>The coastal outcrops of rocks on southern and south-eastern Eyre Peninsula area considered to be of international geological significance, particularly the area from Whalers Way – Fishery Bay to Cape Carnot (unreferenced, cited in Edyvane and Nias, undated). Cape Carnot as been recognised as a geological “monument” (Fanning et al., 1979). The Cape Carnot rock outcrops are listed on the <i>Register of the National Estate</i>. The rocks constituting Cape Carnot are amongst the oldest known in South Australia. Their age is early Proterozoic / Archaean (2400 million years bp), and the rocks consist of granulites and gneisses showing folded layering. The structures, textures and mineralogy of these rocks indicate that they have been subjected to extremes of metamorphism and chemical change. The Cape Carnot Rocks are the most easterly outcrop of Archaean rock in Australia; also the most accessible and well preserved amongst the three only other areas in South Australia (Fanning, 1975; Cooper et al., 1976; Fanning et al., 1979; Australian Heritage Commission, undated).</p> <p>Kellidie Bay Conservation Park and the islands of the Mount Dutton Bay Conservation Park are listed on the <i>Register of the National Estate</i>. Coastal and marine features in Kellidie Bay that contribute to the listing include the coastal vegetation (including tea tree, and coastal swamps with sedges), and the habitat for White-bellied Sea Eagles, Ospreys, and Cape Barren Geese. Mount Dutton Bay Conservation Park consists of The Brothers, Rabbit Island, Goat Island, two unnamed islands off the south east end of Horse Peninsula, and one unnamed island at the northern end of Mount Dutton Bay, about 0.5km off shore from Mount Dutton Bay West. The Park is recognised by the Australian Heritage Commission for its significance as a breeding and nesting area for coastal birds, including Sooty Oystercatcher, Little Penguin, Crested Tern, Caspian Tern, Pacific Gull, Silver Gull, Rock Parrot, and the Eastern Reef Heron. All five species of cormorant utilise the islands, including large roosting colonies of Black-faced Cormorant and Large Pied Cormorant.</p> <p>Coffin Bay is listed as an <i>Indicative Place</i> on the Register of the National Estate (N.B. <i>Features of significance are listed in other parts of this table</i>).</p> <p>Coffin Bay wetlands have been identified as areas of international importance for shorebirds (Watkins, 1993, cited by Morelli and de Jong, 1995).</p>
<p>13. Major Commercial and Recreational Fish, Sharks, Molluscs and Crustaceans</p>	<p>Some of the commercially and/or recreationally fished species that occur in Southern Eyre Peninsula (including deeper waters further offshore) include the following:</p> <p><i>Fish</i>: Ocean Leatherjacket (mainly commercial), Pilchard (mainly commercial), Australian Salmon, Jackass Morwong (deeper water, commercial), Blue-eye Trevalla (deeper water, commercial), Southern Bluefin Tuna (deeper waters, commercial); King George Whiting (particularly in Coffin Bay); Garfish, Tommy Ruff, Trevally, Long-finned Pike and Mullet (Coffin Bay); various Wrasse species (e.g. Blue Groper, Blue-Throated Wrasse and other reef species); Redfish (Red “Snapper”); Yellowtail Kingfish, Samson fish, Conger Eel (NB both Redfish and Conger Eel are often found in or near reefs and caves); Southern Blue Morwong; Snapper; Sweep; Boarfish; Silver Drummer; Striped Trumpeter (caught incidentally in the Coffin Bay area),</p> <p><i>Sharks and Rays</i>: School Shark, Gummy Shark, Bronze Whaler and/or Black Whaler, Saw Shark, other Shark species, various species of rays and skates (species not known for this report).</p> <p><i>Invertebrates</i>: Southern Rock Lobster, Greenlip and Blacklip Abalone (major invertebrates on the exposed southern side of southern Eyre Peninsula), and Giant Crabs (deeper waters). Sand Crabs, Scallops, Mud Cockles, Octopus, and Rock Crabs</p>

	are some of the major invertebrates in the shallower, less exposed bays (mainly Coffin Bay). Southern Calamari and Giant Cuttlefish also occur in the area, but not in large numbers.
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8.15 The "Heel" of Yorke Peninsula (Gulf St Vincent Bioregion)

Figure 17 depicts the location of this area.

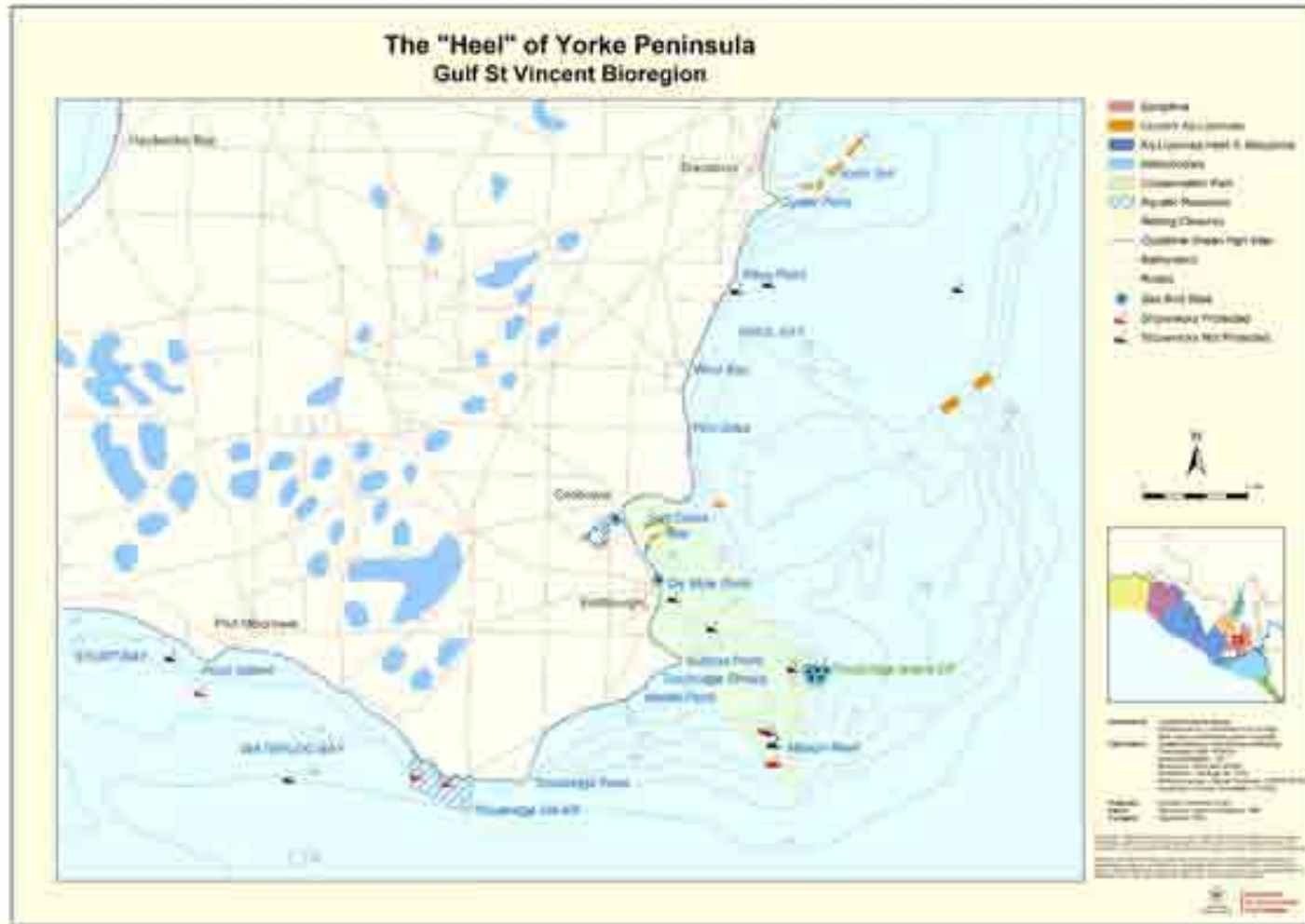


Figure 17: The "Heel" of Yorke Peninsula

1. Biogeographic Significance	<p>Features of outstanding biogeographic significance are currently not known for this area.</p>
2. Major Physical Influences, and Relative Productivity Level	<p>Major Physical Influences</p> <p>“Heel” of Yorke Peninsula / Troubridge Shoals / Marion Shoals</p> <ul style="list-style-type: none"> ♦ The region is one of strong tidal current flow, and the area is also subject to strong wind-induced waves, both of which influence the benthic topography and biota of the region (described in various sections below). ♦ Current maps in the S.A. Coast and Marine Atlas (DTUP, 2001, data by P. Petrusevics), show that the eastern Investigator Strait region is one of 8 areas in coastal South Australian area in which current strengths are strongest, particularly in winter, and the zone of influence extends to the “heel” of Yorke Peninsula, and into south-western Gulf St Vincent. The Edithburgh area and surrounds experience relatively strong current speeds for most of the year. ♦ The wind-driven and density-induced water flows in the Troubridge area, move north-easterly into Gulf St Vincent (Bye, 1976; Shepherd <i>et al.</i>, 1976). ♦ Tidal action is responsible for erosion in the area, and the transport of large quantities of fine carbonate material into the gulf (Shepherd and Sprigg, 1976). <p>Relative Productivity</p> <p>No specific information on productivity is available for this area, for this report, however the following is noted as relevant:</p> <ul style="list-style-type: none"> ♦ “Heel” of Yorke Peninsula / Troubridge Shoals / Marion Shoals: The wind-driven and density-induced water flows in the Troubridge area, that move north-easterly into Gulf St Vincent (Bye, 1976), carry sediments, nutrients and larvae into the gulf system (e.g. see Shepherd <i>et al.</i>, 1976; Petrusevics, 1991). ♦ Northern Investigator Strait: The seagrass meadows of Investigator Strait and the heel of Yorke Peninsula are a significant contributor to the total primary productivity of the region, in terms of plant biomass production and nutrient recycling. They also have an important role in stabilising existing sediments, and promoting new sediment production (i.e. the seagrass blades baffle wave action, and reduce water movement, so that fine suspended particles settle out, and are trapped by the root mesh of the seagrass. The sediments associated with the Investigator Strait seagrass meadows consist of carbonate skeleton debris from epiphytic coralline algae, bryozoa, molluscs and foraminifera, and aggregates of aragonite and quartz grains (Shepherd and Sprigg, 1976). The seagrass meadows of northern Investigator Strait and the heel of Yorke Peninsula, though provision of habitat, are also a major contributor to the productivity of scalefish and prawns in the region (Jones <i>et al.</i>, 1990; Edyvane, 1996b; DENR, 1997).
3. Bioregional Representativeness of Habitat	<p>The “heel” of Yorke Peninsula is classified as being part of the Gulf St Vincent Bioregion (IMCRA Technical Group, 1998), and contains several of the features considered characteristic of that bioregion, namely:</p> <ul style="list-style-type: none"> ♦ moderate wave energy coastline; ♦ Tertiary sedimentary cliffs; ♦ Beaches, sandflats, beach ridges and estuarine deposits; ♦ Shore-fringing macroalgal communities on reefs, including the shallow water brown macroalgae <i>Hormosira banksii</i>; ♦ <i>Scaberia agardhii</i>, <i>Sargassum</i> species, <i>Cystophora</i> species, <i>Seirococcus axillaris</i> and/or <i>Ecklonia radiata</i> in the macroalgal canopy on subtidal reefs; ♦ Intertidal and shallow subtidal seagrasses, dominated by fine <i>Zostera</i> species, and <i>Zostera</i> (= <i>Heterozostera</i>) <i>tasmanica</i>;

	<ul style="list-style-type: none"> ♦ Benthic seagrass beds (mainly species of <i>Posidonia</i>, and <i>Amphibolis antarctica</i>); ♦ Previously, sparse seagrass beds in deeper waters (e.g. 30+m) (N.B. these deeper <i>Zostera</i> beds have now been degraded by prawn trawling (Tanner, in press, cited by Shepherd, pers. comm., 2004).
<p>4. Habitat Rarity</p>	<p>Habitat types in the area that are not common in other coastal marine areas of S.A. include:</p> <ul style="list-style-type: none"> ♦ Shallow water sponge-dominated habitat between Edithburgh and Troubridge Island, which are exposed to strong tidal currents; ♦ Orontes Shelf which is 10km - 20km wide, composed of calcreted shell beds in waters deeper than 10m, off the mid western Yorke Peninsula e.g. off Stansbury; and including extensive erosion escarpments (to 5m high) in the Troubridge area, associated with the southern end of the Orontes Shelf (calcreted shell and sand beds); ♦ Extensive sand bars in shallow waters along the south-east coast of Yorke Peninsula, some of which are up to 2km - 4km long.
<p>5. Habitat Diversity</p>	<p>The diversity of habitats in the region include:</p> <ul style="list-style-type: none"> ♦ Samphire (Salt Creek); ♦ Sandy-mud tidal flats, with blue-green algal mats (Salt Creek Bay); ♦ Sand and/or shingle beaches along the south-west coast of Gulf St Vincent (e.g. Coobowie, Stansbury and several others) and around Troubridge Island, a sand island; ♦ near-shore calcareous headland reefs of various heights, forms and orientations, including vertical reef “walls”, caverns, crevasses, overhangs (e.g. south-eastern end of Waterloo Bay, extending to Troubridge Point, and low near-shore cliff reefs along parts of south-western Gulf St Vincent) and intertidal reefs (e.g. Coobowie, and intertidal platform reef at Port Moorowie); ♦ intertidal fine seagrass beds (e.g. Salt Creek Bay / Coobowie); ♦ dense, extensive subtidal seagrass beds in the region, from shallow subtidal to around 20m e.g. parts of Waterloo Bay, seaward of the fringing reef between Troubridge Point and Sultana Point, eastwards of Sultana Point (interspersed with reef and sand habitats), northward of Sultana Point to Edithburgh, Salt Creek Bay, around Troubridge Island, Giles Point (mainly seaward of 5m) and in much of the shallow near-shore waters up to Oyster Point / Stansbury; ♦ benthic sand habitat e.g. seaward of coastal reef strip off parts of the “heel” of Yorke Peninsula, and wide sandy shallow water shoals interspersed with seagrass beds and calcareous patch reef in parts of south-western Gulf St Vincent, and around the sand island Troubridge Island; ♦ shallow water “sponge gardens” habitat (e.g. approx. 5m-6m deep, in channels with rapid tidal currents between Edithburgh and Troubridge Island), associated with tidally exposed consolidated, heavily dissected sand reefs (e.g. between Troubridge Island and Sultana Point), with many “gutters” in the reef and sand patches; ♦ Orontes Shelf (composed of 10km - 20km wide calcreted shell beds in waters deeper than 10m, off the mid western Yorke Peninsula e.g. off Stansbury); and including “hilly” calcreted shell and sand beds with erosion escarpments up to 5m high (part of outer and southern edge of Orontes shelf, east of Troubridge Island to approximately 15m deep); ♦ mixed habitats e.g. calcareous patch reef interspersed with seagrass in the Port Moorowie/Waterloo Bay area, calcareous patch reef and platform reef interspersed with sand and seagrass beds near Edithburgh and Salt Creek Bay, and around Troubridge Island; patches of seagrass and sand strips amongst the consolidated sand reef in Sultana Point area. <p><u>Selected Habitat Notes</u></p>

(Shepherd and Sprigg, 1976; SARDI S.A. Benthic Survey data, 1993 and 1997; Robinson *et al.*, 1996; Edyvane and Baker, 1998a; DEH 1:10 000 - 1:25 000 aerial photographs; Shepherd and Brook, 2002; Fairhead *et al.*, 2002).

Troubridge Hill, Troubridge Point, Marion Reef

In 1993, a SARDI benthic survey of the shallow aeolianite reefs (e.g. 5m) at the foot of southern Yorke Peninsula recorded mixed *Cystophora* species and *Ecklonia radiata* as reef dominants, with *Sargassum* species and the large red *Osmundaria prolifera* as sub-dominants, and an understory of mixed corallines and a diversity of other red taxa (e.g. species of *Erythroclonium*, *Rhabdonia*, *Areschougia*, *Webervanbossaea*, *Dasya*, *Laurencia*, *Champia*, *Euptilota*, *Ptilocladia*, and *Asparagopsis armata*, among others); green algae (e.g. species of *Caulerpa* and *Codium*; *Dictyosphaeria sericea*), and small browns (e.g. *Lobophora variegata*). Species of *Erythroclonium*, *Plocamium*, *Cliftonaea*, *Cladurus* and *Areschougia*, as well *Osmundaria prolifera*, are locally abundant in the understory of *Cystophora*-dominated reefs in the **Troubridge Hill** and **Marion Reef** areas.

“Heel” of Yorke Peninsula

A shallow near-shore calcareous reef platform extending from the south-western end of **Waterloo Bay to Troubridge Hill - Troubridge Point** area occurs close to the shore. The reef platform is approximately 50m to 300m wide (S.A. Department of Fisheries 1993; S.A. Coast and Marine Atlas, 2000), dropping sharply to a depth of 15m. The vertical faces of this habitat contain many crevasses, caverns and overhangs, and in the deeper shaded areas, animal assemblages dominate (e.g. gorgonian corals, hydroids and sponges are common) (Johnson, 1988a). Beyond the reef strip, a bare coarse sand habitat occurs. Shepherd and Sprigg (1976) recorded aeolianite reef in the nearshore area (5m - 15m) off the eastern “heel” of Yorke Peninsula, extending into waters east-south-east of the “heel”, to around 20m deep. The authors considered the area to be rich in macroalgal species, as well as sponges, crinoids, reef molluscs, Rock Lobsters and other benthic organisms.

Sultana Point, Salt Creek Bay, Troubridge Island, Giles Point

Close to shore, tidal flats occur along the **Heel of Yorke Peninsula**, from north of **Troubridge Point**, up to **Giles Point**, and the most extensive areas of tidal flats include those north of **Sultana Point**; also around **Troubridge Island**, and at **Salt Creek Bay** (PIRSA, SARDI and DEH map, in Bryars, 2003). There is a coastal lagoon (**Salt Creek Swamp**) inland from **Salt Creek Bay**. In the shallow subtidal, seagrass beds and sand dominate in the “**Heel**” of Yorke Peninsula area, with seagrasses comprising mainly *Posidonia* spp. (e.g. *P. sinuosa*; *P. angustifolia*). *Halophila australis* is also present, to a lesser extent. Seagrass beds occur to approximately 20m deep in most of the coastal marine waters from **Troubridge Point** to **Giles Point**, including the waters around **Troubridge Island** and southwards. The small seagrass *Zostera* (= *Heterozostera tasmanica*) extends mainly south from **Troubridge Island**. There are extensive seagrass beds and sandbanks around **Troubridge Island**, interspersed with patchy calcareous reef. In the shallows around **Coobowie** (e.g. 1m – 2m), there is calcarenite reef with *Scaberia*, turfing browns in the Dictyotales, the green *Ulva*, and *Zostera* (= *Heterozostera*) patches in sand. Patch reefs also occur nearshore at **Edithburgh**, and at **Giles Point** (PIRSA, SARDI and DEH map, in Bryars, 2003). During the early 2000s, a government survey in the offshore area (e.g. 10m – 15+m) between **Edithburgh** and **Port Giles**, showed that the surveyed area comprised predominantly bare sand habitat; with an ascidian assemblage (recorded on sand throughout the sampled area, but particularly prevalent in the eastern and central sections); an ascidian / *Halophila* seagrass assemblage; a sparse invertebrate / turfing macroalgae assemblage, and a dense stand of *Posidonia* (recorded on a shallow sandbar, comprising only 2 of 18 sampling sites within the survey area, but forming an average of 98% of the surface cover where it occurred within the sampled area). Bryozoa and Scallops also occur in the area between Edithburgh and Port Giles (SARDI data, 2002).

Port Giles: In a benthic survey of the nearshore area, Fairhead *et al.* (2002) reported in the nearshore area (within 400m of shore), dense beds of *Posidonia* seagrass, as well as a mixed habitat of *Amphibolis* seagrass, interspersed with rocky reef. The rocky reef areas were covered with canopy taxa such as species of *Cystophora*, *Scaberia agardhii*, *Sargassum* species, and *Ecklonia*, with an understory of filamentous red macroalgae.

	<p>Further offshore the benthic cover was mainly sand, with a sparse cover of <i>Halophila</i> seagrass (Fairhead et al., 2002).</p> <p>Southern Orontes Bank Shepherd and Sprigg (1976) also recorded calcreted shell beds on the outer edge of the Orontes Shelf, the southernmost extent of which lies East of Troubridge Island, extending northwards in waters to 15+m deep, with the escarpments (“drop offs”) seaward of the seagrass-covered flat reef banks that occur off south-western Gulf St Vincent (e.g. Klein Point, Stansbury). The shell reefs form extensive flat rock surfaces 10km to 20km wide, and low erosion escarpments (up to 5m in height off the bottom), dominated by mixed sponges, ascidians and reef molluscs. Seagrasses partly cover the bank from close to shore to approximately 10-15m deep (Shepherd and Sprigg, 1976; SARDI S.A. Benthic Survey data, 1997, unpublished; DEH 1: 10 000 and 1: 25000 aerial photographs).</p>
<p>6. Taxonomic Diversity</p>	<p>Marine Plants “Heel” of Yorke Peninsula: Abundant and diverse red macroalgal assemblages (including large, structurally dominant species) in the Troubridge region, and a relatively high abundance and diversity of articulated coralline red species (compared with 16 of 17 other sites sampled along southern Yorke Peninsula) (Edyvane and Baker, 1998a). Shepherd and Sprigg (1976) also considered the aeolianite reef in the nearshore area (5-15m) off the “heel” of Yorke Peninsula, extending to around 20m deep east-south-east, to be rich in macroalgal species. Johnson (1988) described the Troubridge Hill Aquatic Reserve as containing a “diverse marine flora”.</p> <p>Bony and Cartilaginous Fish “Heel” of Yorke Peninsula: The region is popularly recognised (but not formally documented) for a high species diversity of fish in coastal reef areas, such as Troubridge Hill, including reef fish such as Western Blue Devil, Victorian Scalyfin, Blue Morwong, Boarfish species, Magpie Perch, species of rock whiting, Western Talma, Herring Cale, Silver Drummer, numerous Wrasse species and many other reef fish taxa, as well as numerous commercial and recreational scalefish species, and variety of elasmobranchs (pelagic sharks, and benthic sharks and rays) (Johnson, 1988a; Christopher, 1988; DIASA, undated, and various dive reports and dive promotion materials). No quantitative assessment of fish species diversity in the area is available for this report. Shepherd and Sprigg (1976) also considered the aeolianite reef in the near-shore area (5-15m) off the heel of Yorke Peninsula, extending to around 20m deep east-south-east, to support a “varied fish population”.</p> <p>Invertebrates “Heel” of Yorke Peninsula, Troubridge Shoals, Marion Shoals: There is an abundance and high species diversity of some invertebrate taxa (hydroids; nudibranchs; gastropod molluscs; sponges; echinoderms; ascidians; bryozoa; gorgonians and other corals) on calcareous/aeolianite and shell-bed reefs and shallow subtidal calcrete ledges. A survey in 1993 (SARDI SA Benthic Survey data, unpublished) recorded a variety of sponge species in the shallow water from Troubridge Hill area, but the diversity has not been quantified. Shepherd and Sprigg (1976) also considered the aeolianite reef in the near-shore area (5-15m) off the “heel” of Yorke Peninsula, extending to around 20m deep east-south-east, to be rich in sponges, crinoids, reef molluscs, Rock Lobsters and other benthos. Troubridge Hill: Ivanovici (1984) and Johnson (1988) described the Troubridge Hill Aquatic Reserve as containing “many benthic organisms” and a “diverse marine fauna”.</p> <p>Edithburgh / Salt Creek Bay / Coobowie: There is reportedly an abundance and diversity of sponges, ascidians, reef molluscs, and bryozoa, amongst other invertebrate groups. Also, there is a diverse jetty pylon community at Edithburgh, in which 30 sponge species, 10 bryozoan spp., 20 colonial ascidian spp., nine solitary ascidian spp., amongst other groups, have been recorded (Butler, 1982). Other biota in addition to those described above have been listed by DIASA (undated), Christopher (1988), Brown (undated) and various unpublished divers’ and dive club reports, which includes several species of cephalopods, a variety of nudibranch</p>

	<p>(“sea slug”) and other opisthobranch species, various crab species, amongst numerous other invertebrate fauna (see section 11 below, on Popular Dive Spots).</p> <p>Coastal and Marine Birds Troubridge Island: At least 42 species of coastal birds (including waders) and sea bird species have been recorded on the island (see Robinson <i>et al.</i>, 1996).</p>
<p>7. Habitat for Endemic Taxa / Threatened Taxa / Rare or Uncommon Taxa</p>	<p>Marine Plants Hillock Point, Troubridge Hill and Cootes Hill: The uncommon coralline red species <i>Amphiroa gracilis</i> is found in the region (recorded by Edyvane and Baker, 1998a; see description by Womersley, 1996). Investigator Strait and Edithburgh: The red macroalgal species <i>Bonnemaisonia spinescens</i>, which has a nationally recognised limited range (Turner, 2000; Cheshire <i>et al.</i>, 2000) is found in the region. The species is generally found in waters deeper than 10 metres (Womersley, 1996). Edithburgh: The brown macroalgal species <i>Spatoglossum australasicum</i> which has a nationally recognised limited range (Turner, 2000; Cheshire <i>et al.</i>, 2000) is found around Edithburgh. The species range is restricted to the Gulf region of South Australia. It is unclear how this species reproduces as no fertile material has ever been collected from the limited number of specimens obtained (Womersley, 1987). Troubridge Point: The uncommon macroalgal species <i>Champia parvula</i>, is found in the area. It is considered to have a large range, which extends to the Tasmanian coast, but it is a species that is not commonly found (Turner, 2000; Cheshire <i>et al.</i>, 2000). It has two known varieties, one of which (<i>C. parvula</i> var. <i>amphibolis</i>), has been found only growing epiphytically on <i>Amphibolis</i> sp., on Tiparra Reef in the Spencer Gulf (Womersley, 1996).</p> <p>Bony and Cartilaginous Fish “Heel” of Yorke Peninsula, Edithburgh, Troubridge Shoals, Marion Shoals: Presence of species of conservation concern, such as Leafy and Weedy Seadragons, various pipefish species, and two species of seahorse. Seahorses and pipefish, some species of which are of conservation concern, are locally abundant in the area. Pipefish species are particularly associated with the seagrass beds and sand habitats in the area (DIASA, undated, and other dive promotion materials; Dragon Search Community Monitoring Project data 1994-1999; J. Baker, pers. obs.). A number of syngnathid species found in S.A. are listed in IUCN’s Red List 2003 (IUCN, 2003). Short-Headed Seahorse <i>Hippocampus breviceps</i> and Leafy and Weedy Seadragon are listed as <i>data deficient</i>, and Southern Pot-bellied Seahorse (<i>H. bleekeri</i>) was listed as <i>Vulnerable</i>, under its former name, <i>H. abdominalis</i>, which now refers only to the NSW population. Pogonoski <i>et al.</i> (2002) suggested as conservation status for Pot-bellied Seahorse: <i>Lower Risk, Conservation Dependent</i>, as did the Australian Society of Fish Biology (2001) list of species of conservation concern. South Australian pipefish species are considered by some researchers to be threatened due to their strong site association, but none are officially listed by IUCN to date. All syngnathids (seahorses, seadragons, pipefish, pipehorses) are now formally listed under the <i>Environment Protection and Biodiversity Conservation Act 1999</i>. Edithburgh, Salt Creek Bay, Coobowie, Stansbury, Port Giles: As above, presence of species of conservation concern, such as Leafy and Weedy Seadragons, and a number of pipefish and seahorse species. Seahorse species, sometimes observed in groups, in the area are the Short-Headed Seahorse and Southern Potbelly Seahorse. Pipefish species in the area include Smooth Pipefish, Pugnose Pipefish, Spotted Pipefish, Wide-body Pipefish and Port Phillip Pipefish, amongst others (Fairhead <i>et al.</i>, 2002; Dragon Search data, 1996-2003; museum and survey records, cited in Baker, in press). The little known Gulf Pipefish <i>Stigmatopora</i> nov. sp. (<i>Stigmatopora nasospatulata</i>) has been recorded in the Edithburgh area, and may be endemic to the gulfs region of South Australia (Browne, 2004). Coastal Reefs at the Heel of Yorke Peninsula: Presence of reef fish species of conservation concern, such as Western Blue Devil, as well as Blue-throated Wrasse, Rosy Wrasse and other Wrasse species (see Section 9.2, and Baker,</p>

	<p>in press).</p> <p>Edithburgh area: According to unpublished records from divers and dive groups, species that are less commonly observed and recorded, such as the Smooth Angler and Common Stargazer (which is regularly recorded in the S.A. gulfs, but not in other areas), as well as the Numbfish, are regularly found around the Edithburgh jetty (see Section 11 below on Popular Dive Spots). Another uncommon species recorded in the area is the Southern Longfin <i>Beliops xanthokrossos</i>, a smaller reef species from the same family as the Western Blue Devil (see Baker, in press for summary).</p> <p>Smooth Cardinalfish (<i>Vincentia macrocauda</i>), a mouth-brooding fish species of potential conservation concern (see Baker, in press), has also been recorded in the area (e.g. Troubridge Island).</p> <p>Edithburgh is one of a few areas in South Australia where the Broadnose Sevengill Shark <i>Notorynchus cepedianus</i> has been recorded (fishing and diving records, cited by Baker, in press).</p> <p>Deeper water off the “Heel” of Yorke Peninsula is one of few areas where the South Australian endemic Coastal Stingaree <i>Urolophus orarius</i> has been recorded (see Baker, in press for summary of published distribution records). A single specimen was also recorded recently during beam trawl sampling in the Port Giles area (Fairhead et al., 2002). Stingaree species such as this are of conservation concern due to their limited known depth range, strong habitat association, and viviparous method of reproduction. <i>Urolophus orarius</i> is considered to be a threatened species (P. Kyne, IUCN Shark Specialist Group, pers. comm., 2004).</p> <p>Invertebrates</p> <p>Edithburgh, Port Giles, and other parts of south-western Gulf St Vincent: Diving (e.g. Reefwatch) and survey records (e.g. Fairhead, 2002) have shown that an uncommon bottle-tail squid of apparent limited known distribution in South Australia is found in the area: the Striped Pyjama Squid (Striped Dumpling Squid) <i>Sepioloidea lineolata</i>, is also known from a few locations in southern Qld, NSW and W.A. (see Edgar, 2000, and map in Norman and Reid, 2000). The species has been included as one of conservation concern, in South Australian Reef Watch’s “Feral or In Peril” program (Reef Watch Community Environmental Monitoring Program, 2002).</p> <p>The physically unusual endemic octopus <i>Grimpella thaumastocheir</i>, which has a restricted distribution in southern Australia and is regarded as a uncommon species (Zeidler, pers. comm. to DEH, 2001), is found in the Edithburgh region (Zeidler and Norris, 1989).</p> <p>The Southern Pygmy Squid, <i>Idiosepius notoides</i>, is restricted to seagrass habitats in Spencer Gulf and Gulf St Vincent (W. Zeidler, pers. comm. to DEH, 2001), and has been recorded in the south-western Gulf St Vincent area (e.g. at Port Giles – see Fairhead et al., 2002).</p> <p>The unusual, phototrophic sponge <i>Cymbastela</i> sp. (which has been described as “rare”) has been recorded on reefs in the Edithburgh area (Cheshire et al., 1995).</p> <p>Edithburgh area: <i>Saccoglossus apantesis</i>, an uncommon species and member of the unusual “acorn worm” phylum (Hemichordata), grows to a length of 8.5cm and is found amongst <i>Zostera</i> spp. roots (Shepherd, 1997b).</p> <p>Port Moorowie: <i>Halgerda graphica</i>, a sea slug species described in 1903 from Kangaroo Island, and rarely recorded since, has been found in the area (N. Holmes, cited by Rudman, 2002).</p> <p>The Troubridge Island area is one of few sites where the toxic sponge <i>Neofibularia mordens</i> is found (S. Shepherd, pers. comm., 2004). Gulf St Vincent is the type locality for this species, and it is possibly endemic within S.A. (see Hooper, 1999, and Australian Government Department for the Environment and Heritage, 2003d).</p> <p>“Heel” of Yorke Peninsula / Troubridge Shoals / Marion Shoal / Edithburgh / Stansbury: The region is an important one for cowries, volutes and other “specimen shells”, some of which are rare, and many species of specimen shell are also of conservation concern due to their vulnerable population characteristics (see Section 9.2). An incomplete list of specimen shell species know to occur in various parts of the region that encompasses “Heel” of Yorke Peninsula / Troubridge Shoals / Marion Shoal / Edithburgh / Stansbury, includes the following (see Baker, 2002, for examples of localities, and a preliminary summary of conservation status according</p>
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to various specimen shell authorities in Australia): *Zoila friendii thersites* (Hump-Backed Cowrie), including black forms; other cowrie species; also *Ericusa fulgetra* (Lightning Volute, one of the more commonly observed volute species); *Lyria mitraeformis*; *Notovoluta kreuslerae* (Kreusler's Volute), and other volute species (Baker, 2002, and pers. obs., and specimen shell market records, 2001-2002). Also, presence of a variety of opisthobranch mollusc species, some of which are uncommonly recorded. Two examples include the uncommon tropical nudibranch *Aegires villosus*, recorded at **Edithburgh**, and the endemic species of opisthobranch *Philinopsis troubridgensis* (Burn, 1989; Rudman, 2000a, 2000b). Locally abundant gorgonian corals, particularly in nearshore reef habitats of low light exposure around the **Heel of Yorke Peninsula** (e.g. crevices in cliff reefs, wreck sites etc) (Ivanovici, 1984; Johnson, 1988a; Christopher, 1988; DIASA, undated). Gorgonian corals are susceptible to damage from diving (e.g. breakage and sedimentation) and from other sources of increased sedimentation.

Investigator Strait

Paracyathus vittatus, a low cylindrical stony coral, recorded only from Investigator Strait, and the colonial dendroid stony coral *Dendrophylla atrata* (Shepherd and Veron 1982).

Ascidian species that may be endemic to S.A., and have been found in the **Investigator Strait** area, amongst a limited number of other locations in S.A., include *Leptoclinides* sp. 3; *Eudistoma constrictum*; and *Polycitor obeliscus* (recorded only once in S.A.) (Kott, 1997; Australian Government Department of the Environment and Heritage, 2004b).

Bottom of Gulf St Vincent

Uniophora nuda is a relatively uncommon species of sea-star, only known from the lower regions of the Gulfs of S.A. and the North coast of Kangaroo Island where it occurs on seagrass beds and sandy bottom to 60m deep (Shepherd and Thomas, 1989).

Claudenus antipodus, a hard ascidian which grows to 10cm, has a limited known distribution, and has been recorded from sandy bottoms in Gulf St Vincent and Investigator Strait (Kott, 1997; Australian Government Department of the Environment and Heritage, 2004b).

Marine Mammals

Port Moorowie: According to regional southern Yorke Peninsula promotional materials, Southern Right Whales are irregularly observed in the area during winter migration. IUCN Red List 2003 classified Southern Right Whale as *conservation dependent*. Southern Right Whale is a protected species at Commonwealth level (*EPBC Act, 1999*), and also under the *South Australian National Parks and Wildlife Act 1972*. Bottlenose Dolphin are also regularly observed in the **Heel of Yorke Peninsula** area. IUCN Red List 2003 classified Bottlenose Dolphin as *Data Deficient*.

Coastal and Marine Birds

Troubridge Point – Port Moorowie: Habitat for coastal birds, including Osprey (*rare* under S.A. legislation) and White-bellied Sea Eagle (*vulnerable* under S.A. legislation).

Troubridge Island / Shoals provide habitat for Hooded Plover and breeding areas for Fairy Tern (NPWS 1995, Robinson *et al.*, 1996), both of which are listed as *vulnerable* under *National Park Wildlife Act 1972*. Recognised and documented threats to Hooded Plover populations in general are outlined in Chapter 9. Fairy Tern breeding success is reported to have markedly declined in other parts of S.A. (NPWS, 1995).

Troubridge Island provides habitat for:

Cape Barren Goose, Peregrine Falcon and Rock Parrot (all of which have a coastal association) (Robinson *et al.*, 1996), and all of which are listed as *rare* under South Australian legislation;

Arctic Skua (Robinson *et al.*, 1996), which breeds in the circumpolar regions of the Arctic Circle and northern Europe, and seasonally migrates to southern and eastern Australia (Pizzey, 1988);

	<p>Bridled Tern (Robinson <i>et al.</i>, 1996), which is considered to be uncommon in southern Australia (Pizzey, 1988).</p> <p>A large number of invertebrates and macroalgae, and a smaller number of fish species, that occur in the Investigator Strait region are endemic to southern Australia, but quantification is not possible for this report. Examples of some invertebrate species that may be endemic within South Australia only are discussed above.</p>
<p>8. Other Important Taxa</p>	<p>Marine Plants The “Heel” of Yorke Peninsula: High abundance of coralline red macroalgae (Edyvane and Baker, 1998a), which forms important habitat for some fish and some invertebrate groups (e.g. molluscs - for example, see Shepherd and Daume, 1996, and Daume <i>et al.</i>, 1997 for importance of coralline algae to abalone).</p> <p>Bony and Cartilaginous Fish “The “Heel” of Yorke Peninsula and Investigator Strait: Although Snapper stocks have been depleted in the area, particularly during the 1980s to mid-1990s (see McGlennon and Jones, 1997, and Fowler, 2000, 2002), the southern part of Gulf St Vincent and Investigator Strait area has traditionally been an area for larger Snapper which have migrated southwards (Kailola, 1993). Shepherd and Sprigg (1997) also reported that the consolidated sand dune reefs of Investigator Strait were “excellent Snapper grounds”, and the large fish have been taken by both commercial and recreational fishers in the region for many years. Larger, older Snapper are considered to be key contributors to the spawning potential of the stock (Jones <i>et al.</i>, 1990; Anon, SARDI, 1995).</p> <p>Reef areas, such as Troubridge Point, Edithburgh, and Giles Point, and patch reefs off Troubridge Island are reported to provide habitat for one or more of the life stages King George Whiting, Snapper, West Australian Salmon, Tommy Ruff, Southern Sea Garfish, Yellow-eye Mullet, Trevally, Leatherjacket species, Western Blue Groper and other Wrasse species, Snook, Sea Sweep, Silver Drummer Gummy Sharks, and Whaler Sharks (Bryars, 2003).</p> <p>Seagrass beds along the “Heel” of Yorke Peninsula are reported to provide habitat for King George Whiting, Snapper, West Australian Salmon, Tommy Ruff, Southern Sea Garfish, Red “Mullet”, Trevally, Leatherjacket species, Snook and Whaler Sharks (Bryars, 2003).</p> <p>Sheltered beach areas around the Heel of Yorke Peninsula are reported to provide habitat for one or more of the life stages of School Whiting, West Australian Salmon, Tommy Ruff, Yellow-eye Mullet, Mulloway, flathead species and Whaler Sharks (Bryars, 2003).</p> <p>Invertebrates Troubridge Point to Port Giles: Anecdotal reports (from divers and dive groups) of abundant large Spider Crabs (<i>Naxia, Helicarcinus</i> and <i>Leptomithrax</i> species) in the area. Examples of other large benthic invertebrates in the sand and seagrass habitats of the area (e.g. sampled at Port Giles – see Fairhead <i>et al.</i>, 2002) include the Southern Dumpling Squid <i>Euprymna tasmanica</i>; Red Swimmer Crab <i>Nectocarcinus integrifrons</i>; sponge crabs (<i>Cryptodromia octodentata</i>) and other crab species; Craylet species (in the genera <i>Galathia</i> and <i>Munida</i>); various species of Pebble Crabs (Leucosiidae family); Queen Scallop <i>Equichlamys bifrons</i>; brittle stars (e.g. <i>Ophiura</i> and <i>Ophiothrix</i> species); sea cucumbers (e.g. <i>Lipotrabeza</i> sp.), sea urchins (e.g. the Pebble Collector Urchin <i>Pseudoboletia indiana</i> and the Purple Sea Urchin <i>Heliocidaris erythrogramma</i>) and opisthobranch sea slugs, amongst others.</p> <p>Stansbury: Previously, an important habitat for the native oyster <i>Ostrea angasi</i>, but the species has not been collected in the area for many years (Berggy, 1996). Corbett and Scrymgour (1973, cited by Paxinos and Clarke, 1996) also reported that the Native Oyster <i>O. angasi</i> was often found in the Yorke Peninsula area.</p> <p>Shallow marine habitats in south-western Gulf St Vincent (e.g. Coobowie and Stansbury, amongst other locations) are settlement areas for juvenile Western King Prawns, although such locations are of less significance in this regard compared to those in far northern Gulf St Vincent (Kangas and Jackson, 1997).</p> <p>Reef areas, such as Troubridge Point, Edithburgh, and Giles Point, and patch reefs</p>

	<p>off Troubridge Island are reported to provide habitat for one or more of the life stages Southern Calamari, Giant Cuttlefish, Maori Octopus, Greenlip and Blacklip Abalone, and Purple Sea Urchin (Bryars, 2003).</p> <p>Sheltered beach areas around the Heel of Yorke Peninsula are reported to provide habitat for Sand Crabs and baitworm species (Bryars, 2003).</p> <p>Coastal and Marine Birds</p> <p>Troubridge Island: In addition to coastal and marine birds for which Troubridge is a major breeding and feeding area, as well as habitat for birds listed on international treaties (see Section 9 below), other bird species that occur in the area include the following, some of which are highly abundant on the island: Double-banded Plover (considered to be a migrant species from New Zealand, where it breeds, according to Pizzey, 1988), Red-capped Dotterel, Black-fronted Dotterel, Black Swan, White-faced Heron, Black-tailed Native Hen, Buff-banded Rail, Sooty Oystercatcher, Pied Oystercatcher, Sacred Kingfisher, Masked Plover, Silver Gull, Pacific Gull, Australian Gannet, Australian Pelican, Black Cormorant, Little Pied Cormorant, Little Black Cormorant, Crested Tern and Caspian Tern (DELM, 1993; NPWS, 1995; Robinson <i>et al.</i>, 1996).</p> <p>Salt Creek Bay: Presence of migratory wading birds at Salt Creek (DENR, 1997).</p>
<p>9. Notable Feeding, Breeding/Spawning and Nursery Areas</p>	<p>Bony and Cartilaginous Fish</p> <p>The “Heel” of Yorke Peninsula, Tapley Shoals, Troubridge Shoals, Marion Shoals: Spawning area for King George Whiting (Fowler and McGarvey, 1997, 1999), and feeding area for numerous commercially and recreationally important species, particularly in the benthic seagrass beds. West of the area described in this table (e.g. Waterloo Bay, Sturt Bay), the oceanography of the area in the vicinity of the seagrass beds is considered to have an important larval advection function for some fish species (e.g. see Petrusevics, 1991).</p> <p>Edithburgh, Salt Creek Bay, Coobowie, Stansbury: An important larval settlement area/nursery and feeding area for juvenile fish (e.g. King George Whiting and Garfish, and other scalefish species) north of Sultana Point, including the Edithburgh area, Salt Creek Bay, Coobowie Bay, and Stansbury (Jones <i>et al.</i>, 1990; Petrusevics, 1991; Edyvane, 1996b; DENR, 1997) .</p> <p>Edithburgh, Salt Creek Bay, Coobowie: A breeding area for the Port Jackson Shark, which aggregates seasonally to breed in shallow waters. For example, close to shore, many dozens (hundreds, according to one report) of Port Jackson Shark eggs have been seen aggregated in the Edithburgh area (T. Isaacson, pers. comm. to MLSSA, 2002; A. Brown, Reefwatch diver, pers. comm., 2003).</p> <p>Reef areas, such as Suicide Point, Troubridge Hill, Troubridge Point, Edithburgh, and Giles Point, and patch reefs off Troubridge Island are reported to provide spawning areas for Sea Sweep and Western Blue Groper, and some of these locations also provide a nursery function for juvenile King George Whiting, Snapper, West Australian Salmon, Tommy Ruff, Trevally, Sea Sweep and Western Blue Groper and other Wrasse species (Bryars, 2003). Seagrass beds along the “Heel” of Yorke Peninsula are also reported to provide habitat for the spawning adults of Southern Sea Garfish and Snook, the larvae of Southern Sea Garfish, and also serve as nursery areas for juvenile King George Whiting, Snapper, West Australian Salmon, Tommy Ruff, Southern Sea Garfish, Red “Mullet”, flathead species, Trevally, Leatherjacket species, and Whaler Sharks (Bryars, 2003). Unvegetated subtidal sand habitats around the “Heel” of Yorke Peninsula reportedly provide habitat for spawning adult Snook, and larvae of Southern Sea Garfish, and also serve as nursery areas for juvenile King George Whiting, Snapper, West Australian Salmon, Tommy Ruff, Yellow-eye Mullet, Red “Mullet”, flathead species, flounder species, Trevally, and Whaler Sharks (Bryars, 2003).</p> <p>Tidal flats of Goldsmith Beach, Sheoak Beach and Salt Creek Bay are reported to provide habitat for both adult and juvenile King George Whiting, School Whiting, West Australian Salmon, Tommy Ruff, Southern Sea Garfish, Yellow-eye Mullet (also in Salt Swamp Creek), flathead species and flounder species (Bryars, 2003). Most of these species also occur in the vicinity of the tidal flats surrounding Troubridge Island (Bryars, 2003).</p> <p>Invertebrates</p>

	<p>Edithburgh, Salt Creek Bay, Coobowie, Stansbury: Larval settlement area / nursery and feeding areas for crustaceans such as Western King Prawn, and several crab species (including Sand Crab) (Berggy, 1996; Edyvane, 1996; DENR, 1997; Boxshall and Williams, 2000).</p> <p>Edithburgh to Troubridge area: The shallow-water sponge beds in the area are important habitat for cowries, some of which are obligate feeders on host sponge species, and reproduce locally due to their live-bearing habit (which contrasts with tropical cowries, which are more widely dispersed due to planktonic larvae) (see Ponder and Grayson, 1998, and Baker, 2002). The area is also important habitat for volute shell species, southern Australian species of which also have localised reproduction.</p> <p>The “Heel” of Yorke Peninsula and Investigator Strait: Aeolianite reefs and calcreted shell beds in the area both provide sheltering habitat for Rock Lobster, and an important habitat for reef molluscs (Shepherd and Sprigg, 1976).</p> <p>Reef areas, such as Troubridge Point, Edithburgh, and Giles Point, and patch reefs off Troubridge Island are reported to provide spawning areas for Southern Calamari and Giant Cuttlefish, and nursery areas for juvenile Maori Octopus (Bryars, 2003). Seagrass beds along the “Heel” of Yorke Peninsula provide habitat for both adults and juveniles of Razorfish, King Scallop and Queen Scallop. Unvegetated subtidal sand provides habitat for adult Southern Calamari, and for adult and juvenile Sand Crabs, Razorfish, and King and Queen Scallops, as well as being a nursery area for juvenile Western King Prawn (Bryars, 2003).</p> <p>Tidal flats of Goldsmith Beach, Sheoak Beach and Salt Creek Bay are reported to provide habitat for adult and juvenile Sand Crabs, Razorfish and baitworm species (Bryars, 2003).</p> <p>Coastal and Marine Birds</p> <p>Troubridge Island: Important habitat, feeding and breeding areas, for sea birds and waders, including Little Penguin (around 4000 breeding birds), Black-faced Cormorant, Pied Cormorant, Crested Tern (around 200 breeding birds), Caspian Tern, Fairy Tern, Pacific Gull (minor breeding area) and Silver Gull (around 20,000 breeding birds) (Robinson <i>et al.</i>, 1996; S.A. Coast and Marine Atlas, 2001). There are numerous flocks of dotterels, plovers, Ruddy Turnstones, Greenshanks, sandpipers and oystercatchers that feed around the island (Robinson <i>et al.</i>, 1996). The area is an important summer feeding ground for migratory wading birds listed on international treaties (NPWS, 1995). Examples of migratory birds include Ruddy Turnstone, Sharp-tailed Sandpiper, Sanderling, Red Knot, Curlew Sandpiper, Red-necked Stint, Great Knot, Mongolian Plover, Lesser Golden Plover, Bar-tailed Godwit, and Greenshank.</p>
<p>10. Shipwrecks and Artificial Reefs</p>	<p>South-Eastern Yorke Peninsula</p> <p>A number of shipwrecks in the area are semi-intact, or if broken up, contain large portions of the hull and fittings, which provide additional habitat for attached invertebrates and plants. Some of these wrecks also act as fish-attracting devices, due to their three dimensional structure, and the additional habitat provided for sheltering, feeding etc. Examples include: <i>Clan Ranald</i>, west of Troubridge Hill; <i>Sultana</i>, near Sultana Point; <i>Marion</i> at Marion Reef; <i>Iron King</i>, south-east of Edithburgh (near the <i>Marion</i>). Part 2 of this table details the wrecks that have been found in the area, including those cited above.</p> <p>There is an artificial reef at Coobowie (besser blocks, laid in 1966), which attracts whiting (DIASA, undated) and other fish species, and provides habitat for invertebrates (e.g. molluscs); and an artificial reef at 15m depth, at Giles Point (tyre modules).</p>
<p>11. Popular Dive Sites</p>	<ul style="list-style-type: none"> ♦ Important dive sites in the region include: Troubridge Point, Troubridge Hill, Troubridge Island, the sponge beds between Edithburgh and Troubridge Island, Edithburgh jetty, and wreck sites (e.g. <i>Clan Ranald</i>), amongst other parts of the area. ♦ For example, Troubridge Hill and Troubridge Point are recognised for the variety of micro-habitats in the nearshore reef system (platforms, “pinnacles”, “bommies”, “overhangs”, “swim-throughs”, crevices, “chasms” etc), containing diverse and

	<p>abundant assemblages of marine invertebrates (sponges, ascidians, reef molluscs, bryozoa, amongst many other groups) and reef fish. Gorgonian corals and Rock Lobsters are mentioned in DIASA's guide and other dive promotion materials, as being some of the features of interest in the area. Various dive promotion materials list fish species such as Western Blue Groper, Western Blue Devil, Magpie Perch and many other species.</p> <ul style="list-style-type: none"> ◆ Dive promotion materials (e.g. Aquanaut, undated and Dive South Australia, 2004) also list the sponge beds and "Giant Spider Crabs" in the Troubridge Shoals / Island area. ◆ Edithburgh jetty is widely recognised for its diversity of invertebrates (e.g. at least 30 sponge species, 10 bryozoan species, 20 colonial ascidian species, nine solitary ascidian species, amongst others, have been recorded at the jetty (Butler, 1982). Very large starfish, and Blue-ringed Octopus are other features of this site (Christopher, 1988). Biota listed in DIASA's dive guide, other dive reports (e.g. Brown, undated) and also cited by diving organisations and individual divers as features of the Edithburgh jetty include "very large" sea stars, numerous nudibranch species, flatworms, sponges, ascidians, cowries, Doughboy Scallops, abalone and other molluscs, abundant Hermit Crabs, Spider Crabs and various other crab species (including the tropical species <i>Schizophrys aspera</i>) shrimps and other small crustaceans, sea spiders, worms, cuttlefish, Lined Dumping Squid (i.e. Striped Pyjama Squid), Giant Cuttlefish (habitat near the jetty is a minor breeding area for this species, according to Rowlings, 1994), various species of octopus, and various fish taxa (Numbfish, Shaw's Cowfish and Ornate Cowfish, Boxfish, Rock Ling, Smooth Anglerfish, Stargazer, Victorian Scalyfin, Gurnard Perch, Banded Sweep, Red "Mullet", Tasmanian Blenny and various other species of blenny, various goby species, Leatherjackets, Southern Pot-bellied Seahorses, Weedy and Leafy Seadragons, various pipefish species) as well as Port Jackson Sharks and Eagle Ray (Brown, undated; MLSSA dive reports; DIASA, undated; Aquanaut, undated). Many of the reef fish species that are common in the gulfs of S.A. also occur in the vicinity, as well as a number of commercially and recreationally valued fish (see section on Recreational Fishing in Part 2 of this table). ◆ The jetties at Stansbury and Port Giles are also recognised for diving, due to their role in providing habitat for the prolific invertebrates that live on the pylons (particularly the dense growths of bryozoa, as well as the presence of Leafy Seadragons, Port Jackson Sharks, various crab species, various nudibranch species, and the reef fish (e.g. Rock Ling, and many other species) and schooling fish (e.g. large Yellow-tail Kingfish) that occur in the vicinity of the jetties (Brown, undated, and other diving reports for Yorke Peninsula sites).
<p>12. National and/or International Importance</p>	<ul style="list-style-type: none"> ◆ Troubridge Point - Port Moorowie: Listed on the <i>Register of the National Estate</i>, in recognition of coastal features, such as geologically significant coastal rocks (Permian cliff exposures, including glacial deposits and fossiliferous late Cainozoic sandstone and limestone) and habitat for coastal birds, including rare and vulnerable species such as Osprey and White-Bellied Sea Eagle. ◆ Troubridge Island / Shoals: Feeding ground for migratory wading birds listed on international treaties (JAMBA, CAMBA), such as Ruddy Turnstone, Sharp-tailed Sandpiper, Sanderling, Red Knot, Curlew Sandpiper, Red-necked Stint, Great Knot, Mongolian Plover, Lesser Golden Plover, Bar-tailed Godwit, and Greenshank. ◆ There are classified coastal geological monuments at Giles Point (coastal cliffs, including an outcrop of Pliocene Hallett Cove sandstone, and Cainozoic beds), and in the Stansbury and Port Vincent areas (limestone with solution features) (Edyvane, 1996b).
<p>Major Commercial and Recreational Fish, Sharks, Molluscs and Crustaceans</p>	<p>Some of the commercially and/or recreationally fished species that occur in parts of the area that collectively encompass the "Foot" of Yorke Peninsula, and Investigator Strait, northwards into south-western Gulf St Vincent to approximately Giles Point / Port Giles, include:</p> <p><i>Fish:</i> Australian Salmon, King George Whiting, Garfish, Snapper, Tommy Ruff, Trevally, Snook, Sweep, Yellow-eye mullet (more prevalent in the south-eastern part of Yorke</p>

	<p>Peninsula, around the Troubridge region), Flathead and various Leatherjacket species. Blue Morwong, various Wrasse species, Boarfish, Red “Mullet”, Blue Mackerel, Gurnard Perch, Rock Ling and Swallowtail (deeper waters), are also known to occur in parts of the area.</p> <p><u>Sharks and Rays:</u> Gummy Shark, School Shark, Bronze Whaler and/or Black Whaler, Whiskery Shark, and various ray species.</p> <p><u>Invertebrates:</u> The major invertebrates caught commercially and recreationally are Southern Rock Lobster (mainly in the southern part of the area described here – see 9.1.15 for more information), Southern Calamari, various specimen shell species, and Greenlip Abalone (N.B. although productivity of greenlip was high during the 1970s, productivity during the past 2 decades has been considerably lower due to <i>Perkinus</i> disease). Western King Prawns are also caught in the region, in waters deeper than 10m. Other invertebrates of commercial and/or recreational significance in the area include Cuttlefish, Sand Crab and Blue Swimmer Crab (the latter two in western Gulf St Vincent), Velvet Crab, and species of Octopus.</p> <p>Some of the commercially and/or recreationally significant species that occur in parts of the area that collectively encompass the Port Giles area northwards, include:</p> <p><u>Fish:</u> Garfish, King George Whiting, Tommy Ruff, Australian Salmon, Snook, Flathead, Yellow-eye Mullet, Yellow-fin Whiting, Snapper, Yellow-tail Kingfish, species of leatherjacket, Red “Mullet”, sweep, Striped Perch.</p> <p><u>Sharks and Rays:</u> Bronze Whaler and/or Black Whaler, Gummy Shark, and various ray species.</p> <p><u>Invertebrates:</u> Western King Prawns (in waters deeper than 10m), Southern Calamari, Blue Swimmer Crab, Sand Crab, specimen shells, and Cuttlefish.</p>
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8.16 Upper Gulf St Vincent (Gulf St Vincent Bioregion)

Figure 18 shows the location of this area.

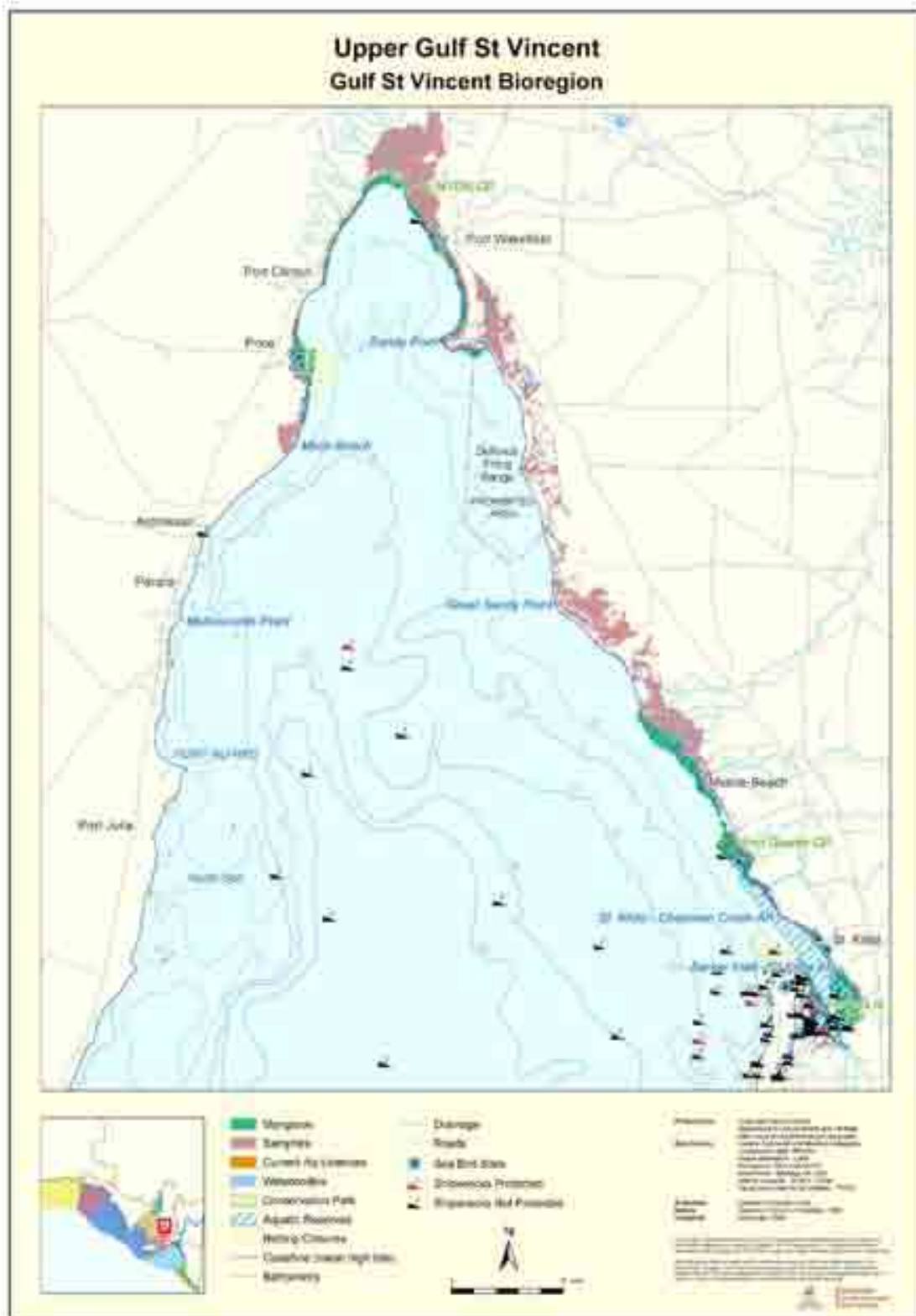


Figure 18: Upper Gulf St Vincent

<p>1. Biogeographic Significance</p>	<p>Northern and North-eastern Gulf St Vincent</p> <ul style="list-style-type: none"> ♦ The largest tidal wetland and mangrove ecosystem in Gulf St Vincent, and the second largest in South Australia. The saltmarsh and mangrove ecosystem in north-eastern Gulf St Vincent (GSV), covering approximately 20,000 hectares (Edyvane, 1999b), is considered to be of national significance. The temperate mangrove <i>Avicennia marina</i> is uncommon in south-eastern Australia, with the largest stands occurring in Spencer Gulf and GSV (Edyvane, 1996b). The mangroves of the Light River Delta have been described as the largest area of near <i>pristine</i> mangroves in South Australia (DC Mallala Foreshore Advisory Committee and EcoConnect, 2002). ♦ The northern and north-eastern part of GSV, described by Edyvane (1999b) as the Clinton Biounit, contains the largest area of seagrass meadows in Gulf St Vincent (i.e. around 132 500 ha), and the second largest in South Australia (Edyvane, 1999b). In terms of temperate seagrass distribution, these meadows are significant at a national level (Edyvane, 1996b).
<p>2. Major Physical Influences, and Relative Productivity Level</p>	<p>Major Physical Influences (Pritchard, 1967; Bye, 1976; Shepherd and Sprigg, 1976; de Silva Samarasinghe and Lennon, 1978; Lennon <i>et al.</i>, 1998; IMCRA Technical Group, 1998)</p> <ul style="list-style-type: none"> ♦ confined “inverse estuary”, characterised by relatively high mean salinities (ranging from 35.5 to 42.0ppt) and temperatures (up to 26°C and higher, in summer); ♦ low wave energy; oceanographically “sheltered” coastline; weak currents, and extensive area of “quiet water” shallows; ♦ clockwise water circulation, with a seasonal outflow of saline water in a gravity current on their eastern sides, from April – December each year; ♦ large tidal range (to at least 100m in some areas). Also, periods of “dodge” tide (when semi-diurnal and diurnal tide components show little variation over a 24 hr period); ♦ input of suspended carbonate matter from the south, which is transported northwards to the upper gulf area, resulting in turbid upper gulf waters; ♦ long-shore drift, resulting in accumulation of sediments in the upper gulf area. <p>Relative Productivity Level (Notes compiled from PPK <i>et al.</i>, 1992; Morton <i>et al.</i>, 1987; Adam, 1995; Edyvane, 1995c; NSW Fisheries 1998; Morrisey 1995, cited by Connolly, 1999; Connolly, 1999; NSW EPA, 2000; DC Mallala Foreshore Advisory Committee [FAC] and EcoConnect, 2002).</p> <ul style="list-style-type: none"> ♦ The extensive mudflats, tidal creeks and mangrove areas of the shallow, hypersaline upper GSV system are an important decomposition area, and the site of a significant detritus-based food chain (with drifting and decomposing plant material, and microbiota as the basis). The general ecology of intertidal mudflats and mangrove estuaries is well-documented (e.g. see Edyvane, 1995c; DC Mallala FAC and EcoConnect, 2002, for summaries). Studies in other areas have shown that one square kilometre of mangrove forest contributes around 600 tonnes per annum of leaf litter to the detrital food chain. One visible indication of the productivity is the abundance of worms and other infauna, and the abundant birds, marine snails and crabs (e.g. fiddler crabs and other species) that feed on or in the mudflats. Small gastropods and bivalves, worms and tube worms, barnacles, shrimps, amphipods, sea lice (isopods), insects (including mosquitoes and midges and their larvae) and other small fauna in mangrove systems have important ecological roles; for example, as food sources for various fish and crustacean species, and some coastal bird species. Mosquitoes in the mangrove area of north-eastern GSV are also reported to be the major pollinators of mangrove flowers (S. Vines, pers. comm., cited by DC Mallala FAC and EcoConnect, 2002). Mangrove areas have an important role in recycling and redistributing nutrients within estuarine systems, and the roots and pneumatophores also help to stabilise sediments and control coastal

	<p>erosion. Mangroves have a significant nursery function for numerous fish and crustacean species, and also provide shelter and roosting and feeding areas for some coastal bird species.</p> <ul style="list-style-type: none"> ♦ The extensive tidal channels and sediment flats in the area also have important physical and chemical functions, and are a significant habitat for invertebrates (particularly infauna); a feeding area for fish and crustaceans that inhabit the shallows; and a feeding area for local, regional and migratory shore bird species). ♦ Intertidal and supratidal saltmarsh / samphire areas are an important buffer zone between the land and sea, that reduces erosion and flooding, filters pollution, helps to purify the coastal water, and plays an important role in soluble nutrient recycling in estuarine systems. Saltmarsh areas act as a “buffer” between land and mangroves, by helping to regulate salinity levels, reduce water flow, and reduce the load of suspended sediment entering estuarine environments (Haines, 1979; Edyvane, pers. comm., 1992; Connolly, 1999). Samphire saltmarshes, including those that are emerged at low tide, are also important feeding grounds and refuges from predators for larval and juvenile fish (such as Gobies, Hardyheads and Mullet) and feeding area for crustaceans (crabs, shrimps etc) (Morton <i>et al.</i>, 1987; Connolly <i>et al.</i>, 1997; Connolly, 1999). Saltmarshes support high numbers of small molluscs, insects, larvae, and other food sources for estuarine fish, water birds and coastal waders (Morton <i>et al</i> 1987; Edyvane, 1995c; Butler and Jernakoff, 1999; Connolly, 1999). Saltmarsh soils are also an important source of microalgal cells that form part of estuarine food web. The surface films of micro-biota (such as diatoms and cyanobacteria) in saltmarsh areas have important ecological roles. Saltmarsh soils and estuarine sediments are important sites for the accumulation, consumption and re-mineralisation of organic matter, and the sediment-water interface provides optimum conditions for the degradation of organic detritus (Edyvane, 1995c; Connolly, 1999, cited by NSW EPA, 2000). When saltmarsh areas are flushed by extreme high tides, they also contribute significantly to nutrient recycling and replenishment (e.g. in soluble form) in estuarine ecosystems, since they are a source of ammonia, silicates, phosphate and dissolved organic nitrogen (Haines, 1979). ♦ The extensive seagrass meadows of north-eastern Gulf St Vincent are a major “carbonate factory”, providing habitat for the small calcareous organisms that produce shelly sands. The sediments associated with the GSV seagrass meadows consist of carbonate skeleton debris from epiphytic coralline algae, bryozoa, molluscs and foraminifera, and aggregates of aragonite and quartz grains (Shepherd and Sprigg, 1976). The seagrasses are also a contributor to the significant productivity of fish, crabs and prawns in the gulf, both locally and regionally (Jones, 1984; Edyvane, 1996b; Zacharin, 1997; DENR, 1997; DC Mallala FAC and EcoConnect, 2002). The seagrass meadows of north-eastern GSV are also a significant contributor to the total primary productivity of the area, in terms of trapping and recycling nutrients, and production of plant biomass. The seagrasses have an important role in trapping and stabilising existing sediments, and promoting new sediment production (i.e. the seagrass blades baffle wave action, and reduce water movement, so that fine suspended particles settle out, and are trapped by the root mesh of the seagrass – Shepherd and Sprigg, 1976). Seagrass stems, blades and roots provide also substrate for a variety of epifloral and epifaunal species (many of which contribute to sand production), and a feeding area for grazers. ♦ The north-eastern area of Gulf St Vincent is believed to be a very important link to the continued productivity of fish and crustaceans that are heavily utilised by both commercial and recreational fishers in GSV (Jones, 1984; Edyvane, 1996b; Dalgetty, 1997). This is largely due to the high biological productivity of the samphire / mangrove / mudflat / sandflat / seagrass ecosystems, and the importance of the area as a larval settlement area, nursery, and feeding area for fish and crustacean species (described in other sections of this table). <p>In summary, the saltmarsh, mudflat, sandflat, mangrove and seagrass habitats in the area have the outstanding ecological significance, and are recognised as important contributors to the biological productivity and ecological functioning of Gulf St Vincent, particularly the northern part of the gulf.</p> <p>Freshwater Habitats: Rivers and creeks in the northern Adelaide area that drain to Gulf</p>
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	<p>St Vincent have an important role in breeding cycles, nutrient cycles and the productivity of aquatic systems. For example, river and stream beds provide habitat in the sediments, rocks and gravel in the beds, which is often kept moist during summer by groundwater flows. The permanent pools, which retain water for long periods, also provide refuge habitat, enabling aquatic biota to survive dry periods. Aquatic and semi-aquatic plants provide important habitat for invertebrate and vertebrate fauna; emergent plants such as reeds, rushes and sedges provide food, nesting sites and refuges for many aquatic and terrestrial birds. In pools, floating and submerged plants provide habitat for fish and invertebrates and food for aquatic birds. Riparian vegetation also improves habitat diversity by providing shade in some areas. Moving water (riffles) and still water (pools and backwaters) also provide shelter for fauna in the woody debris (NAB Catchment Management Board, 2001).</p>
<p>3. Bioregional Representativeness of Habitats</p>	<p>The area described here comprises extensive supratidal, intertidal and shallow subtidal habitats, in an oceanographically sheltered environment that has low wave energy, weak currents and relatively high salinity (i.e. inverse estuary). Features of the described area that are stated by IMCRA Technical Group (1998) as being characteristic of the Gulf St Vincent Bioregion include:</p> <ul style="list-style-type: none"> ◆ confined inverse estuary, with higher salinities and temperatures in the upper reaches of the Gulf; mean salinities ranging from 35.5 to 42.0ppt; ◆ low wave energy coastline; ◆ tides extending to meso-tidal size (to 3.3m in the upper Gulf areas); ◆ tidal plain coast with shallow offshore gradient; ◆ extensive supratidal and intertidal areas; ◆ beaches, beach ridges, sandflats and estuarine deposits; ◆ in sheltered areas, extensive intertidal areas dominated by <i>Avicennia marina</i> mangrove, fine <i>Zostera</i> sp. seagrasses, and <i>Zostera</i> (= <i>Heterozostera</i>) <i>tasmanica</i>, and the “sea grape” brown macroalga <i>Hormosira banksii</i> on hard substrates in shallow waters; ◆ extensive subtidal seagrass meadows, dominated by species of <i>Posidonia</i> (mainly <i>P. australis</i> in the shallow upper gulf, and <i>P. sinuosa</i> and <i>P. angustifolia</i> in other areas) and <i>Amphibolis antarctica</i>; ◆ low marine plant species diversity; ◆ coastal <i>Wetlands of National Importance</i> (e.g. Clinton, Barker Inlet, Wills Creek, Port Gawler); ◆ true rivers present (e.g. Port Adelaide, Wakefield, Gawler); ◆ intermittent streams (e.g. Clinton, Wills Creek).
<p>4. Habitat Rarity</p>	<p>Light River Delta (North-east Gulf St Vincent) The Light River delta is a regionally uncommon habitat of mixed freshwater / saltwater wetland (Edyvane, 1996b), providing habitat for both freshwater and saltwater species of plants and animals.</p> <p>Creeks and Rivers Draining to North-Eastern GSV Although creeks and rivers in the area are not rare habitats <i>per se</i>, the creeks and rivers of northern Adelaide region that drain to Gulf St Vincent have been extensively modified, and the total area of freshwater wetlands and floodplains, which have vital ecological roles, has been drastically reduced, both in the northern plains area, and in GSV as a whole (NAB Catchment Management Board, 2001).</p> <p>Northern Gulf St Vincent In the northern and north-eastern part of the upper Gulf St Vincent, the area of ecologically important saltmarsh habitat is declining. According to the Australian Heritage Commission (undated), the Port Clinton area is the only significant natural (i.e. undisturbed) samphire community in the Gulf St Vincent region. The presence</p>

	<p>of saltmarsh is included in this section because, although it can not be classified as a “rare” habitat, the extent of saltmarsh reduction in the area (and in South Australia generally) due to various impacts, is significant (see section on Issues for Risk and Impact Assessment, and references by Shepherd <i>et al.</i>, 1989; Steffensen <i>et al.</i>, 1989; Kinhill Stearns, 1985; Bucher and Saenger, 1989; Edyvane, 1991 and 1996c; Lewis <i>et al.</i>, 1998).</p>
<p>5. Habitat Diversity</p>	<p>In general, the major habitats in the area include:</p> <ul style="list-style-type: none"> ♦ freshwater drainage channels; ♦ supratidal and intertidal salt marsh / samphire areas (both vegetated areas and bare saline flats); ♦ mangroves; ♦ intertidal sand-flats and mud-flats (the latter including cyanobacterial mats); ♦ intertidal / shallow subtidal seagrass, e.g. fine <i>Zostera</i> species, and <i>Zostera</i> (= <i>Heterozostera</i>) <i>tasmanica</i>; ♦ benthic seagrass (e.g. species of <i>Posidonia</i> and <i>Amphibolis</i>); ♦ benthic sand habitats; ♦ mixed habitats: e.g. patches of shelly reef / muddy-sandy sediments / seagrasses. <p>More specific descriptions are summarised below (from Womersley and Thomas, 1976; Butler <i>et al.</i>, 1975; Shepherd and Sprigg, 1976; PPK <i>et al.</i>, 1992a; Morelli and de Jong, 1995; Edyvane, 1996b; Paxinos and Clarke, 1996; Edyvane, 1999b; DC Mallala Foreshore Advisory Committee and EcoConnect, 2002; DEH Saltmarsh Mapping Program, 2001, and 1:10 000 aerial photographs).</p> <p>Far Northern Gulf St Vincent (Port Price to Sandy Point)</p> <ul style="list-style-type: none"> ♦ Freshwater inputs e.g. Wills Creek, Shag Creek, and Wakefield River. Wakefield River is the major drainage channel in the area (but usually flows only in winter); ♦ Extensive supratidal and intertidal samphire / saltmarsh area (e.g. from Price, extending around the top of the gulf, to Sandy Point), with supratidal samphire extending several kilometres inland at the head of the gulf; ♦ Extensive intertidal sandflat and mudflat areas (e.g. from Clinton to Port Wakefield, and at Sandy Point) which are composed of stranded beach ridges of shelly and swampy deposits, some fringed by <i>Zostera</i> seagrass species; ♦ Mangrove forest which are up to 1km wide on either side of Price Creek, and extending around the head of Gulf St Vincent (including Port Wakefield) in a band, approximately 200m wide on the north-western side, and more than half a kilometre wide on the north-eastern side, down to Sandy Point. The mangrove forests fringe large tidal channels. Mangroves extend up to 2km inland in some parts of the area; ♦ Intertidal / shallow subtidal seagrass meadows which include pure stands of <i>Zostera</i> sp. and <i>Zostera</i> (= <i>Heterozostera</i>) <i>tasmanica</i> in some areas; ♦ Extensive benthic seagrass meadows (mainly <i>Posidonia</i> species); ♦ Subtidal sand habitat. <p>North-Eastern Gulf St Vincent</p> <p>The coastal area of north-eastern GSV is composed mainly of Holocene sediments, forming a wedge that is thickest under the Port River estuary. In the shallow margins of the gulf, the sediment is a coarse shelly sand with a high calcium carbonate content (DC Mallala Foreshore Advisory Committee and EcoConnect, 2002). The creeks and rivers of the Northern Adelaide and Barossa catchments discharge to the low energy north-eastern section of Gulf St Vincent, characterised by wide tidal flats, mangrove woodland, samphire shrubland, tidal creeks and offshore seagrass meadows (NAB Catchment Water Management Board, 2001).</p> <p>More specifically, habitats include the following (compiled from Womersley and Thomas 1976; Butler <i>et al.</i>, 1975; Shepherd and Sprigg, 1976; PPK <i>et al.</i>, 1992a; Morelli and de Jong, 1995; Edyvane, 1996b; Paxinos and Clarke, 1996; Edyvane, 1999b; Delta</p>

Environmental, cited by DC Mallala Foreshore Advisory Committee and EcoConnect, 2002; DEH Saltmarsh Mapping Program 2001, and 1:10 000 aerial photographs):

- ♦ Large, *modified* estuary (**Port River**) and several other smaller freshwater inputs into the system including **Light River** and **Gawler River**, which usually flow only in winter (see section on *Issues for Risk and Impact Assessment*), **Salt Creek** and **Dry Creek**.
- ♦ Freshwater wetlands / marshes (e.g. **Light River** area);
- ♦ Dunes, and extensive areas of stranded beach ridges (cheniers) of shelly and swampy deposits, extending inland up to 2km;
- ♦ Sand beaches;
- ♦ Extensive low gradient supratidal and intertidal samphire / saltmarsh habitat (e.g. **Parham** to **Middle Beach**, and at **Port Gawler**), including both vegetated areas and bare saline flats;
- ♦ Extensive *Avicennia marina* mangrove forests, backing the sandflats and mudflats (**Middle Beach / Light River** to **Torrens Island**) that are dissected by tidal channels and creeks (e.g. **Swan Alley Creek**, **Chapman Creek**, **Broad Creek**, **North Arm Creek**), with mangrove forests extending inland to approximately 2km in some places;
- ♦ Large area of intertidal and shallow subtidal sandflats and mudflats, some colonised by *Zostera / Heterozostera* seagrass species (which dominate the substrate in some of the more sandy areas);.
- ♦ Extensive benthic seagrass meadows of *Posidonia* and *Amphibolis* species, previously recorded in waters to approximately 10m – 15m deep (e.g. Shepherd and Sprigg, 1976), but now degraded (Neverauskas, 1985a, 1985b, 1987a, 1987b, 1987c, cited by Lewis *et al.*, 1998; Shepherd *et al.*, 1989; Zann, 1995; Kinhill, 1998). *Posidonia* species are also recorded in shallower waters, in parts of the **Port River/Barker Inlet** estuarine system;
- ♦ Benthic sand habitat;
- ♦ Small areas of calcareous / consolidated shell substrate, supporting mixed macroalgae and invertebrate assemblages;
- ♦ Razorfish (*Pinna bicolor*) and sea cucumber (Holothuroidea) assemblage on muddy substrates, in waters deeper than 8m, particularly on the north-western side of Gulf St Vincent (Shepherd and Sprigg, 1976);
- ♦ In deeper waters (approximately 12 – 25m), on the north-eastern side of upper GSV, west of Outer Harbour, mixed ascidian / scallop / Razorfish / sea star assemblages with *Halophila* seagrass and shell fragments (Shepherd and Sprigg, 1976).

Selected Habitat Notes

General Zonation of Intertidal and Shallow Subtidal in North-Eastern Gulf St

Vincent: The intertidal area seaward of the supratidal samphire zone is dominated by extensive sandy and muddy flats, in many parts of the area covered by the mangrove *Avicennia marina*. Samphire species (see location descriptions below) are, in some areas, mixed with the mangroves (Butler *et al.* 1975), but mostly form a band above the intertidal. The mangrove areas and bare intertidal mud and sand flats grade into intertidal *Zostera* sp. and *Zostera* (= *Heterozostera*) *tasmanica* seagrass, with *Posidonia* seagrass in the subtidal. Both *Zostera mucronata* and *Z. muelleri* have been recorded in upper Gulf St Vincent. Mudflats in the area are mostly bare, with the exception of the blue-green algae *Oscillatoria* and a rich community of diatoms (see Butler *et al.*, 1975). Macroalgae are found in some areas (mainly species of green macroalgae from the genera *Ulva*, *Enteromorpha*, *Chaetomorpha* in mangrove areas; the brown *Hormosira banksii* on hard substrate; and smaller red macroalgae such as species of *Gelidium*). Gastropods such as species of *Bembicium*, *Salinator* and *Austrocochlea*; bivalves such as species of *Modiolus*; species of the cockle *Katylisia*, and *Pinna bicolor* (Razorfish), are also common. There are “plentiful” polychaete worms and crustaceans, particularly the mud crab *Helograpsus haswellianus* (Womersley and Thomas, 1976, cited by Paxinos and Clarke, 1996). The brown algae *Hormosira banksii* occurs on stones or on the large mussel *Brachidontes erosus*. Fine seagrasses occur in the lower

intertidal, seaward of the mangroves, and in tidal channels. A fine species of *Zostera* is abundant in the area. Another *Zostera* species, *Z. (= Heterozostera) tasmanica* grows at slightly lower depths, extending into the sublittoral (Womersley and Thomas, 1976). *Posidonia australis* is the most common seagrass in the subtidal area, but *Amphibolis antarctica* also occurs (Womersley and Thomas, 1976; Connolly, 1986; Morelli and de Jong, 1995; PPK *et al.*, 1992a).

Ardrossan: There are Pleistocene clay cliffs that dominate the coastline in this area.

The cliffs are around 18m high, and are composed of mottled red and green clays, overlaid by red sandy clays with gravel bands and lenses, and thin white bands of alunite (Field Geology Club of South Australia, 1997). At the base of the cliff is a beach composed of large pebbles, some of which include fossils such as Archaeocyathids (that were originally cup-shaped, sponge-like animals) and Trilobites, both from the Cambrian age. The Cambrian rock (around 540 million years old) outcrops south of Ardrossan. Also on the pebble beach at the base of the Ardrossan cliffs are water-worn boulders of sandstone, rich in clay and the green mineral glauconite, and containing the fossilised remains of the screw shell *Spirocolpus (Turritella)*. The sandstone is from the Eocene (around 40 million years old). A major portion of the cliffs in the Ardrossan area is formed from Tertiary sediments, containing an assortment of fossilised molluscs and bryozoa. The Ardrossan beach also contains black sand, composed of the heavy mineral ilmenite (an oxide of iron and titanium) (Field Geology Club of South Australia 1997). In the subtidal at **Ardrossan**, dense seagrass has been mapped around 1km from the shore, with sparse seagrass further seaward (CSIRO / SARDI mapping, in S.A. coast and Marine Atlas, 2001). Seaward of the shallow subtidal seagrass in the Ardrossan area, and extending northwards, Shepherd and Sprigg (1976) recorded mainly muddy sediments colonised by *Pinna* "Razorfish" (covered with small sponges, ascidians and bryozoa); burrowing sea cucumbers; and large solitary ascidians (*Phallusia* sp.).

North-east of Ardrossan is **Tiddy Widdy Beach**, with sand in the intertidal and seagrass beds in the shallow subtidal. Between Tiddy Widdy and **Mangrove Point**, there is a broad area of supratidal samphire, extending more than 1km inland in places. The intertidal area comprises mainly scattered mangroves, backed by samphire that is degraded in places, and vegetated cheniers (beach ridges).

The area of established and prograding mangroves widens towards the **Mangrove Point – Price** area (DEH Saltmarsh Mapping, in S.A. Coast and Marine Atlas, 2001). Uniform seagrass beds, with patches of bare sand parallel to the coast, have been recorded in the shallow subtidal along this stretch of coast, to at least 3km seaward (DEH Saltmarsh Mapping project in S.A. Coast and Marine Atlas, 2001; CSIRO and SARDI mapping, in S.A. Coast and Marine Atlas, 2001).

Price area, and northwards (includes **Wills Creek Conservation Park**): Description from Morelli and de Jong (1995) and DEH's Saltmarsh mapping project (in S.A. Coast and Marine Atlas, 2001): The **Price** area consists of supratidal and intertidal samphire saltmarsh, and sand flats / mudflats; intertidal mangroves; and shallow subtidal seagrasses. There are salt evaporation fields adjoining the system (a modified feature, but included here due to their ecological significance). The area is subject to regular inundation by seawater. The area has two tidal creeks (**Wills Creek** and **Shag Creek**) which form shallow estuaries at **Mangrove Point**. Mangrove forests line the coast and are dissected by numerous small tidal channels, which provide effective drainage when the tide recedes. The mangrove stand is up to 2km wide in places. Adjacent to the mangrove fringe, a zone of occasional inundation supports a samphire low shrubland of *Sclerostegia arbuscula*, *Halosarcia halocnemoides* and *Sarcocornia quinqueflora*. Above the supratidal zone, both old and recently formed sand spits occur, and a low limestone escarpment forms the western boundary of the area. Much of the area lies below high tide level, and is therefore subjected to daily inundation (Seager, unpublished, cited by Morelli and de Jong, 1995). North of Mangrove Point, the tidal channels are lined with seagrass. There is also bare sand forming an intertidal strip along the coast between **Mangrove Point** and **Port Clinton**, and uniform seagrass in the

subtidal (DEH Saltmarsh Mapping, in S.A. Coast and Marine Atlas, 2001).

Port Clinton: There is a small sandy beach at **Port Clinton**, however the remaining area is dominated by mangroves and mud flats. The coverage of mangroves in the **Port Clinton** is narrower (e.g. 100m – 200m wide strip) than at **Price**.

Clinton Conservation Park: The area includes the head of the Gulf St Vincent, from **Port Clinton** township to South of **Port Wakefield** township. The conservation park encompasses the continuous coastal fringe of intertidal and supratidal samphire; intertidal and supratidal mudflats, and intertidal mangroves with many large tidal channels (extending as far as 600m inland). Dense seagrass has been recorded in the shallow subtidal in this area (CSIRO and SARDI mapping, in S.A. Coast and Marine Atlas, 2001). The mangrove coverage is broader on the eastern side (e.g. **Port Wakefield** area) than the western side, and shallow subtidal seagrass is denser on the western side than the eastern side. The **River Wakefield** is the only major drainage channel in the area, and the only major input of freshwater into the tidal flat system of far northern GSV. There are stranded shell and sand beach ridge deposits in the area above the water line. The hinterland consists of alluvial fan deposits, which are incised with small creek gullies. These creeks either fan out onto the tidal flats, depositing red clay loam and gravel on the surface, or continue across to the sea. Above the supratidal zone, stranded samphire at the head of the gulf extends up to 5km inland on the north-eastern side. Samphire / saltmarsh shrublands are dominated by species such as *Sclerostegia arbuscula*, *Halosarcia halocnemoides*, and species of *Sarcocornia* (Martin, 1980, cited by Morelli and de Jong, 1995; DEH Saltmarsh Mapping project in S.A. Coast and Marine Atlas, 2001). On the eastern side of **Clinton Conservation Park**, between the head of the gulf and the **Port Wakefield** area, the coastal vegetation forms parallel zones, grading from sparse intertidal seagrass, to bare sand (which is more extensive at the mouth of the **River Wakefield** than further north), mangroves, intertidal samphire, supratidal samphire, and stranded samphire (DEH Saltmarsh Mapping project in S.A. Coast and Marine Atlas, 2001).

At **Sandy Point**, there is patchy seagrass and bare sand in the intertidal area, backed by scattered mangroves and intertidal samphire, and vegetated beach ridges. The supratidal samphire flats are extensive in the Sandy Point area and southwards, extending several kilometres inland.

Between **Sandy Point** and **Parham**, in the **Prohibited Area** used for weapons proofing, the coastal strip of intertidal bare sand is around 1km – 1.5km wide, backed by a thin band of vegetated beach ridges (degraded in places), behind which lies stranded samphire and bare flats, extending several km inland (DEH Saltmarsh Mapping, in S.A. Coast and Marine Atlas, 2001). Dense seagrass has been recorded in the shallow subtidal in this area (CSIRO and SARDI mapping, in S.A. Coast and Marine Atlas, 2001).

In the **Parham** area, dense seagrass has been recorded in the shallow subtidal (CSIRO and SARDI mapping, in S.A. Coast and Marine Atlas, 2001), with bare sand and patchy seagrass in the intertidal (DEH Saltmarsh Mapping, in S.A. Coast and Marine Atlas, 2001). The coastal area comprises vegetated beach ridges, patches of samphire (degraded further inland) and bare saline flats. Further south, towards **Great Sandy Point**, there is bare sand and patchy seagrass in the intertidal, backed by patches of intertidal and supratidal samphire, saline patches, and a broad area of bare flats (DEH Saltmarsh Mapping, in S.A. Coast and Marine Atlas, 2001). The shallow subtidal is recorded to be dense seagrass (CSIRO and SARDI mapping, in S.A. Coast and Marine Atlas, 2001). At **Great Sandy Point** itself, the area of samphire widens, and extends up to 4km inland. The samphire is interspersed with bare saline patches at both **Great Sandy Point** and **Port Prime**. The samphire at **Thompson's Beach** and **Port Prime** is mainly supratidal (Delta Environmental, cited by DC Mallala Foreshore Advisory Committee and EcoConnect 2002). Further seaward in this area, there are several seagrass-lined channels, surrounded by patches of dense and patchy intertidal seagrass, and bare sand (DEH Saltmarsh Mapping, in S.A. Coast and Marine Atlas, 2001). Between **Webb Beach** and **Thompson's Beach**, at the outlet to **Baker's Creek**, there is scattered growth of

	<p>mangrove saplings, and evidence of a previous mangrove stand, in the form of mangrove tree stumps scattered over the mudflats (Delta Environmental, cited by DC Mallala Foreshore Advisory Committee and EcoConnect, 2002).</p> <p>Between Port Prime and the northern end of the Light River delta, there are vegetated beach ridges, backed by supratidal samphire and bare salt pans, and fronted by a sand beach, around 9km long southwards from Port Prime. There is uniform seagrass in the intertidal and shallow-subtidal (DEH Saltmarsh Mapping, in S.A. Coast and Marine Atlas, 2001).</p> <p>The Light River delta contains numerous small drainage channels through the near pristine mangrove area, which is up to 1.7km wide in places. The mangroves are backed by intertidal saltmarsh (between around 500m and 1.8 km wide), and supratidal saltmarsh that extends more than 1km inland (DEH Saltmarsh Mapping, in S.A. Coast and Marine Atlas, 2001).</p> <p>The Light River delta was mapped in 2000 as part of the National Land and Water Resources Audit, and the following statistics were calculated (see GeoScience Australia, 2001 – 2004):</p> <p>Classification: river-dominated Sub-classification: tide-dominated delta Flood/ebb delta (km²): 0.11 Channel (km²): 0.15 Intertidal flats (km²): 0.06 Mangrove (km²): 0.89 Saltmarsh / salt flat: (km²) 3.13 Bedrock perimeter: (km) 0.12 Water area (km²): 0.06 Entrance width (km): 0.08 Perimeter (km): 2.42 Maximum length (km): 1.15</p> <p>South of the Light River, in the Salt Creek and Middle Beach area, the band of mangrove and samphire narrows towards the south, but extends to the Port Gawler area. North of Middle Beach, there are numerous drainage channels through the mangroves. Further landward of the mangroves, there are scattered beach ridge deposits in the Salt Creek – Middle Beach area, surrounded by samphire. Patchy seagrass has been recorded in the intertidal (DEH Saltmarsh Mapping, in S.A. Coast and Marine Atlas, 2001). Between Middle Beach and Port Gawler, the samphire is replaced by degraded vegetated beach ridges (cheniers), fronted by intertidal sand, mangroves and patchy seagrass. The area of mangroves, and intertidal and supratidal samphire, widens at Port Gawler. Dense seagrass has been recorded in the shallow subtidal along the coast in this area (CSIRO and SARDI mapping, in S.A. Coast and Marine Atlas, 2001; DEH Saltmarsh Mapping, in S.A. Coast and Marine Atlas, 2001).</p> <p>Port Gawler and Buckland Park: Buckland Park is included in this report due to its indirect connection to upper Gulf St Vincent, during periods of overflow. The Port Gawler area is a significant estuarine habitat for the Gawler River, consisting of extensive tidal flats (shelly silts, clays, and sands) and fringing mangrove forests that are crossed by a multitude of tidal channels. The mangroves at Port Gawler are more than 1km wide, backed by intertidal and supratidal samphires DEH Saltmarsh Mapping, in S.A. Coast and Marine Atlas, 2001). Shellgrit ridges (stranded beach deposits) occur along a belt within the mangrove forest. To the east, within 500 m of the area, lie extensive shallow salt evaporation ponds, which are a part of the salt-extraction system, extending from the Barker Inlet / St Kilda region. A samphire saltmarsh community occupies the area between the mangroves and the evaporation ponds. Adjacent to the ponds lies Buckland Park Lake, which was formed by damming the mouth of the Gawler River. The Lake is a shallow, ephemeral freshwater lake and is divided into a southern and northern basin. When filled (mainly in winter), the Lake consists of a relatively long (2 km) and narrow (0.4 km) stretch of shallow open water. Several channels (to 1.5m deep) radiate from the Lake and penetrate into the surrounding lignum swamps. The Gawler River, which has its source over 40 km to the East, flows through both sites and forms a long,</p>
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narrow estuary at **Port Gawler**. During periods when **Buckland Park Lake** overflows, water leaves the Lake via spillways and is channelled through the mangroves and out to sea. Water levels drop during spring (September through to November) and rapidly dry up in summer, following pumping of the lake remove saline water from the southern basin. The sub-littoral / shallow subtidal zone at **Port Gawler** supports seagrass meadows of *Zostera* (*Z. mucronata*, according to Morelli and de Jong, 1995), *Zostera* (= *Heterozostera*) *tasmanica* and *Posidonia australis*. Low *Avicennia marina* mangrove forest occupies almost the entire upper-littoral zone and extends over 1.4km inland at its widest point. Samphire communities of *Sclerostegia arbuscula* and *Sarcocornia quinqueflora* occupy the flats behind the mangroves. On slightly higher ground *Halosarcia halocnemoides* and *Halosarcia flabelliformis* occur, and the slopes of the low shellgrit ridges support a low chenopod shrubland of *Maireana oppositifolia* and *Atriplex paludosa* with some *Halosarcia halocnemoides*. *Halosarcia* samphire also occurs around part of Buckland Park Lake (SANPWS, 1983b; Paton *et al.*, 1991, cited by Morelli and de Jong, 1995).

The **Gawler River** was mapped in 2000 as part of the National Land and Water Resources Audit, and the following statistics were calculated (see GeoScience Australia, 2001 – 2004):

Classification: Tide-dominated

Sub-classification: tidal flat/creek

Channel (km²): 0.48

Intertidal flats (km²): 0.55

Mangrove (km²): 4.54

Floodplain (km²): 0.18

Saltmarsh / salt flat (km²): 1.89

Water area (km²): 0.17

Entrance width (km): 0.22

Perimeter (km) 6.58 :

Maximum length (km): 2.66

Freshwater swamps of tall sedgelands, *Bolboschoenus caldwellii*, and *Phragmites australis* occur at the **Little Para River** outlet (Ferguson, 1986; Fotheringham, 1994, cited by Morelli and de Jong, 1995).

Avicennia marina low mangrove woodland occupies the intertidal zone at many points along the **Barker Inlet** to **St Kilda** coast, and extends in some places up to 2km inland, with numerous tidal channels occurring through the mangrove system. Extensive salt evaporation ponds occur adjacent to most of the mangrove and samphire areas.

Muddy swamps and extensive mud and sand flats occur in the area, with some of the flats colonised by *Zostera muelleri* and *Zostera* (= *Heterozostera*) *tasmanica* seagrasses in the intertidal and shallow subtidal. *Zostera* is the dominant seagrass in the intertidal and shallow subtidal areas. *Posidonia* seagrass occurs in deeper subtidal areas in north-eastern GSV, and lesser amounts of *Amphibolis antarctica*. It is noted that in the **St Kilda** area, there are now patches of bare sand in the shallow subtidal, following the degradation of seagrass due to the Bolivar sewage outfall (GeoScience Australia, 2001 – 2004; DC Mallala Foreshore Advisory Committee and EcoConnect, 2002).

Barker Inlet – St Kilda: The shoreline has wide tidal mudflats and an extensive belt of mangroves fringing the samphire saltmarsh flats and low-lying dunes of the coastal plain. Saltmarshes constitute approximately 376 ha, or 13% of the estuary area (Bucher and Saenger, 1989, cited by Connolly *et al.*, 1997). Within the **Port Adelaide River – Barker Inlet** system lie **Torrens Island** and **Garden Island**. Along the eastern shore of the Gulf, several creeks feed into the Inlet, including **Chapman Creek**, **Swan Alley Creek**, **Broad Creek** and **North Arm Creek**. There are numerous smaller tidal creeks within the dense mangroves on the eastern side of Barker Inlet, such as **Garnets Creek**, **Post Creek**, **Burrows Creek**, and **Shooting Creek**, amongst others. Freshwater is contributed by stormwater drainage and the **Little Para River**, which opens into the inlet as **Swan Alley Creek**. There is now reduced runoff into **Barker Inlet** from the **Little Para River** due

	<p>to the construction of wetlands for stormwater filtration.</p> <p>Samphire saltmarsh communities in the Barker Inlet – St Kilda area are concentrated in the Torrens Island area; also south of North Arm Creek; east of the mangroves and associated tidal creeks, north of Swan Alley Creek; and small patches at Mutton Cove, and south east of Point Grey (PIRSA, SARDI and DEH map, in Bryars, 2003). Samphire communities are dominated by <i>Sclerostegia arbuscula</i> and <i>Sarcocornia quinqueflora</i>, which abut the mangroves in areas that are regularly inundated by tides. A low chenopod shrubland of <i>Maireana oppositifolia</i> and <i>Atriplex paludosa</i> interspersed with <i>Sclerostegia arbuscula</i> and <i>Lawrenzia squamata</i> occurs on the higher parts of the saltmarsh, chenier and beach ridges, dunes and levee banks. <i>Halosarcia halocnemoides</i> and <i>H. flabelliformis</i> form low heath to open scrub and are largely confined to salt scalds (Morelli and de Jong, 1995; Connolly <i>et al.</i>, 1997).</p> <p>The Barker Inlet / St Kilda area was mapped for the National Land and Water Resources Audit, and the following statistics were calculated (GeoScience Australia, 2001 – 2004):</p> <p>Classification: tide dominated Sub-classification: tidal flat / tidal creek Tidal sandbanks (km²): 31 Channel (km²): 13.51 Intertidal flats (km²): 7.18 Mangrove (km²): 17.65 Floodplain (km²): 3.03 Saltmarsh / salt flat (km²): 6.31 Seagrass coverage (km²): 25.4 Water area (km²): 49.64 Entrance width (km): 9.84 Perimeter (km): 90.62 Maximum length (km): 15.67 Mean wave height (m) 0.55 Max wave height (m) 2.10 Tidal range (m) 2.10</p> <p>Deeper subtidal (to centre of Upper Gulf and Mid Upper Gulf): Seagrass beds (mainly <i>Posidonia</i> species, but <i>Amphibolis antarctica</i> is also present in some areas) occur to at least 8m-10m deep. Much of the upper central Gulf region comprises sand and sandy-mud substrates, dominated in some areas by <i>Pinna</i> “Razorfish” (which acts as a reef micro-habitat by increasing the extent of hard substrate available for attachment of benthic organisms), burrowing sea cucumbers, and the solitary ascidian <i>Phallusia</i> (Shepherd and Sprigg, 1976). More recent studies by SARDI in the non-trawled northern area of GSV showed that the seagrass and <i>Pinna</i> beds recorded during the 1960s are still present. Small patches of shelly reef also occur in the area, mainly in water deeper than 8m to 10m. The brown macroalgae <i>Hormosira banksii</i>, <i>Scaberia agardhii</i>, and species of <i>Sargassum</i> also occur on various calcareous patch reefs, with small species of red macroalgae. Small aggregations of various coral species have also been recorded in some parts of the upper gulf (Shepherd and Sprigg, 1976; Edyvane, 1999b; SARDI, 2001d).</p>
<p>6. Taxonomic Diversity</p>	<p>Bony and Cartilaginous Fish Barker Inlet – St Kilda: More than 70 species of fish have been recorded in the area (Morelli and de Jong, 1995).</p> <p>Estuarine, Coastal and Marine Birds Port Price – Clinton: A species-rich, important habitat and breeding area for wetland / wading, coastal and sea birds. Around 49 bird species have been recorded in the Port Price / Wills Creek / Shag Creek area, and 38 species at Clinton, of which 11 species are listed on international treaties (Morelli and de Jong, 1995). Port Gawler and Buckland Park: 65 coastal bird species have been recorded in the region. Of these, 16 species at Buckland Park and 12 species at Port Gawler are listed under treaties (Morelli and de Jong, 1995). Middle Beach to Port Parham (including Light River Delta): Reported diversity of wetland birds associated with saltwater and freshwater habitats (Edyvane, 1996b).</p>

	<p>Smith (2002) recorded 40+ species of wetland birds and coastal shore birds, of which 17 species were wetland birds.</p> <p>Barker Inlet – St Kilda area: High species diversity, and important breeding and feeding area for many of the 57 species of wading birds, coastal birds and seabirds recorded in the St Kilda and Barker Inlet area (Morelli and de Jong, 1995). Around 93 bird species have been recorded in the constructed Greenfields wetlands, many of which are water birds and coastal waders. Of the 93 species, 23 species appear to breed within the wetland (PPK, 1997, cited by NAB Catchment Water Management Board, 2001).</p> <p>Other PPK <i>et al.</i> (1992a) reported “diverse” saltmarsh communities in the Port River – Barker Inlet area.</p> <p>Light River: The area is recognised for its high diversity of wetland plant species (Edyvane, 1996b).</p> <p>The Defence Dept Firing Range at Port Parham is stated to be an area of high biodiversity (unspecified), due to its restricted access since the latter part of last century (V. Neverauskas, submission to Senate Inquiry into Gulf St Vincent, 2000). A high number of samphire species occur in north-eastern Gulf St Vincent (DC Mallala FAC and EcoConnect, 2002)</p>
<p>7. Habitat for Endemic Taxa / Threatened Taxa / Rare or Uncommon Taxa</p>	<p>Marine Plants Torrens Island: Presence of red macroalga <i>Gracilaria</i> sp., which is reported to have a limited range at a national scale (Cheshire <i>et al.</i>, 2000; Turner, 2000). Northern GSV: The tropical species <i>Sargassum decurrens</i> is usually found from Rottnest Island in WA northwards to northern Australia, and also New Caledonia. The species has been recorded as drift specimens in the Marino and Port Stanvac area, and these may have originated from northern GSV, which is an example of a relict tropical population (Womersley, 1987).</p> <p>Bony and Cartilaginous Fish Northern and North-Eastern Gulf St Vincent: Habitat for the uncommon and endemic <i>Magpie Fiddler Ray</i> (South Australian Museum, 2001). The species has rarely been recorded to date in S.A., with few specimens known, and all of those are from Gulf St Vincent. Previously considered to be a colour variant of the Fiddler Ray, the Magpie Fiddler is now considered a close relative. The species is known to occur in northern Gulf St Vincent, where activities and impacts (dredging, trawling, bomb testing, pollution-induced seagrass decline and other habitat disturbances) may increase the vulnerability of this species.</p> <p><i>Weedy Seadragons</i> were recorded along the stretch of coast from the Parham area southwards to Outer Harbour, during surveys from 1965 to 1971. Numerous <i>Weedy Seadragons</i> were observed during this period, usually in waters 5m – 15m depth, in <i>Posidonia</i> and <i>Amphibolis</i> seagrass (S. Shepherd, SARDI, pers. comm. to Dragon Search program, 2001). Comprehensive fish sampling surveys have not been undertaken in the area recently, and it is not known whether weedy seadragon populations still exist in the area, given the decline in seagrass coverage and habitat quality that has occurred in this area during the past 3 decades. <i>Weedy Seadragon</i> was listed as <i>data deficient</i> in the IUCN Red List 2003, and the species is considered vulnerable to population impacts due to its strong site association.</p> <p>The shallow seagrasses of upper Gulf St Vincent are important habitat for a number of other strongly site-associated small fishes which have localised breeding, including various species of <i>Pipefish</i> (Syngnathidae family), and some of the species in the Clinidae family (the <i>Weedfish</i> and <i>Snake-blenny</i> family) and the Apogonidae family (<i>Cardinalfish</i> family). Fish in the Clinidae and Apogonidae families are strongly site-associated and produce live young, and therefore have limited dispersal, which may increase their vulnerability to impacts, particularly habitat degradation. Also, the S.A. gulfs are near the end of the geographic range for some of these species (see Gomon <i>et al.</i>, 1994; Kuitert, 1996a; Baker, in press).</p> <p>The Deep-bodied (Deepbody) Pipefish <i>Kaupus costatus</i> occurs in the area. The species</p>

belongs to a monotypic, endemic Australian genus, known from isolated populations in Victoria, Flinders Island (Tasmania), and several places in South Australia (e.g. Spencer Gulf, **upper Gulf St Vincent**, and Kangaroo Island) (Kuitert, 1996b; Kuitert, 2000; B. McDonald, unpublished survey data; Browne, 2004). Deep-bodied Pipefish has a very specific habitat: quiet (i.e. low energy) shallow (usually 3m or less, but see below) seagrass beds in silty bottom yet clear-water environments. It is secretive and usually only seen when dragnet samples are taken. The species often occurs in small aggregations, in the intertidal zone (Kuitert, 1996b). In Gulf St Vincent, the species has been reported from the **Port River – Barker Inlet** system; **Port Gawler to Middle Beach**; and lower Fleurieu locations such as Cape Jarvis, and Kangaroo Island (e.g. American River) (Jones et al., 1996; Kuitert, 1996b and 2000; R. Browne, pers. comm., 2003). The abundance of *K. costatus* along the north-eastern coast of Gulf St Vincent (e.g. from Port Gawler to Middle Beach, and possibly further north), makes that area the site of the greatest known population of *K. costatus* in Australia (R. Browne, pers. comm., 2003). The species is not common on the other north-western side of Gulf St Vincent (R. Browne, pers. comm., 2003).

North-eastern Gulf St Vincent: Fish which utilise both marine and freshwater habitat (e.g. Congolli *Pseudaphritis urvillii*) occur in parts of the area, such as downstream of the **Gawler River** weir, and the **Wakefield catchment** (Hicks and Sheldon, 1999; Department for Water Resources, 2000; NAB Catchment Water Management Board, 2001). The quality and quantity of estuarine and freshwater habitat for such species has been severely reduced in north-eastern GSV (**see Issues for Risk and Impact Assessment**). Due to habitat impacts, Congolli has been classed (in a recent inventory of freshwater fish distribution) as a species of conservation concern in S.A. (see Hammer, 2002). The National Parks and Wildlife Council and Department for Environment and Heritage (2003) has recommended that the species be listed as *Rare*, under a schedule of the *National Parks and Wildlife Act 1972*.

Barker Inlet: A number of newly discovered species of estuarine goby (Gobiidae) have been collected in recent years from the Barker Inlet area (data by M. Hammer, cited by Browne, 2003).

The Rock Ling, *Genypterus tigrinus* is found in northern GSV (e.g. **Ardrossan** area – see **Popular Dive Sites**, below). The species has been described as “uncommon” (Nielsen *et al.*, 1999, cited by Froese and Pauly, 2003), and is susceptible to decline from spear fishing and angling (see section 9.2, and Baker, in press for summary of conservation status).

Invertebrates

Rare and/or endemic invertebrates are not known for this area, for this report. However, examples of species which may have a limited known distribution, include the (i) brown or black striated sea anemone *Edwardsia vivipara*, found on low energy coasts in GSV, on sandy or muddy shores (Thomas and Shepherd, 1982), and (ii) *Elminius adalaidae*, a species of barnacle described in 1988 (Bayliss, 1988). *E. adalaidae* is an intertidal barnacle, common in the Adelaide region in sheltered localities and is very abundant in mangroves. Another barnacle species from the upper GSV area, *E. erubescens* may also have a limited distribution (Bayliss, 1994).

Marine Mammals*

North-Eastern GSV: Important habitat for Bottlenose Dolphin (for feeding, mating, calving and juvenile rearing). A large number of dolphins (up to 300), including around 30 “resident” species, are known from the **Port River / Barker Inlet / Outer Harbour** and **north-eastern GSV** area (M. Bossley, pers. comm., 2001; City of Port Adelaide – Enfield, 2003). The species was listed as *Data Deficient* in the IUCN Red List 2003.

* (Note: In the area than encompasses St Kilda – Outer Harbour – Port Adelaide, the Leopard Seal *Hydrurga leptonyx*, Blue Whale *Balaenoptera musculus*, Short-finned Pilot Whale *Globicephala macrorhynchus* and Killer Whale *Orcinus orca* have been observed in the area, but very infrequently (see Ling, 1991; Morelli and de Jong, 1995). All of the above species of conservation concern are rarely observed in

South Australian waters, and the upper Gulf St Vincent area is not considered to be a significant habitat for any of these species, as only stray individuals have been found in the area).

Estuarine, Coastal and Marine Birds

Northern GSV: Important habitat for the race *rosinae* of the Samphire Thornbill (Slender-billed Thornbill) *Acanthiza iredalei* which utilises samphire, lignum and mangrove habitat in the area (Matthew, 1994, cited by Smith, 2002). The *rosinae* race is endemic to the northern shores of the Gulf of St Vincent South Australia (SAOA, 1977, Blakers *et al.*, 1984), and is patchily distributed, from the **Barker Inlet – Torrens Island** area, around the top of the gulf, to the **Price / Ardrossan** area on Yorke Peninsula (Smith, 2002). There are 3 population foci: **Price** (fewer than 1,000 individuals), **Clinton Conservation Park to Sandy Point** (4,000), **Port Prime south to Torrens Island** (4,000). The bird has also probably disappeared from around Port Adelaide (Matthew 1994, cited by Garnett and Crowley, 2000). Specific examples of locations where *A. iredalei rosinae* has been recorded include **Torrens Island, Middle Beach, Port Prime, Webb Beach**, and the **Light River** floodplain (Matthew 1994; Smith, 2002). Samphire Thornbill is classified as *vulnerable* under South Australian legislation, and it is estimated that less than 10,000 of these birds exist (Garnett and Crowley, 2000; Smith, 2002).

Port Price – Wills Creek – Shag Creek – Clinton: Bird species found in the area that are listed as *vulnerable* under the *National Parks and Wildlife Act 1972* include Eastern Curlew, Fairy Tern, White-bellied Sea Eagle and Samphire Thornbill. Also a habitat for Musk Duck, listed as *rare* under S.A. legislation (Morelli and de Jong, 1995).

Middle Beach to Port Parham: Habitat for Fairy Tern (*vulnerable*) (Smith, 2002).

Port Gawler and Buckland Park: Amongst the 16 migratory species that occur at Buckland Park Lake, 11 species not commonly encountered at other locations around the Adelaide region include the Blue-billed Duck, Freckled Duck, Australasian Shoveller, Spotless Crake, Baillon's Crake, Buff-banded Rail, Long-toed Stint and Pectoral Sandpiper (Morelli and de Jong, 1995). Bird species found in the Port Gawler – Buckland Lake area and listed as *rare* under S.A. *National Parks and Wildlife Act 1972*, include Cape Barren Goose, Rock Parrot (**Port Gawler**) Musk Duck, Blue-billed Duck, Australasian Shoveller and Baillon's Crake. Spotless Crake, found in the area, is also considered rare (Morelli and de Jong, 1995; Birds S.A., 2001 and 2002; Rogers, 2002). Bird species that are found in the area and listed as *vulnerable* in S.A. include White-bellied Sea Eagle, Freckled Duck (e.g. recent counts of 50 and 80 Freckled Duck at **Buckland Park Lake**, including juveniles, however breeding in the area has not been confirmed – Rogers, 2002), Eastern Curlew, Fairy Tern, and Samphire Thornbill (Morelli and de Jong, 1995; Rogers, 2002). Little Egret, found in the area, is also considered vulnerable (Morelli, 1995), although the species is not formally listed to date. The Little Bittern, which is uncommon in South Australia has been recorded several times recently at **Buckland Park Lake** (Rogers, 2002). Carpenter and de Jong (2001, cited by Rogers, 2002) suggested that Little Bittern may migrate from the wetlands of the Darling River system to the wetlands and extensive reed-beds along the S.A. section of the Murray River. Rogers suggested that the extensive flooding of Buckland Park in September 2001 may have provided an attractive alternative destination. The 2001 records are reported to be only the second sightings from Buckland Park, the first being in 1935 (Glover, 1976; Rogers, 2002). Broad-Billed Sandpiper, another wader that is uncommonly recorded in S.A., has been reported from the Buckland Park area (Parker and Cox, unpublished, cited by Rogers, 2002).

Barker Inlet – St Kilda: Bird species that are found in the area and listed as *vulnerable* under *National Parks and Wildlife Act 1972* include White-Bellied Sea Eagle, Little Egret (also recorded on **LeFevre Peninsula**), and Samphire Thornbill (Morelli and de Jong, 1995). Preceding its listing under NPWSA legislation, the Gulf St Vincent race of the Samphire Thornbill was listed as *vulnerable* by Watt (1990) and *insufficiently known* by Garnett (1992). Samphire-dwelling bird species may be particularly vulnerable in the area, due to the limited remaining area of samphire habitat, and reduced opportunity for landward accession of the samphire due to reclamation. Reclamation reduces the available space for the necessary landward movement of samphire in the event of land subsidence, and/or sea level rise. Burton (1982a and 1982b) discussed a related concern, regarding the limited space

	<p>for the landward movement of mangroves.</p> <p>Supratidal Flora</p> <p>North-eastern Gulf St Vincent: Presence of saltmarsh plant species of conservation concern: <i>Halosarcia flabelliformis</i> and <i>Centrolepis cephaliformis</i> (see Ferguson, 1986; Fotheringham, 1994a for saltmarsh species lists). The species is recognised in the Wetland of National Significance listing for the Port Gawler area (Morelli and de Jong, 1995). <i>Halosarcia flabelliformis</i> is also present at a number of other areas, such as Middle Beach – Salt Creek area; north of the Light River; north and south of Thompson’s Beach, and Webb Beach (survey by P. Coleman, cited by DC Mallala Foreshore Advisory Committee and EcoConnect, 2002). The species is listed nationally under the <i>EPBC Act 1999</i> as <i>vulnerable</i>.</p> <p>Mutton Cove (LeFevre Peninsula): A vegetation survey during the late 1990s identified 25 species of native vegetation in and around Mutton Cove, including two species with a conservation rating of <i>vulnerable</i> (Emmett, AMCS, pers. comm., 1999).</p> <p>North-east Gulf St Vincent: There is remnant salt-tolerant vegetation, including uncommon and regionally rare species, in the Torrens Island area (ETSA, 1986; Fotheringham, unpublished data; Kraehenbuehl, pers. obs., cited by PPK <i>et al.</i>, 1992).</p>
<p>8. Other Important Taxa</p>	<p>Bony and Cartilaginous Fish</p> <p>North-eastern Gulf St Vincent: Anecdotal evidence of relatively large numbers of large ray species (Capel, 1994). A research survey in 1975 (unknown reference) also showed the presence of large “craters” 10-20km west of Outer Harbour, apparently caused by ray activity in sandy substrate.</p> <p>Barker Inlet system: Large numbers of smaller fish species, such as Small-mouthed Hardyhead, Glass Goby, Blue-spotted Goby, amongst others (Morelli and de Jong, 1995; Jones <i>et al.</i>, 1996; Jackson and Jones, 1999; Connolly <i>et al.</i>, 1997; Connolly, 1999), which are a food source for other estuarine and marine fauna (see section on Notable Feeding and Breeding areas for summary of importance of Barker Inlet for numerous other fish species). Other common smaller fish species in the system include Crested Weedfish.</p> <p>Numerous commercially and recreationally significant fish, crustaceans, molluscs, and some elasmobranch species utilise the habitats of Far Northern and North-Eastern Gulf St Vincent, including the tidal flats, mangroves and tidal creeks, subtidal sand habitats, and seagrass meadows. Examples are provided below in the section on Notable Feeding, Breeding / Spawning and Nursery Areas.</p> <p>Fish which utilise both marine and freshwater habitat occur in parts of the area, such as the lower reaches of the Gawler River, which drains into upper Gulf St Vincent (Hicks and Sheldon, 1999; NAB Catchment Water Management Board, 2001). Examples include the Common Galaxias or Jollytail (<i>Galaxias maculatus</i>), Mountain Galaxias (<i>Galaxias olidus</i>), and Flathead Gudgeon (<i>Philypnodon grandiceps</i>) (Hicks and Sheldon, 1999).</p> <p>Invertebrates</p> <p>Northern and North-eastern GSV: Important settlement areas for Western King Prawn larvae (Kangas and Jackson, 1997; Zacharin, 1997) (see section below, on Notable Feeding / Breeding, Spawning and Nursery Areas). Also, abundance of smaller prawn species, such as Strawberry Prawns, in the shallow seagrass beds. Small prawn species are utilised as a major seasonal food source by a number of fish species (such as Snook) in GSV (Bertoni, 1995).</p> <p>North-eastern GSV: Abundant Mud Cockles and Razorfish are found in the area. Razorfish (<i>Pinna bicolor</i>) are considered to provide “micro-reef” habitat, by housing a “rich epizoic assemblage” e.g. small sponges, ascidians, bryozoa, tube worms (Shepherd and Sprigg, 1976), and provide the hard substrate required for some species to settle, in areas of limited hard substrate (e.g. muddy and sandy sediments). Mud Cockles (<i>Katelysia</i>), of which there are three main species in the area, may have important ecological roles due to being abundant suspension-feeders in the system. Mud Cockles are also a food source for some fauna in the area. There is also a high abundance of some other estuarine invertebrate groups e.g. worms, small crab species and other small macro-crustaceans, and micro-</p>

	<p>crustacea. The mud crab <i>Helograsmus haswellianus</i> is abundant on mudflats in the region (Womersley and Thomas, 1976). Tube worms (<i>Diopatera</i> sp.) and beach worms (family Onuphidae) in the area play a role in sediment processing and nutrient recycling, and are a food source for some fauna of the mudflats and sand flats. Seaweed worms (garden worms) are also found in the area, where dead seagrass is washed up, and also have a similar role in nutrient recycling, and as a food source for birds and other fauna. Blood worms (<i>Glycera</i> sp.), which “swarm” in the waters of Port River – Barker Inlet during winter, are also a food source for estuarine fauna.</p> <p>The Southern Blue-ringed Octopus is also abundant in the shallows, in parts of the Barker Inlet system (J. Baker, pers. obs., 1991). This species has benthic young, and feeds on crabs, small fish, shrimps and shellfish.</p> <p>North-eastern Gulf St Vincent: The large “milk bottle “ ascidian <i>Phallusia obesa</i> is abundant in parts of the area e.g. amongst <i>Pinna bicolor</i> beds (Shepherd and Sprigg, 1976).</p> <p>Coastal and Marine Birds</p> <p>Port Price – Wills Creek – Shag Creek: Breeding and/or feeding habitat for Australian Pelican, Sooty Oystercatcher, Caspian Tern, Crested Tern, Black Cormorant, Little Black Cormorant, Pied Cormorant and Little Pied Cormorant. White-faced Herons and Great Egrets are abundant along the tidal creeks (Morelli and de Jong, 1995).</p> <p>Middle Beach to Port Parham (including Light River Delta): In addition to the coastal sea birds and waterbirds listed in other sections of this table, the area also provides habitat for Hoary-headed Grebe, Little Egret, Australian White Ibis, Little Black Cormorant, Black Cormorant, Pacific Black Duck, Australian Spotted Crake, Black-tailed Native Hen, Red-capped Plover, Red-kneed Dotterel, and Silver Gull (Smith, 2002).</p> <p>Torrens Island Conservation Park: Uncommon migratory waders which visit the park during summer include Terek Sandpiper, Bar-tailed Godwit, Whimbrel, Lesser Golden Plover (SAOA, 1976).</p> <p>Other</p> <p>Far northern and North-Eastern Gulf St Vincent: There is a rich community of diatoms in the mudflat and mangrove areas, both in the mud, and on other organisms (Butler <i>et al.</i> 1975; Womersley and Thomas, 1976). Diatoms are an important group at the base of the food chain.</p>
<p>9. Notable Feeding, Breeding/Spawning and Nursery Areas</p>	<p>Bony and Cartilaginous Fish, and Invertebrates</p> <p>Ardrossan: An important feeding area for invertebrates such as Blue Swimmer Crabs (see Notes on Social and Economic Values and Uses), and a nursery area for juvenile Western King Prawns. The Ardrossan – Price area is considered to be one of the several nursery areas in GSV for Western King Prawn, where high concentrations of juvenile prawns are recorded (Kangas and Jackson, 1997; South Australian Government, submission to Parliament of South Australia’s Senate Inquiry into Gulf St Vincent, 2000).</p> <p>Port Price – Wills Creek – Port Clinton – Port Arthur – Port Wakefield – Sandy Point: Extensive tidal channels and tidal flats in the area are major nursery and/or feeding area for fish, ray, crustacean and mollusc species. Examples include King George Whiting, Yellow-fin Whiting, School Whiting, Southern Sea Garfish, Western King Prawn, Yellow-eye Mullet, Tommy Ruff, West Australian Salmon, Blue Swimming Crabs, Mud Cockles, Baitworm species, Razorfish, flounder species and flathead species, and Southern Fiddler Ray, amongst others (Morelli and de Jong, 1995; Parliament of South Australia, 2000; Fairfax Publishing – F2, 2002; Bryars, 2003). Important areas include Price Creek, Wills Creek, Port Clinton, Port Arthur, and Wakefield Creek, amongst others (Morelli and de Jong, 1995).</p> <p>Port Price – Wills Creek – Port Clinton – Port Arthur – Port Wakefield – Sandy Point: Subtidal soft bottom (sandy) habitats in the area provide nursery and/or feeding areas for King George Whiting, Yellow-fin Whiting, Snapper, Southern Sea Garfish, Western King Prawn (Kangas and Jackson, 1997), Yellow-eye Mullet, Red “Mullet”, Tommy Ruff, West Australian Salmon, Blue Swimming Crabs, Razorfish, King and Queen Scallop, flounder species and flathead species, Southern Fiddler Ray and other ray species, and Whaler Sharks (Bryars, 2003, and recreational</p>

	<p>fishing reports). Kangas and Jackson (1997) showed that the Port Clinton, Port Arthur and Port Wakefield areas were the most important in Gulf St Vincent in terms of numbers of post-larval and juvenile prawns settling into the shallows. The seagrass meadows of Far Northern Gulf St Vincent and the Barker Inlet system also provide spawning and/or nursery areas for Blue Swimmer Crabs, Razorfish, Southern Calamari, King and Queen Scallop, Southern Sea Garfish and Snook, and nursery areas for King George Whiting, Snapper, West Australian Salmon, Tommy Ruff, Southern Sea Garfish, Red "Mullet", Leatherjacket species, Trevally, flathead species and Whaler Sharks (Bryars, 2003). Mangrove forests in Far Northern Gulf St Vincent provide nursery areas for juvenile Blue Swimmer Crabs, Western King Prawn, King George Whiting (also post-larvae), Yellow-fin Whiting, West Australian Salmon, Tommy Ruff, Southern Sea Garfish and Yellow-eye Mullet (Bryars, 2003). Of the far northern Gulf St Vincent nursery areas for Yellow-fin Whiting, Port Arthur and Port Clinton are particularly important. The smaller mangrove-lined embayments are particularly favourable habitat for post-larvae and juvenile of Yellow-fin Whiting (Ferguson, 1999 and 2000).</p> <p>Port Gawler and Buckland Park: Nursery area for various fish and crustacean species (including Western King Prawn). Thirteen species of fish, most commercially and recreationally significant, have been recorded using the area as a nursery (Morelli and de Jong, 1995).</p> <p>Tidal flats, subtidal sand and shallow seagrass habitats from Port Parham to St Kilda (including Webb Beach, Great Sandy Point, Thompson's Beach, Port Prime, Light beach, Middle Beach / Salt Creek area, Port Gawler / Chapman Creek area, Fork Creek) provide feeding and/or nursery areas for Blue Swimmer Crab, Razorfish, King Scallop, Queen Scallop, King George Whiting, Yellow-fin Whiting (tidal flats and subtidal sand habitats), Snapper, West Australian Salmon, Tommy Ruff, Southern Sea Garfish, Red "Mullet", flathead species, Trevally, Leatherjacket species, and whaler sharks (Bryars, 2003). The habitats also provide spawning areas for Blue Swimmer Crab, Razorfish, Mud Cockles (on the tidal flats) Southern Calamari (in the seagrass), King Scallop and Queen Scallop (subtidal sand and seagrass habitats), Southern Sea Garfish, Yellow-fin Whiting (subtidal sand habitat) and Snook (Bryars, 2003).</p> <p>Port River – Barker Inlet area: The Inlet, adjoining mangrove creeks, tidal flats, and subtidal seagrass and sand habitats serve as important nursery areas for a number of important commercial and recreational marine fish and crustacean species. The Barker Inlet system has been described as the most significant fish and crustacean nursery and feeding area in Gulf St Vincent, and is also significant spawning area for some fish species. Fish from the Barker Inlet system recruit to fishing areas as far as Cape Jervis, Stansbury, and Port Vincent (Jones, 1984). Tagging studies have shown that Yellow-fin Whiting from the estuary recruit to metropolitan coastal waters, where they make up a significant portion of the recreation fish catch (Jones, 1980). A summary of the ecological importance of Port River – Barker Inlet system and the associated tidal creeks, for commercially and recreationally significant fish is as follows (see Jones, 1979, 1980, 1984; Connolly, 1994a and 1994b; Connolly <i>et al.</i>, 1997; Bryars, 2003):</p> <p><i>Feeding</i> area for Yellow-fin Whiting (N.B. an important area of GSV for this activity), King George Whiting, Garfish, Yellow-eye Mullet, Jumping Mullet, Mulloway, Snapper, Black Bream, Striped Trumpeter, flounder species, and Blue Swimming Crab (Jones, 1984; Connolly, 1994a and 1994b). Connolly (1994a) showed that in the Barker Inlet system, more species and more individuals of small fish, including juvenile King George Whiting, gathered over eelgrass than in bare sandy areas, and removal experiments (Connolly, 1994b) supported the notion that young fish primarily use seagrass estuaries for epifaunal feeding;</p> <p><i>Nursery</i> area for King George Whiting (N.B. a major nursery area in GSV for this species), Yellow-fin Whiting, Southern Sea Garfish and Western River Garfish, Yellow-eye Mullet, Tommy Ruff, Striped Trumpeter, Whaler Sharks, Black Bream, flathead species, flounder species, Blue Swimming Crab, Western King Prawn (N.B. a major nursery area in GSV for prawns), Mulloway, and Australian Salmon (a species which exhibits environmentally-driven "pulses" of strong recruitment into sheltered estuaries such as Barker Inlet following the spawning events in south-western Australia and subsequent transport of eggs, larvae and post-larvae across southern Australia – Lenanton <i>et al.</i>, 1991; Jones, 1999);</p> <p><i>Spawning</i> area for Yellow-fin Whiting, Garfish, Yellow-eye Mullet, Western River Garfish,</p>
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Jumper Mullet, and Black Bream (Jones, 1984; Bryars, 2003).

Northern Gulf St Vincent: Habitat for Bronze Whaler Shark pups, observed in summer, in the upper GSV (Cappo, 1992). The upper Gulf St Vincent area may be an important “nursery” and feeding area for young Bronze Whalers, as evidenced by the abundance of Bronze Whalers that are caught (particularly commercially, for the “fish and chip” market) in upper gulf waters. Bronze Whaler is a viviparous shark species, with around 7 to 20 pups per litter. Pupping may occur at any time of the year but there is a peak in births in summer (Kailola *et al.*, 1993; Last and Stevens, 1994).

Northern Gulf St Vincent: The seagrass beds in the area are important for Garfish reproduction during the spawning season, and Northern GSV is also an important area for larval Garfish, which are retained in the area due to oceanographic patterns. Larval Garfish were found in greatest abundance in northern GSV, during neuston surveys of Gulf St Vincent and Investigator Strait in 1998 and 2000 (FRDC Project Report 97/133 summary, undated).

Dimmlich *et al.* (2004) reported that during a long term sampling program (1986 to 2001) of the densities of eggs and larvae of the Australian Anchovy in gulf and continental shelf waters across South Australia, the highest densities of eggs were found in northern Spencer Gulf and **northern Gulf St Vincent**, however larvae were more abundant further south of these areas, in shelf waters.

The **Zanoni** has been described as “highly valuable as an aggregation and nursery area for Snapper” (Environment Australia, 2001)

Marine Mammals

Port River – Barker Inlet – Outer Harbour: Important habitat area for Bottlenose Dolphins, used by the species for feeding, sheltering, mating, calving, juvenile nursing / rearing and recreation. Around 20 – 30 “resident” Bottlenose Dolphins use the Port River / Barker Inlet area, and a total of around 300 have been observed as visitors. The area is unique in terms of the dolphin populations proximity to a major urbanised area (M. Bossley, submission to Parliament of South Australia, 2000; Government of South Australia, 2002; DEH, 2003c).

Coastal and Marine Birds

Northern and North-Eastern GSV: In general, the whole of the intertidal and supratidal area of northern and north-eastern Gulf St Vincent provides key habitat (especially feeding grounds) for local and migratory wading, coastal, and sea birds (Butler *et al.*, 1973; Close and McCrie, 1986; Morelli and de Jong, 1995; Copley, 1996; Smith, 2002). Examples of bird species in the area include Great Egret, Red-capped Dotterel, species of plover, Eastern Curlew, Bar-tailed Godwit, Greenshank, Curlew Sandpiper and other sandpiper species, Little Stint, and several species of tern and gull (Field Naturalists Society of S.A., undated). Also contains important breeding areas for some coastal bird species.

Clinton Conservation Park: Around 11 species of migrant shorebird occur, including the Sharp-tailed Sandpiper, Curlew Sandpiper, Red-necked Stint, Bar-tailed Godwit, Common Greenshank and Grey Plover. Numbers between 1981 and 1985 ranged from 4541 Red-necked Stints, 3530 Sharp-tailed Sandpipers, 2500 Banded Stilts, 1300 Banded Lapwings, 500 Grey Plover and 460 Common Greenshank (Wanke, 1971, unpublished records; Taylor and Taylor, 1977, unpublished records; Martin, 1980; Watkins, 1993; Matthew, 1994; Morelli and de Jong, 1995).

Port Price – Wills Creek – Shag Creek contains breeding colonies of four cormorant species (Black Cormorant, Little Black Cormorant, Large Pied Cormorant, and Little Pied Cormorant), and is particularly significant breeding area for Large Pied Cormorant (over 1000 breeding pairs). The area is also a breeding habitat for two Tern species. The area is an important habitat for 16 species of migratory shorebirds, including Ruff, Double-banded Plover, Whimbrel, Black-tailed Godwit and Red Knot. From July 1981 to June 1984, the maximum number of waders counted at **Price** salt fields were 9800 Banded Stilts, 4000 Red-necked Stints, 2400 Curlew Sandpipers, 1800 Sharp-tailed Sandpipers, 970 Bar-tailed Godwits, 700

Red-necked Avocets, 500 Great Knots and 420 Red-capped Plovers (Close and McCrie 1986; Seager, unpublished; Australasian Wader Group Study counts 1993b unpublished records, cited by Morelli and de Jong, 1995).

Middle Beach to Port Parham (including Light River Delta): Important feeding and/or resting area for numerous migratory bird species listed under international treaties, such as Sharp-tailed Sandpiper, Red-necked Stint, Greenshank, Grey Plover, Curlew Sandpiper, Bar-tailed Godwit, Red Knot and other species (Smith, 2002) (N.B. see section below on National and/or International Importance for more detail about population estimates). The area is also an important habitat for other waterbirds and coastal sea birds, including Australian Pelican, Little Pied Cormorant, Pied Cormorant, Black Swan, Grey Teal, White-faced Heron, Great Egret (with breeding evident at Bakers Creek), Caspian Tern, Crested Tern, Whiskered Tern and Pacific Gull (Smith, 2002). Recent population estimates in the area include 1500-2000 Grey Teal; 600-1000 Whiskered Tern (with the largest population numbers recorded in 2001 at Light Beach); 350-4000 Black Swan; 120-150 Australian Pelican, 400-500 Little Pied Cormorant; around 200 each of Pied Cormorant, White-faced Heron, Great Egret and Caspian Tern; and 300 Crested Tern (Smith, 2002). Large numbers of Banded Stilt also occur in the area (e.g. 2200 estimated at Port Prime), which is considered to be an important non-breeding habitat for this species (Smith, 2002). The area is considered important for Pacific Gull because the species is reported to have declined in abundance over its range in southern Australia, due to human disturbance on beaches and at breeding sites (Higgins and Davies, 1996, cited by Smith, 2002).

Light River Delta: Considered to be one of few key habitats for the Samphire Thornbill *Acanthiza iredalei* race *rosinae* (Smith, 2002), due to the prevalence of suitable habitat species in the area, such as *Sclerostegia arbuscula* samphire (which is a taller and less abundant species that is preferred by the thornbills, compared with the more common “ground” samphires in upper Gulf St Vincent), as well mangroves, and the shrubs *Nitraria* and lignum (Matthew, 1994, cited by Smith, 2002).

Port Gawler and Buckland Park: An important feeding, breeding/roosting area for waterbirds, and a feeding area for migratory shorebirds. At Buckland Park Lake, 21 species were found breeding, 11 of which were waterfowl, such as Freckled Duck, Hardhead, Australasian Shoveller, Blue-billed Duck, Chestnut Teal and Australian Shelduck. Maximum numbers recorded between 1989 to 1991: 5200 Grey Teals, 1100 Red-necked Stints, 1000 Black Swans, 300 Sharp-tailed Sandpipers, 200 Pacific Black Ducks, 180 Chestnut Teals, and 100 Australian Shelducks at Buckland Park Lake (SANPWS, 1983; Paton *et al.*, 1991; Morelli and de Jong, 1995). At Port Gawler, there are well-established nesting colonies of Pied Cormorants. Other regular inhabitants include White-bellied Sea Eagle, Great Egret, Glossy Ibis, and Caspian Tern (Morelli and de Jong, 1995). At **Port Gawler**, 12 species of migrant shorebird occur, including the Common Greenshank, Marsh Sandpiper, Wood Sandpiper, Common Sandpiper, Black-tailed Godwit, Curlew Sandpiper and Golden Plover (Morelli and de Jong, 1995).

Buckland Park: Attracts an “extremely wide variety” of waterbirds, in particular waterfowl, that use the lake and associated swamps for feeding, breeding and roosting, and is most important freshwater breeding habitat for waterbirds on the Adelaide Plains (Morelli and de Jong, 1995). Buckland Park is included in this report due to its periodic connection with the waters of Gulf St Vincent, during periods of overflow.

St Kilda – Chapman Creek and Barker Inlet area: An important habitat, including breeding / roosting, sheltering and feeding areas, for Australian Pelican, Pied Cormorant and Black Cormorant, Oystercatchers, Caspian Tern, and species of egrets, herons and gulls, amongst others. The area contains breeding sites for 18 bird species. A colony of 600 Pied Cormorants breed in mangroves in a lagoon of the nearby salt fields. The little Pied Cormorant, Australian Pelican (approximately 100), Little Egret, Rufous Night Heron, Silver Gull (300 000), Caspian Tern and Crested Tern breed in the area, collectively including the Torrens Island and Outer Harbour areas. Breeding waterfowl include the Australian Shelduck and Chestnut

	<p>Teal. Pied Oystercatchers nest on the sandy beaches and spits of Torrens Island and Outer Harbour; and Black-winged Stilts commonly breed on samphire flats (Morelli and de Jong, 1995). The Barker Inlet – St Kilda area is also a migration stopover for up to 12 species listed under international treaties. Common migrant species during the spring-summer months include the Red-necked Stint, Sharp-tailed Sandpiper, Curlew Sandpiper, Common Greenshank, Marsh Sandpiper, and Black-tailed Godwit (Ferguson, 1986; Cox, 1990; Australasian Wader Study Group count, 1993a unpublished records; Goonan, 1993).</p> <p>The sand and mudflats of LeFevre Peninsula are considered to be major feeding areas for thousands of migratory shorebirds, comprising species such as Stints, Sandpipers, and Plovers. Arctic Skua and the Wilson’s Storm Petrel have also been recorded in the area (D. Close, CCSA, pers. comm., 1999). Le Fevre Peninsula / Pelican Island area is also considered to be one of only three regular breeding sites for Australian Pelicans in South Australia (Close, CCSA, pers. comm. 1999; Dalgetty, 2003), and also an important breeding area for Black-faced Cormorants, and an irregular breeding site for Southern Black-backed Gulls, Little Egrets and Sooty Oyster Catchers (D. Close, CCSA, pers. comm., 1999).</p>
<p>10. Shipwrecks and Artificial Reefs</p>	<p>North-east Gulf St Vincent: Well over 60 shipwrecks of various types and constructions occur in the region. Most are broken up, but some have fittings and parts of the hull intact, and many serve an ecological function as fish aggregating / sheltering areas. A list of ships wrecked in the area is provided in the section on Notes on Social and Economic Values and Uses.</p> <p>There is also a sunken barge off Ardrossan that is classified as an artificial reef (Branden <i>et al.</i>, 1994), and the wreck of the <i>Zanoni</i> (see section below) also functions as an “abundant artificial reef” (DEH, 2003b).</p>
<p>11. Popular Dive Sites</p>	<ul style="list-style-type: none"> ♦ Zanoni, is a protected shipwreck in approximately 15-20m of water, around 15km south-east of Ardrossan, and 20km west-south-west of Parham. The <i>Zanoni</i> is considered to be a popular dive spot due to the reef fish populations, which aggregate around the wreck (Edyvane, 1999b). The <i>Zanoni</i>, which is accessible to divers by permit from DEH, has been described by DIASA (undated) as “a haven for many forms of marine life”. Popular biological features of the site include “large” schools of Snapper and trevally, regular presence of various ray and shark species, and presence of various species of soft corals and sponges (Ivanovici, 1984; Environment Australia, 2001). “Numerous types of fish” inhabit the sponge-covered wreck site (Heritage South Australia, 2000a). ♦ There is an artificial reef near Ardrossan (sunken barge), with some ecological value as a site for fish aggregation. The barge also provides a hard substrate for the growth of invertebrates such as soft corals (DEH, undated). ♦ The jetties at Ardrossan are also recognised. The shorter jetty (mainly used for fishing) is promoted mainly for the benthic fauna (Blue Swimmer Crabs, Spider Crabs, Scallops etc) on sand and rubble surrounding the jetty. The longer jetty (grain-loading jetty) is particularly recognised for its schooling fish (including Kingfish); reef fish species; benthic fish such as Rock Ling; and growth of sponges, ascidians and other invertebrates on the pylons, particularly at the end of the jetty. Other features of interest include nudibranchs, and “moon” jellyfish in the surrounding waters (Adelaide SCUBA, undated; Anonymous, undated). ♦ There are several other wreck sites in north-eastern Gulf St Vincent area, that serve as additional hard substrate and fish aggregating devices (See table on Notes on Social and Economic Values and Uses).
<p>12. National and/or International Importance</p>	<p>Wills Creek and Clinton Conservation Parks are listed as <i>Wetlands of National Importance</i> (ANCA, 1996; Environment Australia, 2001b), and Clinton Conservation Park is listed on the <i>Register of the National Estate</i>. Clinton it is stated to be one of the major undisturbed mangrove and saltmarsh associations in the State (and such associations are markedly depleted in South Australia), and an “important bird and marine fauna habitat” (Australian Heritage Commission, undated).</p>

Wills Creek Conservation Park is considered to be the most southerly example on Yorke Peninsula of an undisturbed, high quality mangrove community, and the unusual topographical and botanical features of the Wills Creek area are stated to be of regional importance (Morelli and de Jong, 1995). This mangrove system contains a larger number of associated environmental types compared with some of the other conserved mangrove areas in S.A., according to the listing for the Wills Creek area as a Wetland of National Importance (Seager, undated, cited by Morelli and de Jong, 1995).

Clinton Conservation Park and the coastal zone of the **Price** area (including the industrial salt fields backing the coastal area at Price) have been identified as an area of international importance for shorebirds (Watkins, 1993). As migration “stop-over” areas, Clinton provides habitat for approximately 11 such species, and the **Port Price – Wills Creek – Shag Creek** area provides habitat for approximately 18 species listed under international treaties (Morelli and de Jong, 1995).

Middle Beach to Port Parham (including **Light River Delta**): A significant area for migratory birds listed under the CAMBA and JAMBA international treaties. The area is considered to be particularly significant for Sharp-tailed Sandpiper (estimated 600 to 1000 individuals, or 0.4 – 0.6% of the known world population) and Red-necked Stint (estimated 6000 to 8000 stints, or 1.3 – 1.7% of the known world population) (Smith, 2002). In addition to these species, other birds in the area listed under JAMBA and/or CAMBA include Grey Plover (e.g. 90 birds recorded at **Thompson’s Beach** in 2001, and a population estimate of 250 for the Middle Beach to Port Parham area, which is of national significance); Lesser Golden Plover; Mongolian Plover; Bar-tailed Godwit (around 200+ estimated in the area, including sites such as **Thompson’s Beach** and **Port Parham**); Whimbrel; Eastern Curlew; Greenshank (estimated population 300- 400, which is also of national significance); Grey-tailed Tattler; Ruddy Turnstone (estimated 150 – 200); Red Knot (estimated 600, of national significance); Great Knot (estimated 100); Curlew Sandpiper (estimated 600-1000, also of national significance); Broad-billed Sandpiper; and Caspian Tern (estimated 170-250) (Smith, 2002).

The **Middle Beach to Port Parham** area is considered to be internationally significant in terms of the recorded population numbers of the Australian bird species Red-capped Plover and Banded Stilt, with estimated populations numbers of 800-1000 Red-capped Plover (0.9 – 1.1% of the known world population) and 5000+ Banded Stilt (2.4% of the known world population) (Smith, 2002).

Port Gawler and **Buckland Park, Barker Inlet** and **St Kilda** are listed as *Wetlands of National Importance* (ANCA, 1996). **Port Gawler** is also listed on the *Register of the National Estate*. These areas, mainly comprising samphire saltmarsh, mangroves, tidal sediment flats and shallow subtidal seagrass, are recognised for their significant estuarine function, as described in other sections of this document. Although **Buckland Park** is not a marine feature, it is included in this report due to an indirect connection with Gulf St Vincent waters, during periods of overflow. Buckland Park Lake is the only substantial freshwater habitat on the Adelaide Plains and is also the single most important breeding habitat for a range of waterfowl within the Adelaide region (Morelli and de Jong, 1995). The **Barker Inlet – St Kilda** area is nationally considered to be a good example of temperate mangrove and saltmarsh communities, and is the largest area of mangroves in the Gulf. The proximity of this mangrove stand to Adelaide is considered to be an important feature, there being few other similar stands in or near any major city in Australia.

Torrens Island Conservation Park is on the *Register of the National Estate*, in recognition of the presence of saltmarsh and mangroves (including over 30 species of salt-tolerant plants), uncommon migratory bird species, and an abundance of small mud and sand-dwelling invertebrates (such as worms, and shrimp species) that provide an important food supply for fish of the Barker inlet – Port River system.

The **Port Gawler – Buckland Park** area is significant for migratory birds. For example, 16 species at Buckland Park and 12 species at Port Gawler are listed under international JAMBA and/or CAMBA treaties, such as Common Greenshank, Marsh

	<p>Sandpiper, Wood Sandpiper, Common Sandpiper, Black-tailed Godwit, Curlew Sandpiper and Golden Plover (Morelli and de Jong, 1995; H. Possingham, pers. comm., cited by NAB Catchment Water Management Board, 2001).</p> <p>Barker Inlet – St Kilda has 12 to 16 species under international treaties regularly recorded visiting the area. Port River Mouth is internationally significant for one bird species under international treaty, and the commercial salt fields (run by Penrice) in north-eastern Gulf St Vincent are of international importance for 7 species of shore bird, as well as being the 3rd most important site for shore birds in South Australia and one of the 20 most important sites in Australia (Watkins, 1993; Morelli and de Jong, 1995).</p> <p>A number of uncommon migratory wading birds are also present during summer at Torrens Island Conservation Park (SAOA, 1976).</p>
<p>13. Major Commercial and Recreational Fish, Sharks, Molluscs and Crustaceans</p>	<p>Some of the commercially and/or recreationally fished species that occur in parts of the area that collectively encompasses the Far Northern Gulf St Vincent area include:</p> <p><i>Fish</i>: Garfish, Tommy Ruff, Snook, King George Whiting, Yellow-fin Whiting, Yellow-eye Mullet, Snapper, Sand Whiting, Leatherjacket species, Australian Salmon, Striped Trumpeter, species of Flathead and Flounder, species of Weed Whiting, Red “Mullet”, estuarine species such as Mulloway and Black Bream, and wide-ranging pelagic species such as Yellow-tail Kingfish, Trevally, Blue Mackerel and Barracouta.</p> <p><i>Sharks and Rays</i>: Bronze Whaler and/or Black Whaler, Gummy Shark and other shark species; various ray and skate species.</p> <p><i>Invertebrates</i>: Blue Crab, Southern Calamari, Mud Cockle, Razorfish, Cuttlefish, Rock Crabs, Sand Crabs, Mussels, Beach Worms.</p> <p>Some of the commercially and/or recreationally fished species that occur in parts of the area that collectively encompasses the North Central and North-Eastern Gulf St Vincent area (i.e. from the Light River area southwards to approximately Glenelg include:</p> <p><i>Fish</i>: King George Whiting, Tommy Ruff, Garfish, Yellow-eye Mullet, Snook, Australian Salmon, Blue Mackerel, Yellow-fin Whiting, Snapper, Striped Trumpeter, Red “Mullet”, species of Flathead and Flounder, Yellow-fin Whiting, species of Weedy Whiting, estuarine species such as Mulloway and Black Bream, small numbers of wide-ranging species such as Yellow-tail Kingfish, Trevally, and Jack Mackerel.</p> <p><i>Sharks and Rays</i>: Bronze Whaler and/or Black Whaler, Gummy Shark, Dog Shark and Elephant “Shark” (however Dog Shark and Elephant “Shark” are not common in the area), other shark and ray species.</p> <p><i>Invertebrates</i>: Blue Crab, Mud Cockle, Southern Calamari, Tube Worm, Blood Worm, Beach Worm, Cuttlefish, Rock Crabs, Sand Crabs, and Mussels.</p>

8.17 Southern Fleurieu / North-East Kangaroo Island / Backstairs Passage / Encounter Bay / Upper Coorong (Gulf St Vincent Bioregion)

Figure 19 depicts the location of this area.



Figure 19: Southern Fleurieu / North-East KI / Backstairs Passage / Encounter Bay / Upper Coorong

<p>1. Biogeographic Significance</p>	<ul style="list-style-type: none"> ♦ North-east kangaroo Island / Backstairs Passage / Pages Islands: High tidal flow environments are uncommon in South Australian coastal waters, and the high current speeds of Backstairs Passage (up to 250 cm/second, Shepherd and Sprigg, 1976), have resulted in distinct assemblages, both within the Passage, and at its edges – e.g. north-eastern Kangaroo Island. Deepwater trenches adjacent to Cape Jervis and the Dudley Peninsula reach a maximum depth of 80m, and feature exposed rock ledges dominated by invertebrate fauna (DEH, unpublished survey information, 2003). Steep depth gradients also occur close to shore on north-eastern Kangaroo Island, also contributing to the unique sessile invertebrate-dominated assemblages that are not found in other parts of South Australia’s coastal waters. Assemblages in the shallower waters of the region are dominated by large erect species of sponge and bryozoan, soft corals and gorgonian corals, sea pens, and a variety of echinoderm groups (feather stars, brittle stars, basket stars, sea stars) (KI-AMCS, 2000; Edyvane, 1999b). Assemblages in deeper waters (tidal race of Backstairs Passage) dominated by large sponges (forming “sponge gardens”) and large bryozoa, brittle stars and basket stars, and high densities of brachiopods (Shepherd and Sprigg, 1976; Edyvane, 1999b; KI-AMCS, 2000). ♦ Pages Islands: Biogeographically significant population of Australian Sea Lions, with the largest breeding colony in the world occurring at North and South Page Islands. During the early 2000s, approximately 2,100 Australian Sea Lions populated the island (DEH, 2003g), a decline from previous estimates, when over 1,250 individuals were recorded on South Page, and 1,491 on North Page, during the early 1990s (Gales, 1990; Gales <i>et al.</i>, 1994), providing approximately one quarter of the state’s pup production. Around 450 pups, on average, are produced on the Pages Islands every breeding season (Rowley, 2001 –see information on high pup mortality rates in section on Issues for Risk and Impact Assessment), and in 2002, Shaughnessy <i>et al.</i> (in prep.) counted 500 pups at the Pages Islands, making this the most important colony in South Australia, in terms of pup production. Shaughnessy (2002) considered the Pages Islands to be the most important area in South Australia in terms of pinniped conservation. The Australian Sea Lion is endemic to South Australia and Western Australia only, and, due to the population size and the number of pups produced on the Pages, the breeding colony in this area is of national and global significance. The Sea Lions at the Pages Islands also represent the most easterly positioned breeding colony of Sea Lions in South Australia (Berggy, 1996). ♦ Murray Mouth/Goolwa/Sir Richard Peninsula: A major estuarine and coastal wetland area in South Australia (Murray River outlet) and biogeographically “unique” coastal dune barrier (Coorong). The Murray Mouth estuary and Lower Murray is considered to be a region of outstanding national and international conservation value, particularly for its variety of wetland habitats and significance for waterbirds and other coastal birds (see NPWS, 1984 and 1990; Morelli and de Jong, 1995; ANCA 1996; Edyvane <i>et al.</i>, 1996; Murray Darling Basin Commission and DWLB, 2002). The area regularly supports more than 200,000 birds, including a large number of migratory species and individuals. <p>Minor Features of Biogeographic Significance Apart from Encounter Bay, there are few areas of shallow subtidal seagrass between Cape Jervis (bottom of Fleurieu), and Lacepede Bay in the upper South-East, making the seagrasses of Encounter Bay area regionally significant as habitat. Encounter Bay is the most easterly biogeographic limit of the distribution in South Australia of the seagrass <i>Amphibolis griffithii</i>. Encounter Bay features the western limit of an extensive offshore reef system, representing a former coastline, that extends along the Coorong Coast</p>
<p>2. Major Physical Influences, and Relative Productivity Level</p>	<ul style="list-style-type: none"> ♦ According to current maps by P. Petrusevics (in S.A. Coast and Marine Atlas), the North-East Kangaroo Island and Backstairs Passage areas are amongst the 8 areas in S.A. waters where both winter and summer <i>current speeds</i> are strongest. ♦ The steep depth gradients in some areas strongly influence habitat types and biotic composition. There are steep depth gradients on the North-East Kangaroo Island coast, and around Cape Jervis / Fishery Beach. Waters 40m deep occur around

	<p>1.5km from the Cape Jervis coast, in northern Backstairs Passage. On the other side of the passage, coastal waters and gradients are even steeper e.g. waters 35-40m deep, within 500m - 1km from the coast in the vicinity of Alex Lookout, Cuttlefish Bay, Snapper Point and Cape Coutts (DTUP, 2002).</p> <ul style="list-style-type: none"> ♦ North-east kangaroo Island/Backstairs Passage/Pages/South tip of Fleurieu: The combination of <i>high tidal flow environments</i> in a <i>deep coastal water channel area</i>, and (in the case of North-east kangaroo Island, and Cape Jervis) <i>steep depth gradients</i> close to the coast, are major physical influences in the region, and are partly responsible for the unique biotic assemblages in some areas. For example, part of the Passage and North-east Kangaroo Island are dominated by communities of large attached invertebrates, influenced by the oceanographic conditions (Shepherd and Sprigg, 1976; Shepherd, pers. comm.; Edyvane, 1999b; KI AMCS, 2000 and 2001). ♦ The biota of the Cape Jervis area, on the eastern side of the Passage, may also be strongly influenced by the effects of tidal currents (T. Kildea, pers. comm. 2003), and the area is well known for its “tidal races”. ♦ The Murray Mouth: The geomorphology of the Murray Mouth and associated sand peninsulas; the flow regime; the significant freshwater and sediment input to the coastal area; and associated variety of freshwater, estuarine and saltwater habitats, make the Murray Mouth estuary a major physical and biological influence in the region. It is the largest estuarine area in South Australia, and the outlet to the largest river system in Australia. The flow of the Murray Mouth estuarine area is integral to the ecosystem functioning of the Coorong region and the adjacent coastal and marine area, including the Youngusband Peninsula and Sir Richard Peninsula, and the waters of the Encounter Bay – upper Coorong region ♦ Encounter Bay has a large depth range (from intertidal to 40m deep) (S.A. Coast and Marine Atlas, 2001), and incorporates extensive areas of offshore platform reef, contributing to the habitat diversity of the area (B. McDonald, DEH, pers. comm., 2003). ♦ Wave energy and swell exposure are highly variable throughout the broad region described in this table, ranging from shallow, sheltered quiet water environments such as inner American River and Pelican Lagoon, to the wave and swell-exposed coast of the bottom of the Fleurieu, Encounter Bay and the Murray Mouth. General features of the oceanography pertaining to each area described in other sections of this table, in relation to habitat types. <p><i>Relative productivity cannot be documented with the data available, for parts of the area discussed in this table.</i></p>
<p>3. Habitat Representative-ness</p>	<p>Within the area described in this table, the northern and western sections, and waters less than 30m between southern Fleurieu and western Encounter Bay, form part of the St Vincent Gulf Bioregion. The eastern section, and waters in the southern section deeper than 30 m, form part of the Coorong Bioregion. Some of the features that are characteristic of these bioregions for the region described, according to descriptions by IMCRA Technical Group (1998) are as follows:</p> <p>St Vincent Gulf Bioregion (see IMCRA Technical Group, 1998)</p> <ul style="list-style-type: none"> ♦ Moderate wave energy coastline; ♦ Precambrian meta-sedimentary and Tertiary cliffs; ♦ Holocene beaches; ♦ dunes and beach ridges; ♦ typical cool temperate (Flindersian) flora and fauna; ♦ <i>Hormosira banksii</i> (on intertidal reefs), and fine seagrasses in the <i>Zostera</i> genus (including <i>Heterozostera</i>), on sand in intertidal areas; ♦ extensive subtidal seagrasses to around 17m, becoming sparsely vegetated at deeper depths; ♦ seagrasses dominated by <i>Posidonia australis</i> in (some) shallow waters, and <i>Amphibolis antarctica</i> and mixed species of <i>Posidonia</i> in the Mid and Southern Gulf areas; with <i>Posidonia</i> aff. <i>ostenfeldii</i> seagrass forming small communities along

	<p>exposed parts of the lower gulf;</p> <ul style="list-style-type: none"> ♦ “isolated reefs” and shore-fringing macroalgal communities dominated by <i>Scaberia agardhii</i> and species of <i>Sargassum</i> in sheltered areas, and <i>Ecklonia radiata</i>, <i>Seirococcus axillaris</i> and species of <i>Cystophora</i> in moderately exposed areas; ♦ presence of the fish <i>Vanacampus vercoi</i>, <i>Acentronura australe</i> and <i>Campichthys tryoni</i>*; ♦ Wetlands of National Importance: Cygnet River and American River; ♦ “Tidal creeks” – American River. <p>*N.B. Referred to in IMCRA (1998) as “a distinct South Australian and subtropical element in the fish fauna”. <i>C. tryoni</i> is found in Qld, and there is only one record from South Australia, an old museum specimen provisionally referred to as being this species (see Froese and Pauly, 2003, citing Dawson, 1985; see also Kuitert, 1996).</p> <p>Coorong Bioregion (see IMCRA Technical Group, 1998)</p> <ul style="list-style-type: none"> ♦ “High deep water wave energy” at the Murray Mouth; ♦ large barrier coast dominated by gradational near-shore offshore gradient; ♦ headlands and cliffs of Precambrian crystalline rock and meta-sediments; ♦ Pleistocene dune rock cliffs, headlands, shore platforms and reefs, interspersed with Holocene pocket beaches; ♦ marine flora and fauna typical of transitional warm to cold temperate (Flindersian Province); ♦ intertidal and sublittoral fringe dominated by the brown macroalga <i>Cystophora intermedia</i>; ♦ flora of rocky limestone shores includes species of the red macroalga <i>Plocamium</i>, the green <i>Caulerpa</i>, and brown canopy macroalgae <i>Cystophora</i> (e.g. <i>C. subfarinata</i>, <i>C. moniliformis</i> and <i>C. platylobium</i>) and <i>Ecklonia radiata</i>; ♦ granite boulder coasts dominated by canopy-forming brown macroalgae <i>Scytothalia dorycarpa</i>, <i>Acrocarpia paniculata</i>, <i>Carpoglossum confluens</i> and <i>Ecklonia radiata</i> on exposed coasts, and species of <i>Cystophora</i> in areas of moderate wave energy; ♦ southern coast dominated by large beach-dune barrier complex comprising the extensive Coorong lagoon and Holocene beach ridge plains; ♦ Coorong Lagoon, supporting one of the largest concentrations of wader birds and migratory birds in Australia; ♦ Coastal Wetlands of National Importance - Coorong Lagoon, including Lakes Alexandrina and Albert; ♦ region dominated by (the influence of) the Murray River, and extensive estuarine and ephemeral salt lakes of the Coorong Lagoon.
<p>4. Habitat Rarity</p>	<p>North-east kangaroo Island (Kangaroo Head to Cape St Albans): Biogeographically significant shallow-water (e.g. 12+m) sessile invertebrate faunal assemblages have been recorded by both community and government surveys in the Cuttlefish Bay - Snapper Point - Cape Coutts region during the 1990s. Similar assemblages are known in South Australian coastal waters only from the deeper Backstairs Passage region – see below). Large specimens of erect sponge and bryozoan species, soft corals and sea pens, and mixed echinoderms (feather stars, brittle stars) which are abundant in the area, are uncommon throughout South Australia as dominant components of the benthos, particularly in shallow waters (Shepherd and Sprigg, 1976; S. Shepherd, pers. comm.; Edyvane, 1999b; KI AMCS, 2000 and 2001).</p> <p>Backstairs Passage: Biogeographically significant deep coastal water (e.g. to 60+m) sessile invertebrate faunal assemblages recorded (see Shepherd and Sprigg, 1976) in the rocky channels of the Backstairs Passage region, which are not known to occur in other parts of South Australia. The area is characterised by large specimens of erect sponges and bryozoa, abundant epizoic brittle stars and basket stars, and high densities of brachiopods, which are uncommon throughout South Australia as dominant components of the benthos, although there are similarities in composition with the assemblages recorded in shallow water in the vicinity (e.g. North-eastern</p>

	<p>Kangaroo Island) (see Shepherd and Sprigg, 1976; Edyvane, 1999b; KI-AMCS, 2000 and 2001).</p> <p>Murray Mouth / Goolwa / Sir Richard Peninsula: The Murray River outlet is the major estuarine area in South Australia, and also contains a significant coastal wetland area, of which there are few in South Australia. The area also comprises part of the biogeographically unique coastal dune barrier system of the Coorong. There is no other estuarine system similar to the Coorong, in southern Australia. Morelli and de Jong (1995), in the description of the Lower Murray area as a <i>Wetland of National Importance</i>, described the Coorong (including the Lower Murray area) as supporting “an unusual set of aquatic habitats”.</p>
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5. Habitat Diversity

The following descriptions are compiled from Shepherd and Sprigg (1976); Australian Heritage Commission (undated); Baker and Edyvane (1996); Edyvane and Baker (1996b); Edyvane *et al.* (1996); Collings and Cheshire (1998); Edyvane and Baker (1999a); Edyvane (1999b); KI-AMCS (2000); DTUP’s South Australian Coast and Marine Atlas (2001 version), B. McDonald, DEH, pers. comm., 2003; and 1:25,000 aerial photographs from DEH.

Southern Fleurieu habitats include:

- ♦ river and creek outlets (e.g. Myponga River, Bungala River, Yankalilla River, Carrickalinga Creek);
- ♦ sand and pebble beaches;
- ♦ intertidal calcareous reef platforms (e.g. Aldinga);
- ♦ largest intact seagrass meadows along Fleurieu Peninsula coastline, south of the metropolitan area - e.g. Yankalilla Bay and Rapid Bay (Edyvane, 1999b), with minor cover of seagrass at Morgan Beach and Fishery Beach (Bryars, 2003);
- ♦ reefs of various types, topographies and orientations, including topographically complex calcareous reefs (e.g. Aldinga) and metamorphic headland/cliff face reefs (e.g. Carrickalinga Head, Rapid Head) and near-shore “submarine caves”;
- ♦ boulder conglomerate and cobble/rubble/pebble “patch” reefs within seagrass beds and/or sand areas (e.g. in Yankalilla Bay, Rapid Bay, Lady Bay and in Second Valley, surrounded by seagrass, and as far north as Carrickalinga Head, extending up to several kilometres offshore);
- ♦ basement rock reefs (e.g. 5km offshore, south-west of Normanville, according to Shepherd and Sprigg, 1976);
- ♦ subtidal bare sand habitat (e.g. near-shore, part of Rapid Bay).
- ♦ Seaward of near-shore seagrass and patch reef, an ascidian/scallop/sea star assemblage occurs on sandy substrate, to approximately 30 m.

Cape Jervis to Newland Head habitats include:

- ♦ minor river outlet (**Tent Rock Creek**);
- ♦ small beaches;
- ♦ extensive areas of benthic sand;
- ♦ coastal metamorphic cliff base fringing reefs;
- ♦ near-shore boulder reefs and cobble / rubble reefs;
- ♦ invertebrate-dominated “strip” reefs at 15 m, surrounded by sand;
- ♦ mixed sand / boulder reef and sand / cobble reef habitats.

Headlands and Deeper waters of North-east kangaroo Island (e.g. Dudley Peninsula)

Habitats include:

- ♦ reefs of various compositions and forms. Examples include metamorphic reef, of various forms and orientations, including vertical “rock walls”; boulder and cobble reef of mixed geology; calcareous platform reef, and “hilly” and rugose calcareous reef containing a variety of micro-habitats, as occurs in deeper waters out of **Nepean Bay**. Reefs in the **Dudley Peninsula** area are dominated by mixed macroalgae and invertebrates in near-shore area, and mixed invertebrate assemblages in deeper waters (e.g. habitat dominated by large basket bryozoan and other bryozoan species, massive sponges, soft corals, gorgonian corals, sea pens, feather stars and other crinoids, basket stars, reef molluscs and red macroalgae (Shepherd and Sprigg, 1976; SARDI S.A. Benthic Survey data, 1994, unpublished; KI-AMCS, 2000).
- ♦ dense seagrass beds (e.g. **Antechamber Bay**);

- ♦ sand beach (e.g. **Antechamber Bay**);
- ♦ small estuary (**Chapman River**);
- ♦ mixed patch reef/seagrass habitats;
- ♦ benthic sand habitat.

Bay of Shoals - Western Cove - Nepean Bay habitats include:

- ♦ **Cygnnet River** estuary - largest freshwater fed wetland on Kangaroo Island);
- ♦ samphire flats (e.g. **Western Cove**);
- ♦ regionally significant shallow water bays which includes more than half of the major shallow bay area of north-eastern Kangaroo Island, including extensive shallow sandy, muddy and shelly lagoonal habitat (e.g. **Cygnnet River** estuary, and around **Beatrice** and **Busby Islets**, and **Cape Rouge**) with intertidal seagrass and numerous invertebrate species, beaches, intertidal seagrass;
- ♦ extensive benthic seagrass meadows in **Bay of Shoals** and parts of **Western Cove** (however seagrass in the area is declining in quality and quantity – *see **Issues for Risk and Impact Assessment***);
- ♦ benthic sand habitat;
- ♦ calcareous macroalgal-dominated patch reefs (e.g. **Point Morrison** area);
- ♦ invertebrate-dominated reefs in deeper waters out of **Nepean Bay** (see **Habitat Notes** below).

American River – Eastern Cove habitats include:

- ♦ **American River Inlet** and **Pelican Lagoon** – comprising regionally important calm water, sheltered tidal habitat (which is uncommon on Kangaroo Island and adjacent Southern Fleurieu), with shallow intertidal and subtidal seagrass and intertidal benthic invertebrate assemblages;
- ♦ Minor estuarine area (**Deep Creek**, north-east of **Baudin Beach**);
- ♦ intertidal and shallow subtidal sand, mud and shell beds;
- ♦ extensive seagrass meadows in **Eastern Cove**;
- ♦ extensive shallow sandy habitats (e.g. central **Eastern Cove**);
- ♦ mixed seagrass/ calcareous patch reef communities with a diversity of large brown macroalgal species;
- ♦ “hilly” and rugose aeolianite reef in deeper waters of the bay, containing a variety of micro-habitats.

Backstairs Passage / Pages Islands habitats include:

- ♦ shallow subtidal metamorphic platform and boulder reefs;
- ♦ diversity of reef habitat types and forms, dominated by macroalgae in shallow areas and mixed invertebrates on deeper reefs;
- ♦ deepwater, tidally-scoured trenches with associated reef habitats of varied form;
- ♦ deeper water habitat dominated by large basket bryozoa and other bryozoan species, massive sponges, epizoic feather stars and brittle stars, and high densities of brachiopods;
- ♦ sparsely covered mixed substrate of sand, silt and pebbles in some deeper Backstairs Passage waters.

Encounter Bay habitats include:

- ♦ minor river outlets (**Hindmarsh** and **Inman Rivers**);
- ♦ minor stands of estuarine vegetation;
- ♦ small beaches;
- ♦ Fringing calcareous platform reefs (both intertidal and subtidal);
- ♦ Offshore calcareous platform reefs (associated with former coastlines)
- ♦ mixed seagrass/patch reef habitats (containing mixed seagrass and macroalgal assemblages);
- ♦ seagrass beds;
- ♦ cobble/pebble reefs;
- ♦ granite boulder reefs (both macroalgal-dominated and invertebrate-dominated, according to depth and orientation);
- ♦ subtidal “cliffs”, crevices, caverns and overhangs, particularly around granite islands, and dominated by invertebrates;
- ♦ bare sand habitat (intertidal and subtidal).

Murray Mouth / Goolwa / Sir Richard Peninsula habitats include:

- ♦ major estuarine area (**Murray River** outlet);

- ♦ large coastal dune barrier; beaches;
- ♦ coastal lagoons;
- ♦ salt lakes, and extensive salt marsh;
- ♦ extensive estuarine wetlands, including sedge and rush communities;
- ♦ estuarine channels;
- ♦ extensive mudflats and sandflats;
- ♦ seagrass beds (marine side);
- ♦ benthic sand habitat; and
- ♦ patch reefs in deeper water.

Selected Habitat Notes

Southern Fleurieu

The general features of the intertidal ecology in the Southern Fleurieu and Encounter Coast region and its islands were discussed in Womersley and Thomas (1976) and Shepherd and Womersley (1970). General features include:

Rough and moderate water rocky coasts

Littorinid snails (*Nodilittorina unifasciata* and *N. praetermissa*) are plentiful in the splash zone, feeding on thin algal mat cover, such as *Calothrix* sp. (Womersley and Thomas 1976); various lichen species are also conspicuous. Eulittoral algae include species of the green *Ulva* and *Enteromorpha*. Common fauna include crabs (e.g. *Grapsidae* family) and isopods in the supralittoral; barnacle species in the eulittoral (*Chamaesipho* and *Chthamalus* sp.), and larger surf barnacles, limpets, turban shells and black mussels in the mid-eulittoral. Algae of the mid-eulittoral zone include blue-green species, the brown *Splachnidium rugosum*, and the worm-like red alga *Nemalion* (Womersley and Thomas, 1976). In mid-eulittoral areas of moderate water movement, polychaete worms, *Tetraclina* barnacles, periwinkle and coniwinkle species are common. Lower eulittoral areas are characterised by the large *Balanus* barnacle, large chiton species, *Halpilton* coralline algae, “sea grapes” (*Hormosira banksii*), and species of multi-branched red algae *Laurencia*, *Wrangelia* and *Dasya*. The brown *Cystophora intermedia* is a common upper sublittoral macroalgal species (Shepherd and Womersley, 1970), adapted to withstand very turbulent conditions. Other dominant macroalgae include *Ecklonia radiata* and various species of *Cystophora* and *Sargassum*, *Scaberia agardhii* and green *Caulerpa* species. Abalone, stalked ascidians (*Pyura* sp.) and seastars also occur. Hodge (1932) reported that Encounter Bay intertidal area is also home to a variety of sponge crab species, small prawn species, and numerous chiton species.

Sandy Beach Coasts

In exposed areas comprising coarse sand, few species are supported. Among those which can find a foothold are species of the isopods *Acteacia* and *Cirolana*, the Goolwa cockle *Donax (Plebidonax) deltoides* (commercially important) and the sand dwelling conical gastropod *Polinices (Conuber) incei* (Womersley and Thomas, 1976), whose egg masses (popularly known as “sausage blubbers”) are often washed up on beaches.

Aldinga

According to the Australian Heritage Commission (AHC) (undated), the coastal section between Maslin and Aldinga Bays is characterised by cliffs of different coloured layered marls and sands. Fossiliferous Cainozoic rocks are exposed along sections of the cliff. Sandy beach deposits and rock debris from the cliffs above, form a shore section about 100 m wide. The shore reef outcrop is approximately 5km long (AHC, undated). The near-shore part of **Aldinga Reef** consists of a large intertidal calcareous platform. Part of the reef system is intertidal and shallow subtidal (to approximately 300m seaward in the north and south of the reserve to 500m seaward in the central part off **Snapper Point**), and part of the **Aldinga Reef** and **Pinnacles** system is submerged (out to the “drop-off” at 1200 m or more from shore). There are both invertebrate-dominated and macroalgal-dominated assemblages, and the reef contains a number of micro-habitats for invertebrates due to the high topographical complexity (e.g. caves, fissures, pinnacles). In waters less than 20m, Shepherd and Sprigg (1976) recorded a mix of aeolianite (sandstone) reef and seagrass meadow (mostly *Posidonia*) in the **Aldinga** area. Edyvane (1999b) reported that the main species of *Posidonia* in the Fleurieu area, such as Aldinga, are *P. sinuosa* and *P. angustifolia*, with lesser amounts of *P. coriacea*. The brown macroalga *Hormosira banksii* is abundant on the shallow reef flat (particularly in the northern section). The reef patches of the mixed rock pool/sandy habitat in the southern section, support *H. banksii*, *Caulocystis uvifera*, and other macroalgae. Sponges, hydroids, ascidians, and molluscs are recorded as common reef inhabitants on the intertidal platform (Johnson, 1988a). Shallow sandy patches (e.g. southern part of the intertidal reef area) support fine seagrasses (Zosteraceae), as well as patches of *Posidonia*, and a species of the “sea lettuce” *Ulva* occurs throughout the mixed reef patch/sand area. The shallow reef pools contain abundant molluscs, sponges, hydroids and ascidians (Johnson,

1988a). Sandy areas surrounding the reef system are colonised by fine seagrasses (Zosteraceae), as well as *Posidonia* and *Amphibolis* seagrass species in deeper waters. Seagrass patches are also present north of **Snapper Point**. On the outer intertidal edge of the reef is a band of red turfing algae, such as *Gelidium pusillum*. Off the edge of the intertidal area to around 10m depth, *Ecklonia*, and species of *Cystophora* and *Sargassum* are common (Ivanovici, 1984).

Cheshire *et al.* (1998) also recorded these species of brown macroalgae as the dominant cover on limestone reefs at **Aldinga** at a depth of 5m and 10m, with smaller brown (e.g. *Lobophora variegata*) and red algae, and encrusting species, in the understory. Edyvane (1999b) also reported that near-shore reefs in the **Aldinga Bay** region were dominated by *E. radiata*, species of *Cystophora* and *Sargassum*, with turfing browns such as *L. variegata*, greens (*Caulerpa* sp.) and small reds in the understory. Cheshire *et al.* (1998) recorded ascidians, hydroids, anemones and tube polychaetes as the principal invertebrate groups on the shallow reef (5 m) at **Aldinga**, with gastropod molluscs and anemones more prevalent at 10 m. The reef complex extends 1.2km offshore from **Snapper Point**, and at the seaward edge, there is a “drop-off” into deeper water, with a steep submarine cliff of approximately 10m. The deeper vertical faces of the “drop-off” support a “rich” and abundant sessile fauna, such as sponges, and also gorgonian corals and other invertebrate groups (Johnson, 1988a). An assemblage dominated by stalked ascidians (e.g. *Pyura spinifera*), Scallops and seastars, was recorded on sandy substrate in waters approximately 10m - 20m deep in the bay area (Shepherd and Sprigg, 1976). Hammer oyster *Malleus meridianus*, Razorfish *Pinna bicolor*, and scallop assemblage on silty substrate in deeper waters (22 to 25+ m) (Shepherd and Sprigg, 1976), seaward of the sand strip.

Carrickalinga Head to Cape Jervis

The Carrickalinga area is part of an actively developing cliff line, displaying exposures of the Adelaide Geosyncline early Cambrian (meta-sedimentary) fossiliferous rocks, of the Kanmantoo Group (AHC, undated). Heavily dissected shore platforms of folded rock occur at the base of **Carrickalinga Head** (AHC, undated). There are sandy beaches, mainly in the northern part of the area, and between the headlands. At **Normanville**, there is a double crested dune system extending approximately 2.5kms either side of **Bungala Creek**. The sand is medium to fine grained quartz and considered to provide an essential sand supply for maintaining the beach in the area (AHC, undated). There is sand, as well as rubble reef in the near-shore area of **Lady Bay**. Seagrass beds in **Yankalilla Bay** are mostly *Posidonia* species, with *Amphibolis* and some patches of *Halophila* also present. Edyvane (1999b) reported that the most common seagrass species in the Fleurieu area, such as **Yankalilla Bay**, were *Posidonia sinuosa* and *P. angustifolia*, *Amphibolis antarctica*, and *Halophila australis*. Seagrasses occur as meadows in the bays, and in shallow, sandy areas offshore, adjacent to reefs and boulder fields (Edyvane, 1999b). There are boulder conglomerate reefs in patches, and as cobble / rubble, throughout much of **Yankalilla Bay**, and there is intertidal and shallow subtidal metamorphic platform reef extending from the coastal headlands (e.g. **Carrickalinga Head**). In general, shallow reefs in the area are dominated by mixed species of *Cystophora* and *Sargassum* (as well as *E. radiata* in some areas, such as shallow reefs at **Second Valley**); small red, brown (e.g. *L. variegata*) and green (mainly species of *Caulerpa*) macroalgal species in the understory, and mixed invertebrates (sponges, ascidians, echinoderms, molluscs). There is bare sand near-shore in the **Rapid Bay** area. On boulder / cobble reef patches in the **Rapid Bay** area, mixed species of brown macroalgae such as *Cystophora*, *Sargassum*, *S. agardhii* and *Caulocystis uvifera* occur, with *E. radiata*, and turfing browns (e.g. *L. variegata*) and mixed invertebrates also present on these reefs. Shallow “cave” reefs in headland areas, are dominated by mixed invertebrates. In various headland areas, some of the main groups that have been reported include hydroids, sponges, soft corals and bryozoa. In deeper waters, submerged relict boulder beach deposits, which occur as patch reefs amongst the seagrass, have been recorded throughout the **Yankalilla Bay** area, as far north as **Carrickalinga Head** (Shepherd and Sprigg, 1976), extending up to several kilometres offshore, in some areas. During a mid-1990s survey, visual inspection indicated that *Sargassum* species dominated the cover on the cobble reef at 20m in the **Second Valley** area (Collings and Cheshire, 1998). Seaward of seagrass meadows and patch reefs in the region, Shepherd and Sprigg (1976) recorded an ascidian / scallop / sea star assemblage, on sandy substrate, to approximately 30m. There are few seagrass beds along the south coast of the Fleurieu (i.e. between **Rapid Head** and **King Head**), however small areas of seagrass include those at **Morgan Beach** and **Fishery Beach** (PIRSA, SARDI and DEH map, in Bryars, 2003).

Cape Jervis to Newland Head

From **Cape Jervis to Newland Head / Rosetta Head** area, the coast comprises mainly steep cliffs interspersed with small beaches, with direct exposure to the open waters of the Southern Ocean. In the **Cape Jervis / Morgan Beach** area, part of the cliff face has exposed Permian glacial sediments about 30 m thick, consisting of boulder clay and sandy clay, and containing erratics of (various) sizes (AHC, undated). Cambrian metamorphic rocks outcrop on the cliff face and below on the shoreline. There are large glacial erratics at the surface. The sand beach and intertidal areas north of **Cape Jervis** are covered with eroded Kanmantoo metamorphic rocks, and granite boulder erratics from the Encounter Bay group (Ludbrook, 1980). Other major rocks in the coastal region include Cambrian Inman Hill Formation arkose, and Kanmantoo meta-sandstones.

Tilted platform reef (inshore) and boulders overlying mixed sand / reef habitat, seaward of the platform (both composed of metamorphic rocks), occur in the area between **Blowhole Creek** and northern **Cape Jervis** (Shepherd *et al.*, 2001). The coastal area of **Deep Creek** contains steep metamorphic cliffs separated by small bays. There is a serrated shore platform cut in Cambrian meta-sediments (Kanmantoo group), along the coast from **Lands End** to **Fishery Beach**. The area extends about 2.4km (north-west to south-east) and 0.8km inland. The platform reaches a maximum elevation of 3m above sea level and slopes abruptly down to sand dunes and thence to the shoreline. Its serrated nature reflects the steeply dipping nature of the bedrock. Above this platform, and about 10 m above sea level, there is an aeolianite deposit, which extends inland, and is up to 30 m wide. In the **Land's End - Fishery Beach** area, the aeolianite slopes gently towards the sea and has small karst features developed in it, from pit weathering by sea spray action (AHC, undated). Large areas of exposed calcrete pavement are also present. **Fishery Beach** is enclosed by the shoreline and the site looks out across Backstairs Passage to Kangaroo Island (AHC, undated). In the **Fishery Bay – Cape Jervis** area, reef is more continuous, and interspersed in some parts with seagrass patches, to around 1km from shore (12 to 13m) (Shepherd *et al.*, 2001). Shallow metamorphic platform and rubble reef in the **Cape Jervis** area (and northwards) is dominated by mixed species of *Cystophora* and *Sargassum* (up to 12 species of these two brown macroalgae have been recorded in the area), and *Acrocarpia paniculata*, *E. radiata*, and *Seirococcus axillaris* are also present (Emerson and Collings, 1998; Collings and Cheshire, 1998; Edyvane, 1999b). Understorey flora include species of green (*Caulerpa brownii*), brown (*Dilophus gunnianus* and *Halopteris* sp.) and red (*Plocamium* spp. and *Rhodomyenia australis*) macroalgae, and articulated coralline algae (*Amphiroa anceps* and *Metagoniolithon* species) (Collings and Cheshire, 1998). Seagrass beds are also present, dominated by species of *Posidonia* and *Amphibolis*. Reef area at around 9m to 10m depth is dominated by the brown macroalga *S. axillaris*, and mixed species of *Cystophora* and *Sargassum*. The kelp *E. radiata* is also present (Collings and Cheshire, 1998). There are many sponges and other sessile invertebrates in the area, due to the fast currents, and steep depth gradients close to shore in the **Cape Jervis / Fishery Beach** area.

Tunkalilla to Fishery Beach (including **Porpoise Head / Deep Creek Conservation Park**): Coastal cliffs are predominant in the area, e.g. adjacent to the creek at **Tunkalilla**. The beaches at **Tunkalilla**, **Parsons**, and **Waitpinga** are all high energy beaches backed by steep hills. **Tunkalilla Beach** occurs between the rugged metamorphic cliff lines of this section of the Southern Fleurieu. The eroding cliff and beach areas are comprised of Quaternary deposits of high level alluvium, outwash gravels, and laterised and kunkarised surface deposits, which form eroding cliffs, exposed beneath recent sands (Llewelyn-Davies Kinhill, 1977; Coast Protection Board, 1984). In the subtidal area, there are extensive stretches of benthic sand habitat along much of this stretch of coast, seaward of the near-shore cliff, boulder and rubble reefs. Heavy metamorphic basement rock reef occurs close to the coast, from 15 m deep to shore, interspersed with sand. Rubble reef occurs in deeper waters (15 m to 30 m), composed of the basement rock. For example, from **West Tunkalilla** to **Porpoise Head**, there is heavy basement rock reef (Cambrian Inman Hill Sub-Group arkose) from 15 m to the shore, and rubble (from the metamorphic basement rock in deeper waters of 20 to 30 m) (Llewelyn-Davies Kinhill, 1977; Coastal Protection Board, 1984; Baker and Edyvane, 1996). At 5m to 6m depth at **Tunkalilla West**, bare rock and sand are interspersed with metamorphic rock boulders. A 1994 benthic survey showed that the boulders were covered with *Scytothalia dorycarpa* and *Acrocarpia paniculata*, with calcareous (mainly *Halipilton roseum*, but also a species of *Metagoniolithon*) and other red macroalgal taxa (e.g. *Nizymenia australis*, and species of *Peyssonnelia*) and mixed sponge species in the understorey (Baker and Edyvane, 1996). At 15m, in the **Tunkalilla West** area (eastern end of **Deep Creek Conservation Park**), metamorphic basement rock rubble overlying sand ripples occurs. No benthic cover was recorded at sampled sites at this depth during a 1994 survey. In the **Porpoise Head** area, a shallow reef (5m) was dominated by mixed brown macroalgae (*Seirococcus axillaris* and *Scytothalia dorycarpa*, with lesser amounts of *A. paniculata*, species of *Cystophora* and *Sargassum*, *E. radiata*, and the large red *Osmundaria prolifera*. Coralline algae (*Halipilton roseum*, and species of *Metagoniolithon* and *Cheilosporum*), turfing brown taxa (*Zonaria spiralis* and *Chlanidophora microphylla*), sponges and ascidians were the principal understorey groups. In deeper water, basement rubble reef occurs. At a depth of 15 m, a 1994 benthic survey showed that the **Porpoise Head** rubble reef was partly covered with *E. radiata* and *S. dorycarpa*, with minor cover of species of *Sargassum* (e.g. *S. sonderi* and *S. verruculosum*), and a dense understorey of mixed sponge and ascidian species (up to 75% of the rock cover), and several small macroalgal taxa (mainly a *Rhodomyenia* species) (Baker and Edyvane, 1996, Edyvane and Baker, 1999a, and SARDI S.A. Benthic Survey data, 1994, unpublished).

Waitpinga / Parsons / Newland Head area: The exposed headland and beach areas extend along approximately 8km of the coastline, from a plateau. The area is dissected by **Waitpinga Creek**, where a lagoon and grey mudflats occur along the lower reaches. Behind **Waitpinga Beach**, there is a stranded shore platform across consolidated dunes. At **Newland Head**, there is flat metamorphic Kanmantoo rock platform, with sand at 10 - 15m deep, and granite boulders interspersed with sand in the shallower areas (5m). **Newland Head** has well preserved cliff top parabolic dunes. **Parsons** and **Waitpinga** beaches are separated by a steeply dipping resistant outcrop of Kanmantoo group meta-sediments capped with calcareous deposits. The eroding cliff and beach areas (e.g. **Waitpinga**) are comprised of Quaternary deposits of high level alluvium, outwash gravels, and

latarised and kunkarised surface deposits, which form eroding cliffs, exposed beneath recent sands. The beaches are backed by two well defined dune crests (Llewelyn-Davies Kinhill, 1977; Coast Protection Board, 1984; AHC, undated). Reefs in the **Newland Creek** area are mainly marine extensions of the metamorphic coastal cliffs (to approximately 200m from shore). In 1994, a benthic survey showed that boulders at a depth of 5m were mostly bare, but some were covered with approximately 50% *Sargassum paradoxum*, and minor amounts of smaller turfing brown (e.g. *Dictyota* sp.) and red taxa (species of *Delisea*, *Laurencia*). Further seaward, approximately 200m from shore, bare sand habitat was recorded. During the 1994 benthic survey, bare sand was recorded at most sites between 5m and 20m around **Newland Head** (out from **Waitpinga Beach**), and between **Parsons Beach** and **Newland Head**. In some areas of **Newland Head**, flat, platform “strip reef” occurs at 15m, surrounded by bare sand. In 1994, the reef strips were dominated by mixed sponge, bryozoan and hydroid species (up to 60% cover), and the brown macroalga *S. dorycarpa*, with minor amounts of *E. radiata*, *Carpoglossum confluens* and *Cystophora monilifera*. Smaller understorey species were dominated by the small turfing red species (mainly a *Rhodymenia* species), with minor amounts of species of *Plocamium* and *Spyridia*, amongst other understorey taxa (Baker and Edyvane, 1996; Edyvane and Baker, 1999a, and SARDI S.A Benthic Survey data, 1994, unpublished).

Encounter Bay and Islands

The **Encounter Bay** coastline is a high-energy coast, subject to persistent year-round moderate to high-energy south-west swells (Bourman, 1979, cited by Edyvane *et al.*, 1996). Wave, swell and surge conditions in the **Encounter Bay** area vary according to depth and degree of exposure to the Southern Ocean. Encounter Bay and the islands in and out of it, are subject to three main types of wave energy (Shepherd and Womersley, 1970):

- ♦ prevailing swells from the south-west (generated by the Southern Ocean);
- ♦ local seas caused by local offshore winds, which produce short waves, and onshore winds, which produce higher waves that combine with the swell and reinforce it;
- ♦ local swell in early summer, the prevailing south to south-east winds generate a short swell, which may be superimposed upon the prevailing swell.
- ♦ Oceanic swell is more severe in winter, and periods of very low swell can occur at any time throughout the year (Shepherd and Womersley, 1970, cited by Baker and Edyvane, 1996).

The coast of **Encounter Bay** is geologically and geomorphologically similar to the eastern part of Kangaroo Island, sharing similar rock sequences such as the Cambrian Kanmantoo mixed metamorphics and the Cambro-Ordovician Encounter Bay Granites. The area from Cape Jervis to Rosetta Head comprises steep coastal cliffs of Cambrian Inman Hill Formation arkose, Kanmantoo metamorphics and meta-sandstones, and Permian glacial deposits. Much of the **Encounter Bay** coastal area from **Rosetta Head** to **Victor Harbor** comprises Permian glacial deposits such as the glacial tills, sands and clays of the Cape Jervis Beds (which outcrop in **Encounter Bay** from **Victor Harbor** to the **Goolwa area**), and outcrops of Delamerian granites (Daily *et al.*, 1974; Griffin and McCaskill, 1986). Evidence of the Permian glaciation includes the *roche moutonee* at **Rosetta Head**, the moraine at **King’s Point** (west of Victor Harbor), and the partly exhumed valleys of Backstairs Passage (Parkin 1969). At **Rosetta Head**, the coastal morphology changes from cliffs, to long sweeping sand beaches backed by dunes, interspersed at the western end by the granite outcrops of **Rosetta Head** itself, **Granite Island**, and **Freeman Knob**. Granitic rocks also form rounded hills on promontories, and offshore islands such as **Wright Island**, **West Island** and **Seal Island** are also composed of granite. Also in the area are granite “erratics”, which were reportedly deposited by a moving ice sheet during the Permian. Examples can be found along the foreshore around **Victor Harbor** and **Yilki** (Cameron, 1979). The eroding cliff and beach areas of **Encounter Bay** and **Middleton** areas, reportedly comprise Quaternary deposits of high level alluvium, outwash gravels, and latarised and kunkarised surface deposits, which form eroding cliffs, exposed beneath recent sands (Llewelyn-Davies Kinhill, 1977; Coastal Protection Board, 1984).

The **Port Elliot – Middleton** area contains the footslopes and outwash plain of the southern Mt Lofty Ranges, and a calcarenite dune ridge forms a wedge against the footslopes near **Middleton** (Heyligers, 1981). The modifying influence of the southern Fleurieu cliffs and islands upon the swell and currents, has led to the development of two strongly curved beaches and fore-dunes near **Port Elliot** (Heyligers, 1981). Halstead (1987) summarised the major marine habitats in part of Encounter Bay. Between **Inman River** and **Rosetta Head**, the habitats from the shoreline to 1.5km seaward were summarised as intertidal platform reefs (3%); intertidal sand (<2%); mixed macroalgal-seagrass assemblages with granite erratics (<3%); mixed macroalgal-seagrass assemblages (56%); other macroalgal assemblages (< 4%); calcareous platform reef (18%); and seagrass meadows (15%) (Halstead 1987, cited by Baker and Edyvane, 1996). The Encounter Bay region contains a variety of habitat types due to the variation in geology and oceanography from west to east, and from the inner to outer parts of the bay (Baker and Edyvane, 1996).

A system of offshore platform reefs interspersed with unvegetated sediments extends parallel to the Coorong Coast from an origin near Seal Island in Encounter Bay. Surveys of the Encounter Bay sections of the reef system (McDonald and Miller, unpublished data) suggest assemblage dominance by typical mixed algal flora with strong representation by *Ecklonia*, varied furoid algae and a diversity of canopy forming and understorey red algal species. Attached invertebrate fauna also associate with the reef system, including a variety of ascidians, sponges and other taxa.

Common shallow subtidal flora in the **Encounter Bay** region includes the brown macroalga *Hormosira banksii* ("sea grapes"), and red taxa (e.g. species of *Laurencia*, *Wrangelia* and *Dasya*, and articulated corallines such as *Haliptilon roseum*). The subtidal boulder habitats of the **Encounter Bay** islands support stands of large brown macroalgae (mainly *E. radiata*, mixed *Cystophora*, mixed *Sargassum* species and *Scytothalia dorycarpa*, with *Acrocarpia paniculata* in more exposed areas), with diverse red macroalgal assemblages in the understorey. Common understorey taxa including species of the red genera *Plocamium*, *Gelidium*, *Callophycus*, *Melanthalia*, *Pterocladia* and *Phacelocarpus*, the green genus *Caulerpa*, turfing brown species, and various crustose and articulated coralline species (Shepherd and Womersley, 1970; Baker and Edyvane, 1996; Cheshire and Miller, 1998). Apart from red macroalgae, sponges, bryozoa, hydroids and sponges dominate deeper reef (e.g. 25+m) areas, such as those around the islands, and gorgonians and soft corals are also present on the deeper reefs. Seagrass meadows in Encounter Bay, including seagrasses around the islands, are commonly dominated by *Amphibolis* (both *A. antarctica* and *A. griffithii* present) and species of *Posidonia*. The seagrass *Zostera* (= *Heterozostera*) *tasmanica* is also present in subtidal areas (Shepherd and Womersley, 1970; Baker and Edyvane, 1996). Five seagrass species (including the intertidal *Zostera*, and subtidal species of the aforementioned genera) have been recorded in the **Victor Harbor** area, described as a "luxuriant multi-species community" (Cheshire and Miller, 1998).

In the bay area north of the start of the causeway to **Granite Island** (i.e. between the **Hindmarsh River** and **Granite Island**), a study by Cheshire and Miller (1998) showed that the near-shore area (1 m - 5 m depth) had a substrate mainly composed of sand with smaller areas of exposed sandstones. The benthic communities on the sandy substrates were dominated by seagrasses, comprising mixed and mono-specific stands of *Posidonia sinuosa*, *Amphibolis* spp., fine *Zostera* sp. and *Zostera* (= *Heterozostera*) *tasmanica*. The seagrass beds in the area were reported to have a very high density of seagrass shoots. Sandstone reef patches supported mixed macroalgae (*Cystophora monilifera* and a species of *Sargassum* were the dominant brown macroalgae at the time of the survey, with an understorey of turfing browns, mixed reds (e.g. *Osmundaria prolifera*, and species of *Plocamium*, *Erythroclonium*, *Botryocladia*, and others), small green macroalgae, and various sessile and motile macro-invertebrates. The dense seagrass and macroalgal beds run in a band from the shore to 3 to 4 m depth, parallel to the shore line. The width of this band increases with proximity to **Granite Island** (Cheshire and Miller, 1998).

Granite, Wright, West, Seal and Pullen Islands: All are granite islands. **Wright, Granite, and Seal** Islands form barriers against the action of swells from the Southern Ocean into Encounter Bay, and protect the coastline. **West Island** (10ha) has cliffs on all sides except the north, and is surrounded by boulders. The south-west side is the most exposed to the Southern Ocean. **Seal Island** (1.2ha) consists mainly of granite boulders, and is periodically submerged. Quartz and other minerals, of which the granite is composed, reportedly contribute a major part of the sand of the beaches in the Encounter Bay area (Shepherd and Womersley, 1970; AHC, undated). Major habitat types around **West Island** include submarine "cliffs", crevices and caverns; granite boulder and rubble reef areas; sand habitat, and seagrass beds on the lee of the island. Along the eastern and southern sides of **West Island**, steep cliffs descend abruptly into the intertidal zone, and continue to a sandy floor at around 25 m. Granite blocks and boulders around the island have broad sloping faces, and form crevices, caverns and overhangs which provide many different micro-habitats for marine biota (Johnson, 1988a). The general features of the macroalgal vegetation changes markedly around the island, from the rough to more sheltered sides. Three habitat types have been recognised: the rough water southern and western coasts; the moderately rough water sections on the eastern and northern shores; and the semi-sheltered section of **Abalone Cove** (Shepherd and Womersley, 1970). To the lee of **West Island** extensive beds of seagrasses are present (see Shepherd and Womersley, 1970). In general, the subtidal boulder and crevice habitats of the **Encounter Bay islands** support *E. radiata*, species of *Cystophora* and *Sargassum*, and *A. paniculata* as canopy macroalgae, with diverse red macroalgal assemblages in the understorey (up to 200 species recorded at **West Island**), with common taxa including species of the red *Plocamium*, *Gelidium*, *Callophycus*, *Melanthalia*, *Pterocladia* and *Phacelocarpus*) and the green *Caulerpa*. Island reefs contain a high diversity of reef invertebrates, such as hydroids, bryozoa, sponges, sessile and stalked ascidians, sea stars and brittle stars, chitons, anemones, gastropods and other molluscs, and crustaceans (Shepherd and Watson, 1970; Kangas and Shepherd, 1984). Sponges, bryozoa, hydroids and sponges dominate deeper reef (e.g. 25+m), and gorgonians and other corals are also present. There is a high abundance and diversity of invertebrates associated with the boulder, cave, and crevice micro-habitats. **Pullen Island** is a granite islet at the mouth of **Horseshoe Bay**, just south of **Port**

Elliot. Similar to West Island, a 1996 benthic survey found that granite patch reef at **Pullen Island**, at 8m to 10 m, is dominated by mixed red taxa (e.g. species of *Melanthalia*, *Phacelocarpus*, *Callophycus*, amongst others), the canopy brown *E. radiata*, and a dense understorey of mixed sponge and bryozoan species (Baker and Edyvane, 1996; Edyvane and Baker, 1999a). An earlier survey (Kildea, 1991) showed that the inner protected side of **Pullen Island** was dominated by *Cystophora moniliformis* and large variety of gastropods. **Granite Island** contains granite boulder habitats popularly considered to support diverse benthic floral and faunal assemblages in the subtidal area. Exposure around the island varies, and includes rough water habitats exposed to the full impact of the Southern Ocean, on the southern side of the island. In the shallows of the protected bay side, species of *Posidonia* and *Amphibolis* form mixed beds on sand, with *Ecklonia*, *Scaberia*, and species of *Cystophora* and *Sargassum* on reef patches (Baker and Edyvane, 1996, and J. Baker, pers. obs.).

Hindmarsh and Inman Rivers: The Inman and the Hindmarsh Rivers open to the sea only by flood waters and high tides, creating lagoons behind the beaches (Llewelyn-Davies Kinhill, 1977; Coast Protection Board, 1984). The **Hindmarsh River** enters the sea at **Victor Harbor**. Both estuaries are described as being saline 1-2km from the coast, and fringed by South Australian swamp paperbark (*Melaleuca halmaturorum*) shrubland with an understorey of salt-tolerant herbs (AHC, undated). Reed beds occur in the rivers, and small dunes are situated near the mouth. Womersley (1984) reported that the seagrass *Lepilaena cylindrocarpa* occurs at the river mouth of the Inman, but the species might no longer be present in that area.

North-Eastern Kangaroo Island

Dudley Peninsula: There are reefs adjacent to the metamorphic cliffs along the north-east coast of Kangaroo Island (**Kangaroo Head**, **Ironstone Point**, **Penneshaw** and other locations). According to the Department of Mines and Energy (undated map), outcropping rocks at the north-east coast of Kangaroo Island consist mainly of Cambrian metamorphic rocks (e.g. shales, schists, sandstones), with Permian glacial deposits in the **Penneshaw** area. The area is exposed to strong tidal currents, and there are steep depth gradients close to shore. For example, according to a bathymetry coverage from the S.A. Coast and Marine Atlas (DTUP, 2000), waters off the area from **Alex Lookout** to **Snapper Point** are 35-40m deep at 500-700m offshore. The steep depths and strong currents close to shore provide ideal conditions for the growth of sessile invertebrate fauna, and result in distinct invertebrate-dominated community types that are uncommon at the bioregional scale (discussed below). Shallow patch reefs in the **Kangaroo Head** area are dominated by mixed macroalgae (species of *Cystophora*, *Sargassum* and *Caulocystis*) and mixed sessile invertebrates. Reefs in the more exposed shallow areas such as **Cable Bay** and **Snapper Head** are dominated by mixed robust canopy-forming brown macroalgae, such as *Scytothalia dorycarpa*, *Carpoglossum confluens*, *Seirococcus axillaris*, *Acrocarpia paniculata*, and *Ecklonia radiata*, with species of *Cystophora* and *Sargassum* also in the canopy, and an understorey of green *Caulerpa* species, mixed sponges, ascidians, bryozoa, and encrusting coralline algae (Edyvane, 1999b). East of **Kangaroo Head**, there are dense *Posidonia* beds in sand, and at 5m, mixed reef patches and seagrass beds. Both *Posidonia* sp. (70% dense) and *Amphibolis antarctica* (60% dense) are present at a depth of 5m. *Zostera* (= *Heterozostera*) *tasmanica* is also present in the seagrass beds (5 to 25% cover). The reef at 5m is covered with mixed brown macroalgae, dominated by *Cystophora* species (e.g. *C. monilifera*), *E. radiata*, *S. axillaris* and several *Sargassum* species (including *S. verruculosum* and *S. lacerifolium*) (SARDI S.A. Benthic Survey data, 1994, unpublished). Mixed sponge and soft coral assemblages are also predominant in some areas close to the coast. In 2002, a survey along 400m of the shallow subtidal at **Hog Point**, recorded block reef and boulders at 1m-2m depth, grading to sand at 5m depth. The shallow reef areas were covered with *Ecklonia* (30%), *Cystophora siliquosa* (20%), *C. moniliformis* (20%), *C. monilifera* (20%), and *Sargassum fallax* (10%) (Shepherd *et al.*, 2002). A similar benthic cover was recorded on shallow reef at the **Penneshaw** Breakwater, where the reef blocks had abundant crevices (Shepherd *et al.*, 2002).

Biogeographically significant shallow-water (e.g. 12+m) sessile invertebrate faunal assemblages have been recorded in the **Cuttlefish Bay - Snapper Point - Cape Coutts** region (Edyvane, 1999b; KI AMCS, 2000 and 2001). Similar assemblages are known in South Australia only from the Backstairs Passage region - see below). The fauna is dominated by abundant soft corals and gorgonian corals of various species; large erect sponges (species of *Thorecta*, *Dendrilla*, *Aplysilla*, amongst others); large erect bryozoa (species of *Adeona*, *Triphylozoon*, *Celleporaria*, *Orthoscuticella*, amongst others); sea pens; and a diversity of echinoderms (crinoids, basket stars, brittle stars, sea stars), and filamentous red macroalgae. The presence of soft invertebrate benthos in much of the area from **Ironstone Point** to **Cape Coutts** has been confirmed by recent surveys (community and government Hog Bay Monitoring Project, co-ordinated by KI-AMCS, 2000; see also Edyvane, 1999b).

Further south is **Antechamber Bay**, which has a sand beach along the entire length of the bay. The mouth of the **Chapman River** is in the northern part of **Antechamber Bay**, and the river runs from **Lashmar Lagoon** into the bay. Backing **Antechamber bay**, there is coastal scrub, sand hills and lagoons. Subtidally, there are dense

seagrass beds (according to SARDI S.A. Benthic Survey, 1994 data) and mixed invertebrates in inner **Antechamber Bay**. At **Cape Willoughby**, there are gneissic rock reefs exposed at the coast, and in the subtidal (Shepherd et al., 2002).

Outer Nepean Bay / Eastern Investigator Strait: The deeper waters out of **Nepean Bay** (into eastern Investigator Strait), contain “massive orange sponges, crinoids, reef molluscs, and large populations of the sea cucumber *Ceto cuvieria*”, and the area has been classified by Shepherd and Sprigg (1976) as the southernmost part of the “*Heterozostera – Lunulites*” assemblage that occurs in much of **Investigator Strait**. The other dominant assemblage recorded in the area (from 25 m to 30+m) is the bryozoan assemblage, dominated by the basket bryozoan *Adeona grisea* and several other bryozoan species, as well as massive sponges, feather stars (e.g. *Antedon incommoda*) and Hammer Oysters (Shepherd and Sprigg, 1976).

Bay of Shoals - Western Cove - Nepean Bay: Two major bays on the coast of north-eastern Kangaroo Island occur in this area. **Nepean Bay** has been described as an open bay with river deposition, and **Bay of Shoals** as a closed, low energy non-depositional bay (Fotheringham, pers. comm., cited by Edyvane, 1999b). The **Bay of Shoals** is protected from high-energy wave action by a spit. The coast consists of sandy beaches and sandy mud flats (Gilliland, 1996), and there are sand and cobble shoals at the entrance (Fotheringham pers. comm., cited by Edyvane, 1999b). There is a tidal creek surrounded by saltmarsh, in the south-western corner of the **Bay of Shoals** (PIRSA, SARDI and DEH map, in Bryars, 2003). Water is generally shallow, less than 5m deep, and supports meadows of *Posidonia* seagrass (Gilliland, 1996). The area includes the estuarine habitat of the **Cygnets River** estuary and south-western part of **Western Cove**, including samphire flats (e.g. from **Nepean Bay** up to **Cygnets River**) and sandflats / sandbars, and a beach area near **Nepean Bay Conservation Park**. Tidal flats occur around the bay, from east of Redbanks, around inner Western Cove, and up to the area north of Cape Rouge (PIRSA, SARDI and DEH map, in Bryars, 2003). Dominant subtidal habitats in the area include *Posidonia* beds with sponges in **Western Cove**, and *Posidonia / Amphibolis* beds out from **Bay of Shoals**. Beds of *Halophila* seagrass with filamentous red algae (e.g. *Chirocanthia arborea*) and the succulent red *Botryocladia sonderi* occur near **Kingscote** (Edyvane and Baker, 1996b, and SARDI S.A. Benthic Survey data, 1994, unpublished). Gilliland (1996) described **Nepean Bay** as having waters that are generally between 10m and 20m deep, with parts of the nearshore area dominated by macroalgal assemblages to a depth of 3m - 4m. Sparse seagrass beds (*Posidonia* sp.) are reportedly dominant to a depth of 8m (Gilliland, 1996) (but see also description below for **North-Eastern Bays** in general, which includes **Nepean Bay**).

Nepean Bay differs from the non-depositional environment of the **Bay of Shoals**, by having sedimentary deposition from the **Cygnets River**; depositional features such as beach ridges, and slightly higher wave energy than the **Bay of Shoals** (Fotheringham pers. comm., cited by Edyvane, 1999b). There are patch reefs in the area between **Redbanks** and **Point Morrison**, and tidal flats (such as **Brownlow Beach** and **Morrison Beach**) occur almost continuously around Western Cove, between **Beare Point** and the western end of **Redbanks** (PIRSA, SARDI and DEH map, in Bryars, 2003). Subtidally, at the time of a benthic survey in 1994, patch reefs in the area (e.g. **Point Morrison**) were covered by species of *Cystophora* and *Sargassum*, with the turfing brown *Lobophora variegata* and mixed sponge species in the understory (SARDI S.A. Benthic Survey data, 1994, unpublished). Patch reef dominated by *Cystophora* species and other brown macroalgae, has very limited distribution in the **Bay of Shoals – Western Cove** area, and is more prevalent further to the east, in Eastern Cove (see below). Based on the description for “aeolianite reef” in Shepherd and Sprigg, 1976, as well as the intertidal description in Thomas and Edmonds, 1979, and unpublished records from divers, there is evidence for diversity and abundance of benthic and infaunal marine invertebrate groups associated with the shelly habitats and shallow sandy / mud habitats that support intertidal seagrass in the area. Examples of the invertebrate groups include bivalve molluscs, sponges, anemones, sea stars, sea cucumbers, polychaetes, and crabs. The level of species diversity within the major groups is not known for this report. The deeper waters out of **Nepean Bay** contain massive orange sponges, crinoids, reef molluscs, and large populations of the sea cucumber *Ceto cuvieria* (Shepherd and Sprigg, 1976). The area has been classified by Shepherd and Sprigg as the southernmost part of the “*Heterozostera – Lunulites*” assemblage that dominates Investigator Strait. The other dominant assemblage (see Shepherd and Sprigg, 1976) in deeper waters is the “bryozoan” assemblage, dominated by the basket bryozoan *Adeona grisea* and several other bryozoan species, as well as massive sponges, feather stars (e.g. *Antedon incommoda*) and Hammer Oysters.

Beatrice Islet: An area (approximately 103 ha, according to NPWSA, 2002a) of emerged sand and mud on a large tidal sand spit. The islet is exposed at low tide, and there are cockle beds in the mud of Beatrice Islet.

Busby Islet: A low lying sand and shellgrit islet of approximately 17 ha (NPWSA, 2002a), the majority of which is subject to inundation. *Sarcocornia* samphire is present on the Islet (Morelli and de Jong, 1995). Both **Beatrice** and **Busby Islets** protrude from a large sand and mud spit extending approximately 9 km south-east from **Cape Rouge** (Morelli and de Jong, 1995; AHC, undated).

Cygnets River Estuary and Marshes: The wetland areas receive inflow from the **Cygnets River** (originating 47km west), the local catchment (originating 1-4 km west) and tidal seawater. The coastal part of the estuary includes features such as Swamp Paperbark (*Melaleuca halmaturorum*), mainly south of the river; samphire saltmarsh (e.g. *Sarcocornia* sp.), which extends for approximately 7.5km along the coast and is intersected by tidal streams; and mudflats and estuarine seagrass, near the mouth of the river (AHC, undated; DTUP, 2001). The **Cygnets River** estuary has been described as the largest, freshwater-fed wetland on Kangaroo Island, comprising 850ha of low coastal dune, supratidal and intertidal saltmarshes, saline swamps, sand bars and seasonally inundated mudflats (ANCA, 1996, cited by Edyvane, 1999b). There is swamp paperbark in the supratidal area of **Nepean Bay Conservation Park** (AHC, undated), and the park represents the only reserve conserving coastal sand plain on the coast (ANCA, 1996, cited by Edyvane, 1999b).

Eastern Cove: Waters in the **Eastern Cove** area range from intertidal to around 13m deep (Gilliland, 1996). Near-shore, Gilliland (1996) reported that the area is dominated by macroalgal communities to a depth of 3m – 4m, and that sparse seagrass beds (*Posidonia* sp.) are dominant between 4m – 8m. A SARDI survey in 1994 reported *Posidonia sinuosa* at 15m at one site sampled in the centre of **Eastern Cove**, also the succulent red *Botryocladia sonderi*, minor amounts of a *Sargassum* species, and few other macroalgae. In **Newland Bay**, on the eastern side of **Eastern Cove**, a benthic survey in 1994 recorded *Posidonia sinuosa* and *H. tasmanica* at 10m, with *B. sonderi*. *Posidonia* was also found at 5m, with filamentous epiphytes. In the southern side of **Eastern Cove (Rocky Point)**, both *Amphibolis antarctica* and *Posidonia* species (mainly *P. sinuosa*) were recorded at 5m, with the calcareous macroalga *Haloptilon roseum*. Reef on the eastern side of **Eastern Cove** was dominated by *Scaberia agardhii*, with *Cystophora botryocystis*, *Caulocystis cephalornithos* and species of *Sargassum* (e.g. *S. paradoxum*) also present. Seagrass patches (mainly *Posidonia*) also occur in the area (Edyvane and Baker, 1996b, and SARDI S.A. Benthic Survey data 1994, unpublished). Much of the reef area in the eastern part of **Eastern Cove**, is comprised of consolidated calcareous sand dunes (described by Shepherd and Sprigg, 1976, as the “aeolianite reef” category). This geology provides a hilly, rough bottom topography that is covered with a variety of macroalgae (e.g. see above), sponges, crinoids, reef molluscs and other benthos, and a varied fish and invertebrate population, including high densities of Snapper and Rock Lobsters (Shepherd and Sprigg, 1976). According to Shepherd and Sprigg (1976), the only other examples of this reef type and cover are located in the western part of Investigator Strait (e.g. north of Snug Cove), central Investigator Strait, and on southern Yorke Peninsula.

American River / Pelican Lagoon wetland system, and Inner Eastern Cove: A large, permanently shallow lagoonal system, subject to minimal wave action. Extensive tidal sandflats and mudflats have developed, and the subtidal area is dominated by seagrass beds. The system contains several small islets and a number of sandbanks. The water is less than 2m at low tide in **Pelican Lagoon**. The shoreline contains sandy beaches, calcareous rock outcrops, samphire flats, and consolidated dunes back the shore in some areas. The system may receive some freshwater inflow, via the **American River** channel, from several creeks originating 1km to the north-west, on a ridge south of the American River township (Morelli and de Jong, 1995; AHC, undated).

Physical summary of **American River** and **Pelican Lagoon**, from Morelli and de Jong (1995) and Edyvane and Baker (1996b): **American River** is a tidal channel that links **Pelican Lagoon** to **Eastern Cove**. The several large, permanently shallow lagoons that comprise the **Pelican Lagoon** system, are connected to the open sea by **American River**. The **American River** channel is confined by the Cambrian sediments and Holocene beach sandflat deposits that occur along the western shore, and the calcarenite of **Picnic Point**, and Holocene beach ridges and sandflats between **Sapphire Point** and **Strawbridge Point** along the eastern shore. The tidal flats are composed mainly of sandy mud. The lagoon itself occupies a shallow depression, and is surrounded by low calcarenite scarps, including several low islands also formed of calcarenite. The lagoons system’s eight islets and the shorelines include shelly beaches, and tidal mud and sand flats. At the entrance to American River, there are two limestone points (**Strawbridge Point** and **Buicks Point**).

A summary of habitats in the **American River** area include samphire on some of the mudflats and islets; shelly beaches; tidal channel with coarse sand and shell fragments (N.B. several tidal creeks occur adjacent to the north-eastern part of American River – see PIRSA, SARDI and DEH map, in Bryars, 2003); sandflats and mudflats (and combinations thereof); calcareous patch reefs (composed of *Hormosira banksii*, mussel patches, anemones, and filamentous red and green algae); intertidal and subtidal seagrass beds, and invertebrate assemblages (e.g. sponges are common) (Womersley, 1956; Womersley and Edmonds, 1979; Johnson, 1988a; Morelli and de Jong, 1995; Edyvane and Baker, 1996b; DTUP, 2001). Johnson (1988a) described **American River** as forming extensive lagoons, with shallow sheltered waters and extensive sand and mud flats supporting 3 main forms of seagrass in the shallows: fine seagrass (*Zostera mucronata*, occurring between 0 - 0.5 m deep, according to Womersley 1984, and/or *Heterozostera*, according to Johnson, 1988a); the strapweed *Posidonia*, and the paddleweed *Halophila*. The less commonly reported shallow water marine seagrass *Lepilaena marina* also occurs in the mid-eulittoral of **American River** (Womersley, 1984).

DEH's saltmarsh mapping program (see DTUP, 2001) categorised the following habitats in the **American River** and **Pelican Lagoon** area: Samphires and swamp paperbark *Melaleuca* were recorded mainly on the eastern side (e.g. **Pelican Lagoon Conservation Park**, and **Picnic Point** area). The central part of **American River** was categorised as "intertidal bare (sandy) channel", extending from **Eastern Cove** to **Pelican Lagoon**. Several tidal creeks occur in the south-western part of **Pelican Lagoon** – see PIRSA, SARDI and DEH map, in Bryars, 2003). Channel edges are surrounded on both sides by intertidal seagrass (mainly patchy), and small sand patches. A dense stand of intertidal seagrass was recorded on the western side (south of the golf course, and opposite side of the river to Picnic Point). Within **Pelican Lagoon**, uniform seagrass beds were recorded, with sparse seagrass patches around the islets, and sand patches east of **Independence Point**. Scattered patches of samphire were recorded on the southern side of **Pelican Lagoon**, towards Pennington Bay, and also on the far eastern side of **Pelican Lagoon** ("YMCA corner") (DTUP, 2001).

Subtidal seagrasses in the area comprise mainly *Zostera* (= *Heterozostera*) *tasmanica* (particularly in the inner **American River / Pelican Lagoon** area), *Posidonia australis* and *Amphibolis antarctica*. In western, southern and eastern parts of **Eastern Cove**, occur mixed beds of the three seagrass genera listed above. Mixed seagrass / patch reef habitats occur in south-eastern part of **Eastern Cove** (reef patches were dominated by large *Cystophora* plants and *S. agardhii*, at the time of a survey in 1994), and also the eastern part of **Eastern Cove** (reef patches dominated by *Cystophora* species and mixed brown macroalgae such as *Caulocystis cephalornithos*, *Sargassum* spp., *E. radiata*, and *S. axillaris*, amongst others) (Edyvane and Baker, 1996b, and SARDI S.A. Benthic Survey data, 1994, unpublished).

Summary of the intertidal and shallow subtidal habitats of the **American River** area, from Womersley (1956), and Womersley and Edmonds (1979, cited by Edyvane and Baker, 1996b): The lower eulittoral zone of **American River** inlet is dominated by *Hormosira banksii* which is usually growing on the large mussel *Brachidontes (Austromytilus) erosus*. Mats of species of the green macroalgae *Chaetomorpha* and other small macroalgae also occur here. Fauna includes the sea stars *Patiriella exigua* and a species of *Uniophora*. In the upper sublittoral zone, there is a marked change to a seagrass-dominated habitat. The seagrass *Zostera* (= *Heterozostera*) *tasmanica* is found just above low tide level to around 2m deep, and *Posidonia* covers extensive areas of the flats below low tide level. The paddleweed seagrass *Halophila australis* is found along the edge of the channel or in deeper areas. *Sargassum tristichum* (previously known as *S. biforme*) and *Scaberia agardhii* were reported by Womersley and Edmonds (1979) to occur in the channel, usually attached to submerged boulders or rocks. Various species of green and red macroalgae are also common in the uppermost sublittoral zone, and epiphytic algae are found on *Posidonia*. Common invertebrate groups include sponges, seastars, anemones, sea cucumbers, polychaetes and the Razorfish *Pinna bicolor*.

The general summary of the subtidal flora of sheltered coasts in the **North-Eastern Kangaroo Island Bays** region, is mainly from Womersley (1956), Womersley (1990) and Womersley and Edmonds (1979, cited by Edyvane and Baker, 1996c): Seagrass beds are generally well developed on sandy-muddy areas of tidal flats, extending several metres deep. *Zostera* (= *Heterozostera*) *tasmanica* forms dense and pure masses in thick, firm mud from low tide level down for 3 to 4 m, with occasional plants as deep as 20m (Womersley, 1990). *Posidonia* species extend large distances from about 0.5m below low tide to 20m or so deep. *P. australis* is the most widespread species of tapeweed and it grows sympatrically with *P. sinuosa* and *P. angustifolia* in the shallower part of their range. *P. sinuosa* is widely distributed to a depth of 15m in sheltered bays and inlets, either in pure stands or growing sympatrically with *P. australis* or *P. angustifolia*. In more exposed areas it may form meadows with *Amphibolis*. *Posidonia angustifolia* grows subtidally from 2m to more than 30m deep, and frequently grows in deeper water than *P. australis*. In its deeper range, *P. angustifolia* is often found in association with *H. tasmanica* or *Halophila australis*, and in sheltered positions in its shallower range, in association with *Amphibolis antarctica*. The *Posidonia* leaves often carry a wealth of epiphytes, with only a few macroalgae (e.g. *Caulerpa cactoides* and other *Caulerpa* species), occurring in or adjacent to the beds. Common macroalgae at (and just below) low tide level are species of the filamentous reds *Hypnea* and *Spyridia*; the membranous greens *Ulva* and *Enteromorpha*; and other macroalgae such as *Centroceras clavulatum*, species of *Cladophora*, and often *Polyphysa peniculus*, epiphytic on old Cockle shells. Various molluscs (Scallops, Cockles, Razorfish), polychaete worms, echinoderms, crustaceans (e.g. Spider Crabs), bryozoa and small fish are usually common in this zone.

Murray Mouth

The following general summary of the Murray Mouth region is adapted from Morelli and de Jong (1995): The north-western end of the **Coorong's Northern Lagoon** is connected with **Lake Alexandrina** (76 000 ha) and **Lake Albert** (16 800 ha), with associated shoreline marshes at the mouth of the River Murray. These lakes contain fresh to brackish / saline waters. The area consists of a parallel coastal dune system, saline marshes, samphire, freshwater soaks, and open water. Hypersaline areas do not occur at the **Murray Mouth**, and are restricted to the southern end of the Coorong system. The lagoons of the **Coorong** system receive water from four main sources: by exchange with the sea via the **Murray Mouth**; by freshwater inflow from the **River Murray**, via local rainfall; run-off and groundwater inputs; and by rare inflows through **Salt Creek**. The **River**

Murray is the principal source of freshwater for the **Coorong**. The ephemeral lakes are filled either by local rainfall or when the unconfined aquifer rises above the lake beds in the wet winter months. Water depth of the **Northern Lagoon** is 1m (annual mean) with a maximum (winter) of 3.8m. In the ephemeral lakes, the depth varies between 0.4-1m during winter and spring (USEDSEFM, 1993). The water salinity of the **Northern Lagoon** is 80ppt (maximum) (Suter *et al.*, 1993), and at the **Murray Mouth**, the salinity is generally at (or below) the salinity of seawater (Morelli and de Jong, 1995). In general terms, the Murray Mouth estuary is described as a saline -brackish tidal system, containing extensive mudflats and sparse vegetation (Carpenter, 1995). Coarse sediments are found mainly in deep channels, and finer sediments occur on shallow flats and shallow channels.

Murray Mouth (Specific Features)

The following physical features of the **Murray Mouth** were summarised by Carvalho (see section 4.1.1.1 in Edyvane *et al.*, 1996): The Murray Mouth, which is the only seaward opening of that river, also forms the only connection between the sea and the Coorong barrier lagoon. The Mouth is a narrow tidal inlet whose morphology is strongly related to the marine processes in the area. Although river discharge is essential to the maintenance of the current inlet, the mouth has been maintained by wave action, and tidal flushing during periods of low river discharge. The combined interaction of fluvial, wave, tidal and aeolian processes determine both the characteristics and location of the **Murray Mouth** (Bourman and Harvey, 1983). The Encounter Bay coastline is a high-energy coastline subject to persistent year-round moderate to high-energy south-west swells. Bourman (1979) observed that south to south-westerly waves, with a period of approximately 14 seconds, generally approach more or less parallel to the coastline. All beach material was transported towards the mouth by storm waves, while persistent swell waves removed fine sand from the mouth. During periods of high river flow, river discharge may widen the mouth and remove sediments seawards, while in periods of low flow, the accretion of sediments may form a large delta (Bourman, 1979). Strong westerly winds have been observed to cause aeolian sand drift along Sir Richard Peninsula from the west towards the mouth (Bourman and Murray-Wallace, 1991). Although this aeolian activity is not dominant in moulding the peninsulas, it can play an important role in adding sand to the construction of the barriers along the mouth.

The following features of the **Murray Mouth** were summarised by Carvalho (see section 4.1.1.1 in Edyvane *et al.*, 1996): Depths in the estuary vary from shallow flats and shallow channels to deep channels. Depth varies from less than 1m to around 5m, depending on time of the year, river flow, storms and tides. Freshwater entering the estuary through the barrages can penetrate as far as the end of the **Coorong Northern Lagoon** (Marsh, pers. comm., 1995, cited by Edyvane *et al.*, 1996). Winds play an important role in determining water levels in the estuary. During spring and summer, winds tend to be south-east to south-west, forcing water towards the **Murray Mouth**. During winter, south-west to north-west winds force water towards the South Lagoon (Kotwicki and Clark, 1990). Winds are also the predominant factor influencing water stratification and salinity exchange between the Coorong Lagoons. Tidal action and river flow also determine the penetration of Murray River water in the North Coorong. Salinity in the estuary varies according to the influences of river flow, tidal excursion, and rainfall. During winter, when the barrages are open for longer periods, salinities are usually low, particularly after the opening of the barrages. Noye (1973) noted that salinity in the Coorong was seasonal. During the winter months, salinity progressively increases from **Pelican Point** towards the south-east, with brackish or marine waters in the north lagoon. In spring, the water in the north lagoon increases in salinity. The greatest impact of barrage closure on salinity occurs during summer, with evaporation leading to a general increase in salinity throughout the Coorong. Long periods of barrage closure increase the salinity of the **Murray Mouth** to a level that approaches seawater (see chapter 4.1.1.1 by Carvalho, in Edyvane *et al.*, 1996).

The geomorphology of the **Murray Mouth** area was fully described in a report by Heyligers (1981). The area includes **Hindmarsh Island** and the barrage islands, and some of the main land units comprise:

- ♦ coastal dunes, from the narrow coastal strips west of the **Sir Richard Peninsula** to the wide dunes which form that peninsula;
- ♦ the plains and salt marshes along the **Lower Murray** and the **Goolwa Channel**, mainly occupying the southern half of **Hindmarsh Island**;
- ♦ the calcarenite dune ridge which forms both the northern part of **Hindmarsh Island**, and a wedge against the footslopes near **Middleton** (Heyligers, 1981).
- ♦ The dunes of the **Sir Richard Peninsula** are an important physical and ecological barrier between the lower Murray River and the Southern Ocean. The southern part of **Hindmarsh Island** comprises clay overlying a sand plain, with old channels traversing the plain in a south-eastern direction, and active channels and estuarine flats occupy much of the eastern portion of the island (Heyligers, 1981).

Based on sampling by DEH and SARDI in 1995 (reported in Edyvane *et al.*, 1996), is the following habitat summary for the **Murray Mouth**: "The survey of wetland communities in the estuary, identified 14 supratidal and tidal plant communities and associations, resulting in 10 mapping classes and 3 major subtidal benthic habitat

types. The 3 major subtidal benthic habitats types south of the barrages were shallow mudflats, shallow channels and deeper water channels. A total of 62 supratidal and tidal plant species were recorded for the estuary region. The distribution and composition of these wetland species along the shoreline of the **Murray Mouth** estuary was related to variations in water level, soil salinity and to a lesser extent, shelter. In contrast, subtidal plant diversity for the estuary was low, with a total of 8 macroalgal species recorded. The whole subtidal estuarine region was typified by the presence (and extensive, dense proliferation) of 'opportunistic' algae, such as the filamentous green *Enteromorpha* and *Rhizoclonium* and the red algae, *Gracilaria*, indicating high levels of nutrients within the estuary".

Supratidal and Tidal Freshwater Habitat

Along the **Goolwa Channel**, small vegetated flats occur along the **Sir Richard Peninsula** and **Hindmarsh Island**, and on the channel's shoals. Saltmarsh vegetation in the area includes glassworts, rushes (e.g. *Juncus maritimus*), and saltbush species (Heyligers, 1981, cited by Baker and Edyvane, 1996). A general description of the dominant **Lower Murray** flora (SANPWS, 1991, cited by Morelli and de Jong, 1995) includes the following: the lagoon edge and the ephemeral lakes of the Coorong area are dominated by salt marsh, such as species of *Sarcocornia*, *Halosarcia*, and *Sclerostegia*. They are fringed with dense stands of swamp paperbark *Melaleuca halmaturorum*, along the edges of lagoons and ephemeral lakes. Freshwater soaks along the **Coorong Lagoon** support closed sedgeland of the bulrush *Typha* and sharp-leaf club-rush *Schoenoplectus pungens*.

A aquatic flora survey of **Hindmarsh Island** by Renfrey *et al.* (1989, cited by Edyvane *et al.*, 1996) recorded a total of 85 aquatic (and near aquatic) plant species, representing 33 families. The freshwater environment of the northern and eastern coast of the island was characterised by: an abundance of native species; the occurrence of the threatened species, *Scaevola calendulacea* and *Vallisneria spiralis*; and healthy emergent macrophyte communities dominated by *Typha*, *Phragmites* and *Myriophyllum*. In contrast, the more saline habitats (south of the barrages) on the southern coast of **Hindmarsh Island** had fewer native species. In the aquatic flora survey of Hindmarsh Island, Renfrey *et al.* (1989, cited by Edyvane *et al.*, 1996) recognised 4 major aquatic plant associations:

- *Hydrocotyle-Crassula-Juncus* association: a herbland association consisting of six species. These habitats suffered seasonal inundation with waterlogged soil throughout the year, and are particularly vulnerable to cattle grazing (because cattle damage the soil structure). The association was located throughout the northern and eastern coasts of **Hindmarsh Island**. Predominant naturalised species (*Juncus articulatus* and *Paspalum distichum*) were included in this association.
- *Typha-Phragmites* association: an emergent macrophyte association, typical of the edges of creeks, rivers and lakes where there was sufficient shelter and suitable substrate. This association was characteristic of the deeper freshwater sites along the northern and eastern coasts of **Hindmarsh Island**. The most common weed present in this association was *Berula erecta*.
- *Triglochin-Polygonum* association: another freshwater emergent macrophyte association, and strongly linked to the *Typha-Phragmites* association through the native bindweed *Calystegia sepium* and cumbungi, *Typha domingensis*.
- *Sarcocornia-Distichlis* association: a saline plant association containing native species characteristic of saline environments.

Three species clusters traversed the freshwater-hypersaline gradient: *Paspalum-Schoenoplectus* (0.01-18.69ppt), which occurred on the north and east coast of **Hindmarsh Island** and the **Mundoo Channel**; *Juncus-Bolboschoenus* (0.84-17.22 ppt), which occurred on the north and south coast of **Hindmarsh Island** and the **Mundoo Channel**; and *Sarcocornia-Distichlis* which occurred across a range of salinities (0.38-42.40 ppt) (Renfrey *et al.*, 1989, cited by Edyvane *et al.*, 1996). Thompson (1986, cited by Edyvane *et al.*, 1996), surveyed two sites in the **Murray Mouth** study area: **Rushy Island**, and the western end of **Hindmarsh Island**. The reed species *Phragmites* was recorded on **Rushy Island** (an island located on the southern coast of **Hindmarsh Island** in the **Goolwa Channel**). Within the **Mundoo Channel**, a wetland 'upstream' of the barrages (i.e. and under the influence of freshwater), was characterised by *Typha* and dense growths of submerged macrophytes. In contrast, the wetland 'downstream' of barrages had short sedge communities.

Shallow Subtidal Freshwater Habitat

Among floating and emergent aquatic flora in the **Hindmarsh Island** region, several species tolerate freshwater conditions (i.e. 0.01-0.53ppt) through permanent or seasonal inundation: *Myriophyllum*, *Phragmites* and *Typha*, which generally occur in 1m of water; *Paspalum* and *Schoenoplectus pallidus*, *Hydrocotyle* at mean water level and 25 cm above; and *Muehlenbeckia* at the high water mark (Renfrey *et al.*, 1989, cited by Edyvane *et al.*, 1996). Two subtidal, deepwater and freshwater groups were identified by Renfrey *et al.* (1989, cited by Edyvane *et al.*, 1996): these groups were dominated by the floating macrophytes, *Vallisneria spiralis* and *Schoenoplectus littoralis*. Both associations were located on the north shore of **Hindmarsh Island** in 1m of water. The 1995 DEH / SARDI survey (reported in Edyvane *et al.*, 1996) of the freshwater subtidal macrophyte flora of northern **Hindmarsh Island** recorded a total of 10 species of aquatic macrophytes, excluding emergent and semi-aquatic

flora. Renfrey *et al.* (1989, cited by Edyvane *et al.*, 1996) reported that the freshwater wetland communities of northern **Hindmarsh Island** were characterised by emergent macrophyte communities dominated by *Typha*, *Phragmites*, and *Myriophyllum*.

Shallow Subtidal Marine and Estuarine Habitats

Edyvane *et al.* (1996) described the **Murray Mouth** estuary as an area of low diversity of benthic flora and fauna, based upon sampling undertaken by DEH and SARDI during a 1995 survey, and the previous work of Paton (1982), Geddes and Butler (1984), Kangas and Geddes (1984) and Geddes (1987). Based on the 1995 sampling, Edyvane *et al.* (1996) reported the following benthic habitat description for the Murray Mouth estuary: Shallow mudflats (i.e. less than 2m deep), comprised fine to very fine sand, and represented the majority of the open estuary, from the **Goolwa** barrage to **Pelican Point**. Macroflora was generally absent in areas of high sediment mobility and waterflow. However, in sheltered embayments, 'opportunistic' and filamentous macroalgae dominated, such as *Enteromorpha ralfsii*, *E.clathrata*, *Polysiphonia infestans* and *Ulvaria oxysperma*. The red alga *Gracilaria* was also common. Drift marine macroalgae (e.g. *Zonaria*) was recorded close to the **Murray Mouth**. Within the open estuary, the narrow deeper water channel (approximately 2m - 7m deep), comprised fine to very fine sand, and was devoid of macroflora during the survey period.

Extensive beds of aquatic plants, dominated by the seagrasses *Ruppia tuberosa*, *R. megacarpa* and the (usually freshwater) charophyte *Lamprothamnium papulosum* occur in the northern and southern Lagoons and in the ephemeral salt lakes (SANPWS, 1991, cited by Morelli and de Jong, 1995). The following literature summary of the ecology of the Coorong Lagoons (Womersley, 1975; Brock, 1981; Geddes and Butler, 1984, Geddes, 1987; Geddes and Hall, 1990), is extracted from Edyvane *et al.* (1996): Extensive beds of aquatic plants, generally dominated by a species of the angiosperm *Ruppia* (wigeon-grass), are important in the ecology of the Coorong (Geddes and Butler, 1984), particularly as food for aquatic birdlife (Delroy *et al.*, 1965). The macrophytes are covered with epiphytic growth, which is probably grazed by many of the invertebrates and the small fish.

In the **Northern Lagoon**, at salinities above 60ppt and as high as 80ppt, *Ruppia megacarpa* is the dominant macrophyte, and (the shallow seagrass) *Lepilaena cylindrocarpa* also occurs in the Northern Lagoon (e.g. in mud - Womersley 1984), and *Zostera muelleri* is also common at the northerly locations (Geddes, 1987; Geddes and Butler, 1984, cited by Edyvane *et al.*, 1996). The *Ruppia* and *Lepilaena* beds are particularly extensive south of **Long Point**. The seagrasses *Zostera muelleri* and *Z. (= Heterozostera) tasmanica* have also been recorded in the **Northern Lagoon**, between Robs Point and Camp Noonameena (Snoeijs and Van der Ster, 1981, cited by Edyvane *et al.*, 1996), but are no longer characteristic of the Murray Mouth due to the construction of barrages, which have changed the salinity regime.

Salinity and water depth are the major determinants of the distribution of aquatic plant species and associations in the **Murray Mouth** estuary, **Lower Lakes**, and **Coorong** region. *Ruppia* has the widest tolerance of level and fluctuation of salinity of any genus of submerged angiosperm (Brock, 1981). This characteristic explains its importance in the Coorong ecosystem, where salinities range from below to three times the salinity of seawater. The angiosperm *Lepilaena* is not as common as *Ruppia*, and has a salinity range of 3-50ppt; it is therefore unlikely to occur in areas where salinities range from 45-90ppt, such as the Southern Lagoon (Brock, 1981). Filamentous algae, such as *Cladophora* and *Enteromorpha*, are common in the Coorong, particularly in spring and summer (Womersley, 1975). These calm water macroalgae grow actively under a range of salinities, and respond quickly to both increasing temperatures and to increased nutrients such as phosphate and nitrate. Active growth of *Cladophora* occurs with rising spring temperatures, but these plants grow quickly and often live for only a few weeks (Womersley, 1984), subsequently forming rotting mats. In the **Northern Lagoon**, from October to February 1982, mats of filamentous algae, including *Cladophora*, *Enteromorpha*, and *Oscillatoria* were recorded among the macrophyte beds, covering much of the lagoon bottom (Geddes and Butler, 1984, cited by Edyvane *et al.*, 1996).

Salt Lake Habitat

Extracted from references in Edyvane *et al.* (1996): Fewer aquatic species are hypersaline or tolerate high salinity conditions (i.e. 23.90-56.55ppt), such as the conditions of the inland saline lakes. These include *Ruppia*, which dominates inland saline lakes at depths of 25-50 cm; *Isolepis* and *Lamprothamnion*, which are also found in saline inland depressions; and *Halosarcia*, *Distichlis* and *Sarcocornia*, in shallower areas, around seasonally inundated shorelines at mean water level, and 25 cm above (Renfrey *et al.*, 1989). However, at very high salinities, the distribution of some species can be inhibited. For instance, growth of *Ruppia tuberosa*, an important food species for waterfowl, is generally inhibited by salinities twice above seawater (Delroy *et al.* 1965; Paton, 1982; Geddes and Butler, 1984; cited by Edyvane *et al.*, 1996).

Murray Mouth Island Notes

Mud Islands: comprise 10 marsh islands in **Lake Alexandrina** near the northern end of The Coorong. The islands are covered by species of *Arthrocnemum* as low shrubland, and fringed by closed herb land of

Phragmites australis and *Typha* sp. (AHC, undated).

Eastern Hindmarsh Island: Contains both seasonal and permanent freshwater, and has been highly modified by barrages and farming. The island supports extensive sedge-lands and reed beds, and some areas of swamp paperbark scrub.

Mundoo Island area: This area is in the south-eastern part of **Lake Alexandrina**, where water levels are controlled by barrages. The area is composed of more than 10 small islands, comprising mud flats, swamp paperbark open scrub and extensive sedgeland and reedbeds. The area includes part of the **Murray Mouth** estuary, the lower **Mundoo Channel**, and the **Coorong Channel**. Renfrey *et al.* (1989, cited by AHC, undated), found three aquatic and near aquatic vegetation associations occurring in the **Mundoo Island** area. The first association was a grouping of six species containing plants characteristic of herblands, and dominated by shield pennywort (*Hydrocotyle verticillata*), swamp crassula (*Crassula helmsii*) and several rush species (*Juncus* spp.). The second association of narrow leaf bulrush (*Typha domingensis*) and common reed (*Phragmites australis*) was characteristic of the deeper freshwater sites in the north-eastern part of the area. The third association was also characteristic of freshwater, but was dominated by water ribbons (*Triglochin procera*). The area between **Mundoo Channel** and **Scab Channel** was recognised as the “most pristine” of surveyed habitats in the area (Renfrey *et al.*, 1989, cited by the AHC, undated). Part of the area has been modified (i.e. used for cattle and sheep grazing). Sampling by DEH and SARDI in 1995 (see Edyvane *et al.*, 1996), reported that the shallow channels (i.e. less than 2 m deep), comprise mud, muddy sand and very fine sand, typified the sheltered habitats of the **Mundoo Channel** and **Boundary Creek**. Within these channels, ‘opportunistic’ macroalgae (such as *Enteromorpha ralfsii*, *E.compressa*, *E.clathrata*, *Rhizoclonium* and *Ulvaria oxysperma*) proliferated, and covered the entire bottom of the channels in many locations. The red algae, *Gracilaria* sp. and *Polysiphonia infestans* were also common. In the mid and upper reaches of these channels, sediments were typically black, anaerobic mud. In the upper reaches of the **Mundoo Channel**, *Gracilaria* was associated (as an epiphyte) with outcrops of the tube worm, *Galeolaria*, which formed small, discrete calcareous reef outcrops (up to one to two metres across) in the main channel.

Yalkuri Area and Salt Lagoon, Salt Lagoon Islands (at the eastern border of the area described in this table, near **Pelican Point**): This is a low-lying area of land between **Lakes Alexandrina** and **Albert**. The area contains lagoons, swamp paperbark stands and reed beds, and has been modified by barrages (Carpenter, 1995).

Pages Islands and Backstairs Passage

Pages Islands: Recent benthic surveys of the Pages Islands area have revealed a fringing reef system encircling the island group (DEH, unpublished data, 2003). In profile, the reef system slopes from the intertidal to a depth limit of approximately 30m whereafter the benthic environment is predominantly bare sediment. Video investigations show that the reef systems are typical of exposed reefs throughout the area (B. McDonald, DEH, pers. comm., 2003). Furoid algae dominate shallow subtidal areas before grading to mixed foliose and coralline algal taxa and invertebrate faunal assemblages along the deepwater margins of reef habitat. Recent findings support those reported by Baker and Edyvane (1996, and SARDI S.A. Benthic Survey data, 1994), namely that boulder reefs in the area are dominated by the brown macroalgae *Scytothalia dorycarpa*, *Seirococcus axillaris* (both prevalent between 10m – 20m), *Acrocarpia paniculata* (particularly at 10m and shallower), with sparse cover of *Ecklonia radiata*; and reds such as species of *Phacelocarpus* and *Plocamium*, calcareous reds (e.g. *Haliptilon*) and colonial invertebrates, such as bryozoa, in the understory. Shallower reefs (e.g. 4 m) were dominated by the brown macroalga *Cystophora moniliformis*, calcareous red algae, and pebbles (Baker and Edyvane, 1996, and SARDI S.A. Benthic Survey data, 1994, unpublished).

Backstairs Passage: The area is characterised by high current speeds (up to 250 cm / second, according to Shepherd and Sprigg, 1976), and relatively deep waters (35m – 70m). Richardson and Watson (1975, cited by Shepherd and Sprigg, 1976, and confirmed by DEH, unpublished data), stated that the substrate in Backstairs Passage at around 40m depth consists of “planed off surface of bedrock covered with a thin layer of sediment, made up of coarse sand, small flat pebbles and biogenic carbonates. These sediments form drifts in the lee of sparse reef outcrops...”. There are reef patches in the rocky channels, composed of metamorphic rocks - Permian shales, according to Shepherd and Sprigg (1976). The Backstairs Passage area has a high diversity of sessile and mobile marine invertebrate assemblages (S. Shepherd, pers. comm. cited by Edyvane, 1999b). Faunal assemblages recorded at 50m and deeper (to 60+m) in the tidal race at the centre of Backstairs Passage, include large sponges more than 1m high and wide, large erect “basket” bryozoa (such as *Adeona grisea*) covered with epizoic crinoids (feather stars) and ophiroids (brittle stars) (Shepherd and Sprigg, 1976). In the sediment drifts the brachiopod *Anakinetica cumingi*, which reaches densities of up to 80 per square metre (Richardson and Watson 1975, cited by Shepherd and Sprigg, 1976). There are other species of brachiopod in Backstairs Passage (see section on **Taxonomic Diversity**). Soft corals and gorgonian corals are also found in

Backstairs Passage (Shepherd and Sprigg, 1976; Edyvane, 1999b; KI-AMCS, 2000).

6. Taxonomic Diversity

Marine Plants and Coastal Aquatic Plants

Encounter Bay: High species diversity of macroalgae, particularly red macroalgal species recorded around several of the granite islands (e.g. at least 200 species of macroalgae species recorded at **West Island** - see Shepherd and Womersley, 1970, for examples). Johnson (1988a) described **West Island** boulders as supporting “many different micro-habitats with a great diversity of (marine) plants”.

North-east Kangaroo Island (e.g. part of Eastern Cove): “Rich variety of (macro) algae” (Shepherd and Sprigg, 1976).

Cape Jervis area: There is a high diversity of brown macroalgae on the shallow metamorphic platform and rubble reefs in the Cape Jervis area (and northwards). For example, in the genera *Cystophora* and *Sargassum*, up to 12 species of these two brown macroalgae have been recorded in the area, according to combined results of the following surveys: SARDI S.A. Benthic Survey data (1997, unpublished, cited by Edyvane, 1999b), Emerson and Collings (1998), and Collings and Cheshire (1998).

Mundoo Island: Renfrey *et al.*'s (1989) study of the aquatic and near aquatic flora of the Hindmarsh Island, Mundoo and Goolwa Channels recorded 85 species, of which 60 were native.

Bony and Cartilaginous Fish

Aldinga Reef has been described as containing “many” / “numerous” reef fish (Christopher, 1988; DIASA, undated; Johnson, 1988a; Edyvane, 1996b; and various anecdotal reports from divers). Examples of regularly observed species include Western Blue Devil, Dusky Morwong, Blue-throated, Brown-spotted and other Wrasse species, Yellow-headed Hulafish, Moonlighter, Magpie Perch, Silver Drummer, Dusky Morwong, Blue-spotted Goatfish, Western Talma, Zebra Fish, Old Wife, Herring Cale and Rainbow Cale, Horseshoe Leatherjacket, Spiny-tailed Leatherjacket, Six-spine Leatherjackets and other Leatherjacket species, various Weedy Whiting species, Smooth Toadfish, the two Cowfish species, amongst others (Johnson, 1998a; J. Baker, pers. obs., 2002-2003).

North-eastern Kangaroo Island / Dudley Peninsula: Community and government monitoring programs during the late 1990s (e.g. see KI-AMCS, 2000) recorded most of the reef fish species that are commonly sighted in the Southern Fleurieu area (see below), and it is likely that a complete species inventory of the area would show the fish diversity to be considerably higher in the north-eastern Kangaroo Island reef areas. Glover's (1979) account indicated that Kangaroo Island as a whole had a very high fish species diversity (around 270 species), although the number of these species that occur in the north-eastern headland area of Kangaroo Island cannot be determined for this report.

Lady Bay – Yankalilla Bay – Second Valley – Rapid Bay and Rapid Head - to Cape

Jervis: Although not fully quantified by scientific survey, there is an apparent high diversity of fish species associated with the seagrasses, reefs and sand habitats of the three main bays, as well as **Rapid Bay** jetty, and **Rapid Head** reef. A complete species list not available, but there is anecdotal evidence of high species diversity i.e. “large variety”, “vast array of marine life” according to dive associations, with well over 80 fish species regularly (some occasionally) observed in the area. Examples include Western Blue Devil, Western Blue Groper, Ornate Cowfish, Shaw's Cowfish, Tubemouth, Conger Eel, Yellow-tail Scad, Old Wife (abundant in the Rapid Bay area), Magpie Perch, Dusky Morwong, Southern Blue Morwong, Banded Morwong, Jackass Morwong, Herring Cale and Rainbow Cale, Zebra Fish, Gurnard species, Victorian Scalyfin, Silverbelly, Scorpion-cod and Rock Cod species, several species of Bullseye, Southern Hulafish and Noarlunga Hulafish, Western Talma, Long-snouted Boarfish, Short Boarfish (rarely recorded), various Leatherjacket species (including less abundant and uncommonly sighted species such as the Blue-tailed Leatherjacket and Gunn's Leatherjacket), Blue-throated Wrasse, Senator Wrasse, Black-spotted Wrasse, Castelnau's Wrasse, other Wrasse species, Harlequin Fish, Barber Perch, Red “Mullet” (=Blue-spotted Goatfish), Stargazer, Prowfish, several species of Weed Whiting, Weedfish species, Leafy and Weedy Seadragon, various pipefish species, Blenny and Threefin / Triplefin species, Toadfish, and Globe Fish; as well as commercially and recreationally significant species for fishing, such as Australian Salmon, Tommy Ruff, Snook, Garfish, Snapper, King George Whiting, Sand Whiting and Yellow-fin Whiting, Silver Drummer, Yellow-tail Kingfish, Sweep, Trevally, Yellow-eye Mullet and Jumper Mullet, Long-finned Pike,

species of Flathead and Flounder, amongst others. Various shark and ray species also occur, including some of those shark and ray species listed below for Encounter Bay, as well as Numbfish (Torpedinidae family).

Encounter Bay: The fish species diversity has not been quantified by scientific survey, however well over 70 fish species have been commonly recorded by divers, dive organisations, other groups (e.g. Marine Life Society of South Australia), and fishers (e.g. see recreational fishing reports from FishInternet 2000-2001). Reef-associated fish regularly reported in the area include Blue-throated, Brown-spotted and other Wrasse species, Magpie Perch, Long-snouted Boarfish, Old Wife, Blue-spotted Goatfish, Moonlighter, Zebra Fish, species of Bullseye, species of Weed Whiting, Sweep, Weedfish species, Gurnard Perch species, Southern Sea Carp, Seaperch species, Toothbrush Leatherjacket and other Leatherjacket species (including some that are more common in south-eastern Australia, such as the Brown-striped Leatherjacket), amongst others. Other species known from the area include Pipefish and Pipehorse species, Seahorse and Seadragon species, Globe Fish, species of Blenny and Triplefin / Threefin, Western Kelpfish, Scorpion-cod, Bearded Cod, Southern Blue Morwong and Western Blue Groper (including juvenile Western Blue Groper – Shepherd and Baker, personal observation, 2002). Most of the commercially and recreationally significant fish species common to the southern Fleurieu are also common in the area (i.e. Australian Salmon, Tommy Ruff, Garfish, Snook, Yellow-eye Mullet, Jumper Mullet, Sand Flathead, Sweep, Mulloway, Trevally, Snapper, King George Whiting and other whiting species, Silver Drummer, as well as Mackerel, Bluefin Tuna and other pelagics). River and creek fish in the Encounter Bay area reportedly include Mullet, Galaxias species, Gudgeon species (which may no longer be present, according to T. Kildea, pers. comm., 2001), and catfish (Greater Granite Island Development Syndicate 1988, cited by Baker and Edyvane, 1996). Black Bream, Salmon, and Mullet were once common in the Hindmarsh and Inman Rivers (Hodge 1932, cited by Baker and Edyvane, 1996), but are no longer plentiful since development of the area.

Murray Mouth and lower Coorong: Fish species diversity estimates that are specific to the Murray Mouth are not available for this assessment, although Pierce (1995) reported that 59 fish species are known from the entire Coorong system, comprising 31 species that can be considered as primarily marine, 11 species characterised as estuarine, and 17 species that are essentially freshwater.

North-eastern Kangaroo Island, Encounter Bay, Murray Mouth and deeper waters out of Encounter Bay: High species diversity (and abundance, for some species) of sharks and rays, including Bronze Whaler *Carcharhinus brachyurus* and Black Whaler *C. obscurus* (anecdotal evidence of aggregations of juvenile whaler sharks in the **Encounter Bay** area), Port Jackson *Heterodontus portusjacksoni*, wobbegongs (*Orectolobus* spp.), Rusty *Parascyllum ferrugineum* and Varied *Parascyllum variolatum* Catsharks, Great White *Carcharodon carcharius*, Gummy Shark *Mustelus antarcticus*, School Shark *Galeorhinus galeus*, Whiskery Shark *Furgaleus macki*, Smooth Hammerhead *Sphyrna zygaena* (which seasonally aggregate around the **Murray Mouth**, according to fishers), Saw Sharks (*Pristiophorus* spp.) (in deeper waters), Fiddler Ray *Trygonorrhina fasciata*, Black Stingray *Dasyatis thetidis*, Smooth Stingray *Dasyatis brevicaudata*, Shovelnose Ray *Aptychotrema vincentiana*, Eagle Ray *Myliobatis australis*, Coastal Stingaree *Urolophus orarius* (see section below), Elephant Fish / Elephant Shark *Callorhynchus milii* (seasonal), and others (FishInternet, 2000; and unpublished reports from divers and fishers). Some ray species are prevalent in the **Encounter Bay** and **American River** areas (Ivanovici, 1984; Johnson, 1988a; Morelli and de Jong, 1995; FishInternet, 2000; and unpublished reports from divers).

Marine Invertebrates

Southern Fleurieu (e.g. **Lady Bay - Yankalilla Bay - Second Valley - Rapid Bay and Rapid Head**): No survey information is available for this report, however there are anecdotal reports by divers and dive organisations of high phyletic diversity (and presumably high diversity at the species level and other levels, within some groups) of invertebrates associated with habitats in the area, particularly boulder and cobble reefs in the **Second Valley** area. Common groups in the area include sponges, ascidians, echinoderms, gastropod and cephalopod molluscs, crustaceans (e.g. hermit crabs and

other decapods). Soft corals and sponges are associated with the patch reefs and caves of **Rapid Head** and other headland reefs in the Southern Fleurieu area support a variety of hydroids, bryozoa, and other groups.

Encounter Bay: Intertidal invertebrate fauna in the Encounter Bay area include surf barnacles and other barnacle species, crabs, limpets, sea stars, turban shells, black mussels, polychaete worms, periwinkles and coniwinkles, and chitons (Hodge, 1932; Shepherd and Womersley, 1970; Womersley and Thomas, 1976). There is a high species diversity of several groups of subtidal marine invertebrates, including “species rich” articulated bryozoan communities, and an “extraordinarily high” species diversity of hydroids and pycnogonids (sea spiders) (Shepherd, pers. comm. 1996, cited by Baker and Edyvane, 1996), which also includes a number of uncommon species (Shepherd pers comm., 1996; Staples, 1997). Shallow-water, communities of small bryozoa in **Encounter Bay** area were considered to be denser and richer in species than any other known sites in South Australia at the time (S. Shepherd, pers comm., cited by Baker and Edyvane, 1996). The following is derived mainly from Shepherd and Watson (1970), Kangas and Shepherd (1984), Shepherd (per. comm., 1996) and various divers’ records: Part of Encounter Bay, particularly the subtidal boulder and crevice habitats of the islands, are considered to contain a high abundance of reef invertebrates, including hydroids, sponges, bryozoa, ascidians (both compound and single species, including species of the stalked ascidian *Pyura*), gorgonian corals, various species of sea star and brittle stars, chitons (some of the **Encounter Bay islands** are rich in chiton species), anemones, gastropods and other molluscs (also including various squid, cuttlefish and octopus species) and various crustaceans (sponge crabs, shrimps, and many other groups). Sponges, gorgonians and other corals, bryozoa, hydroids and sponges dominate deeper reefs (e.g. 25+m). Some of these groups are also species-rich in the area. Collectively, the diversity of invertebrate phyla in the area is high. Johnson (1988a) described **West Island** boulders as supporting “many different micro-habitats, with a great diversity of animals”.

North-East Kangaroo Island / Backstairs Passage / Pages Islands: High diversity of several marine invertebrate groups. The **Backstairs Passage** area is considered to be “unparalleled in its diversity of marine invertebrate assemblages, and is one of the richest areas of sessile invertebrate fauna in South Australia (Shepherd, pers comm., cited by Edyvane, 1999b). There are biogeographically significant shallow-water (e.g. 12+m) sessile invertebrate faunal assemblages recorded in the **Ironstone Point - Cuttlefish Bay - Snapper Point - Cape Coutts** region. The fauna is dominated by abundant soft corals and gorgonian corals, large erect sponges (species of *Thorecta*, *Dendrilla*, *Aplysilla*, amongst others), large erect bryozoa (species of *Adeona*, *Triphyllozoon*, *Celleporaria*, *Orthoscuticella*, amongst others), sea pens, and a diversity of echinoderms (basket stars, feather stars, brittle stars, sea stars) and gastropod molluscs (S. Shepherd, pers. comm.; Edyvane, 1999b; KI-AMCS, 2000). This fauna is considered to be unique, with the only similar faunal assemblages recorded at 50m and deeper (to 70+m) in the tidal race at the centre of **Backstairs Passage**, where large sponges occur, some more than 1m high and wide (see above) in “sponge gardens”; and large erect “basket” bryozoa (such as *Adeona grisea*), with abundant epizoic brittle stars and feather stars. Other parts of **North-Eastern Kangaroo Island** (e.g. including part of **Eastern Cove**) have also been described as supporting a “rich variety of sponges, crinoids, reef molluscs and other benthic organisms (Shepherd and Sprigg, 1976).

Backstairs Passage / Pages area also contains a wide variety of brachiopod species, both attached and less common “free-swimming” types (Shepherd, pers. comm., cited by Baker and Edyvane, 1996), some of which are also abundant and in high densities (e.g. drifting brachiopod *Anakinetica cumingi*, which reaches densities of up to 80 / m² (Richardson and Watson 1975, cited by Shepherd and Sprigg, 1976). The area also contains a significant crinoid fauna (Mitchell, pers. comm., cited by Edyvane, 1999b).

American River: According to the Australia Heritage Commission (undated), the wetland system supports a “large variety of invertebrate species”. Common invertebrate groups include various species of sponges, crabs, sea stars, anemones, sea cucumbers, polychaetes and molluscs (including various small bivalves and gastropods, and the Razorfish *Pinna bicolor*) (Womersley, 1956, cited by Edyvane and Baker, 1996c; Morelli and

de Jong, 1995).

Yankalilla Bay – Second Valley – Rapid Bay: There is anecdotal evidence (i.e. from diving organisations) of high phyletic diversity of invertebrates associated with the boulder and cobble reefs in the **Rapid Bay** area (e.g. sponges, ascidians, echinoderms, molluscs), and the patch reefs and submarine caves of **Rapid Head** (including soft corals, sponges, amongst other taxa). The level of species diversity within the major groups is not known for the report.

Estuarine, Coastal and Marine Birds

American River: Fifty-six species of coastal birds (mainly waders) recorded (Morelli and de Jong, 1995), which is considered to be “significant compared to numbers found on (most) wetlands elsewhere in southern Australia”, according to Australian Heritage Commission (undated).

Cygnets River Estuary wetland system: Fifty-three species of coastal wetland birds and seabirds have been recorded in the area (Australian Heritage Commission, undated). According to Oks (SA Department of Fisheries, 1986, unpublished, cited by Edyvane, 1999b), the Cygnets River area has the largest number and highest diversity of birds on Kangaroo Island.

Busby and Beatrice Islets (Bay of Shoals area): The islets provide habitat for 38 coastal and sea bird species, including 12 species which breed in the area, and 13 species under international treaties (Morelli and de Jong, 1995; Australian Heritage Commission, undated).

North-east kangaroo Island (Kangaroo Head to Cape Coutts): More than 40 coastal and/or marine bird species have been recorded as using the area between Kangaroo Head and Cape Coutts, including species of Petrel, Albatross, Prion, Shearwater, Storm Petrel, Cormorant, Oystercatcher, Plover, Stint, Sandpiper, Tattler, Tern, Gull, amongst others (KI-AMCS, 2000).

Chapman River Mouth / Lashmar Lagoon: 50 waterbird species have been recorded, nine of which are listed under international treaties. The number of those species that are restricted to the freshwater **Lashmar Lagoon** area (connected to the **Chapman River**) is not known for this report.

Encounter Bay and Islands: The area contains numerous local and migratory seabird and wading bird species. Although around 100 coastal bird species are regularly recorded (AHC, 2000), the number of these that are associated with terrestrial habitats cannot be determined from this figure. Apart from the rare and threatened species (see below) other local species include Australian Pelican; all five species of Cormorant; Short-tailed Shearwater; White-faced Heron; Masked Lapwing; Red-capped Dotterel; Sooty Oystercatcher; and species of prion and petrel (Cameron, 1979). Granite Island is considered to be “rich in birdlife” (AHC, undated). Migratory species in the Encounter Bay area include Ruddy Turnstone, Double-banded Dotterel, sandpiper species (including migrants from Siberia), Godwit, and Whimbrel (Cameron, 1979). Species of Albatross, Giant Petrel and Prion are also occasionally sighted in Encounter Bay. Twenty bird species recorded from the Encounter Bay region are listed in the CAMBA and JAMBA international treaties, including the Great Egret, Common Sandpiper and Caspian Tern (AHC, 2000).

Murray Mouth and Lower Murray: The specific significance of the Murray Mouth estuary (excluding the lakes) in terms of bird species diversity cannot be determined for this report. However, Carpenter (1995) reported 82 coastal bird species in the **Lower Murray** area (including **Lakes Alexandrina** and **Albert**), including 30 species of waders (of which 20 are migratory), 14 species of waterfowl, and 38 species of other waterbirds. Morelli and de Jong’s (1995) listing of the area for ANCA (1996), reported “90 waterbird and 21 seabird species; 33 listed under (migratory) treaties”. DEHAA (1998) stated that the area provides habitat for 85 water bird species. Irrespective of exact numbers, the area is the most significant in South Australia, in terms of estuarine bird species diversity.

	<p>Mundoo Islands and surrounding area: Approximately 64 coastal and water birds species have been recorded from the area (AHC, undated).</p>
<p>7. Habitat for Endemic Taxa / Threatened Taxa / Rare or Uncommon Taxa</p>	<p>Bony and Cartilaginous Fish</p> <p>Southern Fleurieu / Cape Jervis: Habitat for uncommonly recorded Pipehorse species. Southern little Pipehorse <i>Acentronura australe</i> (= Southern Pygmy Pipehorse <i>Idiotropiscis australe</i> – see Kuitert, 2000) is known from southern Gulf St Vincent (e.g. Cape Jervis and other southern Gulf St Vincent locations), but is not commonly recorded, and may have a limited distribution in S.A. The species is known mainly from dredge samples. The range is known to extend to WA (e.g. Carnac Island) (Dawson, 1985; Froese and Pauly, 2003). The species is assumed to live in macroalgal habitat. There are few <i>Acentronura / Idiotropiscis</i> species, and all are considered difficult to find and rarely observed, some only known from the type material (Kuitert, 2000). Also found in the area is the Deep-bodied (Deepbody) Pipefish <i>Kaupus costatus</i>, a species belonging to a monotypic, endemic Australian genus, known from isolated populations in Victoria, Flinders Island (Tasmania), and several places in South Australia. In Gulf St Vincent, the species has been reported from the Port River - Barker Inlet system; Port Gawler to Middle Beach; and lower Fleurieu locations such as Cape Jervis (Jones et al., 1996; Kuitert, 1996b and 2000; R. Browne, pers. comm., 2003; Browne, 2004). The little known Gulf Pipefish <i>Stigmatopora</i> nov. sp. (<i>Stigmatopora nasospatulata</i>) has also been recorded in the Cape Jervis area, and may be endemic to the gulfs region of South Australia (Browne, 2004). The Javelin Pipefish <i>Lissocampus runa</i>; the Smooth Pipefish <i>Lissocampus caudalis</i>, and the Western Upsidedown Pipefish <i>Heraldia</i> sp. 1, also occur in the lower Fleurieu / Cape Jervis area (OZCAM records, cited by Baker, 2004).</p> <p>The region described in this table, including southern Fleurieu Peninsula, Dudley Peninsula, and Encounter Bay, also provides habitat for Crested Threefin <i>Trinorfolkia cristata</i> (Fricke, 1994), known almost exclusively from S.A. (Kuitert, 1993; Hutchins and Swainston, 1986, 2001; Pogonoski et al., 2002; OZCAM database records, cited by Baker, 2004).</p> <p>North-eastern bays region, including American River / Pelican Lagoon: The area contains a number of pipefish species (Long-Snout Pipefish <i>Vanacampus poecilolaemus</i>, Deep-bodied Pipefish <i>Kaupus costatus</i>, and Verco's Pipefish <i>Vanacampus vercoi</i>), and at least two other small fish species of conservation concern (Eelblenny <i>Peronedys anguillaris</i>, and Spotted Snake-blenny <i>Ophiclinops pardalis</i>). Verco's Pipefish is known from only a few sites in Spencer Gulf, Gulf St Vincent and Kangaroo Island, and appears to have a restricted geographic range (see Kuitert, 2000; Froese and Pauly, 2003; Browne, 2004). The Australian Society of Fish Biology (2001) and Pogonoski et al. (2002) suggested a conservation status of <i>Lower Risk – Near Threatened</i> for Verco's Pipefish. The more broadly distributed Long-snout Pipefish <i>V. poecilolaemus</i> is known mainly from Gulf St Vincent, Spencer Gulf and Kangaroo Island in South Australia; however, it has also been recorded in Bass Strait / Victoria, Tasmania, and W.A. (although populations in W.A. may represent a separate species) (Dawson, 1985; Kuitert, 1996 and 2000). Although the Long-snout Pipefish is not uncommon (e.g. survey data by B. McDonald; and survey data cited in Browne, 2004), its restricted dispersal abilities, and reliance upon seagrass habitats, make it a species of potential conservation concern. Deep-bodied Pipefish <i>K. costatus</i> has been recorded from both gulfs and Kangaroo Island in S.A. (Kuitert, 2000; Browne, 2004), and although relatively abundant in some areas, it is dependent upon shallow eelgrass habitats (Browne, 2003, 2004). Eelblenny <i>P. anguillaris</i> is mostly known from S.A. and southern W.A., and has been recorded from few areas in South Australia, such as Kangaroo Island and in Gulf St Vincent (Gomon et al., 1994, cited by Pogonoski et al., 2002), and is generally considered to have a restricted distribution. Eelblenny occurs in restricted habitats – it lives among seagrass roots (Gomon et al., 1994), and is found in calm bays and still estuaries with prolific seagrasses that form mats over decaying seagrasses (Kuitert, 1993; Kuitert, 1996a and per. comm. to T. Flaherty, 1995; see also Fricke, 1994, and Froese and Pauly, 2003), such as Pelican Lagoon on Kangaroo Island. Spotted Snake-blenny <i>Ophiclinops pardalis</i> is known only from Spencer Gulf, Gulf St Vincent and Kangaroo Island (i.e. endemic to S.A.). (Fricke, 1994; Kuitert, 1996a; Froese and Pauly, 2003, citing Gomon et al., 1994). <i>O. pardalis</i> is found within plant litter at the base and amongst roots</p>

of seagrass, and mixed rock, seagrass and weed (macroalgae) habitat, under seagrass mats or rocks (Kuitert, 1996a), and **North-East Kangaroo Island** provides an example of this habitat.

The apparently rare and endemic Magpie Fiddler Ray (*Trygonorrhina melaleuca*) has been recorded in the **north-eastern bays** region of Kangaroo Island (Glover, 1979; S.A. Museum data, cited by Baker, 2004). It is possible that the Coastal Stingaree *Urolophus orarius*, a shallow water species of very limited known distribution, may also occur in the area, because it is known to occur north of the bays, in eastern **Investigator Strait** (museum records, cited by Baker, 2004). *U. orarius* is considered to be a threatened species (P. Kyne, IUCN Shark Specialist Group, pers. comm., 2004; Baker, 2004).

North-East Kangaroo island (including **Penneshaw** and **American River** area): “nursery” habitat for juvenile Western Blue Groper *Achoerodus gouldii*, a species of conservation concern (see Section 9.2). A survey of the area in 2002 showed that juveniles occurred in shallow sheltered embayments at the eastern end of the island, and the adults occurred in more exposed waters further west on the north side of the island. Juveniles (less than 20cm) were also found in the **Penneshaw** area, in the shallows near the breakwater (A. Brown, pers. comm., 2003), and densities of juveniles in the **Penneshaw** area were 100 times higher than at other sampled sites around northern and western Kangaroo Island (Shepherd *et al.*, 2002). In addition to the survey cited above, fishers have also described juvenile Western Blue Groper as being “common” in macroalgae in **American River** and **Nepean Bay** (Shepherd *et al.*, 2002).

Encounter Bay and Islands: Species of potential conservation concern occur, such as various Pipefish species, Seahorses, and populations of Weedy and Leafy Seadragons. Leafy and Weedy Seadragons are regularly recorded in the reef and seagrass habitats of Encounter Bay, and large aggregations of both species have periodically been observed. Both seadragon species were listed as *Data Deficient* on IUCN’s Red List 2003, and Leafy Seadragon is a protected species under South Australian legislation. According to Edyvane (1999b, uncited reference), syngnathids other than Leafy and Weedy Seadragons that are found in Encounter Bay include the Big-bellied Seahorse (i.e. Southern Pot-bellied Seahorse) and the Short-headed Seahorse. Syngnathid species, including seahorses, most pipefish, and seadragons, are generally considered to be of conservation concern (IUCN Red List 2000 - 2003; Pogonoski *et al.*, 2002; Baker, in press; Browne, 2004). Pipefish species are found throughout the area (e.g. in the seagrass beds around **Granite Island** and the **Bluff**, and other areas within **Encounter Bay**). For example, the Javelin Pipefish *Lissocampus runa*, the Knife-snouth Pipefish *Hypselognathus rostratus*, and the Long-snout Pipefish *Vanacampus poecilolaemus* are three of the species that occur in the area (see records in Baker, in press). Many of the pipefish species in South Australia (and in general) are considered potentially threatened, which is recognised at national level under the Commonwealth’s *EPBC Act 1999*, although pipefish species that occur in South Australia are not officially listed by IUCN to date. Encounter Bay also provides habitat for a number of reef fish species of conservation concern or potential conservation concern (e.g. Western Blue Groper and other wrasse species). Notes on the apparent status of some of these fish species populations in S.A. are provided in Section 9.2.

Encounter Bay is one of the few localities in southern Australia where the small, shallow water fish *Neoaploactis tridorsalis* (Threefin Velvetfish) has been recorded. The species has been described as “very rare” (Gomon *et al.*, 1994). Most other records are from tropical Australia, and the species is poorly known, particularly in southern Australia, possibly because the Threefin Velvetfish would be overlooked during surveys, due to its small size and apparently cryptic appearance (see Baker, in press for summary). Also, Alison’s Blue Devil *Paraplesiops alisonae*, a south-eastern Australian species which has a very limited known distribution in South Australia, as been recorded in the area (W.A. Museum record, cited by Baker, 2004). The little known Orange-barred Pufferfish *Polyspina piosae*, for which there are few published records in S.A., also occurs in the southern Fleurieu / Encounter Bay region (see Baker, in press).

Encounter Bay: There are various shark species of conservation concern in the area, including Whiskery Shark, Saw Sharks, Smooth Hammerhead, School Shark, Gummy Shark and Great White Shark, amongst others (see summaries of conservation status in

Pogonoski et al., 2002 and Baker, in press). It is noted that the rarely recorded large migratory Basking Shark has previously been recorded in Encounter Bay, with museum records from the early 20th century (S.A. Museum data, cited by Baker, in press). The Porbeagle Shark has also been recorded occasionally, and both the Basking Shark and the Porbeagle are of conservation concern at global and national scales (see Pogonoski et al., 2002; Baker, in press).

Murray Mouth: Possibly one of the few habitats in S.A. in which the endangered Estuary Perch *Macquaria colonorum* occurs. During the 1990s, there were no recent records from the Murray Mouth area (Gomon et al., 1994). Higham et al. (2002) reported that the species does occur in the Murray Mouth area, although it was not recorded in a previous estuarine survey in that area (reported in Edyvane et al., 1996). The National Parks and Wildlife Council and Department for Environment and Heritage (2003) has recommended that the species be listed as Endangered, under a schedule of the *National Parks and Wildlife Act 1972*. The Congolli (*Pseudaphritis urvillii*) also occurs in the Murray Mouth area, and is a species of conservation concern (National Parks and Wildlife Council and Department for Environment and Heritage, 2003; Baker, in press). The Lagoon Goby *Tasmanogobius lasti*, an eastern Australian species that is not recorded in most parts of South Australia, also occurs in the **Murray Mouth** area, and is of potential conservation concern in S.A. (see Baker, 2004 for summary). There are seasonal aggregations of Hammerhead Sharks in the Murray Mouth area, and the Hammerhead is also a species of conservation concern (see Pogonoski et al., 2002; Baker, in press).

Pages Islands and Backstairs Passage: Important habitat for Great White Shark, which is regularly sighted around the **Pages Islands**. Great White Sharks are also regularly sighted in **Encounter Bay**. Great White Shark is a protected species in South Australia (under the *Fisheries Act 1982*); is also considered vulnerable at national level (Australian Heritage Commission, 2000), and is protected under the Commonwealth's *Environment Protection and Biodiversity Conservation Act 1999*. The Great White Shark was listed in the IUCN Red List (2003) as *vulnerable* and *conservation dependent*.

North-east kangaroo Island (Kangaroo Head to Cape St Albans) and Pages Islands: Species of conservation concern occur in the area, including Leafy and Weedy Seadragons, Great White Shark, Western Blue Devil, Harlequin Fish, Western Blue Groper, Blue-throated Wrasse, Brown-spotted Wrasse and several of other Wrasse species, and other reef fish species (KI-AMCS, 2000; DIASA, undated; Shepherd et al., 2002; museum and dive survey records, cited in Baker, in press). Great White Shark and Seadragon species are listed in the IUCN Red List (IUCN, 2003). A spawning population of Elephant Shark / Elephant Fish, which seasonally visits the north-eastern Kangaroo island bay areas, such as American River, is also a species of potential conservation concern. Females migrate from deeper water (200+m) into shallow coastal waters to lay eggs, and each female lays only two eggs. Elephant Shark / Fish is a potentially vulnerable species (D. Didier-Dagit, Elephant Shark biologist, pers. comm., 1999) due to having very low fecundity, "boom and bust" recruitment levels, poorly known population dynamics, migratory behaviour, and is vulnerability to capture when in shallow waters during spawning phase. Notes on the apparent status of some of these species populations in S.A. are provided in Section 9.2.

Southern Fleurieu (e.g. Second Valley, Rapid Bay and Rapid Head): Presence of site-associated species of conservation concern, such as seadragons and pipefish, at **Second Valley, Rapid Bay, Rapid Head**, and other sites along this stretch of coast. Site-attached leafy seadragons at Rapid Bay jetty are a particularly well known feature of this area. Seadragons have also been recorded in the near-shore areas between **Cape Jervis** and **Newland Head** by dive groups (e.g. see DIASA, undated); and also during the Dragon Search community-based monitoring program (see Baker, 2003a and 2003b). Large aggregations of pipefish feeding in seagrass (e.g. several hundreds individuals) have been observed by Dragon Search divers, in the vicinity of **Rapid Bay** jetty. Some pipefish species in South Australia are considered by researchers to be potentially threatened, but are not officially listed by IUCN to date. The **Southern Fleurieu** area also provides habitat for a number of reef fish species of conservation concern. For example, Blue Groper is commonly recorded by divers and dive organisations at **Lassiters Reef** and other **Second Valley** sites. Other reef fish species of potential conservation concern include Dusky Morwong, Harlequin Fish, Western Blue Devil, Gunn's Leatherjacket and

Blue-lined Leatherjacket (both uncommon), and various wrasse species. Notes on the status of some of these fish species populations in S.A. are provided in Section 9.2, and in Baker (in press).

A number of other small, site-associated fishes of conservation concern are known from within the region described in this table. For example:

- ♦ Macleay's Crested Pipefish *Histiogamphelus cristatus* is known from locations such as Gulf St Vincent (e.g. **Rapid Bay**), **Encounter Bay**, and **Kangaroo Island**, and also occurs in southern WA (Kuitert, 2000; Froese and Pauly, 2003).
- ♦ Knife-Snout Pipefish *Hypselognathus rostratus*, an uncommon species of southern distribution known mainly from dredge and trawl samples in deeper coastal waters, has been recorded in Gulf St Vincent, and also at 10m depth in the **Victor Harbor / Encounter Bay** area (see Dawson, 1985; Kuitert, 1996a and 1996b; Froese and Pauly, 2003). Knife-snout Pipefish is known from few samples, with a lack of records of brooding individuals. The Knife-snout Pipefish *Hypselognathus rostratus*, as well as the Smooth Pipefish *Lissocampus caudalis*, also occur in the **north-eastern Kangaroo Island bays** area.
- ♦ Gabriel's Snake-Blenny (Frosted Snake-Blenny) *Ophiclinus gabrieli* is reported to occur along the south-eastern coast, to **Kangaroo Island SA**, and northern Tasmania (Kuitert, 1993; Edgar, 2000). The species is found in seagrass areas, commonly amongst blackened, dead, *Amphibolis* seagrass leaves (Kuitert, 1993).
- ♦ Scarlet Cardinalfish (*Vincentia badia*) and Orange Cardinalfish (*V. punctata*), mouth-brooding fish species of potential conservation concern, have been recorded in the **southern Fleurieu** and **north-eastern Kangaroo Island** area (see Baker, 2004, for summary).
- ♦ **Encounter Bay** is the western end of the geographic range of the Crested Flounder *Lophonectes gallus*, an eastern Australian species with few published records in South Australia (see Baker, in press).

Invertebrates

Backstairs Passage/ Pages Islands: In deeper waters (50+ m) of the Passage area, there are high densities of brachiopods, including "free-living" (drifting) species. This is an unusual feature, because most other brachiopod species live attached to the substrate (e.g. see Richardson and Watson, 1975; Richardson, 1997). Backstairs Passage is considered nationally significant for brachiopod fauna. Brachiopods are a rare invertebrate group on a world-wide scale, according to Richardson (1997).

Southern Fleurieu, Backstairs Passage and North-east kangaroo Island: The region is an important one for cowries, volutes and other "specimen shells". Some of the species are rare, and most are of conservation concern due to their vulnerable population characteristics (see **Part 2** of this table, and Section 9.2). An incomplete list of specimen shell species known to occur in various parts of the region that encompasses **southern Fleurieu** area, **Backstairs Passage** and **North-East Kangaroo Island**, includes the following (see Baker, 2002, for examples of localities, and a preliminary summary of conservation status according to various specimen shell authorities in Australia): *Zoila friendii thersites* (Hump-Backed Cowrie, including less commonly observed white forms and golden forms); *Notocypraea angustata* (Plump Cowrie / Tight Cowrie); *Notocypraea comptoni* (Compton's Cowrie); *Zoila marginata orientalis* (= *Zoila marginata raybaudii*); *Notovoluta verconis* (Verco's Volute); *Cassis fimbriata* (Fringed Helmet); *Vasum flindersi* (Flinders Vase) (Baker, 2002).

Backstairs Passage: The specimen shell *Notopeplum translucidum* occurs in the area, and other parts of S.A. and southern W.A., from 10m to 180m. The species is rare, and the type specimen was originally dredged from Backstairs Passage by Joseph Verco (Wilson et al., 1994). *N. translucidum* is considered rare by shell specialists, and is a very valuable species (see Baker, 2002, for examples). **Backstairs Passage** is one of two areas in S.A. where the small murex shell *Favartia (Murexiella) tatei* has been recorded. The species is considered to be rare (Wilson et al., 1994) and appears to be endemic. **Backstairs Passage** is also the site of collection of a number of other shell species that appear to be endemic to South Australia (Wilson et al., 1993, 1994; Academy of Natural Sciences, 2003).

North-East Kangaroo Island: Abundance of the large uncommon sea hare *Aplysia sydneyensis* on seagrass in **Antechamber Bay** (S. Shepherd, unpublished data). Also in **Antechamber Bay**, and along coast towards **Snapper Head**, exists a large population of the uncommon sea hare *Aplysia dactylomela*, which occurs in seagrass beds (S. Shepherd, SARDI, pers. comm., 2004).

American River / Pelican Lagoon system: The sponge communities that occur in the area appear to be more typical of those found in deeper waters. Their occurrence in the American River system is probably indicative of poor light penetration and strong currents (J. Lavers, pers. comm. to T. Flaherty, MCCN, 1995). The sponge *Echinoclathria notialis*, which has been found only in **American River**, appears to be endemic within South Australia (Hooper, in Australian Government Department for the Environment and Heritage, 2003d).

Encounter Bay: Presence of rare or uncommon invertebrates, such as several species of hemichordates ("acorn worms"), which at a State level, appear to be found only in **Encounter Bay**, particularly at **West Island** and **Granite Island** (S. Shepherd, pers. comm., 1996). Hemichordates are an unusual marine invertebrate group, displaying some affinities to vertebrates, and are uncommon at State, national and global scales. The presence of hemichordates (which are often associated with seagrass roots, but also occur in other habitats) is one feature of **Granite Island** that contributes to its listing on the Australian Heritage Commission's *Register of the National Estate*.

Up till the early 1980s, an uncommon species of sea cucumber (provisionally called "*Cucumaria squamatoides*", due to similarities with species in the *Cucumaria* genus - see Thomas, 1982) had been found only in **Encounter Bay** and Gulf St Vincent. Also in the **Encounter Bay** area is a rare phototrophic sponge (*Cymbastela sp.*) recorded around the more sheltered sides of **West, Wright and Seal islands** in Encounter Bay (Cheshire *et al.*, 1995, cited by Australian Heritage Commission, 2000).

The endemic sponges *Forcepia crassanchorata* and *Geodia (Sidonops) flemingi* have been recorded to date only at **Port Elliot**, the type locality for both species (Hooper, in Australian Government Department for the Environment and Heritage, 2003d).

Also present in the area is the **Encounter Bay** area is the regionally uncommon octopus *Argonauta nodosa*, which creates "paper nautilus" egg cases (Cameron, 1979, cited by Baker and Edyvane, 1996).

The **Encounter Bay** region is the eastern geographical limit of the south-western and southern Australian cowrie *Zoila marginata* (Wilson and Clarkson, 2004).

Seal Rocks in **Encounter Bay** is the type locality for the endemic ascidian *Cnemidocarpa tribranchiata*, recorded to date only in S.A. (Kott, in Australian Government Department of the Environment and Heritage, 2004b).

Bluff area of Encounter Bay: the type locality for a newly discovered species of small annelid worm in the genus *Myzostoma*, which is uncommon in southern Australia. The worm lives symbiotically in the host crinoid *Cenolia trichoptera* (data by G. Rouse, S.A. Museum, 2003, cited by MCCN, 2003).

Aldinga, and North-east Kangaroo Island: Gorgonian corals are found in both localities (Ivanovici, 1984; KI-AMCS, 2000). In general, gorgonian corals are considered to be susceptible to impacts from dive activities (smothering from sedimentation, breakage etc) (Environment Australia, 1998a). Gorgonian corals at Aldinga were listed by Ivanovici (1984) as "locally endangered".

Aldinga Reef is one of few sites where the toxic sponge *Neofibularia mordens* is found (S. Shepherd, pers. comm., 2004). Gulf St Vincent is the type locality for this species, and it is possibly endemic within S.A. (see Hooper, 1999, and Australian Government Department for the Environment and Heritage, 2003d).

Various invertebrates and macroalgae, and a smaller number of fish species, that occur in the region are endemic to southern Australia, but quantification is not possible for this report. Examples of invertebrate species that may be endemic within South Australia and/or have a very limited distribution in southern Australia, include:

Acorn Worms (see Shepherd, 1997)

- ◆ *Saccoglossus apantesis*: grow to a size of 8.5 cm; recorded from **Encounter Bay** and Edithburgh area, amongst *Zostera* roots.
- ◆ *Saccoglossus aulakoeis*: grow to a size of 5.5 cm; orange and yellow acorn worm from

eastern **Gulf St Vincent**, often found amongst *Zostera* roots.

Lamp Shells (Brachiopods) (see Richardson, 1997)

- ♦ *Argyrotheca australis*: a small lamp shell, which grows only to 3 mm in size; known from **Cape Willoughby**.

Hard Corals (see Shepherd and Veron, 1982)

- ♦ *Paracyathus vittatus*: low cylindrical coral, recorded from **Investigator Strait**;
- ♦ *Holotrochus*: two species have been found in **Backstairs Passage**;
- ♦ *Platyrochus*: two unattached species have been found in **Backstairs Passage**.
- ♦ *Dendrophylla atrata*: a colonial dendroid coral found in **Backstairs Passage** and **Investigator Strait**.

Sea Spiders (see Staples, 1997)

- ♦ *Nymphon conirostrum*: recorded from **West Island**, amongst hydroids.

Sea Squirts (see Kott, 1997; Australian Government Department of Environment and Heritage, 2004b):

- ♦ *Claudenus antipodus*, a hard ascidian which grows to 10cm, has a limited known distribution, and has been recorded from sandy bottoms in Gulf St Vincent and Investigator Strait, with **Yankalilla Bay** being the type locality (Kott, 1997; Australian Government Department of the Environment and Heritage, 2004b).
- ♦ *Leptoclinides* sp. 2: a pale colonial ascidian with black spots, recorded from **Gulf St Vincent**.
- ♦ *Leptoclinides* sp. 3: an orange, black and white colonial ascidian, from Great Australian Bight (GAB), **Gulf St Vincent** and **Investigator Strait**.
- ♦ *Leptoclinides* sp. 4: an orange and purple-brown marbled colonial species, from **Gulf St Vincent** and the GAB.
- ♦ *Polycitor obeliscus*: a cone-shaped colonial ascidian, known only from **Investigator Strait**;
- ♦ *Polyandrocarpa simulans*: a colonial ascidian recorded in **Investigator Strait**, and also on the west coast of S.A.;
- ♦ *Eudistoma aureum*: found in *Posidonia* beds in **Gulf St Vincent**.

Marine Mammals

Pages Islands supports the largest breeding colony of Australian Sea Lions in the world, and is also the most important site for pup production (Shaughnessy, 2002) (see **Biogeographic Significance**). During the early 2000s, approximately 2,100 Australian Sea Lions populated the islands (DEH, 2003g).

Encounter Bay is an irregular haul-out site for Australian Sea Lion (Halstead, DENR, pers. comm. 1994, cited by Baker and Edyvane, 1996) and the species is also present at **North-East Kangaroo Island**. According to the Australian Heritage Commission (undated), the species has also been recorded using the **American River** wetland system. The Australian Sea Lion is currently listed as *rare* in South Australia (S.A.) under the S.A. *National Parks and Wildlife Act 1972*, and has also been considered by some researchers to be endangered (Gales, 1990; Gales *et al.*, 1994; Dennis and Shaughnessy, 1996).

Encounter Bay: Southern Right Whale is regularly present during the Autumn - Winter - Spring period of mating, calving and juvenile rearing. In some years, up to 40 individuals have been recorded in Encounter Bay in one season (Madigan, 1995), and during the past decade, there has been an increase in the number of whale sightings around **Middleton, Victor Harbor** and coastline in the vicinity. The whales regularly move between **Encounter Bay** and **Kangaroo island**. **Encounter Bay** is the second most significant area in South Australia for migrant Southern Right Whales (Baker and Edyvane, 1996; Australian Heritage Commission, 2000), and the entire coast to 1km offshore forms part of the 'whale highway' during the autumn to spring period (L. McDiarmid, Whale Information Centre, pers. comm., cited by Brook, 2000). The IUCN Red List 2003 classified Southern Right Whale as *conservation dependent*. The species

is listed under S.A. legislation as *vulnerable*, and is also listed under the Commonwealth's *EPBC Act 1999* as a threatened species. Other potentially threatened cetacean species (several whale species, including Sperm Whales, Pygmy Sperm Whales and Pygmy Right Whales) have also been irregularly recorded visiting the **Encounter Bay** area (Glover and Ling, 1976; Australian Heritage Commission, 2000).

North-East Kangaroo Island and Southern Fleurieu: Part of migratory path of threatened Southern Right Whale and Pygmy Right Whale. Community monitoring programs have shown that several other whale species occur irregularly to very rarely in the **North-east Kangaroo Island** area (e.g. Long-finned Pilot Whale, Gray's Beaked Whale and other beaked whales, Killer Whale, Sperm Whale, Minke Whale, and Blue Whale (Flaherty, 1997a; KI-AMCS, 2000). Some of these species are listed in the IUCN Red List 2003 (IUCN, 2003) as threatened, near threatened or data deficient, and most whale species visiting South Australian waters are also protected under schedules of the S.A. *National Parks and Wildlife Act 1972*.

American River – Eastern Cove: Community monitoring programs have observed that Pygmy Right Whales use the sheltered bays off Island Beach and American Beach, one of the few areas in southern Australia where this species is observed inshore. Pygmy Right Whale is listed as rare under the S.A. *National Parks and Wildlife Act 1972*.

North-east kangaroo Island, Southern Fleurieu and Encounter Bay: Bottlenose Dolphins are regularly present in the area. **American River** wetland system and **Eastern Cove** provide habitat for a local pod of Bottlenose Dolphins (Australian Heritage Commission, undated), including feeding and nursery areas. Flaherty (1997b) reported that between 80 and 100 Bottlenose Dolphins have been observed off the northern coast of Kangaroo Island, and that regular feeding groups occur in the area. IUCN Red List 2003 classified Bottlenose Dolphin as *Data Deficient*.

Backstairs Passage: Kemper and Ling (1991) reported the presence of 52 Killer Whales (a whale species irregularly recorded in South Australian waters), herding Australian Salmon through Backstairs Passage. Killer Whale is listed in the IUCN Red List 2003 as *conservation dependent*.

Marine Reptiles

North-eastern Kangaroo Island: Migratory Leathery Turtle (Leatherback Turtle), Green Turtle and Loggerhead Turtle are all recorded as occasional visitors, with isolated sightings reported in most years, according to RISMAL (2000), and there are beachwash reports of both Green and Leatherback Turtles along the coast. All turtle species recorded in South Australia are of conservation concern. Green Turtle was listed under the IUCN Red List 2003 as *endangered*, and is also listed as *vulnerable* under the SA *National Parks and Wildlife Act 1972*, as well as the Commonwealth's *EPBC Act 1999*. Loggerhead Turtle was listed under the IUCN Red List 2003 as *endangered*, and is also listed as an *endangered* species under S.A. legislation, as well as the Commonwealth's *EPBC Act 1999*. Leatherback Turtle was listed under the IUCN Red List 2003 as *critically endangered*, and is also listed under Commonwealth and South Australian legislation, as *vulnerable*.

Marine Plants

Species which reportedly have a limited range over a national scale (Turner, 2000; Cheshire *et al.*, 2000), include the following macroalgal taxa:

- ♦ **North-Eastern Kangaroo Island reefs** (e.g. Kangaroo Head, Penneshaw, Snapper Point): A number of red macroalgal species of nationally recognised limited range have been recorded on reefs by KI-AMCS, such as *Crouania destriana*, *Dasya hapalathrix*, *Dasya wilsonis*, *Erythroclonium sedoides*, *Bonnemaisonia spinescens*, and *Macrothamnion pellucidum* (J. Lavers, cited by T. Flaherty, pers. comm., 2001).
- ♦ **Cape Jervis:** the reds *Bonnemaisonia spinescens* and *Leptoklonion fastigiatum*, and the brown *Spatoglossum australasicum*;
- ♦ **Victor Harbor:** the reds *Acrotrichium amphibolis* and *Heterothamnion sessile*;
- ♦ **West Island:** the red *Antithamnionella multiramosa*;
- ♦ **Cape Willoughby:** the reds *Anotrichium towinna* and *Leptoklonion fastigiatum*;
- ♦ **American River:** the reds *Callithamnion shephardii*, *Dasya tenuis* and *Jania parva*;
- ♦ **Antechamber Bay:** the red *Audouinella blumii*;

- ♦ **Bay of Shoals:** the green *Cladophora aegagropiloidea*.
- ♦ All of the species above were listed by Turner (2000) and Cheshire *et al.* (2000) as potentially threatened species, due to limited known range, based on published records.

Murray Mouth and Coorong: Although species of *Ruppia* (estuarine seagrass) are not rare in S.A., the genus is not regularly recorded in many estuarine areas, at a Statewide scale. *Ruppia* species are an important food source for a number of coastal waterbird species.

Coastal and Marine Birds

North-East Kangaroo Island (Kangaroo Head to Cape St Albans): Habitat for White-bellied Sea Eagle, with nesting sites in a number of locations on the north-east coast. White-bellied Sea Eagle is listed as *vulnerable* in S.A.. The Wandering Albatross and Black-browed Albatross, Northern Giant Petrel and Southern Giant Petrel also visit the area. *Wandering Albatross* was listed as *vulnerable* in IUCN Red List 2003, and also under Commonwealth's *EPBC Act 1999*, and the *NPW Act 1972* in South Australia. Garnett and Crowley (2000) described the breeding population in Australia as *critically endangered*, because the Australian breeding population numbers less than 50 mature individuals. The authors also described the global population, most of which visits Australian waters, as *vulnerable*, due to having decreased in size by 20-50%, based on an appropriate index of abundance, and estimates of fishing bycatch. Garnett and Crowley (2000) considered that the trend in decline was likely to continue for Wandering Albatross, and that the level of genetic interchange between the Australian and visiting population of Wandering Albatross is arguably low, so status of the Australian population is assessed independently (as per Gärdenfors *et al.*, 1999, cited by Garnett and Crowley, 2000).

Black-browed Albatross: Australian breeding population described by Garnett and Crowley 2000 as *Endangered* due to low breeding numbers, and population visiting Australian territory described as *Near Threatened*, principally due to long-line fishing. Globally, the species was listed by IUCN Red List 2002 and 2003 as *vulnerable* and *endangered*, respectively .

Northern Giant Petrel was listed under the Commonwealth's *EPBC Act 1999* as a vulnerable species. The species breeds at a single location within Australian territory (Macquarie Island), and breeding birds from this island mainly forage in inshore waters off southern Australia. Globally, its population size is increasing, but considered to have the potential to decrease to Vulnerable levels (see Garnett and Crowley, 2000). Globally, the species was listed under IUCN Red List 2003 as *near threatened*.

Southern Giant Petrel was listed under the *EPBC Act 1999* as *endangered*; the Australian breeding population was also described by Garnett and Crowley (2000) as endangered due to significant decrease in population size, and the population visiting Australian territory was described by the authors as *vulnerable*. Issues include bycatch long-line fishing, high fidelity to sites, and low immigration rate. The national status of the breeding population is independent of the global status. Globally, Southern Giant Petrel was listed under IUCN Red List 2003 as *vulnerable*.

Deep Creek: Cliff habitat for Peregrine Falcon (Australian Heritage Commission, undated), which is listed as a *rare* species, under the S.A. *National Parks and Wildlife Act 1972*. The area also provides cliff habitat for White-bellied Sea Eagle (Australian Heritage Commission, undated), which is classed as *vulnerable* under S.A. legislation.

American River (Eastern Cove) and Cygnet River (Western Cove) wetland systems: Bird species listed as *rare* under *National Parks and Wildlife Act 1972* that occur in both the American River and Cygnet River estuaries include: Eastern Reef Egret, Australasian Shoveller, Cape Barren Goose, Musk Duck, and Osprey. The Hooded Plover, which breeds in the American River system, is considered *vulnerable* nationally, and under the S.A. *National Parks and Wildlife Act 1972*, and is also considered *rare* at an international scale, according to Australian Heritage Commission (undated). Other bird species listed as *vulnerable* under South Australian legislation that reportedly occur in both the American River and Cygnet River estuaries include: White-bellied Sea Eagle, Eastern Curlew, and Fairy Tern. Cape Barren Goose, Musk Duck, Little Egret (**Cygnet** estuary) and Osprey, recorded in both estuarine systems, are also considered *vulnerable*, according to ANCA (1996), although these birds are not listed under the

Commonwealth *EPBC Act* 1999 as threatened species.

Pelican Lagoon: Coastal bird species recorded from the park that are classified as *rare* under S.A. legislation include Osprey, Cape Barren Goose and Peregrine Falcon (Australian Heritage Commission, undated). **Cygnets River** estuary is a breeding area for Australasian Shoveller, Cape Barren Goose, and Musk Duck (AHC, undated), all classified under S.A. legislation as *rare*. Coastal bird species recorded from the park that are classified as *vulnerable* under the *National Parks and Wildlife Act 1972* include White-bellied Sea Eagle (AHC, undated).

Busby and Beatrice Islets (Bay of Shoals area): Bird species considered vulnerable include White-bellied Sea Eagle, Eastern Curlew, Fairy Tern and Little Egret (Morelli and de Jong, 1995), and all except Little Egret are listed as *vulnerable* under the *S.A. National Parks and Wildlife Act 1972*.

Chapman River Mouth / Lashmar Lagoon: The area provides a winter refuge for the Hooded Plover, considered *rare* at international scale, according to Australian Heritage Commission (undated). Species cited by Morelli and de Jong (1995) as *rare* include: Musk Duck, Australasian Shoveller, and the freshwater bird species Baillon's Crake and Spotless Crake. All except Spotless Crake are listed as *rare* under S.A. legislation. Lewin's Rail, Little Egret and Freckled Duck also occur; the latter is listed under S.A. legislation as *vulnerable*, and Morelli and de Jong (1995) listed all as threatened species in S.A.

Encounter Bay and Islands: Uncommon coastal birds have been regularly recorded in the past, such as Little Falcon, which was irregularly recorded flying to and from **West Island** during the 1970's (Paton and Paton, 1977, cited by Baker and Edyvane, 1996), but less commonly observed in recent years. Little Falcon is considered to be uncommon throughout Australia (Pizzey, 1988). Eastern Reef Egret / Heron (*rare* under *National Parks and Wildlife Act 1972*) also occurs in the area (AHC, undated). Breeding colonies of potentially threatened seabirds occur, particularly on **West Island** (e.g. small tern species). Researchers (e.g. Copley, 1996) consider the Fairy Tern to be threatened in South Australia, and it is listed as *vulnerable* under *National Parks and Wildlife Act 1972*. According to National Parks and Wildlife S.A., Fairy Tern breeding success has declined markedly in some parts of S.A. (e.g. **West Island**) in recent years. The **Encounter Bay area** also provides habitat for the *vulnerable* Hooded Plover (Australian Heritage Commission, 2000). The *vulnerable* White-bellied Sea Eagle was regularly seen over **West Island** until 1970 (Paton and Paton, 1977), but not commonly observed on the Fleurieu Peninsula in recent years, possibly due to alteration and destruction of its potential nesting habitats along coastal areas, such as undisturbed coastal cliffs, and tall dead trees near or over water (Pizzey, 1988; T. Dennis, NPWS, pers. comm., 1994, cited by Baker and Edyvane, 1996). "Giant seabirds", described by Hodge (1932) as some of the "rarest records" at the time, occur irregularly in **Encounter Bay**. Apart from Pacific Gull, which is not rare, Hodge may have been referring to Giant Petrel species (which periodically occur in **Encounter Bay**, according to Cameron, 1979) and / or Albatross species. Both Giant Petrels and several Albatross species are recorded in adjacent regions (e.g. see above, for **North-Eastern Kangaroo Island**, and also species list in the table for **Upper South-East**), and hence are also likely to be present, at times, in the Encounter Bay area. Species likely to occur in the area periodically, include Northern and Southern Giant Petrel, Black-browed Albatross, Wandering Albatross, and Shy Albatross, amongst other Albatross species. According to a National Ocean Office map (2002, citing Brothers *et al.*, 1997), the coastal area between **Waitpinga** and the **Murray Mouth** contains at least two sites out of approximately 20 areas within the south-eastern region, in which "higher occurrence" records of the at-sea distribution of the Shy Albatross are recorded, based on marked bird surveys. Shy Albatross is listed as *vulnerable* under S.A. and Commonwealth legislation. A number of other Albatross species are also listed under State and Commonwealth legislation, and in the IUCN Red List 2003 (see **Appendix 4**, this report).

Inman River: Bird species, which are considered of conservation significance (i.e. either uncommon, rare or vulnerable) include the Royal Spoonbill and Hooded Plover (the latter is *vulnerable* under *S.A. National Parks and Wildlife Act 1972*) (Australian Heritage Commission, undated).

	<p>Murray Mouth: Water birds and coastal birds in the area that are listed as <i>rare</i> under S.A. <i>National Parks and Wildlife Act 1972</i> include: Australasian Shoveller, Baillon's Crake, Spotless Crake, and the Golden-headed Cisticola, which, although not a water bird, is associated during breeding with reed beds in the area (Carpenter, 1995). Cape Barren Goose, Musk Duck and Common Tern also occur in the area, and all three listed as <i>rare</i> under S.A. <i>National Parks and Wildlife Act 1972</i>. <i>Vulnerable</i> bird species recorded in the area (Carpenter, 1995) include: Australasian Bittern, Eastern Curlew, Fairy Tern, Latham's Snipe, Little Tern, and Little Egret, and all of these except Little Egret are listed under S.A. legislation as vulnerable species. The <i>endangered</i> Orange-bellied Parrot also occurs in the area. The Orange-bellied Parrot migrates to the Coorong in winter and feeds along the ocean beach and salt marsh areas (Morelli and de Jong, 1995).</p> <p>Coorong (including Murray Mouth): At least 2000 Cape Barren Goose (i.e. 1% of their total population) normally visit the Coorong in summer (Morelli and de Jong, 1995). Cape Barren Goose is listed as <i>rare</i> under the <i>National Parks and Wildlife Act 1972</i>. A number of migratory species that seasonally inhabit the area, and are listed under the CAMBA and JAMBA agreements, are also considered rare and/or threatened under international and national classifications.</p> <p>Coorong Peninsula: A resident wader, the <i>vulnerable</i> Hooded Plover <i>Charadrius rubricollis</i>, nests on the ocean beaches and fore-dunes (Morelli and de Jong, 1995; Australian Heritage Commission, undated; ANZECC, 1995). During 1986-87, 120 Hooded Plovers were recorded (Morelli and de Jong, 1995). The species is listed under the Commonwealth's <i>EPBC Act 1999</i>, and previously under the <i>Flora and Fauna Guarantee Act 1988</i>.</p> <p>Coastal / Aquatic Vegetation</p> <p>Inman River: Swamp Paperbark (<i>Melaleuca halmaturorum</i>) communities are considered <i>rare</i> in the southern Fleurieu - Encounter region, and in South Australia in general (Australian Heritage Commission, 2000 and undated). The Inman River reportedly supports one of the few remaining populations of swamp paperbark on the Fleurieu Peninsula.</p> <p>Murray Mouth: Habitat for <i>Wilsonia rotundifolia</i>, a supratidal aquatic plant recorded by Renfrey <i>et al.</i> (1989), and considered <i>rare</i> in a regional conservation rating by Lang and Kraehenbuehl (1987, cited by Edyvane <i>et al.</i>, 1996). Also habitat for submerged aquatic plant <i>Ceratophyllum demersum</i>, and intertidal and supratidal plant <i>Wilsonia humilis</i>, both classified as uncommon in the aforementioned conservation assessment. <i>Ceratophyllum</i> may also be considered potentially threatened because it is subject to habitat damage (e.g. from vessel traffic and boat moorings), trampling, and removal for the aquarium trade (Edyvane <i>et al.</i>, 1996).</p> <p>Murray Mouth (e.g. north and east side of Hindmarsh Island and Rat Island): Habitat for aquatic plant species with the following regional conservation ratings, as determined by Lang and Kraehenbuehl (1987, cited by Edyvane <i>et al.</i>, 1996): submerged aquatic plant <i>Vallisneria spiralis</i> (<i>endangered</i>); intertidal plant <i>Hemichroa pentandra</i> (<i>vulnerable</i>) and supratidal <i>Wilsonia backhousia</i> (<i>vulnerable</i>). <i>Vallisneria</i> is sought for the aquarium trade (Edyvane <i>et al.</i>, 1996).</p>
<p>8. Other Important Taxa</p>	<p>Marine Mammals</p> <p>There are haul out sites for New Zealand Fur Seals at the Pages Islands (approximately 100 animals at any one time, according to DEH, 2003g) and Encounter Bay Islands. New Zealand Fur Seals also haul out irregularly along various rocky headlands of the Southern Fleurieu. Small groups and individuals of New Zealand Fur Seals are regularly recorded in the Encounter Bay region. During the 1990s, increasing numbers of fur seals have been observed on Seal Rock, and up to 20 adults have been recorded at one time on the rocks at West Island (C. Halstead, DENR, pers. comm., 1994, cited by Baker and Edyvane, 1996). Seal pups are also occasionally observed in the area. The New Zealand Fur Seal is also present along North-East Kangaroo Island. The New Zealand Fur Seal was classified by IUCN Red List 2000 as <i>Lower Risk, but</i></p>

Conservation Dependent, but was not included in the IUCN Red List 2003.

Encounter Bay: Antarctic seal species that are very uncommon in South Australian waters, such as the Leopard Seal and Wedell Seal, occasionally occur in Encounter Bay, and the Southern Elephant Seal has also been recorded (Glover and Ling, 1976; cited by Baker and Edyvane, 1996). However, the sightings represent stray individuals, and Encounter Bay is therefore not considered to be a significant habitat for the species.

North-east kangaroo Island and Encounter Bay: Common Dolphins are regularly present in the area (Australian Heritage Commission, 2000).

Antechamber Bay: A Southern Right Whale Dolphin (*Lissodelphis peronii*) was recorded washed up in the bay in the spring of 2004. The species inhabits Antarctic waters, and the Antechamber Bay stranding represents one of the very few records of the species in Australian waters (ABC Media Report, 7th November, 2004), and possibly the second record from South Australia (the first being a pod of live *L. peronii*, swimming south of Cape Gantheaume on southern Kangaroo Island – see Clarke, 2000).

Bony and Cartilaginous Fish

American River – Eastern Cove: There is an abundance of large marine fauna (sharks, including benthic shark species such as Port Jackson and Wobbegong species; and several ray species) (Womersley and Edmonds, 1979; Ivanovici, 1984; Johnson, 1988a; McKelvey, KI-AMCS pers. comm., 1999). The deep water Elephant Fish / Elephant Shark *Callorhynchus milii*, which is uncommon in South Australian coastal waters due to its main habitats being in deeper waters to 200+m (Last and Stevens, 1994; Didier-Dagit, pers. comm., 1999), apparently migrates into shallow waters, such as **American River**, during spawning season, as evidenced by the seasonal capture of *C. milii* by fishers in the area, and the existence of egg cases in the American River system. The potential vulnerability of this species to over-exploitation is discussed in Section 9.2.

Backstairs Passage: Aggregation area for Snapper (Capel, 1994, and other localised fishing references), and fishers also report that large schools of migratory Australian Salmon move through the area.

Estuaries in the area (**Cygnnet River; Chapman River Mouth; Murray River Mouth**): All are important areas for the life cycle of Black Bream (Glover, 1979; Morelli and de Jong, 1995; Pierce, 1995; Edyvane *et al.*, 1996; Edyvane, 1999b). In addition to Black Bream, the **Chapman River** and **Cygnnet River** also provide habitat for West Australian Salmon, Yellow-eye Mullet and flathead species (Bryars, 2003). **Deep Creek** estuary near **Baudin Beach** (in **Eastern Cove**) is reported to provide habitat for Black Bream and Yellow-eye Mullet (Bryars, 2003).

Reefs around the southern **Fleurieu Peninsula** (e.g. **Aldinga, Carrickalinga, Rapid Head, Second Valley**, and between **Rapid Head** and **King Head**); **Encounter Bay** and **Islands**; the **Dudley Peninsula** (e.g. between **Kangaroo Head** and **Cape St Albans**), and the **North-Eastern Kangaroo Island** (e.g. **Kingscote** area; **Redbanks** to **Point Morrison** area, and parts of **Eastern Cove**) are reported to be used by one or more of the life stages of the following commercially and/or recreationally significant fish species: King George Whiting, Snapper, West Australian Salmon, Tommy Ruff, Southern Sea Garfish, Yellow-eye Mullet, Trevally, Leatherjacket species, Snook, Western Blue Groper, Blue-throated Wrasse and other Wrasse species, Sea Sweep, Silver Drummer, Gummy Shark and Whaler Sharks (Bryars, 2003). Most of the species listed above, as well as Mulloway and Yellow-tail Kingfish, are also reported to utilise reefs at the foot of the **Fleurieu Peninsula** (e.g. **Cape Jervis**, extending eastwards to **Newland Head / King Head** area).

There is a “cleaning station” at the **Rapid Bay** jetty, where cleaner fish remove ectoparasites from other fish species. Studies have shown that cleaning ectoparasites from fish is very important for reef fish health (S. Shepherd, SARDI, pers. comm., 2004).

Seagrass beds in **Antechamber Bay**, and also around **West Island**, and in the western part of **Encounter Bay** (e.g. **Rosetta Head** to **Hindmarsh River**), are reported to be used by one or more of the life stages of the following commercially and/or recreationally significant fish species: King George Whiting, West Australian Salmon, Tommy Ruff, Southern Sea Garfish, Trevally, flathead species, Leatherjacket species, Snook and Whaler Shark (Bryars, 2003). These species, as well as School Whiting, Snapper (**Southern Fleurieu** area), Red “Mullet”, Mulloway (**Southern Fleurieu** area), Yellow-tail Kingfish and flounder species, are also reported to utilise the seagrass meadows and/or unvegetated sand habitats in northern **Nepean Bay** (including **Bay of Shoals** and **Western Cove**), and along the **Southern Fleurieu Peninsula** (e.g. **Aldinga Bay**;

Yankalilla Bay; Rapid Head to King Head (Bryars, 2003). Most of the forementioned species, except Mulloway, are also reported to utilise the sand habitats around **The Pages Islands** (Bryars, 2003). Seagrass meadows and sand habitats in **Eastern Cove** and **American River** are reported to be used by one or more of the life stages of King George Whiting, School Whiting (on sand), West Australian Salmon, Tommy Ruff, Southern Sea Garfish, Red "Mullet", Trevally, flathead species, leatherjacket species (in seagrass), Snook, flounder species (on sand) and Whaler Sharks (Bryars, 2003).

Unvegetated sand habitats in the **Antechamber Bay** area are reported to be used by one or more of the life stages of King George Whiting, School Whiting, West Australian Salmon, Tommy Ruff, Yellow-eye Mullet, Trevally, flathead species, flounder species, Snook and Whaler Sharks (Bryars, 2003). Beach habitats around **Eastern Cove** (e.g. **Norma Cove** and **Newland Bay**), **American Beach**, and the **Dudley Peninsula** (e.g. **Hog Bay** and **Antechamber Bay**) are reported to be used by one or more of the life stages of most of these species, although Snook and Trevally are not reported to use the more sheltered of these beach habitats (Bryars, 2003).

Beach habitats along **Southern Fleurieu Peninsula** (e.g. **Myponga, Carrickalinga, Normanville, Lady Bay, Second Valley** and **Rapid Bay**), are reported to provide habitat for King George Whiting, School Whiting, West Australian Salmon, Tommy Ruff, Yellow-eye Mullet, Black Bream, Mulloway, flathead species, flounder species, and Whaler Sharks (Bryars, 2003). Surf beaches along the south coast of the Fleurieu, to Encounter Bay (e.g. **Blowhole Beach, Deep Creek Cove, Boat Harbour Beach, Tunkalilla, Callawonga Beach, Ballaparudda Beach, Parsons, Waitpinga, Dump, Boomer, and Knights** beaches, **Victor Harbor**, and **Horseshoe Bay**) are reported to provide habitat for one or more of the life stages of School Whiting, West Australian Salmon, Tommy Ruff, Yellow-eye Mullet, Mulloway, flathead species, and Whaler sharks (Bryars, 2003). Similar species are reported for sheltered beaches in **Encounter Bay** (Bryars, 2003).

Tidal flats around **Bay of Shoals, Kingscote Spit, Eastern Cove, American River**, and/or **Christmas Cove** are reported to provide habitat for School Whiting (**Bay of Shoals / Kingscote** area, **Eastern Cove** and **American River**), West Australian Salmon, Tommy Ruff, Southern Sea Garfish, Yellow-eye Mullet, flathead species, flounder species, Yellow-tail Kingfish (**Bay of Shoals / Kingscote** area) and Whaler Sharks (Bryars, 2003).

Middleton Beach – Goolwa Beach - Murray Mouth – Coorong Beaches: Surf beaches in the area provide habitat for one or more of the life stages of School Whiting, West Australian Salmon, East Australian Salmon, Tommy Ruff, Yellow-eye Mullet, Mulloway, flathead species, School Shark, Gummy Shark and Whaler Sharks (Bryars, 2003).

Invertebrates

North-East Kangaroo Island / Backstairs Passage: Spawning aggregations of Giant Cuttlefish (*Sepia apama*) and breeding aggregations of opisthobranch molluscs (i.e. nudibranchs) occur off **Dudley Peninsula** (KI-AMCS, 2000). Aggregations of Spider Crabs, which normally occur in deep water, are recorded at relatively shallow depths in the area, such as **Dudley Peninsula** (KI-AMCS, 2000). Abundance of uncommon Sea Hare (*Aplysia sydneyensis*) (S. Shepherd, unpublished data) in **Antechamber Bay**.

South-East Gulf St Vincent / Southern Fleurieu: High abundance of Southern Calamari (as evidenced by high yields from commercial and recreational fishing), including breeding areas (see section below).

Parts of the area between **Cape Jervis** and **Newland Head:** High abundance of attached benthic invertebrates, relative to many other shallow, wave-exposed areas sampled in S.A. as part of a government benthic survey program during the 1990s, at which macroalgae dominated the reef cover, rather than benthic invertebrates (see reference citations Edyvane and Baker - 1996b, 1996c, 1996d, 1998a, 1998b, 1999a, 1999b - throughout this report, for indications of macroalgal dominance at sampled sites). Sponge and ascidian species comprised up to 75% of the reef cover in some sampled parts of the southern Fleurieu area (e.g. **Porpoise Head**), and mixed sponges, hydroids and bryozoa formed up to 60% of the reef cover at some sampled sites at **Newland Head** (table in Baker and Edyvane, 1996, and unpublished SARDI S.A. Benthic Survey data, 1994).

Reefs around the southern **Fleurieu Peninsula** (e.g. **Aldinga, Carrickalinga, Rapid Head, Second Valley** and between **Rapid Head** and **King Head**); **Encounter Bay** and **Islands**; and **Dudley Peninsula** (e.g. between **Kangaroo Head** and **Cape St Albans**) provide habitat for Southern Rock Lobster, Greenlip and Blacklip Abalone, Scallops and various octopus species (including Pale Octopus and Southern Blue-ringed Octopus).

	<p>Offshore from Tunkalilla, there previously existed a large population of Greenlip Abalone, however the population was fished to extinction in the late 1960s (S. Shepherd, SARDI, pers. comm., 2004). Reefs around the southern Fleurieu Peninsula; Encounter Bay and Islands, as well as north-eastern Kangaroo Island (e.g. Kingscote area; Redbanks to Point Morrison area; Eastern Cove; Dudley Peninsula area) are reported to be used by one or more of the life stages of Southern Calamari, Giant Cuttlefish, and Purple Sea Urchin. Southern Rock Lobster is also reported to use habitat in the Point Morrison area and other reefs in Eastern Cove (Bryars, 2003).</p> <p>Beaches around the Dudley Peninsula (e.g. Hog Bay and Antechamber Bay) and along the south coast of the Fleurieu, to Encounter Bay (e.g. Blowhole Beach, Deep Creek Cove, Boat Harbour Beach, Tunkalilla, Callawonga Beach, Ballaparudda Beach, Parsons, Waitpinga, Dump, Boomer, and Knights beaches, Victor Harbor, and Horseshoe Bay) are reported to be used by one or more of the life stages of Sand Crabs and baitworm species. Tidal flats in the Bay of Shoals area, between Point Marsden and Beare Point, are reported to provide habitat for Western King Prawns, Sand Crabs, Mud Cockles, Razorfish and baitworm species. Tidal flats in the Christmas Cove area are also reported to be a habitat for baitworm species, and tidal flats in the Eastern Cove, American River and Pelican Lagoon areas are reported to provide habitat for one or more of the life stages of Western King Prawn, Sand Crab, Mud Cackle, Razorfish, and baitworm species (Bryars, 2003).</p> <p>On north-eastern Kangaroo Island, shallow marine habitats in Bay of Shoals, Eastern Cove, Western Cove and American River are settlement areas for juvenile Western King Prawns, although such locations are of less significance in this regard compared to those in far northern Gulf St Vincent (Kangas and Jackson, 1997).</p> <p>Seagrass beds in Antechamber Bay, and also around West Island, and in the western part of Encounter Bay (e.g. Rosetta Head to Hindmarsh River), are reported to be used by one or more of the life stages of Southern Calamari (Bryars, 2003). Sand Crabs, Razorfish, Southern Calamari and King and Queen Scallop are reported to utilise the seagrass meadows and unvegetated soft bottom (sand) habitats in northern Nepean Bay (including Bay of Shoals and Western Cove), and in Eastern Cove and American River (Bryars, 2003). Unvegetated sand habitats in the Dudley Peninsula area are reported to be used by Sand Crab and Southern Calamari (Bryars, 2003).</p> <p>Murray Mouth: The Coorong system is an importance habitat for amphipods (e.g. species of <i>Melita</i> and <i>Paracorophium</i>) (Kangas and Geddes, 1984, cited by Edyvane <i>et al.</i>, 1996). In terms of numerical abundance, "amphipods form a major part of the macrobenthic fauna of the Coorong and are probably important in food chains leading to fish and birds". The abundance of amphipods is considered to be the principal driving feature of the winter and early spring growth of juvenile estuarine fishes, particularly Flounder, Bream and Mullet. Seasonal blooms of the Cladoceran Micro-crustaceans <i>Daphnia carinata</i>, <i>Ceriodaphnia quadrangula</i> and the Copepod <i>Boeckella triarticulata</i> are also ecologically significant, being the dominant zooplankton in the now turbid Murray Mouth area of the Coorong system, which are flushed from the freshwater lakes when the barrages are open (Edyvane <i>et al.</i>, 1996).</p> <p>Middleton Beach – Goolwa Beach - Murray Mouth - Coorong: High abundance of the Goolwa Cackle (<i>Donax deltooides</i>). According to Ludbrook and Gowlett-Holmes (1989), another species of <i>Donax</i> (<i>D. electilis</i>) also occurs in the area. Goolwa Cockles are a food source for crabs, some fish species, large beach worms, and Silver Gulls, and other sea birds (Haddon, 1992; Murray-Jones and Johnson, 2003). In addition to Goolwa Cockles, Bryars (2003) reported this area to be habitat for Sand Crabs and baitworm species.</p> <p>Coastal and Marine Birds</p> <p>Bay of Shoals - Busby and Beatrice Islets: Approximately 12 species of migrant shorebirds occur including the Grey Plover, Greater Sand Plover, Whimbrel, Grey-tailed Tattler, Bar-tailed Godwit and Red Knot (Morelli and de Jong, 1995). Thousands of Red-necked Stints and Red-capped Plovers, and hundreds of Curlew Sandpipers, Sharp-tailed Sandpipers, Ruddy Turnstones, Sooty Oystercatchers and Pied Oystercatchers (the latter two are non-migratory species) have been recorded feeding on the spit (Raines, 1994, cited by Morelli and de Jong, 1995).</p> <p>American River wetland system: Seventeen waterbird species are listed under international migratory treaties; sixteen are listed on the Japan-Australia Migratory Bird Agreement (JAMBA) and seventeen are listed on the China-Australia Migratory Bird Agreement (CAMBA) (Australian Heritage Commission, undated). The area is a migration stop-over</p>
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for species such as Grey Plover *Pluvialis squatarola*, Pacific Golden Plover *P. fulva*, Lesser Sand Plover *Charadrius mongolus*, Whimbrel *Numenius phaeopus*, Bar-tailed Godwit *Limosa lapponica*, Red Knot *Calidris canutus*, and Sanderling *C. alba* (Morelli and de Jong, 1995).

North-east kangaroo Island: Breeding colonies of Little Penguins occur at **Penneshaw** and **Kingscote**, and headland areas around the **Dudley Peninsula**.

Pages Islands: Habitat for Little Penguin, Silver Gull, Short-tailed Shearwater, Fluttering Shearwater, Australasian Gannet, Black-faced Cormorant, Pied Cormorant, White-faced Heron, Ruddy Turnstone, Sooty Oystercatcher, Pacific Gull, and Crested Tern (NPWS, 1983; DEH, 2003g).

Chapman River Mouth: Seven to nine species of migrant shorebird have been recorded in the area, including Lesser Sand Plover, Common Sandpiper, Common Greenshank, Marsh Sandpiper, Sharp-tailed Sandpiper, Red-necked Stint, and Curlew Sandpiper (Raines, 1994, cited by Morelli and de Jong, 1995).

Encounter Bay: Habitat for various coastal and sea bird species. **Pullen Island** provides habitat for colonies of Silver Gulls, and other seabird species including Crested Terns, Little Pied Cormorants and Black Cormorants. Sooty Oystercatcher, Black-faced Cormorant, Short-tailed Shearwater, and the White-fronted Tern have been recorded using **West Island** (Australian Heritage Commission, undated). **Hindmarsh River (Encounter Bay)** provides an “island-refuge and corridor” for coastal birds (AHC, undated). Although **Encounter Bay** is not a major site for wading birds, numerous coastal wading birds, including migratory species, have been recorded in the area. Migratory species include Ruddy Turnstone, Double-banded Dotterel, Common Sandpiper, Godwit, and Whimbrel (Cameron, 1979). According to Hodge (1932, cited by Baker and Edyvane, 1996), birds that were previously common in the Encounter Bay area included Red-Capped Dotterels, sandpiper species (including migrants from Siberia), “kingfishers” (presumably the Sacred Kingfisher), curlews and “giant sea birds” (probably larger gull species, Giant Petrels and Albatross species). Other sea birds sighted occasionally include Prions and Shearwaters, and all five species of Cormorant are found in the **Encounter Bay** region. Pelicans are common in the shallows of Encounter Bay, as are White-faced Herons, Masked Lapwings, and Sooty Oystercatchers (Cameron, 1979, cited by Baker and Edyvane, 1996).

Murray Mouth and Hindmarsh Island: Important wetland habitats for 26 migratory bird species (see Carpenter, 1995).

The five species of cormorant that occur in South Australia are found in the **Coorong** area, and some of these breed on the islands in the Southern Lagoon (Morelli and de Jong, 1995).

Aquatic Macrophytes

Murray Mouth and Coorong: Importance of submerged macrophytes and other estuarine plants as feeding habitat for **Murray Mouth** and **Coorong** birds. The globally distributed charophyte *Lamprothamnion papulosum*, which is common in freshwater lakes, but occurs in only a few coastal regions of South Australia, is a food for waterfowl in the Coorong (Delroy, 1974, cited by Womersley, 1984). Extensive beds of aquatic plants, generally dominated by *Ruppia* (wigeon-grass), are important in the ecology of the Coorong (Geddes and Butler, 1984, cited by Edyvane *et al.*, 1996). Species of *Ruppia* are important food items for duck and other waterfowl, which congregate in summer to feed on the turions (starchy “tubers”) and seeds (Delroy *et al.*, 1965, and Delroy, 1974, cited by Womersley, 1984). The macrophytes are covered with epiphytic growth, which is probably grazed by many of the invertebrates and the small fish (unreferenced, cited by Edyvane *et al.*, 1996). In the Northern Lagoon (at salinities above 60ppt and as high as 80ppt), the perennial *Ruppia megacarpa* is the dominant macrophyte, with *Lepilaena cylindrocarpa* also common, and *Zostera muelleri* common at the northerly locations (Geddes, 1987; Geddes and Butler, 1984). The *Ruppia* and *Lepilaena* beds are particularly extensive south of Long Point. In more saline areas (e.g. Southern Lagoon), *Ruppia tuberosa* is more prevalent, and its turions and seeds are a key food source for swans, ducks and other waterfowl, and waders (Delroy *et al.*, 1965, and Paton, 1982, cited by Womersley, 1984, and Edyvane *et al.*, 1996). There are four key plant species, which provide 99% of the food sources available to Coorong waterbirds (USED SFMP, 1993, cited by Edyvane *et al.*, 1996). Other examples of the importance of macrophytes in the Murray Mouth area include the survey by Thompson (1986, cited by Edyvane *et al.*, 1996) of wetland habitats “upstream” and “downstream” of the barrages, which showed that although the aquatic fauna recorded in both areas were very similar

	<p>(including the fish fauna), all the waterfowl (about 200 individuals) were located in the 'upstream' wetland, feeding on the submerged macrophytes which were absent 'downstream'.</p> <p>Murray Mouth: Importance of emerged and semi-submerged macrophytes (e.g. <i>Typha</i>, <i>Phragmites</i>, <i>Myriophyllum</i> etc) as nesting and shelter habitat for waterfowl and other bird species (Thompson, 1986; Morelli and de Jong, 1995; Edyvane <i>et al.</i>, 1996).</p> <p>Marine Plants</p> <p>Parts of area between Cape Jervis and Newland Head: Abundance of calcareous algae in boulder reef areas, compared with most other sampled parts of the southern Fleurieu / Encounter Bay / Backstairs Passage / north-eastern Kangaroo island region, in which calcareous understorey was less prevalent (SARDI S.A. Benthic Survey program data, 1994, unpublished).</p>
<p>9. Notable Feeding, Breeding / Spawning and Nursery Areas</p>	<p>Bony and Cartilaginous Fish</p> <p>Bay of Shoals - Western Cove and American River - Eastern Cove: Important nursery and feeding areas for fish Bay of Shoals and American River are recognised nursery, feeding and refuge areas for juvenile King George Whiting, Garfish, Yellow-eye Mullet, Tommy Ruff and Australian Salmon, and other scalefish (Scott <i>et al.</i>, 1980; Morelli and de Jong, 1995). The nursery area is important for re-stocking the local ecosystem with commercially and recreationally fished species (Morelli and de Jong, 1995). The western section of Western Cove is also considered to be a significant nursery area (unreferenced, cited by Gilliland, 1996). American River may also be a nursery area for sharks and rays (such as Stingrays, Eagle Ray, and other ray species), because small specimens of various species from both groups are regularly recorded in the shallows (e.g. feeding along the edges of the channels) (Womersley and Edmonds, 1979; Ivanovici, 1984; Johnson, 1988a; M. McKelvey, KI-AMCS, pers. comm., 1999).</p> <p>Backstairs Passage: Major seasonal aggregation area for Snapper (Capel, 1994, and unpublished fishers' reports).</p> <p>Encounter Bay: Appears to be an important area for syngnathids, particularly Weedy and Leafy Seadragons, with aggregations of both species (including large aggregations, in some areas) known to occur at various locations within the bay, according to divers, diving organisations, and the Dragon Search community-based monitoring program (e.g. see Baker, 2003a and 2003b).</p> <p>Murray Mouth area (both marine and estuarine components): Important feeding, spawning, migration and/or nursery areas for marine and estuarine fish species, including Black Bream, Mulloway, Greenback Flounder, flathead species, Congolli, Western River Garfish, Western Australian Salmon (reportedly a nursery area), and Yellow-eye Mullet, amongst others (Pierce, 1995; Morelli and de Jong, 1995; McGlennon, in Edyvane <i>et al.</i>, 1996; Bryars, 2003). Mulloway are more abundant in the Coorong area than in any other part of South Australia, and the Coorong is most important nursery area in the State for this species (PIRSA, 1999b). Black Bream and Yellow-eye Mullet spawn in the Murray Mouth / Coorong estuarine area (USEDSEMSC, 1993, cited by McGlennon, 1996, Bryars, 2003).</p> <p>The estuaries of the Cygnets River and Chapman River on Kangaroo island; the Myponga River, Bungala River, Yankalilla River and Waitpinga Creek on the Southern Fleurieu; and the Inman River and Hindmarsh River in Encounter Bay, are reported to provide spawning areas, nursery areas and feeding habitat for Black Bream, and nursery areas for West Australian Salmon and Yellow-eye Mullet (Bryars, 2003). The Inman and Hindmarsh River estuaries are also reported to be nursery areas for juvenile Mulloway (Bryars, 2003).</p> <p>Reefs around the Dudley Peninsula (e.g. between Kangaroo Head and Cape St Albans) and Encounter Bay and Islands, are reported to provide habitat for the spawning adults of Sea Sweep and Western Blue Groper, and nursery areas for juvenile West Australian Salmon, Tommy Ruff, Sea Sweep, and Western Blue Groper (Bryars, 2003). Reefs at The Pages Islands are reported to provide spawning and nursery areas for both of these species (Bryars, 2003). Reefs at North-East Kangaroo Island (e.g. reefs around the Kingscote area; the Redbanks to Point Morrison area, and in Eastern Cove), and around the Southern Fleurieu Peninsula (e.g. Aldinga, Carrickalinga, Rapid Head, Second Valley, and between Rapid Head and King Head), are reported to provide habitat for spawning Sea Sweep, and nursery areas for juvenile King George Whiting,</p>

	<p>Snapper (Southern Fleurieu) West Australian Salmon, Tommy Ruff, Trevally and Sea Sweep (Bryars, 2003).</p> <p>The seagrass meadows in northern Nepean Bay, including Bay of Shoals and Western Cove, and in Eastern Cove, are reported to provide habitat for spawning adult Southern Sea Garfish and Snook, and to be a nursery area for juvenile King George Whiting, West Australian Salmon, Tommy Ruff, Southern Sea Garfish, Red "Mullet", Trevally, flathead species, and Leatherjacket species (Bryars, 2003). Seagrass meadows in Eastern Cove and American River are reported to be nursery areas for juvenile King George Whiting, West Australian Salmon, Tommy Ruff, Southern Sea Garfish, Red "Mullet", Trevally, and Leatherjacket species (Bryars, 2003). The seagrass at Morgan Beach (Southern Fleurieu) is reported to provide a spawning area for Southern Sea Garfish and Snook, and a nursery area for juvenile King George Whiting, Snapper, West Australian Salmon, Tommy Ruff, Southern Sea Garfish, Red "Mullet", flathead species, Trevally and Leatherjacket species, (Bryars, 2003). The seagrass bed at Fishery Beach is reported to provide a nursery area for juvenile West Australian Salmon and Tommy Ruff (Bryars, 2003). The seagrass beds around West Island, Fisherman Bay, and in the western part of Encounter Bay (e.g. Rosetta Head to Hindmarsh River), are reported to be used by juvenile Tommy Ruff and West Australian Salmon (Bryars, 2003).</p> <p>Beach habitats along the Southern Fleurieu (e.g Myponga, Carrickalinga, Normanville / Lady Bay, Yankalilla and Rapid Bay) are reported to provide spawning areas for Yellowfin Whiting and Yellow-eye Mullet, and nursery areas for King George Whiting, School Whiting, West Australian Salmon, Tommy Ruff, Yellow-eye Mullet, Black Bream, Mulloway, flathead species, and flounder species (Bryars, 2003). Sheltered beach habitats at Morgan Beach and Fishery Beach are reported to be spawning areas for Yellow-eye Mullet, and nursery areas for juvenile King George Whiting and/or School Whiting, West Australian Salmon, Tommy Ruff, Yellow-eye Mullet, Black Bream, Mulloway, flathead species, and flounder species (Bryars, 2003). Sheltered beach habitats in Encounter Bay are reported to be a nursery area for juvenile King George Whiting, School Whiting, West Australian Salmon, Tommy Ruff, Yellow-eye Mullet, Mulloway, flathead species, and flounder species (Bryars, 2003).</p> <p>Juvenile King George Whiting, West Australian Salmon, Tommy Ruff, Red "Mullet", flathead species, flounder species and Trevally are reported to utilise the unvegetated sand habitats in northern Nepean Bay, and in Eastern Cove and American River (Bryars, 2003).</p> <p>Surf beaches along the south coast of the Fleurieu (e.g. Blowhole Beach, Deep Creek Cove, Boat Harbour Beach, Tunkalilla, Callawonga Beach, Ballaparudda Beach, Parsons, and Waitpinga) and in Encounter Bay (Dump, Boomer, and Knights beaches and Horseshoe Bay) are reported to provide nursery areas for juvenile School Whiting, and the Encounter Bay surf beaches are also reported to be a nursery area for juvenile Mulloway (Bryars, 2003).</p> <p>Tidal flats in the Bay of Shoals / Kingscote Spit area, and in the Eastern Cove, American River and Pelican Lagoon areas, are reported to be nursery areas for King George Whiting, School Whiting, West Australian Salmon, Tommy Ruff, Southern Sea Garfish, Yellow-eye Mullet, Flathead species and flounder species (Bryars, 2003).</p> <p>Invertebrates</p> <p>Eastern Cove – American River area and Bay of Shoals - Western Cove area: Nursery area for Western King Prawn (Zacharin, 1997; Boxshall and Williams, 2000) and nursery and feeding areas for crabs and other crustacean species. The American River system is also considered important for Southern Calamari, and as a refuge, feeding and breeding area for "<i>many (other) species of invertebrates</i>" (Morelli and de Jong, 1995).</p> <p>Reefs around the Dudley Peninsula (e.g. between Kangaroo Head and Cape St Albans) are reported to provide habitat for the spawning adults of Maori Octopus, and the spawning adults, post-larvae and juveniles of Southern Rock Lobster, Southern Calamari, Greenlip and Blacklip Abalone, and Purple Sea Urchin (Bryars, 2003). Reefs around the Redbanks to Point Morrison area are reported to provide habitat for spawning adults of Southern Rock Lobster, Southern Calamari, and Purple Sea Urchin and nursery areas for juvenile Southern Rock Lobster and Purple Sea Urchin (Bryars, 2003). Reefs around the Southern Fleurieu Peninsula (e.g. Aldinga, Carrickalinga, Rapid Head, Second Valley, and between Rapid Head and King Head) are reported to be used by the spawning adults of Southern Rock Lobster, Southern Calamari, Giant Cuttlefish, Maori Octopus, Greenlip and Blacklip Abalone and Purple Sea Urchin, as well</p>
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as the larval, post-larval and juvenile Rock Lobster, Greenlip Abalone and Purple Sea Urchin (Bryars, 2003). Except for Southern Calamari and Giant Cuttlefish, the forementioned species are also reported to utilise reef habitats at **The Pages Islands** (Bryars, 2003).

South-East Gulf St Vincent / Southern Fleurieu: A major area for spawning aggregations of Southern Calamari (Triantafillos, 2000). There is evidence of breeding areas near **Myponga** and **Second Valley** (Triantafillos, pers. comm. cited by Brook, 2000), and other sites in Southern Fleurieu.

In addition to providing habitat for spawning adult Southern Calamari, seagrass meadows and unvegetated soft bottom habitats along the Southern Fleurieu (e.g. **Aldinga Bay**, **Yankalilla Bay**) also provide habitat for spawning adult Razorfish, and King and Queen Scallops, and the sand habitats are utilised by both adult and juvenile Western King Prawns, and Sand Crabs (Bryars, 2003)

Seagrass beds and sheltered beach areas at **Antechamber Bay**, and beach habitats at **Hog Bay** on the **Dudley Peninsula**, and also along the **Southern Fleurieu** and in **Encounter Bay**, are reported to be habitat for juvenile Sand Crabs (Bryars, 2003).

The seagrass meadows in northern **Nepean Bay** (including **Bay of Shoals** and **Western Cove**) and also in **Eastern Cove** and **American River**, are reported to provide habitat for spawning adult Southern Calamari (Bryars, 2003). Both the seagrass beds and sand habitats in northern **Nepean Bay**, in **Eastern Cove**, and in **American River**, are reported to be nursery areas for juvenile Razorfish and King and Queen Scallop (Bryars, 2003). The seagrass beds at **Morgan Beach** and **Fishery Beach (Southern Fleurieu)** are reported to provide spawning areas for Southern Calamari, and habitat for adult spawners and juveniles of Razorfish (Bryars, 2003). The seagrass beds around **West Island**, **Fisherman Bay** and in the western part of **Encounter Bay** (e.g. **Rosetta Head** to **Hindmarsh River**), are reported to be spawning areas for Southern Calamari (Bryars, 2003).

Tidal flats in the **Bay of Shoals / Kingscote** area, are reported to provide nursery habitat for juvenile Sand Crabs, Western King Prawns, Mud Cockles, Razorfish and baitworm species (Bryars, 2003). The tidal flats in **Eastern Cove**, **American River** and **Pelican Lagoon** areas, are also reported to provide nursery habitat for the forementioned species, other than Sand Crabs (Bryars, 2003).

Middleton Beach – Goolwa Beach - Murray Mouth - Coorong: The surf beaches in this area provide habitat for spawning adults, post-larvae and juvenile Goolwa Cockles, and also adult and juvenile Sand Crabs (Bryars, 2003). Surf beaches in **Encounter Bay** (e.g. **Dump**, **Boomer**, and **Knights** beaches, and **Horseshoe Bay**) are also reported to provide habitat for juvenile Sand Crabs (Bryars, 2003).

Mammals

Encounter Bay: Second most significant area in S.A. for migratory Southern Right Whale (see **Habitat for Endemic Taxa / Threatened Taxa / Rare or Uncommon Taxa**).

Coastal and Marine Birds

American River and Cygnet River wetland systems: The Cygnet River estuarine wetland system is considered to be an “important feeding ground and breeding area for 19 or 20 species of waterbirds, including Yellow-billed Spoonbill, Cape Barren Goose, Musk Duck, Caspian Tern and Fairy Tern, and migratory waders” (Morelli and de Jong, 1995; Australian Heritage commission, undated). Hooded Plover is listed as *vulnerable* under S.A. legislation; considered *rare* at an international scale (according to Australian Heritage Commission, undated), and considered *vulnerable* at Commonwealth level, and this species breeds in the American River system. American River is reported to be a breeding area for at least eight other waterbird and seabird species, including Chestnut Teal, Pied Oystercatcher, Sooty Oystercatcher, Caspian Tern, Fairy Tern, Red-capped Dotterel, and Silver Gull (Morelli and de Jong, 1995; Australian Heritage Commission, undated; DTUP, 2001).

Bay of Shoals - Busby and Beatrice Islet: Provide “important roosting, feeding and breeding areas for many species of seabirds and migratory and non-migratory waders” (Morelli and de Jong, 1995). The islets support 12 species of breeding water birds, including large breeding rookeries of Pied Cormorants, Little Pied Cormorants, Black-faced Cormorants, Australian Pelicans, and White Ibis.

Chapman River Mouth / Lashmar Lagoon: 15 bird species found breeding. Note that the number of these species that are restricted to the freshwater Lashmar Lagoon area (connected to the Chapman River) is not known for this report. The White-faced Heron,

Little Pied Cormorant, Little Black Cormorant, Australasian Shoveller, Musk Duck, Black Swan, Buff-banded Rail and Baillon's Crake and Spotless Crake are known to breed in the area (Morelli and de Jong, 1995). The area is connected to Lashmar Lagoon, which is an important feeding and breeding refuge for waterbirds (including rare and threatened species) and migratory wader species (Morelli and de Jong, 1995) (see above sections).

Pages Islands: There is a small breeding colony of Little Penguins on the Pages Islands, and, according to NPWS (1983), small breeding colonies of other seabirds include those of Australasian Gannet, Fluttering Shearwater, Short-tailed Shearwater, Crested Tern, and Pied Cormorant, amongst others (NPWS, 1983).

Encounter Bay and Islands: Breeding colonies of seabirds (Little Penguin, Crested Tern, Caspian Tern, Fairy Tern, Silver Gull and several other species). There are now more than 2000 pairs of Little Penguins on **West Island** (Brandle pers comm., cited by Copley, 1995 and Baker and Edyvane, 1996); 500 (Brandle, *op. cit.*) or 900 pairs (according to Victor Harbor tourism promotion materials) at **Granite Island**; and smaller groups at **Rosetta Head, Wright Island, and Pullen Island** (according to Australian Heritage Commission, undated), making Encounter Bay the most significant location in the Gulf St Vincent Bioregion for this species. Apart from a major breeding area for Little Penguins, other breeding coastal marine birds on West Island include Silver Gull, Masked Plover, Caspian Tern, Pacific Gull and Crested Tern.

Inman River: The area is considered to be "an important habitat for wading and other bird species, and an important corridor for bird movement from the coast to wooded inland areas" (Australian Heritage Commission, undated). Considered to be "an important habitat" mainly for freshwater birds that may occur near the coast, such as species of Coot, Duck, Heron and Crake (Australian Heritage commission, undated).

Lower Murray and Murray Mouth: These areas constitute major habitat for feeding (and in some cases breeding), for a large number of wading bird species, and an important drought refuge, factors which resulted in the area being listed in 1985 under the *Ramsar Convention* as a wetland of international significance (see DEHAA, 1999). The Lower Murray area also includes the Murray lakes (Alexandrina and Albert). The specific significance of the Murray Mouth estuary (excluding the lakes) in terms of bird habitat is not discussed in this report, however, the Lower Murray in general is the major non-breeding habitat in South Australia for around 35 species, especially waders of freshwater habitats; Cape Barren Goose, grebes, spoonbills, ibis and egret species, bitterns and swamp hens, and other waterbirds associated with reed beds, and terns associated with freshwater habitats (Carpenter, 1995). The Lower Murray area is considered to be the largest area in South Australia of freshwater habitat available for waterbirds over the summer and autumn months. The Murray Mouth part of the Lower Murray system (i.e. excluding the Lakes) is considered to be a major habitat for both small and large migratory wading bird species, as well as local waders and other water birds, and cormorant and tern species. Long term figures and recent discussion (see Paton, 2002) indicate that the Murray Mouth area supported well over than a quarter of a million birds in the 1960s, in one section alone, but numbers have dramatically declined in recent years. Some of the indigenous species for which the Lower Murray (including the lakes) is considered to be a major habitat in South Australia, include Black Swan, Cape Barren Goose, Pacific Black Duck, Chestnut Teal, Great Crested Grebe, Australasian Grebe, Little Black Cormorant, White-faced Heron, Rufous Night Heron, Australasian Bittern, Sacred and Straw-necked Ibises, Royal and Yellow-billed Spoonbills, Buff-banded Rail, Spotless and Baillon's Crake, Purple Swamp Hen, Whiskered Tern and Fairy Tern (Carpenter, 1995). There are at least 26 to 33 migrant bird species using the area as habitat (Carpenter 1995; Morelli and de Jong, 1995). Of these, the area supports relatively large numbers of Red-necked Stints, Curlew and Sharp-Tailed Sandpipers, Greenshanks, and Pacific Golden Plovers (see Carpenter, 1995 and Paton, 2002). Migratory species for which the Lower Murray is considered to be a major habitat in South Australia are listed in the section **National and/or International Importance**. The Murray Mouth area also supports breeding colonies of Australian Pelicans (small numbers), ibis, egrets, spoonbills, and cormorants (Carpenter, 1995). The entire Coorong, including Lower Murray / Murray Mouth, is a drought refuge when central or eastern Australian wetlands dry out (Morelli and de Jong, 1995).

Murray Mouth Islands: Mundoo Islands and surrounding area: Numbers of waterbirds in the area have been estimated to be as high as 30,000. Ten species of waterbirds have

	<p>been reported breeding, including: the Black Swan, Pacific Black Duck, Little Pied Cormorant, Little Black Cormorant, White-faced Heron, Australian White Ibis, Straw-necked Ibis and Royal Spoonbill. Eastern Hindmarsh Island: Supports 30,000 waterbirds, including large numbers of waterfowl such as the Cape Barren Goose (Carpenter 1995). Salt Lagoon Islands: Supports around 10,000 waterbirds, including nesting colonies (e.g. in the swamp paperbark stands and other habitats of the area) (Carpenter, 1995).</p> <p>Coorong (part of which includes the Murray Mouth): According to Morelli and de Jong (1995), the most important migratory species visiting the Coorong area in general, are the Red-necked Stint, Curlew Sandpiper, Sharp-tailed Sandpiper and Common Greenshank. Others include Double-banded Plover, Oriental Plover, Terek Sandpiper, Pectoral Sandpiper, Great Knot, and Red Knot. In drought years, up to several hundred thousand ducks use the Coorong. Previously, a quarter of a million migratory waders were recorded to be present during summer in one part of the estuarine area alone, however numbers have declined dramatically since the 1960s (see Paton, 2002).</p>
<p>10. Shipwrecks and Artificial Reefs</p>	<p>There are dozens of shipwreck sites known in the area included in this table (see Notes on Social and Economic Values/Implications), however most are broken up and covered with sand, or have not been found, and therefore are not known to provide significant additional habitat. Some of the ships and artificial reefs which function as additional habitat are discussed below:</p> <p>Western Cove: There is an artificial reef (450 tyre modules) off Kingscote in 11m of water (PIRSA, 2000-2001). According to Branden <i>et al.</i> (1994), tyre reefs in S.A. have been successful in attracting fish to the structures and in providing a substrate for colonisation of algae and attached fauna.</p> <p>The Rapid Bay jetty is widely recognised for its variety of fish (including high abundance of some site-aggregated species, such as large schools of Old Wife, and other common species including Tommy Rough, numerous Leatherjacket species (including less common species), Moonlighters, Western Talma, site-associated Leafy Seadragons, Weedy Seadragons, and pylon invertebrates (sponges, soft corals etc).</p> <p>Yankalilla Bay: The navy ship <i>Hobart</i> sunk off Wirrina in 2002, is a new artificial reef. The site is expected to become significant for diving (and as a reef substrate for invertebrates and site-attached fish) during the 2000s, due to its many intact structures.</p> <p>Southern Fleurieu: The motor vessel <i>Victoria</i>, wrecked in 1934, lies off Tunkalilla Beach, and has been used as a dive and snorkel site (and formerly as a fishing site, prior to removal of structures – Prescott, 1995), however conditions often make the shallow wreck inaccessible (e.g. see Philippou, 2001). An iron barge (<i>Hopper Barge No. 3</i>), used as a dive site, is located in 6 m of water, approximately 800 m south of the Cape Jervis jetty, 100 m from shore (Christopher, 1988). These and other found wreck sites provide additional hard substrate for attached biota, and presumably attract reef fish to the structures.</p> <p>Encounter Bay: According to reports by divers from MLSSA and recreational diving groups, the jetty and breakwater at Granite Island are recognised for a number of features, such as a mixed fish fauna (including a variety of reef fish, such as Long-snouted Boarfish, Magpie Perch, Old Wife (usually in schools), Moonlighters, sweep, Zebra Fish, Globe Fish, Toothbrush Leatherjacket and other Leatherjacket species, Western Blue Groper and other Wrasse species); benthic sharks, and attached invertebrates (e.g. sponges, ascidians, bryozoa) and mobile invertebrates (e.g. echinoderms).</p> <p>North-east kangaroo Island: Penneshaw Jetty: A survey by S.A. Museum personnel, recorded 20 ascidian species, 10 mollusc species, and several species of crustacean, echinoderm, cnidarian (including soft coral and gorgonian coral), and bryozoan, amongst other recorded invertebrate groups (South Australian Museum survey data, cited by KI-AMCS 2000).</p>
<p>11. Popular Dive Sites</p>	<p>Aldinga Reef: The shallow reef pools are recognised by snorkellers for the presence of shallow reef fish, molluscs, hydroids, anemones, ascidians and macroalgae. Deeper parts of the reef recognised for reef fish (e.g. Western Blue Groper, Wrasse species, Magpie Perch, Western Talma, Leatherjackets, Herring Cale, Hulafish, amongst others)</p>

	<p>and mixed invertebrates (sponges, gastropods, anemones, ascidians, bryozoa), and the “drop-off” area is recognised for the abundance of sessile invertebrates (such as sponges and locally abundant gorgonian corals), large schools of various reef fish, and sharks (Ivanovici 1984; Johnson, 1988a; Christopher, 1988; DIASA, undated; Dive Oz, 2002; Aquanaut, 2002, and various unpublished records from divers).</p> <p>North-east kangaroo Island: Diving sites in the area include reefs below the cliffs all along the north east coast (including reefs in the Kangaroo Head area, Penneshaw, Hog Bay, Ironstone Hill, Cuttlefish Bay, Snapper Point, Cape Coutts etc); and deeper reefs of the north-east coast. Shallow near-shore dive spots (less than 10 m) are recognised for their diversity of reef fish, mixed macroalgal and invertebrate assemblages, reef molluscs and presence of seadragons, dolphins, and irregular presence of Sea Lions, amongst other features. Near-shore reefs in waters deeper than 10 m are recognised for their abundance of large species from several sessile benthic vertebrates (soft corals and gorgonian corals, sponges, erect bryozoa, sea pens), and diversity of echinoderms (e.g. crinoids, basket stars, brittle stars), and aggregations of reef fish (Edyvane, 1999b; KI-AMCS, 2000 and various regional dive tourism promotion materials and unpublished records from divers). Kangaroo Island (including the north-east coast) is promoted as supporting “<i>some of the most spectacular areas of soft coral, sponges and gorgonians in the world</i>” (Dive South Australia, web site and brochure, 2004).</p> <p>Southern Fleurieu (e.g. Carrickalinga - Lady Bay - Yankalilla Bay - Second Valley - Rapid Bay - Rapid Head: Patch reefs and boulder (“bommie”) reefs recognised for abundance and high diversity of reef fish and both mobile and sessile invertebrates (described in other sections of this table), presence of many common reef fish species, as well as some less easily observed species such as Harlequin Fish, Western Blue Devil, several Wrasse species, Western Blue Groper, Tasselled Anglerfish, Pipefish species, Cat Sharks, and presence of Seadragons in some areas (e.g. Rapid Bay, Second Valley). Headland reefs are recognised for abundant sessile invertebrates (see section on Taxonomic Diversity) (Christopher, 1988; DIASA, undated; Merrett, 2000; Hutchison, 2001; Dive Oz, 2002, Dive South Australia, 2004, and various unpublished records from divers).</p> <p>Cape Jervis to Newland Head (including Deep Creek): Near-shore reef patches in the area are recognised by divers for the abundance of sessile invertebrates (e.g. sponges, ascidians), reef fish and Rock Lobster, macroalgae, presence of pinnipeds, and Seadragons. DIASA (undated) has stated that the area is “teeming with life”.</p> <p>Encounter Bay: Sites in Encounter Bay and surrounds (which includes popular dive spots such as the jetty and breakwater at Granite Island; the Bluff - Rosetta Head; reefs in both Encounter Bay and at Port Elliot; Wright Island and West Island, and Port Elliot) are recognised dive sites. Features in the area include the diversity of habitats (variety of reefs types, seagrass beds) and micro-habitats (caves, overhangs, crevices with abundant and diverse attached invertebrates), abundance and diversity of fish species; aggregations of Leafy and Weedy Seadragons; presence of Rock Lobster and Abalone; Fur Seals, diverse macroalgal assemblages, and abundance and diversity of reef invertebrates (sponges, bryozoa, ascidians, echinoderms, gorgonian corals in cave areas, and many other groups (Christopher, 1988; DIASA, undated; Merrett, 2000; Aquanaut, 2002; Dive South Australia, 2004, regional tourism promotion materials, and diving records from MLSSA and individuals). Johnson (1988a) described the eastern and southern parts of West Island that are accessible to recreational SCUBA divers as “the most spectacular and biologically diverse areas of the Aquatic Reserve”. See Habitat Diversity and section on Taxonomic Diversity for more detail about the biotic features of Encounter Bay, many of which are important to divers and snorkellers.</p>
<p>12. National and/or International Importance</p>	<p><i>Wetlands of National Importance</i> in the region include Bay of Shoals - Western Cove; American River and Pelican Lagoon, Busby and Beatrice Islets, Cygnets River estuary; Chapman River estuary, Murray Mouth and Coorong.</p> <p>Cygnets River, American River and Busby and Beatrice Islets (Bay of Shoals area): listed by Morelli and de Jong (1995) and Australian Heritage Commission as habitat for around 17 bird species listed under international treaties, 13 of which are migratory. Migrant</p>

shorebird species in the area include Grey Plover, Grey-tailed Tattler, Greater Sand Plover, Pacific Golden Plover, Lesser Sand Plover, Whimbrel, Bar-tailed Godwit, Red Knot, and Sanderling. Within the area, sixteen species are listed on the Japan-Australia Migratory Bird Agreement (JAMBA) and seventeen are listed on the China-Australia Migratory Bird Agreement (CAMBA) (Australian Heritage Commission, undated). Up to nine international migratory species are recorded in the area of the **Chapman River Mouth** (Raines, 1994, cited by Morelli and de Jong, 1995).

Encounter Bay: Twenty bird species recorded from the region are listed in the CAMBA and JAMBA international treaties, including the Great Egret, Common Sandpiper and Caspian Tern (Australian Heritage Commission, 2000).

Murray Mouth / Goolwa / Sir Richard Peninsula: The Murray Mouth estuary is recognised as an area of outstanding national and international conservation value (Edyvane *et al.*, 1996), because the estuary is connected to the largest river in Australia; contains extensive areas of both temporarily and permanently inundated wetlands (consisting of a large variety of freshwater, estuarine and saltwater habitat types); and provides habitat for a large number and diversity of wading birds, ducks, other waterbirds and coastal birds, including nationally and internationally significant populations.

Backstairs Passage: The diversity of species in the ancient brachiopod group (“living fossils”) are adding new evolutionary insights and information about the biology and environments of their ancestors (Shepherd, pers. comm., cited by Baker and Edyvane, 1996). The area is considered to be of national importance regarding brachiopod diversity (Shepherd, pers. comm., cited by Edyvane, 1999b). The region may also be internationally important for stalked crinoids (J. Mitchell, unreferenced, cited by Edyvane, 1999b).

The **Murray Mouth** area is at the northern end of the Coorong system, which includes Wetlands of International and National Importance.

The **Lower Murray** area (including the Coorong lagoons, and the two major lakes) is of major conservation significance for wading birds and other coastal birds, and has therefore been included (in 1985) in the *Ramsar Convention on Wetlands of International Significance*, and also the JAMBA and CAMBA international agreements for protection and management of migratory birds. Watkins (1993) also identified the Coorong area as being of international significance to shorebirds. Carpenter (1995) reported 26 migratory species under JAMBA and/or CAMBA agreement. Morelli and de Jong (1995), reported 33 migratory species, numbering more than 100, 000 individuals in some years, for the listing of the area as a *Wetland of National Importance*. Irrespective of exact numbers, the area is known to be one of the most significant in southern Australia, in terms of numbers and species diversity of migratory and indigenous wading birds, and one of the top 10 areas for migratory wader numbers in Australia (Morelli and de Jong, 1995; Australian Heritage Commission, undated), and one of the few south of the Tropic of Capricorn. The Lower Murray, including the lakes, is considered to be a major South Australian site for Lesser Golden Plover, Black-winged Stilt, Red-necked Avocet, Wood Sandpiper, Latham’s Snipe, Black-tailed Godwit, Pectoral Sandpiper, Long-toed Stint, Sanderling, Cattle Egret and Great Egret, Glossy Ibis, White-winged Tern, Common Tern and Little Tern (Carpenter, 1995). According to Morelli and de Jong (1995), the most important migratory species visiting the **Coorong** area in general, are the Red-necked Stint, Curlew Sandpiper, Sharp-tailed Sandpiper and Common Greenshank. Paton (2002) provided recent numbers for these species, from February 2001: Red-Necked Stint: 5455; Curlew Sandpiper: 2020; Sharp-Tailed Sandpiper: 1486; Greenshank: 249; Pacific Golden Plover: 106. However, during the past two decades there has been a dramatic decline in the number of Red-Necked Stints (and, to a lesser extent, the number of other waders such as Curlew and Sharp-tailed Sandpiper) appearing annually at the Coorong and Murray Mouth area, which is of great concern in terms of South Australia’s obligation under the Ramsar convention, and the JAMBA and CAMBA agreements (see **Issues for Risk and Impact Assessment** section).

Locations within the region described that are listed on the *Register of the National Estate* include the following (information from Australian Heritage Commission, undated):

	<p><i>Maslin Bay - Aldinga Bay Geological Site, Port Willunga:</i> Features in the Statement of Significance include the “excellent and rare exposures of the older Cainozoic sediments of the Adelaide region”, which include the designated type section for Tertiary Rocks in the St Vincent basin, having scientific and teaching value.</p> <p><i>Carrickalinga Head:</i> Coastal features include the aesthetic value, and geological significance of the cliff line (which contains the type section of the early Cambrian Carrickalinga Head formation, and a contact with the underlying Heatherdale shale).</p> <p><i>Normanville Dunes:</i> Coastal features of the declared area include:</p> <ul style="list-style-type: none"> ◆ the shore platform and cliff line of Yankalilla Hill in Lady Bay, which reportedly represents evidence of previous sea levels 3 to 10 m higher than the present; ◆ the dunes, which demonstrate the interaction between erosion, transportation and deposition of materials, and are one of the only two naturally vegetated coastal dune systems on the coast between Sellicks Beach and Port Elliot; ◆ the report that the Normanville dunes are the last major relics of similar dunes that once existed along the southern Fleurieu and metropolitan coasts; and ◆ the dunes are the type area used by Wood (1937) (who documented S.A.’s coastal vegetation during the 1930s) to define a gulf sand dune. <p><i>Tunkalilla Creek – Tunkalilla Beach area:</i> Coastal features contributing to the declaration include the cliffs adjacent to the creek; part of the type section of the Kanmantoo group; and evidence of previous shorelines in the cliff sequences.</p> <p><i>Cape Jervis North:</i> Cliff face area considered to be an important geological site, comprising the type area for the Cape Jervis beds, a rock sequence used in recognition of Permian glacial beds in the southern part of S.A.</p> <p><i>Lands End to Fishery Beach Area, Cape Jervis:</i> Coastal features included in the Statement of Significance are the geological significance of the area, due to its “relic coastal features, i.e. calcrete-topped aeolianite deposits and stranded shore platform, which are thought to reflect past sea levels at 3 m and 10 m higher than the present sea level”.</p> <p><i>Deep Creek:</i> Coastal features include the steep coastal topography, cliff habitat for rare and threatened coastal bird species, and the aesthetic value of the area.</p> <p><i>Newland Head area:</i> Included in the Register mainly due to terrestrial values such as the biogeographic significance of the coastal vegetation, however other coastal features such as the geologically-significant coastal cliffs of the Waitpinga – Parsons area, and the coastal habitats (e.g. coastal dune and beach, lagoon, creek) are included in the Statement of Significance.</p> <p><i>Hindmarsh and Inman Rivers:</i> Features of significance include the estuarine environments, the naturalness and remnant qualities of the estuarine vegetation, compared with that in the surrounding built up areas, and the use of the areas by coastal birds as a corridor to areas further inland. Swamp Paperbark <i>Melaleuca halmaturum</i>, is now depleted in other parts of the Fleurieu Peninsula, but found along the Inman River.</p> <p><i>Pullen Island Conservation Park:</i> Ecological features considered in the designation include habitat for colonies of Silver Gulls and Little Penguins, and other seabird species including Crested Terns, Little Pied Cormorants and Black Cormorants.</p> <p><i>West Island Conservation Park:</i> Ecological and related features included in the Statement of Significance include</p> <ul style="list-style-type: none"> ◆ the fact that, since the 1960s, West Island has been used for research in the fields of marine ecology, ornithology and fish biology, particularly abalone; ◆ habitat, including breeding areas, for coastal bird species, including Fairy Penguins and the vulnerable Fairy Tern; ◆ the geological significance of West Island, which is a Geological Monument, being an outcrop of the Encounter Bay granite, and is considered to display the best regional
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	<p>examples of massive sheeting (parallel jointing) in granite.</p> <p><i>Granite, Wright and Seal Islands:</i> Features listed in the Statement of Significance include the scenic nature of the islands their role as “sanctuaries for wildlife”, and the protective barrier they form against Southern Ocean swell. Addition listed features include the existence of hemi-chordates (a primitive and rare marine invertebrate group); the “rich birdlife” of Granite Island, including its role as breeding area for Little Penguins; the Geological Monument status of Granite and Seal Islands; the geological contact zone at Wright Island; and the geological significance of all three islands.</p> <p><i>Rosetta Head, Encounter Bay:</i> Recognised as a significant geological site, containing an exposure of the contact between the intrusive granite and Kanmantoo group meta-sedimentary rocks. Two amphibolite dykes intrude into the porphyritic granite on the seaward side of Rosetta Head. Important geological features including occurrences of metamorphic minerals, preserved sedimentary structures, Permian glacial sediments and ice-erosion evidence, contact metamorphic aureole, jointing, and deformation evidence. The coastal aesthetic value also contributed to the declaration on the Register.</p> <p><i>Pelican Lagoon Conservation Park, Kangaroo Island:</i> Included due to its significance as a coastal lagoon with islands and samphire mudflats, that collectively forms an “important waterbird habitat and refuge”.</p> <p><i>Beatrice Islet Conservation Park, Kangaroo Island:</i> A sand islet on a tidal sand spit, declared due to its significance as “feeding and roosting habitat for seabirds”.</p> <p><i>Busby Islet Conservation Park, Kangaroo Island:</i> A sand spit, declared due to its significance as “feeding and roosting habitat for seabirds, including a breeding colony of Australian pelicans”.</p> <p><i>Nepean Bay Conservation Park:</i> The coastal area is recognised by the AHC for its dense vegetation, representative of the original vegetation of the region, and its role in protecting a coastal dune from erosion.</p> <p><i>The Encounter Bay Region,</i> listed on the <i>Register of the National Estate</i> in 2000. Registered area comprises the islands and marine environment of Encounter Bay, approximately 100km of coastline and 17,500 ha of area, extending from Newland Head in the west to the east bank of the River Murray Mouth in the east, and including several public reserves (e.g. at the Bluff). The nominated area includes Seal, Granite, Pullen, Wright, and West Islands. Public reserves at Policeman's Point, and Freeman Knob which are also listed on <i>the Register of the National Estate</i> have national estate values associated with the Encounter Bay listing (Australian Heritage Commission, 2000). The landward extent of the nominated area is to the high water mark, and the seaward boundary is a straight line drawn from Newland Head to the Murray Mouth. In terms of ecological values, the region is recognised by the AHC as significant due to:</p> <ul style="list-style-type: none"> ♦ the high levels of biodiversity and geo-diversity, the latter considered to be due to the Encounter Bay Granite province, the variation and inclusions within the granite itself, as well as the metamorphic aureole surrounding the batholith. Many features are best exposed in the intertidal and supratidal zone (e.g. Rosetta Head). The granite reef, situated between Rosetta Head and the mouth of the Inman River, is considered by the Australian Heritage Commission (2000) to be the only significant reef system of its type on the southern Fleurieu Peninsula. Biodiversity, threatened species, and other features of significance are discussed in other sections of these tables; ♦ the aesthetic landscape/seascape; and ♦ as seasonal habitat for the threatened Southern Right Whale. <p><i>Mud Islands Game Reserve, Goolwa:</i> Recognised by the AHC as important habitat for wading birds, particularly ducks.</p> <p><i>Mundoo Island and Surrounding Area, Goolwa:</i> Features listed in the Statement of Significance include the (undisturbed) wilderness value of the area; use of the habitat by “most of the waterfowl and waders common to the state”; the diversity of “birds and</p>
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	<p>aquatic fauna”; breeding area for cormorants; the historic interest of the area, and its value for recreation and wilderness appreciation.</p> <p><i>Yalkuri Area, Narrung:</i> The area is recognised as “an important refuge for duck and other waterfowl”, and the islands of Salt Lagoon are “important breeding areas for birds”. The “abundant” summer population of the Cape Barren Goose, various Waders, Egrets and Terns, have also been included in the Statement of Significance.</p> <p>Indicative Areas, nominated during the 1990s, and still being considered for the <i>Register of the National Estate</i> (i.e. currently still listed as <i>Indicative</i>, prior to assessment), include:</p> <p><i>American River Marine and Coastal Area:</i> Recognised by the AHC for Indicative status, for its ecological significance in providing breeding and refuge habitats for “many species of invertebrates and fish, which in turn provide an important food source for many species of fish, birds and mammals”, including refuge and/or breeding areas for commercially significant fish species, invertebrates, migratory bird species, and a variety of waterbird species, including rare and threatened species. The area being considered by the Australian Heritage Commission includes “around 2000h, comprising the American River channel, the lagoons at the end of the channel and some of the eastern mainland, incorporating Pelican Lagoon Conservation Park, coastal reserve sections 454, 455 and 458 and the American River Aquatic Reserve”. The perimeter of the lagoons is defined by their high water mark and in the north-west by the entrance to the American River channel, boundary formed by a line from Strawbridge to Buicks Point.</p> <p><i>Busby and Beatrice Islets:</i> Recognised by the AHC for Indicative status because the wetland system provides:</p> <ul style="list-style-type: none"> ◆ important roosting, feeding and/or breeding habitat for “many species of seabird and migratory and non-migratory waders”; ◆ refuge from which birds disperse on to the spit for feeding at low tide; ◆ feeding area for a large number of waterbirds, including thousands of Red-necked Stint and Red-capped Plover, hundreds of Sooty Oystercatchers and Pied Oystercatchers, Curlew Sandpipers, Sharp-tailed Sandpipers and Ruddy Turnstones, and smaller numbers of birds such as Eastern Curlew, Grey-tailed Tattler and Whimbrels; and habitat; and ◆ habitat for four species of vulnerable waterbird. <p><i>Cygnets River Estuary and Marshes:</i> Coastal features recognised by the AHC’s Indicative listing include the importance of the area as a feeding ground and breeding area for 19 species of waterbirds, most of which are migratory waders listed on international treaties (JAMBA and CAMBA). Other features include the coastal bird species diversity (reported to be 53 species), and the use of the habitat by bird species that area considered rare and/or threatened either nationally or at State level, and the presence of the Hooded Plover (of conservation significance also at International level).</p> <p>The <i>Kangaroo Island Coastline</i>, and Encounter and Lacepede Bays (the latter in the upper South-East), were nominated in 1992 for the <i>Register of the National Estate</i>, due to their significance as part of the migration path of Southern Right Whales. Encounter Bay has now been listed (see above), but the other two areas are still classified as <i>Indicative</i> (i.e. not yet assessed by AHC).</p>
<p>13. Major Commercial and Recreational Fish, Sharks, Molluscs and Crustaceans</p>	<p>Some of the commercially and/or recreationally fished species that occur in parts of the area that collectively encompass south-eastern Gulf St Vincent, North-Eastern Kangaroo Island and Backstairs Passage include:</p> <p><i>Fish:</i> Garfish, Australian Salmon, Yellow-eye Mullet, Snapper, King George Whiting, School Whiting, Snook, Tommy Ruff, Trevally, Sweep, Sand Flathead, Silver Drummer, Mulloway, Bream, Leatherjacket species, Red “Mullet”, Blue-throated wrasse and other Wrasse species, Yellow-tail Kingfish, Long-finned Pike and Yellow-fin Whiting (the latter in shallow waters, in the northern part of the area), Southern Bluefin Tuna, Gurnard Perch species and Southern Red Scorpion-cod.</p> <p><i>Sharks and Rays:</i> School and Gummy Shark, Bronze Whaler and/or Black Whaler, other</p>

<p>shark species, Shovelnose Ray, Smooth Stingray and other ray species.</p> <p><u>Invertebrates</u>: Southern Calamari (particularly south-eastern Gulf St Vincent), Giant Cuttlefish, Greenlip and Blacklip Abalone, Purple Sea Urchin, Western King Prawns (e.g. in part of the southern Gulf St Vincent area) and Southern Rock Lobster.</p> <p>Some of the commercially and/or recreationally fished species that occur in the Encounter Bay coast to Murray Mouth area include:</p> <p><u>Fish</u>: Mulloway, Australian Salmon, Snapper, Mullet species (e.g. Yellow-eye), Snook, Tommy Ruff, Trevally, Sand Flathead, Sweep, Callop (Murray Mouth area), exotics (Carp and Redfin Perch - Murray Mouth area), Greenback Flounder, Tailor, Leatherjacket species, Black Bream, King George Whiting, Garfish, Sand Whiting, Murray Cod (Murray Mouth area), Gurnard species and Scorpion-cod, Mackerel, Southern Blue Morwong, Blue Groper,</p> <p><u>Sharks and Rays</u>: School and Gummy Shark, Bronze Whaler and/or Black Whaler, Wobbegong species, Port Jackson Shark, Fiddler ray and other ray species</p> <p><u>Invertebrates</u>: Goolwa Cockle, Southern Calamari, Cuttlefish, Greenlip and Blacklip Abalone, and Rock Lobster.</p> <p>Some of the commercially and/or recreationally fished species that occur in parts of the area that collectively encompass Bay of Shoals, Western Cove, American River, Eastern Cove and South-Eastern Investigator Strait include:</p> <p><u>Fish</u>: Australian Salmon, King George Whiting, Garfish, Southern Calamari, Tommy Ruff, Yellow-eye Mullet, Sand Crab, Snook, Sweep, Trevally, Black Bream, Sand Flathead, Snapper, Leatherjacket species, Flounder, Scorpion-cod and Gurnard species, Red "Mullet", Wrasse species, Dusky Morwong, Weedy Whiting species.</p> <p><u>Sharks and Rays</u>: Gummy Shark, Bronze Whaler and/or Black Whaler, and various ray species.</p> <p><u>Invertebrates</u>: Razorfish, Cuttlefish, Rock Lobster (mainly from deeper reef areas out of the bays), Western King Prawns (occur in part of the area but are not fished in the shallow waters of the bays).</p>
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8.18 Upper South-East (Coorong / Otway Bioregions Boundary)

Figure 20 depicts the location of this area.



Figure 20: Upper South East

<p>1. Biogeographic Significance</p>	<ul style="list-style-type: none"> ♦ Lacepede Bay - Cape Jaffa - Margaret Brock Reef: Transition zone between the Maugean Sub-Province and Flindersian Province biogeographic regions (Womersley, 1984 and 1990). The area contains marine ecosystem components from both biogeographical regions. Ivanovici (1984) listed the area as the most north-westerly extent in Australia of the cool temperate macroalgal reef dominants <i>Durvillaea potatorum</i> and <i>Macrocystis angustifolia</i>. The area which includes Margaret Brock Reef is considered to contain unique assemblages of biota (Edyvane <i>et al.</i>, 1996) due to its position between two biogeographic regions (Ivanovici, 1984). ♦ Upper South-East (e.g. lower Lacepede Bay – Cape Jaffa - Guichen Bay - Baudin Rocks - Cape Dombey - Little Dip): Cool temperate waters that are characterised by seasonal nutrient-rich cold water upwelling (see below, on Major Physical Influences). The cold water upwelling provides conditions for many species of flora and fauna that have adapted to the cool temperate conditions of the South East, and thus do not occur in other parts of South Australia. The upwelling also promotes high productivity of krill, which supports feeding aggregations of Pygmy Blue Whales, which have been observed as far up the Bonney coast as deeper waters offshore from Robe (Gill, 2002, cited by Butler <i>et al.</i>, 2002) (see Area 17 – Lower South East). ♦ The zone of nutrient-rich upwelling, contributes to regionally high biodiversity, particularly amongst the macroalgae, which display exceptionally high species richness. Macroalgal diversity in the South East, particularly within the phyla Rhodophyta and Chlorophyta, is of State and national significance. Colder water upwellings in the upper South-East are considered to be of national significance in their contribution to the productivity of the region (Edyvane <i>et al.</i>, 1996; Edyvane and Baker, 1999a; Butler <i>et al.</i>, 2002).
<p>2. Major Physical Influences, and Relative Productivity Level</p>	<p>Physical Influences</p> <ul style="list-style-type: none"> ♦ Upper South-East (e.g. lower Lacepede Bay – Cape Jaffa – Guichen Bay - Baudin Rocks – Cape Dombey – Little Dip Coast): Nutrient-rich deeper water upwelling is a significant oceanographic feature in the region, and is one of the major physical influences. Upwelling extends, according to strength and duration of south-easterly winds, to several kilometres offshore, and reduces summer and autumn temperatures of bottom water during upwelling periods to around 11-12^oC (Rochford, 1977; Schahinger, 1987; Petrusevics <i>et al.</i>, 1998; IMCRA Technical Group, 1998; Butler <i>et al.</i>, 2002, Figure 6). During summer, the bottom water is characterised by lower temperature, lower oxygen content, higher nitrate concentrations, as well as lower salinity than the overlying surface water (Lewis, 1981). The south-easterly upwelling of cool, nutrient-rich waters is driven by the prevailing south-easterly winds (Butler <i>et al.</i>, 2002), and is responsible for the high productivity of the “Bonney coast”, a region extending from Portland Victoria to the south-east of S.A., and for which the Cape Jaffa - Robe area is the northern boundary. ♦ Upper South-East South Australia: According to current speed maps in the South Australian Coast and Marine Atlas (DTUP, 2001, data by P. Petrusevics), the upper South-East is one of 7 areas in South Australia where summer current speeds are strongest. The Flinders Current, from eastern Tasmania, is one of the dominant influences in South-Eastern S.A., particularly deeper offshore waters (see map in Jeffrey <i>et al.</i>, 1990). ♦ Upper South-East: Influenced by freshwater inputs through drainage channels (e.g. Kingston Main Drain, Drain L, and others) (UEPG, 1982; Hammer, 2002). ♦ Upper South-East: Hyper-saline conditions in some coastal water bodies (e.g. Robe Lakes) (UEPG, 1982; Hammer, 2002). <p>Relative Productivity</p> <ul style="list-style-type: none"> ♦ Upper South-East: Nutrient-rich upwelling in the upper south-east region results in increased phytoplankton biomass and subsequent swarms of krill (Butler <i>et al.</i>, 2002) and also contributes to the high benthic biodiversity in the region, particularly evident amongst the macroalgae (see below), and high biomass of some invertebrate species. ♦ Kingston - Cape Jaffa - Margaret Brock Reef - Kings Camp - Guichen Bay: Large

	<p>stands of Bull Kelp (<i>Durvillaea potatorum</i>) and/or Giant Kelp (<i>Macrocystis angustifolia</i>) and its associated communities occur in the region. Beds of large kelp are a significant contributor to marine productivity, habitat structure, nutrient recycling (with detritus following decay becoming incorporated into the marine food web of the South East), and the ecological functioning of the areas in which they occur (e.g. see PIRSA, 1998; Baker, 2000, Appendix 2, on ecological significance of canopy macroalgae; DPIWE Kelp Watch web site, 2001, and references on kelp ecology therein, compiled by K. Edyvane).</p> <ul style="list-style-type: none"> ♦ There are large amounts of beach wrack deposits in some areas e.g. Kingston and Stinky Bay. Beach wrack deposits have significant ecological values in terms of nutrient recycling and their contribution to near-shore foodwebs (see Kinloch 1998; Master Plan <i>et al.</i>, 2000; Baker 2000, Appendix 2 for summaries).
<p>3. Bioregional Representativeness of Habitat</p>	<p>The area discussed in this table is a transitional zone between the Coorong and Otway Bioregions, and contains features that are characteristic of both bioregions, according to descriptions by IMCRA Technical Group (1998). These include:</p> <p>Coorong Bioregion</p> <ul style="list-style-type: none"> ♦ Pleistocene dune rock cliffs, headlands, shore platforms and reefs; ♦ Holocene pocket beaches; ♦ Holocene beach ridge plains of Lacedepe Bay; ♦ Some nearshore subtidal limestone reefs dominated by red macroalgae; species of the green <i>Caulerpa</i>, species of the large brown macroalgae <i>Cystophora</i>, and <i>Ecklonia radiata</i>; ♦ Extensive seagrass meadows (Lacedepe Bay), dominated by <i>Posidonia</i> species; <p>Otway Bioregion</p> <ul style="list-style-type: none"> ♦ Coastal Wetlands of National Importance (Lakes Robe, Eliza and St Clair); ♦ Generally high wave energy conditions, but attenuated by reef systems which reduce wave energy to moderate level; ♦ Cold temperate waters, with localised, seasonal, nutrient rich upwelling; ♦ Pleistocene dune rock cliffs, shore platforms and offshore reefs; ♦ Sandy beaches within coastal embayments (Guichen Bay); ♦ Flora characterised by Maugean element of the Flindersian Province; ♦ Bull Kelp (<i>Durvillaea potatorum</i>) in the intertidal and sublittoral fringe; ♦ Nearshore subtidal macroalgal communities in some areas dominated by <i>Macrocystis angustifolia</i>; ♦ Extensive seagrass in bays, and in the lee of some reefs ♦ Seagrass beds dominated by <i>Posidonia</i> species and <i>Amphibolis antarctica</i>.
<p>4. Habitat Rarity</p>	<p>Lacedepe Bay – Cape Jaffa – Margaret Brock Reef area</p> <p>The area is considered to be a transitional zone between two major biogeographical provinces (Ivanovici, 1984), resulting in “unique” assemblages of marine biota (Edyvane <i>et al.</i>, 1996; Edyvane, 1999b).</p>
<p>5. Habitat Diversity</p>	<p>Habitats and features represented in the area include:</p> <ul style="list-style-type: none"> ♦ freshwater discharge points via aquifers, drains and coastal lakes; ♦ moderate wave energy beaches (note that the high wave energy beaches that also characterise the Otway Bioregion are located further south); ♦ seagrass-lined bays (including extensive seagrass beds in parts of Lacedepe Bay), and seagrass stands in the lee of reefs; ♦ intertidal calcareous reef, including extensive platforms; ♦ offshore calcareous reefs of various depths, covers and forms (including islands), dominated by a variety of mixed macroalgae and invertebrates, many characteristic of Maugean Sub-Province and assemblages that are indicative of the oceanographic

transition zone;

- ♦ characteristic cool to cold temperate biota (Maugean element of the Flindersian Province), including kelp stands;
- ♦ benthic sand;
- ♦ mixed habitats (e.g. seagrass and calcareous patch reef habitat; dissected calcareous reef and sand habitat etc).

Selected Habitat Notes

(sources: UEPG, 1982; Boreen *et al.*, 1993; SARDI S.A. Benthic Survey data, 1996, unpublished; Edyvane *et al.* 1996; Petrusevics *et al.*, 1998; Edyvane and Baker, 1999a; DEH 1:10 000 aerial photographs; Hammer, 2002; Butler *et al.*, 2002).

Short and Hesp (1980, cited by Master Plan *et al.*, 2000) and the South East Coast Protection District Study Report (UEPG, 1982, cited by Edyvane *et al.*, 1996) outlined the coastal geology and geomorphology of the South-East, which includes the following, in the area described in this table:

Holocene non-cemented dunes occur throughout the Coorong and **upper South-East** area, and these overlie outcrops of a Pleistocene calcreted base unit, which can be seen in part of the **Robe Range** (von der Borch, 1976). The Robe Range is a dune barrier complex formed during low sea level periods between 220,000 and 180,000 years BP, and has been subsequently uplifted and surrounded by high sea levels (Sprigg, 1979). The area is subject to hind-dune instability due to spatial variations in breaker wave energy, nearshore gradients, and beach and fore-dune instability. Highest breaker wave energy areas occur north and south of the area described in this table. Moderate breaker wave energy and rip circulation have caused fore-dune erosion and hind-dune instability between **Nora Creina** and Beachport. The **Nora Creina** area has marked fore-dune erosion, cliff erosion, and localised transgressive dune sheets (Short and Hesp, 1980, cited by MasterPlan *et al.*, 2000). **Wright Bay** comprises small transgressive dune sheets. Generally the fore-dune complexes and the backing beach ridge systems of the upper South-East are relatively stable, however higher breaker wave energies may contribute to some instability in **Guichen Bay** (Short and Hesp 1980 and UEPG, 1982, cited by Edyvane *et al.*, 1996). At the southern end of Guichen Bay, is a series of inter-connecting lagoons (the **Robe Lakes**: Lakes Battye, Nunan, Pub and Fox), and these are artificially connected to the sea via Drain L (Bryars, 2003).

The Beach Ridge Plains that occur in **Lacepede Bay** and **Guichen Bay** may be an expression of sea level changes during the Holocene. More than 7000 years ago, the inter-barrier depression between the Robe and Woakwine Ranges was breached by the sea, causing the lower Murray Valley to flood, and the Younghusband Peninsula and the Robe Range to become nearshore islands. Deposition of Holocene sediments caused the inter-barrier depression to become a tidal estuary, which opens in the outer barrier. A subsequent high rate of sediment supply in the Lacepede, Guichen and Rivoli embayment, combined with low to moderate breaker energy, resulted in the closure of the estuaries and a pro-graded coastline backed by plains of low stranded dunes extending from Woakwine Range to the present shoreline (Short and Hesp, 1980, cited by Edyvane *et al.*, 1996). The Lacepede Bay area comprises mainly stable shoreline and fore-dune ridges, and the **Guichen Bay / Robe** area also includes a very stable beach ridge plain (Short and Hesp, 1980, cited by Master Plan *et al.*, 2000). Habitats within **Guichen Bay** include a surf beach (**Long Beach**); subtidal sand habitat and mixed reef / sand habitat within the bay; seagrass meadows (particularly at the northern end, near **Boatswain Point**), and small sheltered beaches and nearshore reefs at the northern and southern ends of the bay (PIRSA, SARDI and DEH map, in Bryars, 2003).

The **Cape Jaffa / Kingston** area forms the southern end of the major land-form element known as the Coorong Depression (Short and Hesp, 1980, and UEPG, 1982, cited by Edyvane *et al.*, 1996). The depression extends from the Murray Lakes to Cape Jaffa, and was an estuarine environment around 5000 years BP. Subsequent infilling of the estuary with the Lacepede Bay beach ridge occurred, and together with the closure of the Southern Coorong to the sea, formed the ephemeral saline environments of the Kingston Lake Chain. The second major land depression in the area is the Robe Range

– Woakwine Depression, consisting of a corridor of estuarine, clay and shell beds, deposited during the mid-Holocene when the corridor contained an unconfined lagoon, with estuaries at **Guichen** and Rivoli Bays. Infilling of the estuaries resulted in the corridor formation (Short and Hesp, 1980, and UEPG, 1982, cited by Edyvane *et al.*, 1996). There are reefs and sand bottom habitats from **Cape Jaffa** to south of **Wright Bay**, fronted near the shore by a narrow beach strip (PIRSA, SARDI and DEH map, in Bryars, 2003).

Another major coastal landform in the area is what Short and Hesp (1980, cited by Edyvane *et al.*, 1996) defined as the “Stranded Pleistocene Barriers and Relict Coast of the Robe Range Outer Barrier”. In the area described in this table, this landform is represented as the Woakwine Range stranded barrier complex (which is relatively stable, and not subject to erosion); and as outcropping calcareous remnants along the **Robe Range**, including rocky headlands, offshore islands, wave-cut platforms and reefs (Short and Hesp, 1980; UEPG, 1982, cited by Edyvane *et al.*, 1996).

Margaret Brock Reef is the northern-most visible remnant of the Robe Range, and the outermost extremity of the reef lies around 7km west of Cape Jaffa. Much of **Margaret Brock Reef** is submerged. The Robe Range suffered extensive submergence and breaching during the rising sea levels of the Holocene, resulting in the gradual formation of **Guichen Bay**. In the Guichen Bay area, **Baudin Rocks** (Godfrey Islands) are a rugged, fragmented and eroded group of dry rocks and submerged reefs composed of Bridgewater Formation calcareous sandstone. **Baudin Rocks** covers around 5ha., and consists of two larger and numerous smaller islets (Robinson *et al.*, 1996).

Upper South-East Estuarine / Freshwater Drainage area:

The Kingston Main Drain (**Maria Creek**) includes an estuary section in and above Kingston, and, a number of saline pools. Historically, Maria Creek appears to have been fresh or connected to the Tilley Swamp corridor further north, which was a natural pondage area for waters from a wide area, where at times it formed an “inland sea” virtually connecting Salt Creek through to Maria Creek and beyond (Turner and Carter, 1989, cited by Hammer, 2002). Today such connectivity is rare and the region basically separates into Salt Creek, Henry Creek, **Blackford Drain** and **Kingston Main Drain**, interspersed or interconnected with some swamp or drain habitat (Hammer, 2002).

The calcareous reefs at different depths, described below in terms of their dominant macroalgal cover, are also important representative habitat for numerous macro-invertebrates that are common in the area.

The descriptions below refer to the shallower areas of the shelf. Beyond the zone in which macroalgae are prevalent, Boreen *et al.* (1993, cited by Butler *et al.*, 2002) described the shallow part of the narrow continental shelf in the Bonney coast region as comprising exhumed limestone substrates that host dense assemblages of encrusting molluscs, sponges, bryozoa and red algae, and the middle shelf as a zone of swell-wave shoaling and production of mega-rippled bryozoan sands. (The deep shelf and slope are not described here due to their distance from S.A. State waters).

Lacepede Bay - Cape Jaffa - Margaret Brock Reef: Description of the benthic covers in the region is provided below:

- ♦ In inner and southern Lacepede Bay, seagrass beds from 0.5m to approximately 11m or 12m depth, with three or four of the six species forming dense meadows in some areas (i.e. *Posidonia australis* and *P. angustifolia*, *Amphibolis antarctica* and *Zostera* (= *Heterozostera*) *tasmanica*. *Posidonia coriacea* also occurs in Lacepede Bay. Recent surveys (cited by PIRSA, 2004a) have shown that there are also bare sand patches in the vicinity of the seagrass, and some recolonisation of scoured areas of seagrass within the bay has occurred.
- ♦ Reefs (mainly calcareous - consolidated dunes) of various forms and orientations (e.g. parallel calcareous reefs, ledges and patch reefs), comprising different reef assemblages, dominated in shallow waters by:
- ♦ Mixed fucoid algae with diverse red, green (e.g. species of *Caulerpa*) and smaller brown macroalgal understorey taxa, and encrusting coralline cover in some areas. Note

that the green macroalgae (mainly *Caulerpa* spp.) and/or mixed red macroalgae are the dominant cover in some areas of the bay;

- ♦ Bull Kelp (*Durvillaea potatorum*) covered reef, and giant kelp (*Macrocystis angustifolia*) covered reefs in shallow coastal waters (e.g. > 2m), with *M. angustifolia* extending into deeper coastal waters (> 10m). Seagrass patch reef habitat (e.g. 11m), dominated by *Amphibolis* and *Posidonia* seagrasses, mixed brown macroalgae (*Cystophora* spp. and *Scaberia agardhii*, and diverse and abundant red and green macroalgae.
- ♦ Mixed patch reef / sand habitat, to at least 35m, dominated by coarse sediments, bryozoa and mixed red macroalgae in some areas (e.g. 30m – 35m), and by mixed macroalgal communities (e.g. *Cystophora* spp., *Ecklonia radiata* and red macroalgal understory) in shallower waters.
- ♦ Sand habitat (coarse to medium grain) (Petrusevics *et al.*, 1998) in some areas, and fine sand ripples in other areas (e.g. at around 9m).
- ♦ Deeper water (25+m) flat calcareous platform reef habitat, which contain many holes and crevices, and is a major habitat for invertebrates (see below). Calcareous reefs dominated by red macroalgae (*Sonderopelta coriacea*, and species of *Phacelocarpus* and *Lenormandia*, and other low-light tolerant macroalgae), and by sponges, bryozoa and soft corals in deeper areas (e.g. to at least 60m). The reef contains many holes, crevices and other micro-habitats for crustaceans (including Rock Lobster), sponges, other benthic invertebrates, and calcareous organisms. The parallel calcareous reefs in this area stretch from the Coorong to Cape Jaffa, on the Lacepede Shelf, from around 11m to 60m deep.
- ♦ Limestone ledges in northern **Lacepede Bay** are covered with diverse brown and red macroalgae, dominated by *Carpoglossum confluens* and *Cystophora platylobium* in the overstorey, and a species-rich understory of red taxa (species of *Cryptopleura*, *Dictyomenia*, *Haloplegma*, *Erythroclonium*, *Echinothamnion*, amongst many others, including cold temperate species). Limestone reef at inner Margaret Brock reef is dominated by brown macroalgae (e.g. *Seirococcus axillaris* and *Cystophora* spp.) with encrusting coralline red understory. Mixed rock and sand reef at the north end of North Margaret Brock Reef is dominated by abundant red and green taxa. The brown macroalgae *Ecklonia*, *Perithalia caudata*, *Carpoglossum confluens*, *Cystophora* spp., and *Seirococcus axillaris* are also present, but the biomass and benthic cover are dominated by a high abundance and diversity of red macroalgae (described below) and green macroalgae (primarily species of *Codium* and *Caulerpa*). Locally abundant red taxa include species of *Plocamium*, *Callophyllis*, *Cryptopleura*, *Thuretia*, *Pterocladia*, *Carpopeltis*, *Stenocladia*, *Leptophyllis*, *Spyridia*, *Sonderopelta*, *Crassilingua*, *Echinothamnion*, and many others. Articulated and encrusting corallines are also common on the reef surfaces.

Guichen Bay / Baudin Rocks / Cape Dombey / Little Dip

(sources: SARDI S.A. Benthic Survey data, 1996, unpublished; Edyvane *et al.*, 1996; Edyvane and Baker, 1999a; Hammer, 2002; DEH 1:10 000 aerial photographs).

- ♦ Numerous intertidal dune rock platforms, dominated by mixed intertidal macroalgae and reef invertebrates.
- ♦ Shallow calcareous platform reefs of variable topography occur in the entire area, comprising different assemblages, including:
 - ♦ *Macrocystis*-dominated forests occur in the area e.g. at **Cape Dombey**, southern end of **Guichen Bay**, and other exposed areas, and the lee of offshore reefs;
 - ♦ Particularly species-rich red macroalgal assemblages, which formed up to 80% of the benthic cover in some locations sampled during a survey in 1996. The shallow calcareous platform reefs (e.g. 7m) in the **Robe** area are rich in macroalgal red species. Red taxa commonly recorded in this area, between 7m and 20m, include species of *Callophyllis*, *Cordylecladia*, *Craspedocarpus*, *Cryptonemia*, *Spyridia*, *Plocamium*, *Laurencia*, *Gigartina*, *Myriogramme*, *Melanthalia*, *Areschougia*, *Clavicolonium*, *Solieria*, *Champia*, *Involucranna*, *Wrangelia*, and *Sonderopelta coriacea* and many others. Green macroalgae (mainly species of *Codium* and *Caulerpa*) are also highly abundant and species rich in this area, at a statewide scale.
 - ♦ other shallow calcareous reefs in the area are dominated by mixed brown macroalgae (*Ecklonia radiata*, *Carpoglossum confluens*), species-rich red macroalgae (described in

	<p>section on Taxonomic Diversity) and green macroalgae (e.g. several <i>Caulerpa</i> species), and the latter are important in consolidating sediments on reefs in this area;</p> <ul style="list-style-type: none"> ◆ large crevasses occur in the reef in the Robe area, from near-shore to 1km seaward. The crevasses range from 5m to 15m deep; ◆ other reef areas (e.g. parts of Godfrey Islands) are covered with a dense mat of the wiry brown <i>Cladostephus spongiosus</i>, which provides a micro-habitat for numerous small crustaceans and other invertebrates. ◆ Extensive low profile patch reef and sand habitat occurs between Cape Lannes and Southend, dominated at various depths to 25m by brown macroalgae (<i>Ecklonia radiata</i>, <i>Cystophora</i> spp., <i>Carpoglossum confluens</i>, <i>Perithalia caudata</i>), with mixed brown (e.g. <i>Halopteris</i> sp.), green, and red (foliaceous, encrusting and articulated coralline) macroalgal understorey. ◆ Seagrasses (mainly <i>Amphibolis antarctica</i>, but species of <i>Posidonia</i> are also present, such as <i>P. australis</i> and <i>P. coriacea</i>) occur as patches or sparse meadows (e.g. Guichen Bay and Godfrey Islands, between 1m and 4m, and in several other areas with sand substrate). ◆ Bare sand habitat occurs close to shore in some areas, and in deeper coastal areas between reefs (e.g. 12m). ◆ The Little Dip area comprises a complex dune and dune-rock system of cliffs, beaches, shore platforms, reefs and islets, with the coastal strip extending to 2km wide at some points. Extensive inshore rocky platforms and rock pools occur in the area, dominated by a cover of <i>Hormosira banksii</i>, with mixed sessile and mobile benthic invertebrate taxa. ◆ Deeper water (25+m) flat calcareous platform reef habitat, which contain many holes and crevices, and is a major habitat for invertebrates (see below). The calcareous reefs are dominated by red macroalgae (<i>Phacelocarpus</i>, <i>Sonderopelta coriacea</i>, <i>Lenormandia</i> spp. And other low-light tolerant macroalgae), and by sponges, bryozoa and soft corals in deeper areas (e.g. to at least 60m). The reef contains many holes, crevices and other micro-habitats for crustaceans (including Rock Lobster), sponges, other benthic invertebrates, and calcareous organisms. Note that the parallel calcareous reefs in this area stretch from the Coorong to Cape Jaffa, on the Lacepede Shelf, from around 11m to 60m deep. ◆ Robe Lakes: A series of lakes perched in a coastal dune ridge, extending from Robe, but excluding the lakes connected to Drain L. The habitat forms a series of large pools and several lakes without swamp, variable in their submerged and littoral vegetation cover. Hypersaline lakes such as Lake Fellmongery and Lake Robe are fairly open with little cover. Fresher and smaller lakes such as those in the Little Dip Conservation Park have submerged aquatic cover such as <i>Chara</i>, and emergent sedges (Hammer, 2002). <p>At Nora Creina, the subtidal area is characterised by:</p> <ul style="list-style-type: none"> ◆ Sand habitat; ◆ Limestone reefs of variable topography, with mixed brown macroalgae, green and red macroalgae, and various attached and mobile invertebrates; ◆ Dense seagrass beds in inner Nora Creina Bay.
<p>6. Taxonomic Diversity</p>	<p>Marine Plants (SARDI S.A. Benthic Survey data, 1996, unpublished; Edyvane <i>et al.</i>, 1996; Edyvane and Baker, 1999a).</p> <p>Lacepede Bay – Cape Jaffa - Margaret Brock Reef: High species diversity of benthic macroalgae (both at local and statewide scales), including regionally uncommon assemblages of marine plants (see Habitat Notes). High diversity of seagrass taxa with three genera and up to six species recorded in the area.</p> <p>Guichen Bay / Baudin Rocks / Cape Dombey / Little Dip: Diversity of benthic assemblage types, some with high species diversity of macroalgae, particularly red macroalgal species. The shallow calcareous platform reefs (e.g. 7m) in the Robe area are particularly rich in macroalgal red species, which form up to 80% of the benthic cover in some locations. Green macroalgae (mainly species of <i>Codium</i> and <i>Caulerpa</i>)</p>

	<p>are also highly abundant and species-rich in this area, at a statewide scale (see various references by Womersley in bibliography, and also Edyvane and Baker, 1999a) (see Habitat Notes).</p> <p>Nora Creina: High species diversity of marine macroalgae in the vicinity of Nora Creina, according to unpublished collections from S.A. Herbarium.</p> <p>Bony and Cartilaginous Fish</p> <p>Lacepede Bay – Cape Jaffa - Margaret Brock Reef: Anecdotal evidence from divers and dive associations of high diversity of reef fish, and abundance of some reef fish species, such as sweep, Silver Drummer, cale, various leatherjacket species, morwong, various wrasse spp., amongst many others (see section at the end of this table, for further information about some of the fish species occurring in the area).</p> <p>Guichen Bay / Baudin Rocks / Cape Dombey / Little Dip: Anecdotal evidence from divers and dive associations of high diversity of reef fish. See section below on Major Commercial and Recreational Fish for more information about some of the fish species occurring in the area.</p> <p>Invertebrates</p> <p>Lacepede Bay – Cape Jaffa - Margaret Brock Reef; Guichen Bay - Baudin Rocks - Cape Dombey - Little Dip: Divers report a high diversity (presumably at more than one taxonomic level) and abundance of invertebrates (especially sponges, molluscs and bryozoa), however quantitative data are not available for this report.</p> <p>Coastal Birds</p> <p>Guichen Bay: At least 30 coastal and seabird bird species have been recorded using the Robe area (J. Paton, SAOA, unpublished species list, 1989; Robe regional information materials, 2000-2003; Waanders, 2002), and a complete and updated species list would likely show a higher number.</p> <p>Lakes and dune areas of the Little Dip Coast: 42 water bird, coastal bird and sea bird species recorded, 14 of which are listed under international treaties (Australian Heritage Commission, undated).</p> <p>Baudin Rocks (Godfrey Islands): Previously, 30 species of birds were estimated to occur on Baudin Rocks (with some of these species breeding in the area). In addition to rare and vulnerable species (see section below), other species recorded include Little Penguins, Black-faced Cormorant, Pied Cormorant, Little Pied Cormorant, Silver Gull, Rufous Night Heron, White-faced Heron, Sooty Oyster Catcher, Crested Tern, and Australian Shelduck. International migratory species include Pacific Golden Plover, amongst others (Australian Heritage Commission, undated).</p>
<p>7. Habitat for Endemic Taxa / Threatened Taxa / Rare or Uncommon Taxa</p>	<p>A large number of invertebrates and macroalgae, and a smaller number of fish species, that occur in the area discussed here, are endemic to southern Australia, but quantification is not possible for this report.</p> <p>Marine Plants</p> <p>Lacepede Bay: Presence of the uncommon brown macroalga <i>Myriodesma leptophyllum</i>. Several other taxa which may be uncommon at a State-wide scale are present in the area, such as <i>Claviconium ovatum</i>, which has western affinities (i.e. not commonly recorded in S.A., but regularly recorded in W.A.) and <i>Cliftonaea semipennata</i> (Womersley 1994; SARDI survey data 1996; Edyvane and Baker, 1999a). Species which are recognised as having a limited range include the following:</p> <p>Kingston: red macroalgal species <i>Griffithsia pilalyea</i></p> <p>Robe: red macroalgal species <i>Pterothamnion nodiferum</i></p> <p>Cape Lannes: red macroalgal species <i>Helminthocladia beaugleholei</i> (Liagoraceae)</p> <p>Nora Creina: two red macroalgal species (<i>Grateloupia ovata</i> and <i>Scinaia proliferata</i>) and a brown macroalgal species (<i>Homoeostrichus canaliculatus</i>) (Cheshire <i>et al.</i>, 2000; Turner, 2000).</p> <p>Bony and Cartilaginous Fish</p> <p>Lacepede Bay – Cape Jaffa - Margaret Brock Reef - Robe: Presence of the Leafy Seadragon and Weedy Seadragon (DIASA, undated; MCCN Dragon Search project, 1999), which were classified by IUCN Red List 2003 as <i>Data Deficient</i>. The Leafy Seadragon is a protected species in South Australia.</p>

Cape Jaffa: recorded presence of Red Pipefish *Notiocampus ruber*, a monotypic species associated with filamentous red macroalgae, and considered to be one of the least known species of pipefish, possibly due to its cryptic nature (known to date from only 8 records, from NSW, S.A., Tasmania and W.A.) (Kuitert, 1996b, 2000; Froese and Pauly, 2003; Baker, in press).

Robe area: Recorded presence of less commonly known pipefish species Brigg's Pipefish (Brigg's Crested Pipefish) *Histiogamphelus briggsii*, usually recorded in loose macroalgal or seagrass detritus on sand, or from dredge samples, in south-eastern Australia (Dawson, 1985; Kuitert, 2000; Froese and Pauly, 2003). The Javelin Pipefish *Lissocampus runa* also occurs in the area (Baker, in press).

"Bonney Coast": Apart from the syngnathid species listed above, Butler *et al.* (2002) reported that 21 other syngnathid species occur in the "Bonney Coast" region (from Cape Otway / Portland area in Victoria, to Cape Jaffa / Robe area in SA), but these species are not listed here because no details are provided in Butler *et al.* (2002) of the specific localities within the Bonney Coast region.

Lacepede Bay – Cape Jaffa - Margaret Brock Reef / Guichen Bay – Baudin Rocks - Cape Dombey – Little Dip: Presence of site-associated reef fish species of conservation concern in the nearshore marine area, such as Western Blue Groper, Brown-spotted Wrasse, Blue-throated Wrasse, Purple Wrasse (a south-eastern Australian species, with a limited range in S.A.) and other wrasse species, and Banded Morwong, amongst other reef fish. The reported status of, and potential threats to, such reef fish species are listed in Section 9.2, and in Baker (in press).

Kingston: The estuarine fish Tamar Goby *Favonigobius tamarensis*, has been recorded in the area, and is uncommon in the South-East (Hammer, 2002), and in South Australia as a whole, which is at the edge of the species range (Native Fish Australia, 2001).

Robe Lakes: Although the Western Blue Spot Goby is not rare in S.A., one of the Robe Lakes supports a rare, land-locked population of this estuarine species. Also, the South-East of S.A. is the most easterly extent for this goby species (Hammer, 2002).

Robe Lakes may also be one of the few areas in S.A. in which the endangered Estuary Perch *Macquaria colonorum* occurs. Hammer (2002) reported that although the species was not sampled during a survey in 2000 - 2001 of the drainages of south-eastern South Australia, it possibly occurs in the Robe Lakes. The National Parks and Wildlife Council and Department for Environment and Heritage (2003) has recommended that the species be listed as Endangered, under a schedule of the *National Parks and Wildlife Act 1972*.

Upper South-East Estuarine / Freshwater Drainage area: The estuarine fish Congolli *Pseudaphritis urvillii* has been recorded in **Kingston Main Drain** and **Drain L**, and a number of other sites in the area, and is considered to be a species of conservation concern in S.A. (Hammer, 2002, Table 3.0.1), due to population decreases in major estuaries of the Murray-Darling, and reduced abundance, despite a possible range extension due to increased freshwater access (Hammer, 2002). *(N.B. A recent survey of fish species in the coastal drainage areas of the upper South-East recorded 8 native fish species, including several estuarine species, and also including 3 freshwater species of national and/or local conservation significance: Yarra Pygmy Perch, Southern Pygmy Perch, and a threatened, isolated occurrence of River Blackfish (Hammer, 2002).

Invertebrates

Lacepede Bay - Cape Jaffa - Margaret Brock Reef: Presence of endemic and uncommon (at State-wide scale) ascidian species (Kott, 1997). Examples include *Protoholozoa australiensis*, an ascidian composed of small stalked colonies, recorded from **Margaret Brock Reef**; *Aplidium petrosum*, a hard colonial ascidian known from a few localities across S.A., including **Cape Jaffa**; and *Pseudodistoma acuatum*, a pale yellow colonial ascidian with sand embedded, recorded from few locations in S.A., including **Nora Creina** (Kott, 1997; Australian Government Department for the Environment and Heritage, 2004b).

Cape Jaffa – Robe area: *Notomytilus robensis*, a small, fawn-coloured bivalve from shelly sand habitat, has been found to date only in the Cape Jaffa to Robe area, and is likely to be an endemic species within S.A..

Cape Jaffa to Nora Creina: Presence of various species of specimen shells of conservation concern. A species list is not available for this area, for this report, however Section 9.2 provides information on specimen shells, and **Location 17 Part 1**

	<p>provides examples of some shell species collected in the South-East of South Australia).</p> <p>The Cape Jaffa / upper South-East region is the western limit of the south-eastern Australian cowrie <i>Umbilia hesitata</i> (Wilson and Clarkson, 2004).</p> <p>Kingston: Presence of the endemic sponge <i>Clathria (Clathria) noarlungae</i>, which has been found to date only at Port Noarlunga and Kingston in S.A. (Hooper, in Australian Government Department for the Environment and Heritage, 2003d).</p> <p>Marine Mammals</p> <p>Baudin Rocks (Godfrey Islands): Australian Sea Lions occur on the north island of Baudin Rocks, according to Australian Heritage Commission (undated). Australian Sea Lion is classified as <i>rare</i> (S.A. <i>National Parks and Wildlife Act 1972</i>) and considered by some researchers to be a threatened species (e.g. see Shaughnessy, 1999). Cape Jaffa is an irregular haul-out site for pinnipeds.</p> <p>Lacepede Bay: Part of the migratory path of Southern Right Whale. Also, periodic presence of this whale species in the Guichen Bay / Cape Dombey / Little Dip / Nora Creina region. IUCN Red List 2003 classified Southern Right Whale as <i>Conservation Dependent</i>. The species is listed under S.A. legislation as <i>vulnerable</i>, and is also listed under the Commonwealth's <i>EPBC Act 1999</i> as a threatened species.</p> <p>Robe: The upwelling in the Bonney Coast region promotes high productivity of krill, which supports feeding aggregations of Pygmy Blue Whales, which have been observed as far up the Bonney coast as the deeper waters offshore from Robe (Gill, 2002, cited by Butler <i>et al.</i>, 2002). Blue whales are classified as <i>endangered</i>, at international, national and state levels (see Lower South East).</p> <p>Cape Jaffa: Dolphins (Bottlenose and Common) are occasionally observed in the area. Bottlenose Dolphin was listed in the IUCN Red List 2003 as <i>Data Deficient</i>.</p> <p>Coastal and Marine Birds</p> <p>Butchers Gap Conservation Reserve, and Bernoulli and Little Dip Conservation Parks: Presence of Orange-bellied Parrot, which utilises coastal habitat in this area during its winter migration along the Victorian and South Australian coasts. The Orange-bellied Parrot is known to occasionally feed on kelp at tide-lines and attached dune plants above the intertidal, but much of their habitat requirement is terrestrial (Pizzey, 1988, Australian Heritage Commission, undated). The species feeds mainly along beach lines, above the high tide mark, and utilises samphire species such as <i>Acaena novaezealandiae</i>, <i>Sarcocornia quinqueflora</i>, and the introduced coastal plant <i>Cakile maritima</i> (Master Plan <i>et al.</i>, 2000). The Orange-bellied Parrot is listed by ornithologists as <i>very rare</i> (e.g. Pizzey, 1988). The Orange-bellied Parrot was listed as <i>critically endangered</i> in the IUCN Red List 2002 and 2003, with sub-classification C2b. Orange-bellied Parrot is also listed as a threatened species under the Commonwealth's <i>EPBC Act 1999</i>.</p> <p>Lakes and dune areas of the Little Dip Coast: Species in the area that are classified under the SA <i>National Parks and Wildlife Act 1972</i> include Orange-bellied Parrot (<i>endangered</i>), and also considered rare by ornithologists - see above) and the Musk Duck (<i>rare</i>). <i>Vulnerable</i> species include Latham's Snipe.</p> <p>Baudin Rocks (Godfrey Islands): Species which are listed as <i>rare</i> in S.A., that utilise the area, include the Eastern Reef Egret, and small numbers of Peregrine Falcons. There have been at least three recorded sightings and a breeding record (Bonnin, 1968 and 1982) of the Bridled Tern <i>Sterna anaethetus</i> on the island. This is one of only two locations in South Australia where this species from northern and western Australia has been recorded. The records are considered to represent vagrant birds, although the species has also been recorded recently further south along the coast (Rogers, 2002). Fairy Terns, which are listed as <i>vulnerable</i> in South Australia, have been recorded nesting in 1924, 1970, and 1981. Other species that utilise the area, and are listed as <i>vulnerable</i> in S.A., include the Eastern Curlew (Australian Heritage Commission, undated).</p> <p>Little Dip Conservation Park and Guichen Bay Conservation Park: Coastal habitat for Hooded Plover and Fairy Tern, both listed as <i>vulnerable</i> under South Australian legislation (see section below on Notable Feeding, Breeding/Spawning and Nursery Areas for more information about Hooded Plover).</p> <p>"Bonney Coast" / Upper South-East: Butler <i>et al.</i> (2002) reported that 14 species of Albatross, as well as the Blue Petrel and Soft-plumaged Petrel occur in the region referred to as the "Bonney Coast" (from Cape Otway / Portland area in Victoria, to</p>
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Cape Jaffa / Robe area in SA). Albatross species, as well as Blue Petrel and Soft-Plumaged Petrel, are wide-ranging oceanic species that breed mostly in the sub-Antarctic islands (and some albatross species breed in New Zealand), with limited site association to the coast in South Australia. However, the South-East of S.A. is a feeding area for a number of these species. Most albatross species are listed under the *National Parks and Wildlife Act 1972* schedules and/or the Commonwealth's *Environment Protection and Biodiversity Conservation Act (EPBC) 1999*, and are also included in the IUCN's Red List. *Blue Petrel* is listed as *vulnerable* under both *EPBC Act 1999*, and South Australian legislation (*National Parks and Wildlife Act 1972*). *Soft-plumaged Petrel* is listed as *vulnerable* under the *EPBC Act 1999*. Survey notes below refer to an observational survey by ornithologists in 2002, which recorded the following species in the area west-south-west of **Robe**:

- ♦ *Wandering Albatross* (listed as *vulnerable* in IUCN Red List 2003, and also under Commonwealth's *EPBC Act 1999*, and *NPW Act 1972* in South Australia. Garnett and Crowley (2000) described the breeding population in Australia as *critically endangered*, because the Australian breeding population numbers less than 50 mature individuals. The authors also described the global population, most of which visits Australian waters, as *vulnerable*, due to having decreased in size by 20-50%, based on an appropriate index of abundance, and estimates of fishing bycatch. Garnett and Crowley (2000) considered that the trend in decline was likely to continue, and that the level of genetic interchange between the Australian and visiting population of *Wandering Albatross* is arguably low, so status of Australian population assessed independently (as per Gärdenfors *et al.*, 1999, cited by Garnett and Crowley, 2000).
- ♦ *Black-browed Albatross*: Australian breeding population described by Garnett and Crowley 2000 as *Endangered* due to low breeding numbers, and population visiting Australian territory described as *Near Threatened*, principally due to long-line fishing. Globally, the species was listed in the IUCN Red List 2002 as *vulnerable*, and its status in the 2003 Red List was revised to *endangered* level.
- ♦ *Southern Royal Albatross*: (listed as *vulnerable*, according to IUCN Red List 2003 and Commonwealth's *EPBC Act 1999*). Also listed by Garnett and Crowley (2000) as *vulnerable*, because although the size of the breeding population may currently be increasing, the size of the population visiting Australian waters is considered likely to decrease by more than 20% over the next three generations (75 years) as a result of fishing bycatch.
- ♦ *Northern Royal Albatross* (listed as *endangered*, according to IUCN Red List 2003 and Commonwealth's *EPBC Act 1999*). Also listed by Garnett and Crowley (2000) as *endangered* because, globally, the area of occupancy is small and a decrease in the number of individuals has been inferred. Although the status in Australian waters more closely fits the *Vulnerable* category, on the basis of probable decreases in population over the next three generations (75 years), it has been upgraded as per Gärdenfors *et al.* (1999) to match the global *Endangered* status, because all visiting birds are from an *Endangered* population. Drowning in longline fishing gear appears to be the primary threat faced by *Northern Royal Albatrosses* in Australian waters. Birds may also suffer from collision with cables and warps used on fishing trawlers (Gales, 1998; EABG, 1999, cited by Garnett and Crowley, 2000).
- ♦ *Indian Yellow-nosed Albatross*: (IUCN Red List 2002 and *EPBC Act 1999* listings: *vulnerable*; IUCN Red List 2003: *endangered*). Estimated abundance in the **Robe** area at time of a 2002 survey = 60, including many immature birds – see Waanders *et al.*, 2002);
- ♦ *Shy Albatross*: listed as *vulnerable* under *EPBC Act 1999*, and S.A. *NPW Act 1972*. Globally, listed as *near threatened*, in IUCN Red List 2003. At the time of a survey in 2002, the estimated number in the **Robe** area was more than 100. According to a National Ocean Office map (2002, citing Brothers *et al.*, 1997), the Upper South-East (e.g. Robe area) is one of approximately 20 areas within South-Eastern South Australia, in which "higher occurrence" records of the at-sea distribution of the *Shy Albatross* are recorded, based on marked bird surveys.
- ♦ *Northern Giant Petrel*: Listed under the *EPBC Act 1999* as *vulnerable*. The species breeds at a single location within Australian territory (Macquarie Island), and breeding birds from this island mainly forage in inshore waters off southern Australia. Globally, its population size is increasing, but considered to have the potential to decrease to

	<p>Vulnerable levels (see Garnett and Crowley, 2000). Globally, listed as <i>near threatened</i>, under IUCN Red List 2003.</p> <ul style="list-style-type: none"> ♦ <i>Southern Giant Petrel</i>: Listed under <i>EPBC Act 1999</i> as <i>endangered</i>; Australian breeding population also described by Garnett and Crowley (2000) as <i>endangered</i> due to significant decrease in population size, and population visiting Australian territory described by the authors as <i>vulnerable</i>. Issues include bycatch long-line fishing, high fidelity to sites, and low immigration rate. The national status of the breeding population is independent of the global status. Globally, listed as <i>vulnerable</i>, under IUCN Red List 2003. ♦ In addition to the above, another <i>Giant Petrel</i> species was also observed in the Robe area during a recent survey (see Waanders <i>et al.</i>, 2002). Robe Council (2003) also reported that Giant Petrels are seen along the Robe coast. ♦ <i>Cape Petrel</i>: In Australian waters, the species breeds on Heard Island, and that population has been described as <i>Vulnerable</i>. Visitors to southern Australia have been categorised as <i>Least Concern</i>. Extra-limittally, the species breeds on islands throughout Southern Ocean. Non-breeding birds are common off the southern coasts, particularly in winter (Marchant and Higgins, 1990, cited by Garnett and Crowley, 2000). A survey in September 2002 reported a maximum of around 20 in the Robe area at time of survey (see Waanders <i>et al.</i>, 2002). ♦ <i>Fairy Prion</i>: The southern sub-species listed as <i>vulnerable</i> under the <i>EPBC Act 1999</i>. Fairy Prions breed on some sub-Antarctic islands, and other offshore islands both in and out of Australian territory, but have been recorded visiting southern Australian waters to feed. <p>Robe / Upper South-East: Habitat for <i>Flesh-footed Shearwater</i> (listed as <i>rare</i> in S.A.). During a survey in 2002, the species was observed feeding in the waters south-west of Robe, estimated number over 150 in the area at time of survey – see Waanders <i>et al.</i>, 2002). <i>Fairy Tern</i> (listed as <i>vulnerable</i> in S.A.) also occurs in the area (Paton, unpublished species list of the Robe area, 1990; Waanders <i>et al.</i>, 2002).</p>
<p>8. Other Important Taxa</p>	<p>Marine Plants</p> <p>Kingston - Cape Jaffa - Margaret Brock Reef – Kings Camp - Guichen Bay: Large stands of Bull Kelp (<i>Durvillaea potatorum</i>) and/or Giant Kelp (<i>Macrocystis angustifolia</i>) and its associated communities occur in each of these areas. Large Kelp beds provide shelter and feeding areas for fish, molluscs, and crustacea. Kelp forests are a major contributor to marine nutrient recycling, with detritus following decay becoming incorporated into marine food web of the South East (See Baker, 2000, Appendix 2, for overview of the ecological significance of phaeophyte-dominated communities, and summary of the specific ecological role of Giant Kelp in K. Edyvane's DPIWE Kelp Watch web site, 2001).</p> <p>Lacepede Bay to Little Dip: Presence of red macroalgae with cool temperate and cold temperate (Victorian, Tasmanian) affinities such as <i>Gigartina muelleriana</i>, and species in the genera <i>Porphyra</i>, <i>Myriogloia</i> and <i>Grateloupia</i>, amongst others, associated with the Maugean Subprovince (Womersley 1990; Edyvane <i>et al.</i>, 1996).</p> <p>Cape Jaffa - Margaret Brock and other reefs in the area: An abundance of coralline red macroalgae on calcareous reefs (Edyvane and Baker, 1999a), which is an important habitat for invertebrates.</p> <p>Lacepede Bay is considered to be the easterly limit in the South Australian distribution of the seagrass <i>Posidonia sinuosa</i>, and Robe is the western limit of the distribution of the cold temperate brown macroalga <i>Phyllospora comosa</i> (crayweed), which is common in Victoria and Tasmania (Edyvane and Baker, 1999a).</p> <p>Invertebrates</p> <p>Lacepede Bay - Cape Jaffa - Margaret Brock Reef / Guichen Bay / Baudin Rocks / Cape Dombey / Little Dip: Important near-shore habitats for Rock Lobster, which consists of areas of calcareous reef and seagrass. Lewis (1983) stated that prey items were presumably common in the area which included sea urchins, small crustaceans and molluscs. Flat calcareous reef dominates the deeper waters (20+m) of the South East from South of the Coorong to the Victorian border. The reef contains many holes, crevices and other micro-habitats for crustaceans (including Rock Lobster, which are abundant in the area), sponges, other benthic invertebrates, and calcareous organisms.</p>

	<p>The area contains abundant numbers of Blacklip Abalone, as evidenced by catch figures for the region (see Notes on Social and Economic Values and Uses).</p> <p>Lacepede Bay - Cape Jaffa – Margaret Brock Reef: Abundance of bryozoa on reefs deeper than 20m, on the Lacepede Shelf (Edyvane and Baker, 1999a).</p> <p>Reef areas of the upper South-East (e.g. Cape Jaffa, Margaret Brock, The Black Pigs, South Reef, Cape Dombey, Little Dip and Nora Creina) are reported to be used by one or more of the life stages of the following commercially and/or recreationally significant invertebrate species: Southern Rock Lobster, Southern Calamari, Giant Cuttlefish, Maori Octopus, Greenlip and Blacklip Abalone, and Purple Sea Urchin (Bryars, 2003).</p> <p>Guichen Bay / Baudin Rocks / Cape Dombey / Little Dip: Inshore rocky platforms and rock pools contain an abundance of common invertebrates, including species of grazing molluscs (species of limpet and chiton are common), ascidians, sea stars, sea urchins, anemones and crustaceans (Womersley and Edmonds, 1958; Edyvane and Baker, 1999a).</p> <p>Seagrass beds in the area (e.g. Lacepede Bay, Nora Creina Bay, Stinky Bay) provide habitat for Southern Calamari (Bryars, 2003).</p> <p>“Bonney Coast”: The coastal krill (<i>Nyctiphanes australis</i>) is the principal species of euphausiid in south-eastern Australian waters (Johannes and Young, 1999, cited by Butler <i>et al.</i>, 2002). The species is regularly observed in surface and sub-surface swarms, and related to the cold water upwelling along the Bonney Coast (Colman, 2001; Gill, 2002). <i>N. australis</i> is the principal food source for Blue Whales in the area, and also an important prey for many other species (Johannes and Young, 1999, cited by Butler <i>et al.</i>, 2002).</p> <p>Bony and Cartilaginous Fish</p> <p>Upper South-East: A number of recreationally significant fish species attain large sizes in the upper South-East waters. Examples include Australian Salmon (often 2kg – 4kg specimens are recorded), Black Bream (up to 2kg) and whiting (Sweeney, 1996b). Deeper waters of the Upper South-East are also a significant area for School Shark and Gummy Shark (see Notes on Social and Economic Uses section).</p> <p>Reef areas of the upper South-East (e.g. Cape Jaffa, Margaret Brock, The Black Pigs, South Reef, Godfrey Islands, Cape Dombey, Little Dip and Nora Creina) are reported to be used by one or more of the life stages of the following commercially and/or recreationally significant fish species: King George Whiting, Snapper, West Australian Salmon, East Australian Salmon, Tommy Ruff, Southern Sea Garfish, Yellow-eye Mullet, Mulloway, Trevally, Leatherjacket species, Snook, Wrasse species, Sea Sweep, Silver Drummer; Gummy Shark and Whaler Sharks (Bryars, 2003).</p> <p>Surf beach areas of the upper South-East (e.g. Long Beach in Guichen Bay, and beaches between Cape Lannes and Long Gully, including Back Beach; and Stinky Beach, near Nora Creina) are reported to be used by one or more of the life stages of the following commercially and/or recreationally significant fish species: School Whiting, West Australian Salmon, East Australian Salmon, Tommy Ruff, Yellow-eye Mullet, Mulloway, flathead species, School Shark, Gummy Shark and Whaler Sharks (Bryars, 2003). Most of these species (in addition to King George Whiting, Snapper, Southern Sea Garfish, Red “Mullet”, Trevally, and flounder species), also utilise more sheltered beach areas, as well as the subtidal sand habitats (Bryars, 2003)</p> <p>Seagrass meadows in the area (e.g. Lacepede Bay, Guichen Bay, Nora Creina Bay, Stinky Bay) are reported to provide habitat for King George Whiting, West Australian Salmon, East Australian Salmon, Tommy Ruff, Southern Sea Garfish, flathead species, Trevally, Leatherjacket species, Snook, and Whaler Sharks (Bryars, 2003). Most of these species, as well as School Whiting, Snapper, Yellow-eye Mullet, Red “Mullet”, Mulloway, and flounder species, are also reported to use the subtidal sand habitats in Lacepede Bay (Bryars, 2003).</p> <p>Marine Mammals</p> <p>Margaret Brock Reef: Waters surrounding the reef are considered by Robinson <i>et al.</i> (1996) to be a possible feeding ground for the Australian Fur Seal <i>Arctocephalus pusillus</i>, which is uncommon in S.A..</p> <p>Coastal and Marine Birds</p> <p>Little Dip coast: Breeding, roosting and feeding areas for coastal and sea birds, and a feeding area for oceanic migrant species. In addition to the threatened species and</p>
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	<p>migratory species listed above, an incomplete list of other coastal birds regularly (some irregularly) seen in the Robe and Little Dip area include the following: Little Penguin; Short-tailed Shearwater, Australian Pelican, Australian (Australasian) Gannet, Black-faced Cormorant, Pied Cormorant, Little Cormorant, White-faced Heron, Red-capped Dotterel and other dotterel species, Red-Necked Stint, Banded Lapwing, Black-fronted Plover, Double-banded Plover; Black-winged Stilt, Silver Gull, Caspian Tern, Crested Tern; White-fronted Tern; Fluttering Shearwater; Button's Shearwater; Great-winged Petrel (estimated 25 in the Robe area at the time of a survey in September, 2002); White-faced Storm Petrel; Antarctic Prion (observed during a survey in 2002 – see Waanders <i>et al.</i>, 2002) (J. Paton, bird species list for the Robe area; Waanders, Cox, Clark and Rogers, 2002).</p> <p>Guichen Bay Conservation Park: Habitat for Latham's Snipe, Nankeen (Rufous) Night Heron, Sooty Oystercatcher and dotterel species (Australian Heritage Commission, undated).</p> <p>Baudin Rocks (Godfrey Islands): One of the islands contains a large sheltered rock pool surrounded by flat rocks, which is used by various species of ducks and wading birds as a protected place to roost. For example, "large numbers" of Australian Shelduck have been recorded from the lagoon (Australian Heritage Commission, undated).</p>
<p>9. Notable Feeding, Breeding / Spawning and Nursery Areas</p>	<p>Bony and Cartilaginous Fish</p> <p>Kingston – Cape Jaffa - Kings Camp - Guichen Bay: Forests of Giant Kelp (<i>Macrocystis angustifolia</i>) and associated communities occur in the area, which provide shelter and protection for fish from predators and harsh oceanographic conditions (Edyvane and Baker, 1999a).</p> <p>Kingston: Schools of juvenile Garfish in the seagrass beds in the Kingston area are regularly observed by recreational fishers, which implies some significance of the area as habitat for juveniles. Bryars (2003) reported that the seagrass beds of Lacepede Bay provide nursery habitat for juvenile West Australian Salmon, Tommy Ruff, Southern Sea Garfish, flathead species, Leatherjacket species, and Trevally.</p> <p>Reef areas of the upper South-East (e.g. Cape Jaffa, The Black Pigs, South Reef, Godfrey Islands, Cape Dombey, Little Dip and Nora Creina) are reported to provide spawning areas and nursery habitat for Sea Sweep (Bryars, 2003).</p> <p>Surf beach areas of the upper South-East (e.g. Long Beach in Guichen Bay, and beaches between Cape Lannes and Long Gully, including Back Beach; and Stinky Beach, near Nora Creina) are reported to be used by juvenile School Whiting and Mulloway (Bryars, 2003). More sheltered beach habitats in the Upper South-East are also used by juvenile School Whiting, Mulloway, as well as juveniles of Flathead and flounder species. The subtidal sand habitats of the Upper South-East reportedly provide a nursery area for juvenile King George Whiting, School Whiting, West Australian Salmon, Tommy Ruff, Yellow-eye Mullet, Red "Mullet", Mulloway, and species of flathead and flounder (Bryars, 2003).</p> <p>Maria Creek: The estuary is reported to provide habitat for adults of Western and Eastern Australian Salmon, Yellow-eye Mullet, and Black Bream, and a nursery area for juvenile Mulloway (Bryars, 2003).</p> <p>The Robe Lakes (i.e. Lakes Battye, Nunan, Pub and Fox) are reported to provide habitat for both adult and juvenile Yellow-eye Mullet and Black Bream (including spawning and nursery areas for the latter) (Bryars, 2003).</p> <p>Invertebrates (Sources: Lewis, 1983; Edyvane <i>et al.</i>, 1996; Edyvane and Baker, 1999a; Bryars, 2003).</p> <p>Lacepede Bay – Cape Jaffa - Margaret Brock Reef, and deeper calcareous reefs offshore: Important habitat and feeding area for the Rock Lobster, including juveniles (Lewis, 1983; Ivanovici, 1984). Areas of calcareous reef, which provide holes and crevasses for shelter, and contain a number Rock Lobster prey items such as small crustaceans, urchins, echinoderms and molluscs.</p> <p>Lacepede Bay – Cape Jaffa - Margaret Brock Reef: Extensive reef habitat for Blacklip Abalone, including coralline benthic cover, which is a significant habitat for juvenile abalone.</p> <p>Lacepede Bay – Guichen Bay – Baudin Rocks: Intertidal and subtidal seagrass beds in Guichen Bay, around Baudin Rocks and other locations, which provide shelter and feeding grounds for economically (and socially) important fish and crustaceans (e.g.</p>

foraging and sheltering area for Southern Rock Lobster, which also utilise the extensive reefs in this area).

Lacepede Bay: Seagrass beds in the area provide spawning / egg laying areas for Southern Calamari (Bryars, 2003).

Surf beach areas of the upper South-East (e.g. between **Cape Lannes** and **Long Gully**, including **Back Beach**; and **Stinky Beach**, near **Nora Creina**) are reported to be used by adult and juvenile Sand Crabs and baitworm species. Southern Calamari, and both adult and juvenile Sand Crabs, also utilise the subtidal sand habitats in the upper South-East, such as those in **Lacepede Bay** and **Guichen Bay**. Sheltered beaches in the area (e.g. **Lacepede Bay**) are reported to provide habitat for adult and juvenile Sand Crabs and Goolwa Cockles (Bryars, 2003).

Kingston – Cape Jaffa – Kings Camp – Guichen Bay: Forests of Giant Kelp (*Macrocystis angustifolia*) and associated communities, which provide shelter for molluscs and crustacea, particularly Southern Rock Lobster.

Reef areas of the upper South-East (e.g. between **Cape Dombey**, **Little Dip** and **Nora Creina**) are reported to provide spawning areas for Southern Calamari, and both spawning areas and habitat for juveniles, for Southern Rock Lobster, Southern Calamari, Maori Octopus, Greenlip and Blacklip Abalone, and Purple Sea Urchin (Bryars, 2003).

Mammals

The **Bonney Coast** is one of 12 areas in the world where Blue Whales aggregate to feed on krill (Gill, 2002; Butler *et al.*, 2002). Gill (2002, cited by Butler *et al.*, 2002) recorded 216 Blue Whale sightings from dedicated surveys, reports from fishermen and incidental records in the Bonney Upwelling, between 1998 and 2001. Whales were observed between December and May, and they were associated with surface swarms of coastal krill in 48%, and feeding on krill in 36% of all sightings (Gill, 2002). A maximum of 32 Blue Whales were sighted during one survey.

Coastal Birds

Margaret Brock Reef: The abandoned lighthouse platform at Margaret Brock Reef is a breeding area for *Australian* (i.e. *Australasian*) *Gannet*, reported to comprise 170 breeding pairs (ABC Media Report January, 2003; SARFAC, 2003). The Margaret Brock colony is the western-most colony of this bird species in Southern Australia (L. Best, DEH, pers. comm., 2003), and is reported to comprise approximately 1.7 % of the Australian population and 0.5% of the world population (SARFAC 2003, citing a 2003 Referral Notice under the Commonwealth's *EPBC Act 1999*).

Baudin Rocks (Godfrey Islands): The area supports "large" and "regionally important" breeding colonies of Crested Tern, Silver Gull, and Black-faced Cormorant (Robinson and Rowberry 1983; Robinson *et al.*, 1996; Australian Heritage Commission, undated), and is also a breeding area for Australasian (Australian) Gannet (L. Best, DEH, pers. comm. 2003). The area also previously supported what was described as a "large" breeding colony of Little Penguins, however numbers purportedly decreased substantially, during the 1970's and 1980s (see **Issues for Risk and Impact Assessment** section) (Australian Heritage Commission, undated).

Little Dip Conservation Park: Hooded Plovers feed and breed on the beaches and fore-dunes in the Park. Counts of this species were made in 1982-83 along the South Australian coastline from the Murray Mouth to the Victorian border. Depending on the season the Little Dip beaches contained between three and twelve percent of the species population in the survey area. **Little Dip Conservation Park** is considered to be a stronghold for Hooded Plovers in the south-east of South Australia (Australian Heritage Commission, undated).

Lakes and dune areas of the Little Dip Coast: Major breeding area for local and migratory shorebirds. Breeding populations include Black Swans which breed on the lakes. Migration stop-over for 13 species of migrant shorebirds including the Pacific Golden Plover, Common Greenshank, Common Sandpiper, Terek Sandpiper, Ruddy Turnstone, Latham's Snipe, Great Knot, Red Knot, Sharp-tailed Sandpiper, Red-necked Stint, Long-toed Stint and Curlew Sandpiper. 5000 Banded Stilts were recorded at Lake Eliza (South Eastern Wetlands Committee, 1984; Jaensch and Auricht, 1989; Watkins, 1993, compiled by de Jong, 1995) Note that Lake Eliza is not a marine feature, but is included for information, since some of these bird species have a coastal association.

<p>10. Shipwrecks and Artificial Reefs</p>	<ul style="list-style-type: none"> ♦ Most shipwrecks in the area are largely broken up, and could therefore be considered as too fragmented to provide significant additional habitat. ♦ Artificial reefs not known in the area.
<p>11. Popular Dive Sites</p>	<p>(Sources: DIASA, undated; Christopher, 1988; Dive Oz, 1998-2003; Dive South Australia, 2004; South East regional dive promotion materials; unpublished reports from divers).</p> <p>Margaret Brock Reef / Cape Jaffa area: is renown for its abundance and diversity of both marine flora and reef fish; as well as the abundant Rock Lobster; ledges covered with sponges and gorgonians, and the large kelp in the area. Both Weedy and Leafy Seadragons are present in the area. The Pinnacles (Cape Jaffa area) and North Reef (north of Margaret Brock) are recognised for their variety of reef forms (parallel calcareous platform reefs, ledges, crevices, “drop-offs” and “bommies”), abundant reef fish (particularly Banded Sweep, Silver Drummer, leatherjackets, Herring Cale, and various wrasse species) and abundant Rock Lobster. Leafy Seadragons are also present.</p> <p>The shallow reefs up to 1km offshore from Robe, and south of Cape Dombey, are recognised for their rugosity (e.g. containing large crevasses ranging from 5m to 15m depth), and their abundance of Rock Lobster, sponges and other sessile invertebrates, and diverse macroalgae. The reefs adjacent to the Little Dip Conservation Park are recognised for the abundance of Rock Lobster, the abundance and variety of reef fish (including large schools of sweep), and topographical features (long caves and “swim-throughs”, “deep overhangs”, crevices etc).</p> <p>Godfrey Islands and the Black Pigs, 8km north of Robe, are recognised for the abundance of Rock Lobster, macroalgal diversity on patch reefs, diversity of reef fish species, and shelled and unshelled molluscs. The Little Dip coast is recognised for its reef forms (caves, “swim-throughs”, “overhangs”, crevices etc), diversity of reef fish, and large schools of sweep. Nora Creina is recognised for its macroalgal diversity, and other biota associated with the shallow islands at the mouth of the bay. The numerous reef ledges at Stinky Bay are recognised for the presence of Rock Lobster, abundant Abalone, Weedy Seadragons, Wobbegong Sharks, large rays, and various sponges, soft corals and other invertebrates under the ledges.</p>
<p>12. National and/or International Importance</p>	<p>“Bonney Coast” (for which the Upper South-East SA is the boundary): One of only 12 sites in the world where endangered Blue Whales are known to aggregate and feed (Gill 2002; Butler <i>et al.</i>, 2002).</p> <p>Baudin Rocks (Godfrey Islands) (14ha, NPWSA, 2002a): The Conservation Park is on the <i>Register of the National Estate</i>, due to its support of regionally important breeding colonies of Crested Terns and Little Penguins, and the fact that:</p> <ul style="list-style-type: none"> ♦ vulnerable species such as Fairy Terns and Eastern Curlews have been recorded nesting on Baudin Rocks; ♦ rare species such as Eastern Reef Egrets and Peregrine Falcons have been recorded there; and ♦ Australian Sea Lions haul out on the north island of Baudin Rocks. <p>Lacepede Bay Scrub: On the <i>Register of the National Estate</i>. Significant features are mainly terrestrial, but the registered area also includes the beach adjacent to the park. Listed in recognition of its importance as feeding and resting habitat for the migratory, rare and endangered Orange-bellied Parrot.</p> <p>Lakes Robe, Eliza and St Clair: On the <i>Register of the National Estate</i>. Although these lakes are not marine, and are set back from the shoreline, they are considered to have originally been formed as marine lagoons isolated from the sea by the formation of beach dune systems associated with the development of the coastline in this area. The lakes are notable for their range of salinities, and have geological, sedimentological, and limnological significance. Lake Eliza, for example, shows evidence of halite precipitation, and gypsum and carbonate formation, and the lakebed contains unique gelatinous sediments from the deposition of algae and fossilised mussel and oyster</p>

	<p>beds, formed during marine incursion. Also, algal mats have formed around the margins of springs on the lakebed, with evidence of formation of laminar structures similar to stromatolites. Information about the growth, morphology and constructing micro-organisms of these algal mats is of value to the understanding and interpretation of stromatolites and their habitats and are also an important habitat for numerous waterbird species (including rare, threatened and migratory species), some of which have a coastal association.</p> <p>Guichen Bay Conservation Park (103 ha, NPWSA, 2002a): The conservation park is on the <i>Register of the National Estate</i>. Significant features are mainly terrestrial, but the registered area also includes the beach adjacent to the park. Use of the beach area by the Hooded Plover, dotterels, and oystercatchers was mentioned in the Australian Heritage Commission's list of significant features for the registration.</p> <p>Little Dip Conservation Park (2138 ha, NPWSA, 2002a): The conservation park is on the <i>Register of the National Estate</i>. Most of the features of significance in the designation are terrestrial, however two of the features are related to the coastal strip. These are (i) the presence of the threatened Orange-bellied Parrot, which frequents the Park during winter migration along the coast; and (ii) the fact that the Park, including part of Robe Dune Ridge, has been designated a geological monument. It is a portion of the only known area in the world with a complete record of late Pleistocene sea-level changes recorded as stranded dune ridges, with a complex sand dune system bordered by the sea to the west and by salt lakes to the east. The portion of the park relevant to this report is the coastal strip, approximately 11km long, which contains sand dunes, cliffs, shore platforms, reefs and islets. These forms are remnants of the Robe Range, formed as the result of changing sea levels. According to the Australian Heritage Commission (undated), a major sea level rise occurred about 6,000 years ago, at which time the sea level rise slowed considerably. The seaward edge of the dune range was exposed to the sea and eroded, forming extensive cliffs, shore platforms, reefs and islets. As a result of a massive onshore sand supply, extensive beach and dune development also occurred. The coastal landforms provide roosting and nesting sites for "numerous bird species". The coastal strip varies in width from 750m to 2km (Australian Heritage Commission, undated).</p> <p>Robe / Little Dip coast (including Baudin Rocks): Collectively, the Robe / Little Dip coast, lakes and offshore islands in the area contain at least 14 bird species (including coastal wetland birds) that are listed under international treaties for migratory birds (JAMBA and/or CAMBA). Examples include Fleshy-footed Shearwater, Bridled Tern, Pacific Golden Plover, Common Greenshank, Common Sandpiper, Terek Sandpiper, Ruddy Turnstone, Latham's Snipe, Great Knot, Red Knot, Sharp-tailed Sandpiper, Red-necked Stint, Long-toed Stint and Curlew Sandpiper (Australian Heritage Commission, undated; J. Paton, bird species list for the Robe area; Waanders <i>et al.</i>, 2002).</p> <p>The Beach Ridge Plains of Lacepede and Guichen Bays may be a unique expression of sea level changes during the Holocene, and therefore represent a geologically significant area (Short and Hesp, 1980 and UEPG, 1982, cited by Edyvane <i>et al.</i>, 1996).</p>
<p>13. Major Commercial and Recreational Fish, Sharks, Molluscs and Crustaceans</p>	<p>Some of the commercially and/or recreationally fished species that occur in parts of the area that collectively encompass the Lacepede Bay / Cape Jaffa area to Nora Creina (including deeper, Commonwealth waters north and west of Cape Jaffa) include:</p> <p><i>Fish:</i> Ocean Leatherjacket, Jackass Morwong, Snapper, Australian Salmon, Mulloway, Boarfish, Gurnard Perch, Blue Morwong, Blue Groper and various other Wrasse species (e.g. Blue-throated Wrasse), Trevally, Sweep, Blue Warehou and Silver Warehou (deeper waters), Ling (deeper waters), Blue-eye Trevalla (deeper waters), Hapuku (deeper waters), Knifejaw (deeper waters), Redfish (deeper waters) Conger Eel, Southern Rock Cod, Snook, Barracouta, Bastard Trumpeter, Striped Perch, Flathead and Garfish.</p> <p><i>Sharks and Rays:</i> Gummy Shark, School Shark (the 2 major shark species that are caught commercially in the area), Bronze Whaler and/or Black Whaler, Saw Shark, Whiskery Shark, Elephant "Shark" are also caught in lesser numbers, in deeper waters in the area; and various ray species.</p> <p><i>Invertebrates:</i> The major invertebrates caught commercially and recreationally in the area</p>

	are Southern Rock Lobster and Blacklip Abalone. Other commercially and/or recreationally fished invertebrates in the area include Greenlip Abalone, Velvet Crabs, Giant Crabs, Octopus, and Cuttlefish.
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8.19 Lower South-East (Otway Bioregion)

Figure 21 shows the location of this area.



Figure 21: Lower South East

<p>1. Biogeographic Significance</p>	<p>Lower South-East</p> <ul style="list-style-type: none"> ◆ Nutrient-rich deeper water upwelling is a significant oceanographic feature in the region (Schahinger, 1987; Lewis, 1981). Upwelling extends, according to strength and duration of south-easterly winds, to several kilometres offshore, and reduces summer water temperatures during upwelling periods to 11-12^oC (Rochford, 1977; Lewis, 1981; Petrusevics <i>et al.</i>, 1998; IMCRA Technical Group, 1998). The major south-eastern upwelling has recently been named the “Bonney Upwelling”, which extends from Robe in S.A. to Portland, Victoria (Butler <i>et al.</i>, 2002). ◆ The physical conditions in the area and the resultant high productivity of nutrients and phytoplankton (Butler <i>et al.</i>, 2002), promote high productivity of krill, which attracts blue whales to deeper waters off the Bonney Coast. The Bonney Coast region (i.e. south-eastern SA and western Victoria) is one of only 12 areas in the world where Blue Whales (listed as <i>endangered</i> at international, national and state levels) aggregate to feed. The Bonney Coast, of which the lower South East of S.A. is part, is considered to be habitat of major importance for Blue Whales (see Butler <i>et al.</i>, 2002), and during 2002-2003 was being considered for listing under the Commonwealth’s <i>EPBC Act 1999</i>. ◆ Cape Douglas – Victorian Border: Stands of Bull Kelp (<i>Durvillaea potatorum</i>) and Giant Kelp (<i>Macrocystis angustifolia</i>) and its associated communities occur throughout the area. In South Australia, Bull Kelp and Giant Kelp are characteristic of the Upper to Lower South-East of South Australia (see IMCRA Technical Group, 1998), and occur in no other part of this State (see Relative Productivity below, for more information on the significance of kelp). ◆ Eight Mile Creek (connecting Ewens Ponds): The outflow from Eight Mile Creek is considered to be the only “significant river system” with a marine outlet along the South East coast of S.A. (Ashman and Grandfield, 1984, Hallam and Thurgate, 1992, cited by Morelli and de Jong, 1995 and Edyvane, 1999b), with flows of up to 2.3 cubic metres per second. Eight Mile Creek is not a completely natural feature as it has been modified to drain the area, and although the creek may therefore impact the near-shore area (see section on Issues for Risk and Impact Assessment), Eight Mile Creek provides an estuarine function, as does Ellards Creek (which drains Piccaninnie Ponds - see sections below), and significant estuarine areas are uncommon in the south-eastern part of S.A. ◆ The Glenelg River Estuary has been described as “a high value wetland for its ecological features” (Parks, Flora and Fauna Division of DNRE, 1995; Dixon, 2002). Bird (1977) noted that the wetland is of special geo-morphological interest, being the only estuarine lagoon system in Victoria developed within a framework of dune calcarenite ridges (Bird, 1977, after Fraser, 1972, cited by Parks, Flora and Fauna Division of DNRE, 1995). Barson and Calder (1976) stated that the Glenelg River Estuary contains the only remaining relatively undisturbed saltmarsh community in western Victoria. The estuary also supports the only known stand in Victoria of <i>Eucalyptus leucoxylon</i> var. <i>macrocarpa</i> (Barson and Calder, 1976; Gullan <i>et al.</i>, 1990; cited by Parks, Flora and Fauna Division of DNRE, 1995; Dixon, 2002).
<p>2. Major Physical Influences, and Relative Productivity Level</p>	<p>Physical Influences</p> <ul style="list-style-type: none"> ◆ Lower South-East: Nutrient-rich deeper water upwelling is a significant oceanographic feature in the region, and is one of the major physical influences (Lewis, 1981). Upwelling is particularly evident in the Port MacDonnell area. Upwelling extends, according to strength and duration of south-easterly winds, to several kilometres offshore, and reduces summer water temperatures of bottom waters during upwelling periods to 11-12^oC (Rochford, 1977; Lewis, 1981; Petrusevics <i>et al.</i>, 1998; IMCRA Technical Group, 1998). During summer, the bottom water is characterised by lower temperature, lower oxygen content, higher nitrate concentrations, as well as lower salinity than the overlying surface water (Lewis, 1981). The south-easterly upwelling of cool, nutrient-rich waters is driven by the prevailing south-easterly winds (Butler <i>et al.</i>, 2002), and is responsible for the high productivity of the “Bonney Coast” (see below). ◆ According to current speed maps in the South Australian Coast and Marine Atlas

	<p>(2001, data by P. Petrusevics), the lower South-East (e.g. Cape Northumberland area, extending to the Victoria border and further east) is one of 7 areas in S.A. where both summer and winter <i>current speeds</i> are strongest. The Flinders Current, from eastern Tasmania, is a dominant influence in South-Eastern S.A., particularly deeper offshore waters (see map in Jeffrey <i>et al.</i>, 1990).</p> <p>Other major physical influences include:</p> <ul style="list-style-type: none"> ♦ the variable wave energy, ranging from high in areas where nearshore reefs are minor or absent (and thus wave action is not attenuated) (e.g. Brown Bay; Discovery Bay), to low, in more protected bays (e.g. Port MacDonnell Bay); ♦ the narrow continental shelf of less than 30km (thus resulting in steep depth gradients close to the coast), and ♦ the extensive limestone and mobile sand substrates (see Butler <i>et al.</i>, 2002). <ul style="list-style-type: none"> ♦ Freshwater Discharge: “Most of the groundwater discharge in the South East occurs to the sea. Some occurs via drains, wetlands and streams, but most occurs directly from unidentified springs and seeps in the marine environment. Discharge will have local and regional effects on the marine environment, influencing salinity, nutrient concentrations, temperature and flow patterns. It is likely that some marine ecosystems have developed a level of dependence on this discharge, where it occurs. However, there is no information available on the interaction between ecosystems and groundwater discharge” (URS Australia, 2000). Major freshwater discharges in the area include Eight Mile Creek and Ellards Creek, and there are several smaller permanent creeks (e.g. Cress Creek) and freshwater soaks on the beach (e.g. in the Pleasant Cove area; Feast Bay; Discovery Bay; the beach near Pick’s Swamp; and the Victorian border). <p>Relative Productivity</p> <ul style="list-style-type: none"> ♦ Cape Douglas – Victorian Border: Stands of Bull Kelp (<i>Durvillaea potatorum</i>) and Giant Kelp (<i>Macrocystis angustifolia</i>) and its associated communities occur throughout the area. Beds of large kelp are a significant contributor to marine productivity, habitat structure, nutrient recycling (with detritus following decay becoming incorporated into the marine food web of the South-East), and the ecological functioning of the areas in which they occur (e.g. see PIRSA, 1998; Baker, 2000, Appendix 2; DPIWE Kelp Watch web site 2001; and Edyvane, 2003). ♦ Lower South-East: The Bonney Upwelling is responsible for promoting concentrations of phytoplankton, and surface swarms of coastal krill (which attract Blue Whale aggregations along part of the “Bonney Coast” – see Butler <i>et al.</i>, 2002). Other consequences of the upwelling include a distinct colder-water flora (Womersley 1984 and 1990 and see below) comprising a high diversity of macroalgae, particularly red species (Shepherd, 1979; Edyvane and Baker, 1999a); rich assemblages of molluscs and filter-feeders such as sponges, bryozoa and corals (Boreen <i>et al.</i>, 1993, cited by Butler <i>et al.</i>, 2002), and very high productivity in invertebrate fisheries (e.g. Rock Lobster and Blacklip Abalone). ♦ <i>Beach wrack</i> deposits are high in some areas, such as Middle Point, Racecourse Bay, Riddoch Bay, Danger Point, Green Point (particularly large deposits), Pick’s Swamp, Discovery Bay, and coast near the Victorian border (Jones, 2000a and 2000b and undated). Beach wrack deposits have significant ecological values in terms of nutrient recycling and in near-shore foodwebs, amongst other ecological values (see Matthews and Queal, 1997; PIRSA, 1998; Baker, 2000, Appendix 2, for summaries). In particular, the rotting piles of macroalgae on beaches in the lower South-East are recognised for the large numbers of larvae and insects they attract, which in turn attracts large numbers of wading birds, including migrant species, which feed in these areas (K. Jones, Coastcare, undated). <p>Other details of relative productivity for this region are not known for this report.</p>
<p>3. Bioregional Representative-ness of Habitats</p>	<p>The area described here contains features that are characteristic of the Otway Bioregion (IMCRA Technical Group, 1998), namely:</p>

	<ul style="list-style-type: none"> ♦ High deepwater wave energy coastline*, attenuated by a steep nearshore - offshore gradient, and reefs which decrease wave energy to moderate in some areas; ♦ Wave energy dependent upon the orientation to prevailing swell direction, and cross shelf width; ♦ Cool-cold temperate waters that are characterised by localised, regular, seasonal nutrient-rich cold water upwellings; ♦ Pleistocene dune rock cliffs, shore platforms and reefs, which provide coastal protection; ♦ Tertiary sediments; ♦ Sandy beaches in the western part of the Otway Bioregion, within coastal embayments; ♦ Marine flora and fauna typically cold temperate (Maugean element of the Flindersian Province – Womersley, 1984 and 1990); ♦ Intertidal and subtidal fringe on wave-exposed coasts dominated by the Bull Kelp <i>Durvillaea potatorum</i>; ♦ Rocky subtidal macroalgal communities dominated by <i>Macrocystis angustifolia</i> and other large brown macroalgae; ♦ Eastward limit of a number of macroalgal and seagrass species (e.g. the seagrass <i>Posidonia angustifolia</i>); ♦ Areas of seagrass in limited sheltered embayments, and smaller stands in the lee of reefs; ♦ Very high plant species diversity, particularly amongst the red algae; ♦ Coastal <i>Wetlands of National Importance</i>, such as Ewens Ponds and Piccaninnie Ponds. <p>* (Note that the highest wave energy beach which characterises the South Australian portion of Otway Bioregion is located further north, at Canunda);</p> <ul style="list-style-type: none"> ♦ Deeper waters of the South-East: The area also supports fish and crustacean species that are either associated with, or may be more abundant in, cool temperate water habitats. Examples of fish include Southern Conger Eel, Warehou species, and Bastard Trumpeter, which are all caught commercially in the lower South-Eastern S.A. and Western Victorian region. A number of the commercial fish species in the Lower South-East are characteristic of the Otway Bioregion, which also includes Victorian and far north-western Tasmanian waters.
<p>4. Habitat Rarity</p>	<p>Ellards Creek (drains Piccaninnie Ponds) and Eight Mile Creek (draining from Ewens Ponds): Although Ellards Creek outlet is a channel cut through the fore-dunes, it may still qualify as an example of a unique habitat type, because it is one of the two largest discharge points of freshwater in the lower South-East. Similarly, Eight Mile Creek is the other significant estuarine area in the lower South-East of S.A., where such habitats types are uncommon, and most are of small volume and spatial extent.</p> <p>Beach area between Piccaninnie Ponds and Victorian border: There are freshwater springs, which bubble up onto the beach in this area. This is an uncommon feature on beaches in South Australia as a whole. The beach springs are important for coastal birds and molluscs in the area (NPWSA, undated).</p> <p>There are small areas of seagrass in some of the bays, such as parts of Blanche Bay and Port MacDonnell, which are regionally uncommon in the lower South-East in general (Edyvane and Baker, 1999a, and SARDI S.A. Benthic Survey data, 1996).</p>
<p>5. Habitat Diversity</p>	<p>Within the area described in this table, general habitats and features represented in the area include:</p> <ul style="list-style-type: none"> ♦ mud, sand and shingle beaches (particularly shingle), some backed by dunes; ♦ significant freshwater inputs; ♦ calcareous reef of various depths, forms and covers; ♦ kelp stands;

- ♦ seagrass (minor);
- ♦ benthic sand (including mobile sands over calcareous platforms) .

More specifically, the following points describe the main features of habitats in the area:

- ♦ freshwater discharge points via drains, aquifers, groundwater creeks and/or coastal lakes;
- ♦ moderate to high wave energy beaches;
- ♦ small seagrass-lined bays, and seagrass stands in the lee of reefs;
- ♦ shore platforms;
- ♦ sandy beaches within coastal embayments;
- ♦ calcareous reefs, dominated by a variety of mixed macroalgae and invertebrates, many characteristic of Maugean Sub-Province. Reefs are dominated by Bull Kelp (*Durvillaea potatorum*) in the intertidal and sublittoral fringe; and nearshore subtidal macroalgal communities in some areas are dominated by *Macrocystis angustifolia*, extending down to around 25+m in some areas. Deeper reef areas, especially in the western part of the described areas, are characterised mainly by diverse and abundant red macroalgae (Shepherd, 1979; Edyvane and Baker, 1999a) and a dense assemblages of molluscs, sponges, and bryozoa (Butler *et al.*, 2002), and overlapping in distribution with *Macrocystis* forests in some areas where light penetration is sufficient.
- ♦ Benthic sand habitat, especially in the area east of Cape Northumberland;
- ♦ Deeper water (25m to at least 60m) flat calcareous platform reef, which contains many holes and crevices, and is a major habitat for attached fauna such as bryozoa, sponges, molluscs, crustaceans and other invertebrates. Red macroalgae also occur in the area, decreasing in abundance and diversity with depth (and hence light penetration) (see below).

Note: The calcareous reefs at different depths, described below in terms of their dominant macroalgal cover, are also important representative habitat for numerous macro-invertebrates that are common in the area.

Selected Habitat Notes

(from Shepherd, 1979; Edyvane *et al.*, 1996; Edyvane and Baker, 1999a; SARDI S.A. Benthic Survey data, 1996; DEH 1:10 000 and 1:25 000 aerial photographs; S.A. Coast and Marine Atlas, 2001; Jones, Coastcare, undated; Master Plan *et al.*, 2000).

In general, shallow limestone reefs along the coast produce a low energy shoreline in their lee, with intermittent sand and shingle beaches occupying moderate wave energy environments. Nearshore reefs of the region can significantly lower wave energy; they also act as a barrier to onshore sand transport by restricting the development of equilibrium nearshore sand profiles; and the reefs also provide the shingle / sediment to build beaches. The coast of the lower South-East is highly variable and irregular, with morphologies switching between limestone and occasional dune rock shore platforms and low cliffs, to low energy shingle beaches and ridges, with a few moderate energy sandy beaches backed by minor dune fields (Short and Hesp, 1980, cited by Edyvane *et al.*, 1996). Wave energy increases towards the Victorian border, and periodically, there is strong surf at the coast near the border area.

Cape Douglas – Port MacDonnell

The coastal and nearshore marine areas comprises the following:

- ♦ *Rugged, high energy headlands / cliffs* (e.g. **Cape Douglas / Douglas Point, Middle Point, Finger Point, Cape Northumberland**, amongst others);
- ♦ *Various bays*, in some areas backed by dunes. Examples include shallow open bays (**Umpherstone Bay**), small coves and bays with mud beaches, shingle / pebble beaches (near **Middle Point**; and **Pleasant Cove / Cape Northumberland**), and sand beaches (**Finger Point; MacDonnell Bay**),
- ♦ *Coastal wetlands* (in years of high rainfall), such as the **Wool Wash** area near **Port MacDonnell** and the wetland behind the town; the wetland backing **Umpherstone Bay**, and the “Treaclepot Wetland” near **Pleasant Cove**;

- ♦ *Minor freshwater drainage points.* Examples include small creeks that run to the coast, either permanently (e.g. **Cress Creek** at **Port MacDonnell**) or during years of high rainfall (e.g. the creek at **Umpherstone Bay**), and freshwater soaks on the beach (e.g. outlet of Treaclepot Creek, at **Pleasant Cove / Cape Northumberland** area);
- ♦ *Nearshore reefs,* mainly calcareous / limestone and highly dissected (e.g. **Orwell Rocks**), but also including flint pebble reefs (e.g. **Middle Point**) and calcareous cobble reefs. Mixed calcareous patch reef, sand, shingle / pebbles and seagrass habitats occur in some of the nearshore bays (e.g. **Umpherstone Bay**). Near-shore limestone patch reefs (with dune-rock capping, e.g. west of breakwater at **Port MacDonnell**) are dominated by species-rich green and red macroalgae and invertebrates. Gastropod molluscs and decapod crustaceans are abundant in some areas. Limestone reef in the area is often covered with species-rich assemblages of green and red macroalgae assemblages (also with scattered plants of the large brown *Acrocarpia paniculata*) in shallow waters (to 7m – 10m), occurring in areas where Bull Kelp does not dominate (Shepherd, 1979). Surveys during the 1970s and 1990s showed that assemblages contained up to seven species of the green *Caulerpa*, and species of *Codium* and other chlorophytes. Common red macroalgae in such communities include species of *Ballia*, *Chondria*, *Gelidium*, *Hymenena*, *Laurencia*, *Melanthalia* and *Phacelocarpus* as dominant components of the flora, with many other red species also present. In some areas, shallow subtidal reefs (e.g. 4m – 10m) are dominated by invertebrates and red macroalgae rather than large brown canopy macroalgae. The brown macroalga *Ecklonia radiata* and mixed red macroalgae-dominated assemblages of high species diversity, occur on calcareous reefs (e.g. from around 10m – 30m in the Cape Northumberland area) (Shepherd, 1979).
- ♦ *Near-shore Bull Kelp (*Durvillaea potatorum*) forests,* dominating nearshore calcareous reefs to a depth of 4m, and to 12m on pinnacles of submerged reefs (Shepherd, 1979). Kelp has been recorded in a number of nearshore areas, including the **Wool Wash** area (Jones, Coastcare, undated).
- ♦ *Near-shore seagrass beds* (e.g. **Blanche Bay** and **Port MacDonnell** areas).
- ♦ *Giant Kelp (*Macrocystis angustifolia*) forests.* For example, such “forests” have been recorded from Cape Banks to **Cape Northumberland**, to around 25m depth (particularly dense at 15m - 18m), with scattered plants to 35m (Edyvane and Baker, 1999a).
- ♦ *Flat calcareous reef dominates the deeper waters (25+m)* of the South-East, from South of the Coorong to the Victorian border. The reef is dominated in some parts of the lower South-East by mixed red macroalgae to at least 40m depth, and sparse coverage of red macroalgae occur at depths of 60m (Shepherd, 1979). The reef is a significant habitat for invertebrates, and contains many holes, ledges, crevices and other micro-habitats for crustaceans including Rock Lobster, sponges, soft corals, molluscs, and other benthic invertebrates, and calcareous organisms (Shepherd, 1979; Edyvane and Baker, 1999a).

Stony Point to Victorian Border

(Shepherd, 1979; Branden and Shepherd, 1990; Morelli and de Jong, 1995; SARDI S.A. Benthic Survey data, 1996, unpublished; Edyvane and Baker, 1999a; DEH 1:10 000 and 1:25 000 aerial photographs; S.A. Coast and Marine Atlas, 2001).

Features characteristic of the area include:

- ♦ *A major river estuary (**Glenelg River Estuary** – see below);*
- ♦ *Estuarine and freshwater wetlands, and associated creeks and ponds:* There are numerous small ponds and drainage areas in the lower South-East (see Hammer 2002). Two of the most extensive systems are the **Ewens Ponds** and **Piccaninnie Ponds** systems, and other wetland areas near the coast include **Pick’s Swamp** and **Discovery Bay**. **Ewens Ponds** are small spring-fed wetlands along the upper reaches of **Eight Mile Creek**, and are connected to the creek by a narrow channel. The ponds are not a coastal feature, but have a coastal connection via **Eight Mile Creek**. Water flows from **Ewens Ponds** along **Eight Mile Creek** and into the sea, west of **Danger Point**. **Piccaninnie Ponds** are large, spring-fed limestone wetlands bounded by coastal dunes, and high volumes of fresh water are discharged to the coast in the **Piccaninnie Ponds** area (K. Jones, Coastcare, undated). **Ewens Ponds** are water-

filled limestone depressions, over feldspathic siltstone and sandstone of the Otway group. Water in **Ewens Ponds** and **Piccaninnie Ponds** originates from Gambier Limestone, an unconfined aquifer of the Gambier Embayment, then discharges into the ponds. The outflow from **Eight Mile Creek** (estimated to be 2.3 cubic metres per second) makes it the only significant river system in the whole South East of S.A. (Ashman and Grandfield, 1984; Hallam and Thurgate, 1992, cited by Morelli and de Jong, 1995). **Ewens Ponds** comprise First Pond, approximately 13 m deep; Second Pond, 8.5 m deep; and Third Pond, which is 9 m deep. The Ewens Ponds wetland area constitutes a remnant of coastal peat fen, with a cover of mixed tea tree (2 species) as well as a reed swamp formation, and mixed sedgeland (Morelli and de Jong, 1995). Surrounding the ponds and covering much of the creek bed is a closed grassland formation of *Phragmites australis*, *Typha angustifolia*, *Cladium procerum*, *Gahnia trifida* and *G. sieberiana*. A closed scrub formation supports species such as *Leptospermum lanigerum*, *Leucopogon parviflorus*, and *Melaleuca squarrosa* on the upper reaches of the ponds, and in small pockets on the creek bed; the ponds support a submerged association of *Triglochin procera*, *T. striata*, *Lemna disperma*, *Potamogeton pectinatus*, *Ruppia maritima*, *Myriophyllum simulans*, *Ranunculus inundatus* and *Lilaeopsis polyantha*, with a variety of aquatic herbs (Ashman and Grandfield, 1984; Lloyd and Balla, 1986, cited by Morelli and de Jong, 1995; Reynolds, 1999b). Blue-green algae *Anabena*, *Oscillatoria*, *Lyngbya* and a species of the freshwater red alga *Batrachospermum* also occur within the ponds, as well as a species of the moss that grows completely submerged in this area (Reynolds, 1999b). **Piccaninnie Ponds** comprises First Pond, approximately 10 m deep; Turtle Pond, a 6m deep basin at the end of a wide channel; and a 90 m deep chasm which leads into a chamber known as the Cathedral (Morelli and de Jong, 1995). The ponds area comprises a water-filled rift and large submerged cave of Gambier Embayment limestone, surrounded by shallow swamps, found between stable coastal dunes to the south and low calcarenite dunes to the north. The Tertiary marine limestone is partially covered by dune ridges and volcanic deposits. The fringing swamps are dominated by grasses and sedges such as *Phragmites australis*, *Typha* sp., *Cladium* sp., *Elocharis* sp. and *Gahnia trifida*; small sections of shallow open water are dominated by emergent *Triglochin procera*, *Ruppia polycarpa* and algae; over 30% of the area has a cover of tea tree thicket with *Leptospermum lanigerum* and *Melaleuca squarrosa* on peat soils (Lloyd and Balla, 1986; SANPWS 1992b, cited by Morelli and de Jong, 1995).

- ♦ *Minor stands of coastal samphire* (e.g. **Racecourse Bay**);
- ♦ *Minor freshwater drainage points to the coast.* (e.g. **Jerusalem Creek** near **Orwell Rocks**; **Humphries Creek**, which runs to **Flinty Point** at **Racecourse Bay**; **Deep Creek** and McKinnon's Creek / Drain at **Riddoch Bay**, **Stony Creek** at **Green Point**), and freshwater soaks on beaches (e.g. **Feast Bay**; **Discovery Bay**; the beach near **Pick's Swamp**; and the **Victorian border**, the latter area including fast-running "bubbler" soaks, one of which emanates from 6m deep in the beach sand);
- ♦ *Rocky headlands* (e.g. **Orwell Rocks**);
- ♦ *Sand beaches* (e.g. **Brown Bay** and **Riddoch Bay**) and *flint shingle beaches* (e.g. **Racecourse Bay**; **Green Point**, and the beach near **Pick's Swamp**) with backing dunes in some areas (e.g. **Orwell Rocks**; **Brown Bay**; **Green Point**, **Discovery Bay** to **Victorian border**).
- ♦ *Nearshore limestone / calcareous reefs*, some highly dissected (e.g. the limestone "stacks" at **Orwell Rocks**), others low profile, with sand patches in some areas. Examples of limestone reef (including patch reefs) include those at **Racecourse Bay**, **Stony Point**, **Danger Point** and **Green Point** area. Some calcareous reefs in the area are often dominated by *Ecklonia radiata*, and species of *Cystophora* and *Sargassum*. Understorey macroalgae include species of the green *Caulerpa*, the red *Plocamium* (Branden and Shepherd, 1990), and many other red species. Large populations of sea urchins occur in some areas, in crevices and beneath limestone slabs (Branden and Shepherd, 1990);
- ♦ *Mixed habitats* in some bays: benthic sand, patch reefs and stands of Bull Kelp and Giant Kelp (e.g. **Riddoch Bay**, **Discovery Bay**);
- ♦ *Giant Kelp forests* (*Macrocystis angustifolia*), occur at various depths, and overlap in distribution in the shallow depths with the *Ecklonia*-dominated reef as described above. Kelp beds have been recorded in the **Racecourse Bay**, **Riddoch Bay**, **Danger Point**

	<p>and Green Point areas (Edyvane and Baker, 1999a; Jones, Coastcare, undated);</p> <ul style="list-style-type: none"> ♦ <i>Flat calcareous reef</i> dominates the deeper waters (25+m) of the South East, from South of the Coorong to the Victorian border (see description above, for Cape Douglas - Port MacDonnell area). ♦ Note: the above descriptions refer to the shallower areas of the shelf. Beyond the zone in which macroalgae are prevalent, Boreen <i>et al.</i> (1993, cited by Butler <i>et al.</i>, 2002) described the shallow part of the narrow continental shelf in the Bonney coast region as comprising exhumed limestone substrates that host dense encrusting mollusc, sponge, bryozoan and red algae assemblages, and the middle shelf as a zone of swell-wave shoaling and production of mega-rippled bryozoan sands. (N.B. The deep shelf and slope are not described here due to their distance from SA. State waters). ♦ Glenelg River Estuary (western Victoria, near S.A. border): The Glenelg River, which is more than 400km long, originates in the Grampians and ends in an estuary several km east of the South Australia border, in Discovery Bay, around 1km south of Nelson. The Glenelg River Estuary is a large estuarine system consisting of the main channel of the Glenelg River, and a side lagoon called the Oxbow. There are protected estuarine sand beaches at the mouth, and surf-exposed sandy beaches on the ocean side, in Discovery Bay. The estuary is bordered on both sides by the Discovery Bay Coastal Park. Water from a number of wetland systems (e.g. Lindsay-Werrikoo Wetlands and Mundi-Selkirk) drains into the Glenelg River, and ends at the estuary. Mean annual discharge in the Glenelg River at Dartmoor (upstream from Nelson) is around 630 000 mega-litres. Geologically, the Glenelg Estuary consists of Quaternary lacustrine, paludal, alluvial and coastal sediments, on Quaternary aeolian sediments (Parks, Flora and Fauna Division of DNRE, 1995). Bird (1977) noted that the wetland is of special geo-morphological interest, being the only estuarine lagoon system in Victoria developed within a framework of dune calcarenite ridges (Bird, 1977 after Fraser, 1972, cited by Parks, Flora and Fauna Division of DNRE, 1995 and Dixon, 2002). Barson and Calder (1976, cited by Parks, Flora and Fauna Division of DNRE, 1995) stated that the Glenelg River Estuary contains the only remaining relatively undisturbed salt marsh community in western Victoria. The estuarine area supports dense coastal, wetland / swamp and heath vegetation communities. There are also several large coastal lakes east of the estuary, and the largest dunes on the Victorian coast also occur east of the mouth (Wilmap Pty. Ltd. 2002; Parks Victoria, 2002).
<p>6. Taxonomic Diversity</p>	<p>Marine Plants Cape Douglas – Cape Northumberland area: High diversity of benthic macroflora, partly attributed to the nutrient upwelling at Port MacDonnell and the variable wave climate due to presence of extensive nearshore reefs. The area contains species-rich assemblages of macroalgae (around 200 species recorded in some areas e.g. Cape Northumberland – Shepherd, 1979 and 1981), including assemblages that are species-rich in green macroalgae in some shallow waters, and assemblages dominated by diverse red macroalgae, to approximately 40m, with some species extending to 60m (see Habitat Notes).</p> <p>Invertebrates Surveys of invertebrate populations in deeper waters are not available for this report, however it is recognised that the combination of nutrient-rich upwelling, and “exhumed” limestone substrates in the area, support dense assemblages of bryozoa, sponges and molluscs (Boreen <i>et al.</i>, 1993; Butler <i>et al.</i>, 2002), which are also likely to be species-rich.</p> <p>Coastal Birds Ewens Ponds: 43 waterbird species recorded (see Lloyd and Balla, 1986; Morelli and de Jong, 1995, and Rogers, 2002 for examples), several of which are listed under international treaties. Piccaninnie Ponds: 41 waterbird species recorded, several of which are listed under international treaties (Lloyd and Balla, 1986; Morelli and de Jong, 1995; Master Plan <i>et al.</i>, 2000). Around 33 waterbird species have been recorded in the Glenelg River Estuary (BOC,</p>

	<p>1977; DNRE, 1995; cited by Parks, Flora and Fauna Division of DNRE, 1995).</p> <p>Neither qualitative nor quantitative references to taxonomic diversity are readily available for other areas.</p>
<p>7. Habitat for Endemic Taxa / Threatened Taxa / Rare or Uncommon Taxa</p>	<p>Freshwater Plants / Estuarine Plants/ Marine Plants</p> <p>Port MacDonnell: Presence of stands of uncommon and unusually structured deep water green macroalga <i>Palmocladus stipitatus</i>, south of Port MacDonnell (40 - 60m deep). <i>P. stipitatus</i> forms "large stands" in the lower South East, annually shedding the membranous thallus, and leaving an attached stem which can live for up to 10 years (Edyvane and Baker, 1999a). This species has been described as <i>vulnerable</i> (Cheshire <i>et al.</i>, 2000; Turner, 2000), although it has a large range (>500km). Also presence of two red species of macroalgae with nationally recognised limited range: <i>Griffithsia pilalyea</i> and <i>Faucheopsis coronata</i> (Cheshire <i>et al.</i>, 2000; Turner, 2000).</p> <p>Lower South East (e.g. Cape Northumberland): Around 165 species of macroalgae in the lower south-east are considered quite rare (Shepherd, 1981, cited by Butler <i>et al.</i>, 2002).</p> <p>Cape Northumberland: <i>Hormophora australasica</i> present in the area, which has a nationally recognised limited range. <i>Trematocarpus concinnus</i> (Rhodophyta) is also present in the area, and has also been described as a species of conservation concern (see Cheshire <i>et al.</i>, 2000; Turner, 2000).</p> <p>Ewens Ponds wetland system: The site is a remnant of coastal peat fen with a cover of mixed tea tree (closed shrub formation); reed swamp formation; and mixed sedgeland. This type of swamp vegetation formerly occupied extensive areas along the coastal region of the South East, but most has been cleared for agriculture (Morelli and de Jong, 1995). The wetland system contains species classified as <i>rare</i> at State level (<i>Ranunculus inundatus</i> and <i>Melaleuca squarrosa</i>) (Morelli and de Jong, 1995), as well as a number of aquatic plant species that are not usually found growing fully submerged (Master Plan <i>et al.</i>, 2000).</p> <p>Piccaninnie Ponds wetland system: The largest stand in South Australia of the regionally vulnerable plant community Silky Tea Tree <i>Leptospermum lanigerum</i> occurs at Piccaninnie Ponds (Master Plan <i>et al.</i>, 2000). The site also represents the only conserved site which supports a mixed tea tree <i>Leptospermum lanigerum</i> and <i>Melaleuca squarrosa</i> closed shrub formation, and a reed swamp formation with <i>Phragmites vulgaris</i> and <i>Typha angustifolia</i>. This type of swamp vegetation formerly occupied extensive areas along the coastal region of the South-East of S.A., but most has been cleared for agriculture (Morelli and de Jong, 1995). The area provides habitat for 24 species of threatened plants, including the following (Sr = classified rare in South Australia; Sv = classified vulnerable in South Australia): <i>Gentianella diemensis</i> (Sv), <i>Pterostylis tenuissima</i> (Sv), <i>Microtis rara</i> (Sr), <i>Cotula reptans</i> (Sr), <i>Ranunculus inundatus</i> (Sr), <i>Melaleuca squarrosa</i> (Sr), <i>Deyeuxia minor</i> (Sr), <i>Baumea rubiginosa</i> (Sr), <i>Carex pumila</i> (Sr), <i>Gahnia clarkei</i> (Sr) and <i>Hydrocotyle hirta</i> (Sr) (Lloyd and Balla, 1986; SANPWS, 1992b, cited by Morelli and de Jong, 1995). A small number of the plant species at Piccaninnie Ponds are also classified as threatened species at national level (Master Plan <i>et al.</i>, 2000).</p> <p>A number of rare and/or threatened plant species occurring in the Glenelg River Estuary include the Lax Twig-rush <i>Baumea laxa</i> (listed as <i>rare</i> under Victorian legislation); Leafy Greenhood <i>Pterostylis cucullata</i> (listed under Victorian legislation as <i>vulnerable</i>, and also listed under the <i>Flora and Fauna Guarantee Act 1988</i>), and the only known Victorian occurrence of <i>Eucalyptus leucoxydon</i> var. <i>macrocarpa</i> (Barson and Calder, 1976; Gullan <i>et al.</i>, 1990; cited by Parks, Flora and Fauna Division of DNRE, 1995).</p> <p>Invertebrates</p> <p>Cape Northumberland – Port MacDonnell area: Presence of invertebrate species uncommon in South Australia, due to Maugean affinities (e.g. cold temperate ascidian <i>Syoicum citrum</i> - see Kott, 1997).</p> <p>Port MacDonnell and other parts of the lower South-East: Various specimen shell species are found on reefs in the Lower South-East. Many species of specimen shell in southern Australia are of conservation concern due to their vulnerable population characteristics (see section 9.2). An incomplete list of specimen shell species known to occur in various parts of the lower South-East include the following (see Baker, 2002,</p>

for examples of localities, and a preliminary summary of conservation status according to various specimen shell authorities in Australia): *Notocypraea angustata* (Plump Cowrie / Tight Cowrie); a pure white form of the small cowrie *Notocypraea comptoni* (Compton's Cowrie); *Notocypraea declivis* (Sloping Cowrie); the cowrie *Umbilia hesitata* – for which south-eastern S.A. is the western edge of the range – see Wilson and Clarkson, 2004); *Pterynotus* (= *Pterochelus*) *diffusi* (Diffuse Murex); various Triton species, such as a variety of the Sand Triton *Sassia eburnea*, for which the South East of South Australia is the western end of the range.

Ewen's Ponds and Piccaninnie Ponds: Some of the freshwater crustaceans and molluscs in the ponds are uncommon, and have been described, in management plans for the area, as potentially threatened species.

Bony and Cartilaginous Fish

Eight Mile Creek (Ewens Ponds) and Ellards Creek (Piccaninnie Ponds outlet): A number of regionally uncommon fish species associated with the creek outlets and other drainage channels are present in the near-shore area (Short-Finned Eel *Anguilla australis*, Wide-Mouthed Lamprey *Geotria australis* and Short-Headed Lamprey *Mordacia mordax*) (Glover, 1983; Lloyd and Balla, 1986; Hallam and Thurgate, 1992), or have previously been present (Australian Grayling *Prototroctes maraena*, Glover, 1983; Hallam and Thurgate, 1992; Hammer, 2002; Hammer, Adelaide University, pers. comm. 2003). Such species are dependent upon both freshwater and marine habitats at stages in the life cycle. These species are discussed below:

- ♦ Australian Grayling *Prototroctes maraena* is a freshwater fish, but has a marine stage to the life cycle, and the species may be considered vulnerable due to having a narrow habitat range (i.e. the species is dependent upon a small number of estuaries, particularly in cool temperate regions), and due to impacts upon the quality of critical estuarine habitat. Although the species is found in other southern Australian states, its occurrence in South Australia has previously been restricted to small areas of the South-East, having been reported from **Eight Mile Creek (Ewens Ponds)** (Glover, 1983; Kuitert, 1983b) and **Ellards Creek (Piccaninnie Ponds)** (Hallam and Thurgate, 1992). The lower South-East records represent the most westerly extent of the range (Hammer, 2002). An inventory of the freshwater fish of South-East South Australia was recently completed, and the grayling was not found. In South Australia, the species was previously found in a restricted section of the lower South-East until the mid 1980's and is now presumed extinct or to have been a transient population (Hammer, 2002; M. Hammer, Adelaide University, pers. comm., 2003). Glover (1983) reported that the Australian Grayling is one of Australia's *rarest* and most "*extinction-threatened*" fish species. The current status of Grayling is listed as follows: IUCN's Red List 2003: *Vulnerable*; EPBC Act 1999: *Vulnerable*; Tasmanian Threatened Species Protection Act 1995: *Vulnerable*; NSW: *Protected Species* (Fisheries Management Act 1994); Australian Society of Fish Biology 2001 list: *Vulnerable*.
- ♦ The Pouched Lamprey (Wide-Mouth Lamprey) *Geotria australis* and Short-Headed Lamprey *Mordacia mordax* are members of the ancient jawless vertebrates group (Class Cephalaspidomorphi), that contains few living species, but was dominant in seas around 300 million years ago (Edgar, 2000). Both species occur in the lower South-East, such as the **Ewens Ponds** and **Piccaninnie Ponds** systems (Kuitert 1983b; Hammer, 2002). Lampreys have both freshwater and marine stages to the life cycle, and are dependent upon both habitats. After migrating to the sea they become parasitic adults, and following the marine stage during which they grow rapidly, they re-enter fresh water to spawn and die, following an arduous upstream migration. The newly hatched lampreys complete a larval stage within rivers, remain in rivers for several years, and then migrate to sea. Little is known of the marine stage (Edgar, 2000; Water and Rivers Commission of WA, 2000b). *G. australis* reportedly requires permanent creek / river headwaters in good ecological health to complete their life cycle (Water and Rivers Commission of WA, 2000a). *G. australis* may be considered vulnerable, due to narrow habitat range. The species is dependent for part of its life cycle upon a small number of estuaries, particularly in cool temperate regions, and impacts upon the quality of critical estuarine habitat may affect this species. In southern Australia, *G. australis* is considered to have suffered from the effects of weirs, which prevent or inhibit the freshwater migration phase of the life cycle (Inland Rivers Network, NCCNSW 1999). Lampreys must overcome both natural and man-made obstacles in order to migrate upstream and reach their breeding habitat. The journey upstream can

be hazardous and during this time many Pouched Lampreys are reported to die from internal bleeding, blood poisoning, or from injury or exhaustion incurred from attempting to climb over or get around obstacles. Some Pouched Lampreys die after getting lost or stranded during the journey (Pen *et al.*, 1991, cited by Water and Rivers Commission of WA, 2000b). Threats to populations of lampreys include in-stream barriers preventing migration; significant changes in riverine / stream habitat (e.g. water courses drying up from excessive water extraction); and physical damage to stream habitats (SANFA, 2000; Inland Fisheries Service of Tasmania, 2002).

- ♦ Short-Finned Eel *Anguilla australis*, which is found in southern Australian and Tasmanian waters, New Zealand and the south-western Pacific (Inland Fisheries Service, 2002; Native Fish Australia, 2002), has both freshwater and marine stages to the life cycle. In southern Australia, the species occurs in coastal rivers, creeks, lakes and swamps (Inland Fisheries Service, 2002). In S.A., it is known from estuarine creeks, ponds and other drainage areas in the lower South-East, including **Piccaninnie Ponds** and **Hammerhead Pond**, and **Eight Mile Creek** drainage areas, such as **Ewens Ponds**, **Eight Mile Creek** stream, **Jerusalem Creek**, and Clarke Park drain (Hammer, 2002). In South Australia, the species is considered rare (Native Fish Australia, 2002), and a species of conservation concern (Hammer, 2002), but has not been formally listed to date. It is believed that adult eels migrate downstream upon maturity, to breed at great depth in or near the Coral Sea of north Queensland. Spawning time is not well known, but adults are believed to die after spawning. Larval eels are then swept back to the coast by ocean currents, where they transform into glass eels and move into the estuaries from March to November, where they become pigmented elvers. Elvers then move upstream over several years (Inland Fisheries Service, 2002; Native Fish Australia, 2002). The species is commercially fished in Victoria and Tasmania (Inland Fisheries Service, 2002). *Anguilla australis* may be considered vulnerable, due to (i) narrow habitat range within a key part of the life cycle: i.e. the species is dependent for part of its life upon a small number of estuaries, particularly in cool temperate regions, and impacts upon the quality of critical estuarine habitat may affect this species; and (ii) late sexual maturity, particularly for females (between 10 and 20 years of age for females, and 8 to 10 years for males) and relatively long life (more than 30 years) (Inland Fisheries Service, 2002), making populations vulnerable to over-fishing of sexually immature individuals. In southern Australia, *A. australis* is considered to have suffered from the effects of weirs, which prevent or inhibit the freshwater migration phase of the life cycle (Inland Rivers Network, Nature Conservation Council of NSW, 1999). In South Australia, the habitat of Short-finned Eel is restricted, because the species relies upon coastal wetland systems. Hammer (2002) reported that there appears to be density differences in areas with and without fishing pressure, and due to the degradation of wetlands, and fishing (i.e. local capture of adult eels by anglers, and interstate harvest of younger eels in commercial fisheries), the species is likely to have declined in addition to an already restricted range. The species is considered rare in South Australia (Native Fish Australia, 2002). The National Parks and Wildlife Council and Department for Environment and Heritage (2003) has recommended that *A. australis* be listed as Rare, under a schedule of the *National Parks and Wildlife Act 1972* (see National Parks and Wildlife Council and Department for Environment and Heritage, 2003).
- ♦ *Congolli*: The estuarine fish species Congolli *Pseudaphritis urvillii* has also been recorded in ponds, streams and other drainage areas connected with **Ewens Ponds / Eight Mile Creek** system and the **Piccaninnie Ponds / Ellards Creek** system (Ashman and Grandfield 1984, cited by Morelli and de Jong, 1995; Hammer, 2002). Congolli is considered to be a species of conservation concern in South Australia (Hammer 2002, Table 3.0.1), due to population decreases in major estuarine areas (e.g. Murray-Darling Basin) and reduced abundance, despite a possible extension in range due to increased freshwater access (Hammer, 2002). The National Parks and Wildlife Council and Department for Environment and Heritage (2003) has recommended that the species be listed as *Rare*, under a schedule of the *National Parks and Wildlife Act 1972*.

Surveys of fish species in the coastal drainage areas of the Lower South-East (e.g. **Ewens Ponds** and/or **Piccaninnie Ponds**) have recorded, in addition to the estuarine species discussed above, 6 freshwater species of *national and / or State conservation significance* (see Hallam and Thurgate, 1992; Morelli and de Jong, 1995; Hammer, 2002):

- ♦ Spotted Galaxias *Galaxias truttaceus* (of conservation concern in S.A. – see Hammer, 2002);
- ♦ Dwarf Galaxias *Galaxiella pusilla* (listed as *vulnerable* nationally, and also considered to be of conservation concern in S.A. - see Hammer, 2002);
- ♦ River Blackfish *Gadopsis marmoratus* (protected under South Australian legislation);
- ♦ Variegated Pygmy Perch / Ewen's Pygmy Perch *Nannoperca variegata* (nationally listed as *vulnerable*, and protected under S.A. legislation due to its rare status);
- ♦ Yarra Pygmy Perch *Nannoperca obscura* (nationally listed as *vulnerable*, and protected under S.A. legislation); and
- ♦ Southern Pygmy Perch *Nannoperca australis* (SE sub-species protected under S.A. legislation).
- ♦ *Luderick*: Luderick *Girella tricuspidata* is mainly an eastern states species, and is infrequently / rarely found in South Australia (Hutchins and Swainston, 1986; Australian Museum, 2002), which is at the end of the range (Kuitert, 1996a). Luderick is intensively fished by commercial and recreational fishers over most of its range (particularly in NSW and Victoria, but also caught in the **Lower South-East** of S.A.). Luderick is a shallow coastal species (to 20m) (Kuitert, 1996a; Edgar, 2000), with juveniles and adults in estuaries and other shallow coastal areas (Australian Museum, 2002), which may make them vulnerable to nearshore habitat impacts.

Reefs of the Lower South East: Presence of site-associated reef fish species of conservation concern, such as Western Blue Groper, Purple Wrasse (for which south-eastern S.A. is the western limit of the geographic range), and various other Wrasse species. The reported status of these reef fish species, and potential threats to their populations, are discussed in Section 9.2, and in Baker (in press).

Port MacDonnell area: Presence of Weedy Seadragons (Dragon Search Monitoring Program database 1996-2002, and Baker, 2003a.). Weedy Seadragon was listed by IUCN Red List 2003 as *Data Deficient*.

The **Lower South East** is one of few areas where the eastern and south-eastern Australian species *Urolophus bucculentus* (Sandyback Stingaree) has been recorded in S.A. (see Baker, in press, for summary of published distribution records). Stingaree species such as this are of conservation concern due to their strong habitat association, and viviparous method of reproduction.

“Bonney Coast”: Apart from the syngnathid species listed above, Butler *et al.* (2002) reported that 23 other species of syngnathid occur in the region referred to as the “Bonney Coast” (from Cape Otway / Portland area in Victoria, to Cape Jaffa / Robe area in SA), but these species are not listed here because no details are provided in Butler *et al.* (2002) of the specific localities within the Bonney Coast region in which the species have been recorded, and a number of these may be recorded in deeper, Commonwealth-managed waters.

Glenelg River: Habitat for the endangered Estuary Perch *Macquaria colonorum*. Hammer (2002) reported that although the species was not sampled during a survey in 2000 - 2001 of the drainages of south-eastern South Australia, it does occur in the Glenelg River area near the S.A. / Victorian border. Estuary Perch has previously been recorded in the small section of the Glenelg River that occurs in South Australia (S.A. Museum specimens), and Hammer (2002) reported that the species is still likely to occur there, either occasionally or permanently, based on recent capture of specimens upstream (by J. Stehbens, in 2002). The National Parks and Wildlife Council and Department for Environment and Heritage (2003) has recommended that the species be listed as *Endangered*, under a schedule of the *National Parks and Wildlife Act 1972*.

Glenelg River: Habitat for the Large-Mouth Goby *Redigobius macrostoma* (Gomon *et al.*, 1994; Kuitert, 1996b), a species of goby that is more common in eastern Australia, but rarely recorded in South Australia (see Baker, in press, for summary of distribution).

Marine Mammals

Pods of Blue Whales (particularly the sub-species Pygmy Blue Whale), have been recorded along the coast in lower southern eastern South Australia (Australian Broadcasting Commission, 2001; Butler *et al.*, 2002; Parks Victoria, 2002). Pygmy Blue Whale (*Balaenoptera musculus brevicauda*) may be a sub-species of the Blue Whale (Rafic, 1999). According to P. Gill (Deakin University), the Blue Whale population is estimated to be less than 6000 in the Southern Hemisphere, reduced from approximately 250,000 by previous whaling in the 19th and 20th centuries. An aggregation site for Blue Whales is reported to be at a shelf break in deeper Commonwealth waters (200m), mainly between **Port MacDonnell** and **Warrnambool**, Victoria, and is one of only 12 feeding areas in the world where Blue Whales aggregate regularly in relatively large numbers (Media Release, Environment Australia September 2001; Butler *et al.*, 2002). Globally, Blue Whale was listed as *Endangered* in the IUCN Red List 2003, and also in the Commonwealth's *EPBC Act 1999*, and under South Australian legislation (*National Parks and Wildlife Act 1972*).

Southern Right Whales occur seasonally along the coast of the lower South-East, such as the **Port MacDonnell** area (Media release, June 2003) and the **Discovery Bay** coast (Parks Victoria 2002). The Southern Right Whale was listed in the IUCN's Red List 2003 as *conservation dependent*. The species is listed under S.A. legislation as *vulnerable*, and is also listed under the Commonwealth's *EPBC Act 1999* as a threatened species.

Australian Fur Seals occur along the **Discovery Bay** coast near the Victorian / South Australian border (Parks Victoria, 2002). The Australian Fur Seal was classified in the IUCN Red List 2000 as *Lower Risk, but Conservation Dependent*, however it was not included in the IUCN Red List 2003. The Australian Fur Seal has been described as "the world's fourth rarest sea species" (Parks and Wildlife DPIWE, 2003).

Wetland Mammals

Piccaninnie Ponds: The Swamp Antechinus *Antechinus minimus*, classified as *rare* under S.A. legislation, is found in the wetland system (Morelli and de Jong, 1995).

Coastal and Marine Birds

Ewens Ponds / Eight Mile Creek: Habitat for Musk Duck, classified as *rare* under S.A. legislation (*National Parks and Wildlife Act 1972*). Habitat for Australasian Bittern (*vulnerable* under S.A. legislation) (Morelli and de Jong, 1995).

Piccaninnie Ponds / Ellards Creek: Habitat for Hooded Plover (listed under S.A. legislation as *vulnerable*); Musk Duck (*rare*), Latham's Snipe (*vulnerable*), and Australasian Bittern (*vulnerable*) (Morelli and de Jong, 1995; Rogers 2002).

Cape Douglas area: Habitat for Orange-bellied Parrot (listed as *endangered* at national and State level) (NPWSA 2000b), Fairy Tern (*vulnerable*); Musk Duck (*rare*); and Peregrine Falcon (*rare*), for which coastal areas are included as part of the known habitat (Haywood, 2000, unpublished survey report cited by NPWSA, 2000b).

Port MacDonnell area: Recorded bird species listed as *vulnerable* under S.A. legislation include Australasian Bittern and White-bellied Sea Eagle. Orange-bellied Parrots (*endangered*) also occur in the coastal area, and have been observed feeding on samphires, sea rocket and other food sources (Jones, Coastcare, undated).

Feast Bay (eastern end of **Brown Bay**): Feeding area for Orange-bellied Parrot (*endangered*), and "very high numbers" of Hooded Plover (listed as *vulnerable* in S.A.). Orange-bellied Parrots also feed near the coast in the **Pick's Swamp** and **Discovery Bay / Victorian border** areas (Jones, Coastcare, undated), and Hooded Plovers have also been observed at the S.A. / Victoria border area, particularly the coastal park area on the Victorian side. **Discovery Bay Coastal Park** is an important habitat for the *endangered* species Orange-bellied Parrot, and the *vulnerable* Hooded Plover (Parks Victoria 2001, 2002; Jones, Coastcare, undated).

Flesh-footed Shearwaters (classified as *rare* in S.A.) have also been observed by ornithologists near the **South Australian / Victorian border**.

Spits at the Glenelg River Estuary provide valuable breeding sites for the migratory species Little Tern *Sterna albifrons*. The **Glenelg River Estuary** is one of the few sites where Little Terns breed in Victoria. Two pairs of the Little Tern nested on the spit at the Glenelg River mouth in 1991-92 (A. Corrick, pers. comm., cited by Parks, Flora and Fauna Division of DNRE, 1995). Breeding has occurred in the area at least since 1987 (I. Westhorpe and M. Hoog Antink pers. comm., cited by Parks, Flora and Fauna

	<p>Division of DNRE, 1995). The Little Tern was not recorded in western Victoria by Emison <i>et al.</i> (1987), so breeding records in this area are exceptional (Parks, Flora and Fauna Division of DNRE, 1995). The Little Tern is listed under the <i>Flora and Fauna Guarantee Act 1988</i> in Victoria, and is the subject of state-based and national Recovery Plans (see Australian Government 2003a), as is the Fairy Tern <i>Sterna nereis</i>, which also occurs at the Glenelg River Estuary. Fairy Tern is listed under the <i>Flora and Fauna Guarantee Act 1988</i>, and listed as <i>vulnerable</i> under South Australian legislation. The Hooded Plover <i>Thinornis rubricollis</i> also occurs at the Glenelg River Estuary, and is listed as <i>vulnerable</i> under S.A. legislation, and listed under the <i>Flora and Fauna Guarantee Act 1988</i> in Victoria (Parks, Flora and Fauna Division of DNRE, 1995).</p> <p>According to a National Oceans Office map (2002, citing Brothers <i>et al.</i>, 1997), the Lower South-East is one of approximately 20 areas within South-Eastern Australia, in which “higher occurrence” records of the at-sea distribution of the Shy Albatross are recorded, based on marked bird surveys. Shy Albatross is listed as <i>vulnerable</i> under S.A. and Commonwealth legislation. Other albatross species also occur in the area (e.g. Light-mantled Albatross (Rogers, 2002), the Australian breeding and visiting populations of which have been described by Garnett and Crowley (2000) as <i>vulnerable</i>. At least 5 other albatross species listed as <i>vulnerable</i> or <i>endangered</i>, as well as Giant Petrel species, are known from the Upper South-East (see table above) western Victoria, and it is probable that those species also utilise feeding habitat in the Lower South-East. Examples include Black-browed Albatross (listed by IUCN Red List 2003 as <i>endangered</i>); Indian Yellow-nosed Albatross (<i>vulnerable</i> in national listing, and listed by IUCN Red List 2003 as <i>endangered</i>); Wandering Albatross (<i>vulnerable</i> under IUCN, Commonwealth, and South Australian listings) and Royal Albatross (the southern and northern sub-species are classed as <i>vulnerable</i> and <i>endangered</i>, respectively).</p> <p>A large number of invertebrates and macroalgae, and a smaller number of fish are endemic to southern Australia, but quantification is not possible for this report.</p> <p>Other The Southern Bell Frog (Growling Grass Frog) <i>Litoria raniformis</i>, which has a coastal association, occurs in the Orwell Rocks coastal area (K. Jones, Coastcare, undated); the Ewens Pond / Eight Mile Creek wetland system (Morelli and de Jong, 1995); the Piccaninnie Ponds coastal area (K. Jones, Coastcare, undated), and other areas of the lower South East. The species has the status of <i>vulnerable</i> in South Australia, due to reduced habitat (DEH, 2003d).</p>
<p>8. Other Important Taxa</p>	<p>Marine Plants Cape Douglas to Victorian Border: Scattered stands of Bull Kelp (<i>Durvillaea potatorum</i>) and Giant Kelp (<i>Macrocystis angustifolia</i>) and associated communities occur throughout the area. Beds of large kelp provide shelter and feeding area for fish, molluscs and crustacea. Kelp forests are a major contributor to marine nutrient recycling, with detritus following decay becoming incorporated into the marine food web of the South East – see Baker (2000) report for overview of the ecological significance of phaeophyte-dominated communities, and DPIWE’s Kelp Watch web site (2001), for specific information on the ecological significance of Giant Kelp. Cape Douglas to Victorian Border: Abundant coralline algae in some reef areas (Edyvane and Baker, 1999a), which is an important habitat for post-larval and juvenile abalone (e.g. see Shepherd and Daume, 1996; Daume <i>et al.</i>, 1997). Port MacDonnell area: Easterly biogeographic limit of the distribution in South Australia of the seagrass <i>Posidonia angustifolia</i> (Edyvane and Baker, 1999a). Seagrass meadows are not common in the lower south east of South Australia.</p> <p>Invertebrates Cape Northumberland / Stony Point / Danger Point / Green Point: In addition to Southern Rock Lobster and Blacklip Abalone (see section below), other abundant macro-invertebrates occur in the area (e.g. see Shepherd, 1979; Branden and Shepherd, 1990), particularly sea hares, several species of chiton, several isopod species, weed crabs and feather stars, with populations of some taxa (e.g. sea urchins) reaching very high densities. Red Rock Crab, Rough Rock Crab, and stalked ascidians are also locally common in some areas.</p>

The **Finger Point** area has been described as significant for its molluscs (sea shells) (K. Jones, Coastcare, undated).

Piccaninnie Ponds and **Ewens Ponds** and their associated drainage creeks contain a variety of aquatic invertebrates, including freshwater sponges, cnidarians, hydroids, flatworms, other worms, various species of freshwater mussel, various crustaceans (3 species of freshwater crayfish, and species of crabs, yabbies, shrimps and amphipods) and various aquatic beetles, bugs and flies (Lloyd and Balla, 1986; Hallam and Thurgate, 1992; Morelli and de Jong, 1995, Reynolds, 1999b). Some of these taxa, including freshwater sponges, cnidarians and freshwater macro-crustaceans, are not common in coastal areas of South Australia.

Glenelg River Estuary: The sandy inlet area reportedly has abundant invertebrates of various types, such as surf cockles (pipis), shrimp, crabs, sand worms, and “mudeyes” (dragonfly nymph stage) (South East On Line, 2003).

“**Bonney Coast**”: The coastal krill (*Nyctiphanes australis*) is the principal species of euphausiid in south-eastern Australian waters (Johannes and Young, 1999, cited by Butler *et al.*, 2002). The species is regularly observed in surface swarms, and is related to the cold water upwelling along the Bonney Coast (Colman, 2001; Gill, 2002). *N. australis* is the principal food source for Blue Whales in the area, and also an important prey for many other species (Johannes and Young, 1999, cited by Butler *et al.*, 2002).

Reefs in the area (e.g. **Douglas Point** area; **Middle Point**, and from **Cape Northumberland** to the **S.A. / Victorian** border) are reported to provide habitat for one or more of the life stages of Southern Rock Lobster, Southern Calamari, Greenlip and Blacklip Abalone, Giant Cuttlefish, Maori Octopus and Purple Sea Urchin (Bryars, 2003).

The few seagrass beds in the region (e.g. **Port MacDonnell**) are reported to be a spawning area for Southern Calamari (Bryars, 2003).

The **lower South East** of S.A. provides habitat for the cowrie *Umbilia hesitata*, found in south-eastern Australia and Tasmania. South-eastern S.A. is the western edge of the range of this species (Wilson and Clarkson, 2004).

Bony and Cartilaginous Fish

Ewens Ponds (drains to the sea through **Eight Mile Creek**) and **Piccaninnie Ponds area** (drains to the sea through **Ellards Creek**): There are a number of fish species associated with these areas which have a marine association for part of their life cycles (Lloyd and Balla, 1986; SANPWS, 1992b; Hallam and Thurgate, 1992; ANCA, 1996). Apart from the species of conservation concern listed in the section above on **Habitat for Endemic Taxa / Threatened Taxa / Rare or Uncommon Taxa**, other estuarine species in the area include Slender Hardyhead, Common Galaxias, Black Bream, and Yellow-eye Mullet. The latter two estuarine species swim up Eight Mile Creek in schools, towards the ponds.

Reefs in the area (e.g. **Douglas Point** area; **Middle Point**, and from **Cape Northumberland** to the **S.A. / Victorian** border) are reported to be used by one or more of the life stages of the following commercially and/or recreationally significant fish species: King George Whiting, Snapper, West Australian Salmon, East Australian Salmon, Tommy Ruff, Southern Sea Garfish, Yellow-eye Mullet, Mulloway, Trevally, Leatherjacket species, Snook, Wrasse species, Sea Sweep, Silver Drummer, Gummy Shark and Whaler Sharks (Bryars, 2003).

Surf beaches in the area (e.g. between **Danger Point** and the **S.A. / Victorian** border) are reported to be used by one or more of the life stages of the following commercially and/or recreationally significant fish species: School Whiting, West Australian Salmon, East Australian Salmon, Tommy Ruff, Yellow-eye Mullet, Mulloway, flathead species, Trevally, School Shark, Gummy Shark and Whaler Sharks (Bryars, 2003). Some of these species (School Whiting, Western and Eastern Australian Salmon, Tommy Ruff, Yelloweye Mullet, Flathead and flounder species, and Whaler Shark), as well as King George Whiting, are reported to utilise the more sheltered beach habitat in the area (e.g. **Riddoch Bay**, and sections between **Cape Douglas** and the **Victorian border**) (Bryars, 2003).

Subtidal sand habitats in the **lower South-East** are reported to be utilised by King George Whiting, School Whiting, Snapper, West Australian Salmon, East Australian Salmon, Tommy Ruff, Southern Sea Garfish, Yellow-eye Mullet, Red “Mullet”, Mulloway, flathead species, flounder species, Trevally, Snook, School Shark, Gummy Shark and Whaler Sharks (Bryars, 2003).

The few seagrass beds in the region (e.g. **Port MacDonnell**) are reported to be used by one or more life stages of King George Whiting, Western Australian Salmon, Eastern Australian Salmon, Tommy Ruff, Southern Sea Garfish, Trevally, flathead species, Leatherjacket species, Snook, and Whaler Sharks (Bryars, 2003).

Coastal Birds

Lower South-East region: Habitat for Pied and/or Sooty Oystercatchers (e.g. **Feast Bay; Pick's Swamp** coast; **Discovery Bay** to **Victorian border**), Short-tailed Shearwater, Little Penguin (e.g. **Pleasant Cove**), Black-faced and other cormorants; White-faced Storm Petrel; Great-winged Petrel (e.g. **S.A. / Victorian border** coast); Australasian Gannet (e.g. **Pleasant Cove / Cape Northumberland** and other areas), Pacific Gull (e.g. **Port MacDonnell**); Masked Plover (e.g. **Port MacDonnell**, and up to 200 at **Orwell Rocks**; also at **Victorian border** area); Black Swan (e.g. **Pleasant Cove** area, **Port MacDonnell**, **Danger Point**, **Pick's Swamp** coastal area, and wetlands inland from **Orwell Rocks** and **Racecourse Bay; Piccaninnie Ponds** coast); herons (e.g. **Feast Bay; Discovery Bay / Victorian border**, and coast near **Pick's Swamp**); egrets (e.g. **Pick's Swamp** coast); Rufous Night Heron (e.g. **S.A. / Victorian border** area); spoonbill and ibis species (e.g. **Racecourse Bay, Danger Point, Orwell Rocks**); various species of duck (wetlands near **Racecourse Bay, Orwell Rocks, Picks' Swamp, Piccaninnie Ponds** and other areas); Purple Swamphen (**Piccaninnie Ponds**); Blue-winged Parrot (which has a coastal association, and is found in a number of areas, such as **Green Point**, the **Pick's Swamp** coast, and the **Victorian border** region); and various species of shore birds and waders (e.g. sandpipers, dotterels, curlews, snipes etc, which are found in many of the small bays of the Lower South-East, such as **Riddoch Bay, Flinty Point, Feast Bay, Green Point, Discovery Bay** and others) (Jones, 2000a, 2000b and undated; Rogers, 2002, and other bird-observers reports). Pectoral Sandpiper *Calidris melanotos* and Grey-tailed Tattler *Tringa brevipes*, both migratory species, have been recorded in the area (e.g. records from 2001 of Pectoral Sandpiper at **Stony Point**, and Grey-tailed Tattler at **French Point**, in small groups) (Rogers, 2002). A number of other migratory wading birds (including species from the northern hemisphere) occur in the area (Jones, 2000a, 2000b and undated).

Cape Douglas / Douglas Point area: In addition to migratory birds, and rare and/or vulnerable birds species, other species found in the area include Australasian Gannet, Australian Pelican, Black-faced Cormorant, Caspian Tern, Crested Tern, Black Cormorant, Hoary-headed Grebe, Intermediate Egret, Little Black Cormorant, Little Pied Cormorant, Masked Lapwing, Pacific Gull, Pied Oystercatcher, Red-capped Plover, and Sacred Ibis (Haywood, 2000, unpublished survey report, cited by NPWSA, 2000b).

Cape Northumberland: breeding population of Little Penguin, which represents one of only two breeding sites in the South East of South Australia (Robinson *et al.*, 1996).

Port MacDonnell area: Up to 3000 Crested Terns seasonally fly from Pelican Point Reef to roost the boulders at the end of the Port MacDonnell breakwater. Also, large numbers of wetland birds have been recorded on marshes in the coastal area. Examples include Black Swan, various duck species, Ibis, Australasian Bittern, Spoonbills, Purple Swamphen, Pied and Sooty Oystercatchers, Australian Pelican, Chestnut Teal (Jones, Coastcare, undated).

"Very high numbers" of coastal wading birds, sandpipers and dotterels have been reported at **Racecourse Bay / Flinty Point, Riddoch Bay** and **Danger Point** (Jones, Coastcare, undated).

Ewens Ponds / Eight Mile Creek: Migration stopover for migratory waders including Curlew Sandpiper *Calidris ferruginea*, Red-necked Stint, and Common Greenshank *Tringa nebularia* (South Australian Ornithological Association, 1981; South Eastern Wetlands Committee, 1984; Lloyd and Balla, 1986; cited by Morelli and de Jong, 1995). White-Winged Black Tern *Chlidonias leucopterus* and Painted Snipe *Rostratula benghalensis* have also been recorded (Rogers, 2002). Apart from rare, threatened and migratory species, other water-bird species include the White-faced Heron, Straw-necked Ibis, Black Swan, Pacific Black Duck, Great Egret, Intermediate Egret (Rogers 2002), Rufous Night Heron, Caspian Tern, Little Pied Cormorant, Great Crested Grebe, Dusky Moorhen and Royal Spoonbill, amongst others (see Lloyd and Balla 1986 for list of 40 species). Swamp Harriers also feed in the area. The Whiskered Tern *Chlidonias hybridus* has been recorded in relatively large aggregations (e.g. 300) in the area

	<p>(Lloyd and Balla, 1986; Rogers, 2002).</p> <p>Piccaninnie Ponds: Migration stopover for migratory waders including Sharp-tailed Sandpiper <i>Calidris acuminata</i>, Curlew Sandpiper, Red-necked Stint, and Common Greenshank (Lloyd and Balla, 1986). Apart from rare, threatened and migratory species, other coastal and marine water-bird species include the Great Egret, White-faced Heron, Rufous Night Heron, Great Cormorant; Caspian Tern, Pied Cormorant, Great Crested Grebe, Latham’s Snipe, Dusky Moorhen, Royal Spoonbill, Masked Lapwing; Banded Lapwing; Sacred Ibis, Straw-necked Ibis, Australian Pelican, 4 species of duck, and the Black Swan, amongst others (see South Eastern Wetlands Committee 1984; Lloyd and Balla, 1986; Jaensch and Auricht, 1989, cited by Morelli and de Jong, 1995, for list of species).</p> <p>Glenelg River Estuary and Discovery Bay coast: Habitat area for Herons, Spoonbills, Ibis, Dotterels, Terns, Plovers, Snipes, Gull species, Pied Oystercatcher, Australian Pelican, Australasian Gannet, Black Swan, and other waders and coastal birds. Short-tailed Shearwaters (fishing in the coastal waters) and Azure Kingfishers (fishing in the estuary and river) and Little Penguins have also been reported (Parks Victoria, 2001; Wilmap Pty Ltd, 2002; Jones, Coastcare, undated; South-East On Line, 2003, and ornithologists reports).</p> <p>Aquatic Amphibians, Reptiles and Mammals Coastal frog species occur at the “Treaclepot Wetland”, which has a creek outlet to the sea, forming a beach soak in the Pleasant Cove area; and also at Stony Creek (Green Point), and the Pick’s Swamp and Discovery Bay coastal areas (K. Jones, Coastcare, undated).</p> <p>Apart from the Southern Bell Frog (see section above), the Ewens Pond / Eight Mile Creek wetland system provides habitat for a number of frog species associated with wetland systems, including the Southern Brown Tree Frog <i>Litoria ewingi</i>, Common Eastern (Brown) Froglet <i>Crinia signifera</i>, Eastern Banjo Frog <i>Limnodynastes dumerilii</i>, Spotted Grass Frog <i>L. tasmaniensis</i>. Frogs are also plentiful in the Piccaninnie Ponds coastal area (K. Jones, Coastcare, undated). Eastern Snake-necked Tortoise (= Eastern Long-necked Turtle) <i>Chelodina longicollis</i> also occurs in the Ewens Ponds and Piccaninnie Ponds wetlands, as well as the Water Rat <i>Hydromys chrysogaster</i>, and the Swamp Rat <i>Rattus lutreolus</i> (Ashman and Grandfield, 1984; Lloyd and Balla, 1986; Hallam and Thurgate, 1992; SANPWS, 1992, all cited by Morelli and de Jong, 1995).</p>
<p>9. Notable Feeding, Breeding / Spawning and Nursery Areas</p>	<p>Bony Fish Ewens Ponds (drains to the sea through Eight Mile Creek) and Piccaninnie Ponds area (drains to the sea through Ellards Creek) are important areas for a number of freshwater and estuarine fish species. See sections on Habitat for Endemic Taxa / Threatened Taxa / Rare or Uncommon Taxa and Other Important Taxa, for more information about these major habitats supporting estuarine-associated fish species.</p> <p>Reefs in the area (e.g. Douglas Point area; Middle Point, and from Cape Northumberland to the S.A. / Victorian border) are reported to provide a nursery area for juvenile Sea Sweep (Bryars, 2003).</p> <p>Surf beaches in the area (e.g. between Danger Point and the S.A. / Victorian border) are reported to be used by juvenile School Whiting and Mulloway (Bryars, 2003). More sheltered beach habitat (e.g. Riddoch Bay, and sections between Cape Douglas and the Victorian border) is reported to be a nursery area for School Whiting, and species of flathead and flounder (Bryars, 2003).</p> <p>Subtidal sand habitats in the lower South East are reported to provide nursery habitat for juvenile King George Whiting, West Australian Salmon, Tommy Ruff, Yellow-eye Mullet, Red “Mullet”, Mulloway, flathead species, and flounder species (Bryars, 2003).</p> <p>Deep Creek, leading to Riddoch Bay; Ewens Pond, which drains via Eight Mile Creek, into Riddoch Bay; and Piccaninnie Ponds which drains via Ellards Creek into Discovery Bay, are all reported to provide habitat for adult Yellow-eye Mullet, and the adults and juveniles of Black Bream (Bryars, 2003).</p> <p>Glenelg River Estuary: Habitat for estuarine fish species (Black Bream, Mulloway, Yellow-eye Mullet, Estuary Perch, Galaxias species), some of which are found in abundance in the area, such as Black Bream, and common minnows (<i>Galaxias maculatus</i>). The Oxbow, connected to the estuary of the Glenelg River, is also an important fish habitat (South East On Line, 2003).</p>

	<p>Invertebrates</p> <p>Douglas Point to the Victorian Border: Important habitat for life cycle stages of Southern Rock Lobster (calcareous reef area for shelter, with prey items for lobster common in the area (e.g. sea urchins, small crustaceans and molluscs) (Lewis, 1983; Bryars, 2003). Also an important habitat for Blacklip Abalone, which reach high abundance and densities in part of the lower South East (Branden and Shepherd, 1990; Keesing and Baker, 1998; Shepherd <i>et al.</i>, 1999; and also see catch figures in Notes on Social and Economic Values and Uses).</p> <p>Reefs in the lower south east (described here with an eastern limit of the S.A. / Victorian border) also provide a habitat for spawning adults and juveniles of Maori Octopus, and Purple Sea Urchin (Bryars, 2003).</p> <p>Surf beaches in the area (e.g. between Danger Point and the S.A. / Victorian border) are reported to provide habitat for the spawning adults, and the juveniles, of baitworm species; and juvenile Sand Crabs (Bryars, 2003). More sheltered beach habitat (e.g. Riddoch Bay, and sections between Cape Douglas and the Victorian border) is reported to be a nursery area for Sand Crabs, and a habitat for adult and juvenile baitworm species (Bryars, 2003).</p> <p>Mammals</p> <p>The Bonney Coast is one of 12 areas in the world where Blue Whales aggregate to feed on krill (Gill, 2002; Butler <i>et al.</i>, 2002). Gill (2002, cited by Butler <i>et al.</i>, 2002) recorded 216 Blue Whale sightings from dedicated surveys, reports from fishermen and incidental records in the Bonney Upwelling, between 1998 and 2001. Whales were observed between December and May, and they were associated with surface swarms of coastal krill in 48% of all sightings, and feeding on krill in 36% of all sightings (Gill, 2002). A maximum of 32 Blue Whales was sighted during one survey.</p> <p>Estuarine, Coastal and Marine Birds</p> <p>Significant feeding areas for wetland birds, waders and shorebirds, migratory sea birds (e.g. albatrosses), and the coast-associated Orange-bellied Parrot occur in the Lower South-East, and such areas are described in other sections of this table (e.g. see sections on Habitat for Threatened Taxa / Rare or Uncommon Taxa; Other Important Taxa, and National and/or International Importance). Some examples include Douglas Point area, Port MacDonnell, Ewens Ponds, Piccaninnie Ponds, Racecourse Bay, Riddoch Bay, Danger Point, Feast Bay and the Green Point area, the latter which has been described as “extremely important for waders”, due to the large quantities of macroalgal beachwrack, in which shorebirds feed (Jones, Coastcare, undated).</p> <p>Also of particular significance are the Discovery Bay Coastal Park, near the South Australian / Victorian border, where Hooded Plovers nests on exposed locations on the beach, especially between August and February (Parks Victoria, 2002); and the tidal estuary of the Glenelg River, at Nelson, which is a haven for numerous water bird and coastal bird species – see sections above (Fairfax Publishing – F2, 2002; Parks Victoria, 2001).</p>
<p>10. Shipwrecks and Artificial Reefs</p>	<p>The ecological significance of shipwrecks as additional habitat, and as “fish-attracting devices”, in this area is not known. There are many wrecks in the lower South East area, particularly around the Cape Northumberland - Port MacDonnell area (see section on Historic Shipwrecks in Notes on Social and Economic Values and Uses), but many have not been found. It is likely that most have broken up, and therefore are not significant as additional habitat.</p>
<p>11. Popular Dive Sites</p>	<ul style="list-style-type: none"> ♦ Port MacDonnell area: Calcareous reefs in the area are known to divers for their Rock Lobsters and other macro-invertebrates, especially abalone and other molluscs; reef fish; kelp; and colourful marine flora (particularly the abundance and variety of red macroalgae). No other details regarding marine dive sites in the lower South-East are readily available. ♦ The ecological features of freshwater sites such as Ewens and Piccaninnie Ponds are significant, and are discussed in other sections of this table.

<p>12. National and/or International Importance</p>	<ul style="list-style-type: none"> ♦ Cape Douglas / Douglas Point area: Habitat for migratory birds listed under international JAMBA and/or CAMBA treaties: Common Greenshank <i>Tringa nebularia</i>; Sharp-tailed Sandpiper <i>Calidris melanotos</i>; Grey Plover <i>Pluvialis squatarola</i>; Ruddy Turnstone <i>Arenaria interpres</i>; and Red-necked Stint <i>Calidris ruficollis</i> (Haywood, 2000, unpublished survey report, cited by NPWSA, 2000b). ♦ Ewens Ponds: Three waterbird species are listed under international treaties for migratory birds. These are the Curlew Sandpiper, Red-necked Stint and Common Greenshank (SAOA, 1981; South Eastern Wetlands Committee, 1984; Lloyd and Balla, 1986, cited by Morelli and de Jong, 1995). ♦ Piccaninnie Ponds: Habitat for bird species listed under international or other treaties, including the resident bird Great Egret, and the migrant birds Latham’s Snipe, Double-banded Plover, Sharp-tailed Sandpiper, Curlew Sandpiper, Red-necked Stint and Common Greenshank (South Eastern Wetlands Committee, 1984; Lloyd and Balla, 1986; Jaensch and Auricht, 1989, cited by Morelli and de Jong, 1995). ♦ “Bonney Coast” (for which the Lower South East SA is part): One of only 12 sites in the world where endangered Blue Whales are known to aggregate and feed (Gill, 2002; Butler <i>et al.</i>, 2002). ♦ Piccaninnie Ponds Conservation Park is listed on the <i>Register of the National Estate</i> as a “superb example” of a coastal freshwater swamp, supporting threatened flora; water-filled subterranean caverns; and is renowned for exceptional water clarity (Australian Heritage Commission, undated). ♦ The Piccaninnie Ponds wetland is the largest rift in the Gambier Embayment. The site is the only and largest remnant of coastal peat fen reserved in South Australia, and one of a few of its type reserved in Australia (Morelli and de Jong, 1995). ♦ Ewens Ponds Conservation Park is listed on the <i>Register of the National Estate</i>, mainly in recognition of terrestrial values, although estuarine features contributing to the nomination included its value as an “excellent wetland habitat”, and a popular diving spot (Australian Heritage Commission, undated). ♦ Eight Mile Creek (Ewens Ponds) and Piccaninnie Ponds are listed as <i>Wetlands of National Importance</i> (ANCA, 1996; Environment Australia, 2001b). ♦ The Glenelg River Estuary is listed as a <i>Wetland of National Importance</i> (ANCA, 1996; Environment Australia, 2001b), and is one of Victoria’s listed <i>Heritage Rivers</i>. The estuary contains features of geo-morphological and botanical significance at a State-wide scale (see section above on Biogeographic Significance). The Glenelg River Estuary is also part of the Discovery Bay Coastal Park and is listed on the <i>Register of the National Estate</i> (AHC No. 3903). The Glenelg River Estuary is frequented by six bird species listed by both JAMBA and CAMBA international treaties for migratory birds, and two species listed by JAMBA and CAMBA respectively (Bird Observers Club, 1977; DCE, 1992; DNRE Wetlands database, 1995; cited by Parks, Flora and Fauna Division, DNRE, 1995).
<p>Major Commercial and Recreational Fish, Sharks, Molluscs and Crustaceans</p>	<p>Some of the commercially and/or recreationally fished species that occur in parts of the area that collectively encompass the Douglas Point to the Victorian border area (including deeper Commonwealth waters further offshore) include:</p> <p><u>Fish:</u> Ocean Leatherjacket, Australian Salmon, various Wrasse species (e.g. Blue-throated, and other Wrasse species), Hapuku (deeper waters), Yellow-eye Mullet, Sweep, Bearded Cod, Blue-eye Trevalla (deeper waters), Conger Eel, Jackass Morwong, Yellow-eye Mullet, Tommy Ruff, Whiting, Garfish, Snapper, Rock Ling and Pink Ling (deeper waters), Bearded Cod, various flathead species, Barracouta, Redfish (Red “Snapper”), Warehou (deeper waters), Southern Blue Morwong (“Queen Snapper”), Knifejaw (deeper waters), Blue Mackerel (deeper waters), Jack Mackerel, Bastard Trumpeter, Bluefin Tuna and Albacore (deeper waters). Cale, Victorian Scalyfin and various species of Morwong and Wrasse are also common on shallow reefs in the area, along with Boarfish, Gurnard Perch, and various Leatherjacket species. Estuarine fish such as Mulloway and Black Bream are also commercially and/or recreationally significant in some parts of the area, as well as sand-dwelling taxa such as species of Flounder and Flathead (including deeper water flathead species).</p> <p><u>Sharks and Rays:</u> Gummy Shark, School Shark, Saw Shark, Bronze Whaler and/or Black</p>

	<p>Whaler, Dog Sharks, Mako Shark, Elephant “Shark”, other shark species, as well as ray and skate species.</p> <p><u>Invertebrates</u>: Rock Lobster and Blacklip Abalone are the major invertebrates of commercial and recreational value in the area. Other notable commercially and/or recreationally valued invertebrates also present in the area (or parts thereof) include Southern Calamari, Octopus, specimen shells, Cuttlefish, Gould’s Squid (Arrow Squid), Giant Crab, and Greenlip Abalone.</p>
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