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9 Overview of Social and Economic Values and Uses in the Recommended Areas, and Summary of Issues for Risk and Impact Assessment

9.1 Summary of Social and Economic Values and Uses in Recommended Areas

Examples of available data and information used in the preliminary socio-economic overview for each potential MPA include that pertaining to:

- single and multi-sector commercial fisheries;
- recreational fishing;
- aquaculture management zones, lease sites, and species farmed;
- popular dive sites;
- other recreation and marine tourism;
- historic and protected shipwrecks;
- other marine heritage (European, in most areas; but also including American heritage in some areas, and Chinese in others);
- Aboriginal heritage, site usage values, and Native title applications;
- sites for marine research, and marine education values;
- wilderness and aesthetic values;
- towns and settlements;
- coastal mineral deposits and mining leases;
- ports and shipping; and
- other relevant uses and values

Summaries of these values for each focus area that contributes to the representative system of MPAs, are provided in the tables below. Where possible, information is current to 2004. The sections do not provide an economic assessment of marine values such as fishing and aquaculture, which is beyond the scope of this report. However, information is provided about the main fisheries species targetted, and the main aquaculture species raised, with details and approximate quantities provided where appropriate, according to data sources available for this project. Fisheries and Aquaculture statistics change frequently, and therefore the following information is provided as a guide only. Updated aquaculture statistics are regularly published by Primary Industries and Resources South Australia (PIRSA), and the status of fished species and fisheries is available in regularly published stock assessment reports, by SARDI and PIRSA.

9.1.1 Nuyts Archipelago, St Francis Isles and Coastal Embayments (Murat Bioregion)

Aquaculture

Ellis (1999a) described aquaculture, particularly the culture of Pacific Oysters, as an increasingly important regional industry, with substantial increases in productivity anticipated. Although figures specific to the far west coast are not available, Ellis (1999a) reported that three aquaculture industries were considered to have potential to generate over 630 jobs along the Eyre Peninsula by 2001, with such growth areas including oyster farming, and abalone and Rock Lobster culture (Ellis, 1999a).

Pacific Oyster is the main cultivated species on the west coast, with key areas of culturing being **Denial Bay / Ceduna, Smoky Bay** and **Streaky Bay**. When in full production, **Denial Bay** and **Smoky Bay** would both have around 165ha under cultivation (Ellis, 1999a). There is reportedly an additional 120 ha of research and development sites in the Ceduna area (Ellis, 1999a). There are processing facilities in the Far West Coast area.

Denial Bay and **Smoky Bay** together contribute over half of the total State production of oysters for domestic and export use. The majority of oyster culture is intertidal, although sub-tidal oyster culture occurs on a small scale, and increases in this activity are anticipated.

Madigan and Clarke (2000) reported that annual production of adult oysters, in terms of dozens, between 1995 and 1999 was as follows:

- In **Streaky Bay**, annual production was less than 100,000 dozens in 1995, 1996, 1997 and 1999, and around 100,000 dozens in 1998;
- In **Denial Bay**, annual production was less than 200,000 dozens in 1995; over 200,000 dozens in 1996, 1998 and 1999, and over 250,000 dozens in 1997;
- In **Smoky Bay**, annual production was less than 300,000 dozens in 1995, 1996 and 1997, slightly over 400,000 dozens in 1998, and over 720,000 dozens in 1999.

In 2000 / 2001, Knight *et al.* (2002) reported that the production of adult oysters in **Denial Bay** was 570,808 dozens sold, and the combined production for **Streaky** and **Smoky Bays** was around 717,790 dozens sold.

Import of Pacific Oyster spat has increased in **Streaky Bay, Denial Bay** and **Smoky Bay** during the 1990s. In **Denial Bay**, spat import increased from 4,000,000 or less during the early 1990s, to almost 18,000,000 in 1997, and around 14,000,000 in 1999. In **Smoky Bay**, spat import ranged between around 2,000,000 and 6,000,000 for most years of the 1990s, and increased to around 11,000,000 in 1999. In **Streaky Bay**, where production is lower, spat import was less than 2,000,000 during the early to mid 1990s, and increased to over 4,000,000 in 1997 and 1999 (Madigan and Clarke 2000). Figures for oyster spat import for 2000 / 2001 were 11,046,000 for **Smoky Bay**; 8,170,190 for **Denial Bay**, and 4,794,000 for **Streaky Bay** (Knight *et al.*, 2002).

On-shore abalone aquaculture is a newer industry in the area, has also been highlighted as a potential growth industry on the far west coast (Ellis, 1999a).

The aquaculture zoning devised by PIRSA (1996) is being revised, and more recent developments in the rezoning of aquaculture activities at the West Coast were discussed in Ellis (2000a). PIRSA (Ashman, 1996b) zoned for aquaculture development in the following areas (see Map OC(FW)/5 in Ashman, 1996b), which are provided below for background information. For each zone, information on lease sites (as at 2003) is also provided:

Tourville Bay: The zone devised by PIRSA in 1996, comprised the waters below mean spring high water mark (within AMG Zone 53) between Cape Beaufort (363495E, 6439681N) and 360547E 6441190N, and then confined by the following points: 358745E, 6441224N; 356300E, 6439900N, and 357621E, 6436836N (Point Peter). PIRSA (see Ashman, 1996b) provided for "a bare minimum" of development required to "assess the fattening potential for Pacific Oysters" in the mouth of Tourville Bay. PIRSA's management plan provided for a two hectares research and development license (for oyster fattening) within the Tourville Bay zone, with possibility of relocation after a two year trial. Apart from market viability and

technical issues regarding site viability, trial research and development sites were required to assess impacts on the site environment (e.g. habitat, and function as prawn nursery), as well as impacts on fishing and boating. These sites were to be assessed by government after two years of operation, with the provision for further development. Ashman (1996) stated that, following an assessment of the success of the trial period, *“the intention is to review the plan to consider the options for a carefully controlled development of the site which is sympathetic of the conservation significance and existing use made of the bay”*. Within the zone, applications during the 1990s targeted as possible intertidal oyster culture sites, were two sandbank areas, one each side of the main channel draining out of Tourville Bay.

PIRSA’s aquaculture management plan (Ashman, 1996b) excluded development from the **Davenport Creek** area, due to its recognised conservation and social values, and from waters within 100 metres of a boating channel or fishing ground recognised by the Director of Fisheries. Previously, one oyster lease site was approved, for research and development, during the 1990s (South Australian Coast and Marine Atlas, 2001), and at the time, this area constituted two hectares of oyster culture within the Tourville Bay zone (Ashman, 1996b). In 2003, no oyster leases were recorded as being operational in the **Tourville Bay** area (S.A. Coast and Marine Atlas, 2003; PIRSA Aquaculture Public Register, August, 2003).

Murat Bay / Denial Bay area: Murat Bay / Denial Bay is a major oyster-growing area in South Australia. Since the development of the initial leases in the area, conditions for oyster-growing were found to be better further south than the trial areas, and the development of leases continues around the farthest point that can be seen from the jetty (Eyre Peninsula Tourism Association 2000). PIRSA’s Denial Bay Zone (Ashman, 1996b) comprises all the waters within one kilometer of mean high water mark between **Cape Beaufort** and **Half-way Camp**. The Cape Beaufort boundary consists of a straight line from the cape (363573E 6439796N) to one kilometer out from high water mark (364500E, 6439434N). The Half-way camp boundary consists of a straight line between the following points; 372755E 6447138N and 372135E 6446355N. PIRSA’s (1996) management plan specified a set level of development allowed under the Principle of Development Control, of 116 hectares plus six hectares for one license holder (i.e. 122 ha). However, the stated Management Policies for that zone specified a maximum of 162 ha of development. The plan also recognised that leases or portions of leases may be relocated within the zone to take advantage of more productive positions or more favourable substrates. PIRSA (Ashman, 1996b) specified that aquaculture be excluded from the vicinity of the Denial Bay township, thorough provision for a 1km buffer south of the Denial Bay jetty, to protect “visual amenity, recreational use, boating and mooring access”. PIRSA (Ashman, 1996b) sought to retain oyster culture as the only form of aquaculture permitted in the Denial Bay aquaculture zone. The specified exclusion zone was all forms of aquaculture between the mean spring high water mark, the seaward boundary of the zone and the points 365926E 6447617N to 366849E 6447191.5N and 365689E 6446220N to 366613E 6445811N. The Murat Bay zone comprises all the waters below mean spring high water mark between halfway Camp and Cape Thevenard and enclosed by a line between the Denial Bay aquaculture Zone and the following points in AMG zone 53; 371947E, 6442086N (Cape Thevenard); 371498E, 6441169N (Daphnie Rock); 365499E, 6436500N (the flashing light channel marker for the Yatala channel) and 364500E, 6439434N (the most southerly point of the Denial Bay aquaculture zone). PIRSA (Ashman, 1996b) provided for an unspecified number of research and development (R&D) sites for oyster fattening, each site of no greater than 2ha in size, in the Murat Bay zone. Apart from market viability, trial R&D sites were required to assess impacts on the site environment (e.g. seagrass beds), as well as existing uses (e.g. boating and fishing), and sites were to be assessed by government after two years operation, with provision for further development. The 1996 plan also recognised the existing use of the inner waters (to 1km seaward) of adjacent Denial Bay Zone for aquaculture. Prior to the development of PIRSA’s 1996 management plan for the Far West Coast, the 1991 Murat Bay Aquaculture Management Plan had been reviewed twice since its release to accommodate relocations brought about by poor water quality at previous locations. The first review in 1992 allowed the formation of a community lease and relocation of leases from the affected southern portion of the bay (see below, on Smoky Bay). Since 1988, at least 22 shellfish leases, including relocations, have been approved in the inner **Murat Bay** area, **north-east of Cape Beaufort**, including the coastal waters of the bay, to 1km seaward. Oyster leases have been operating in the Murat Bay area since the 1980s. During the mid 1990s there were 116 hectares of leases held within the area (Ashman, 1996b). The leases comprise mainly Pacific Oyster, but have also included trial areas for native oysters, scallop and other bivalves. In 2003, 18 oyster leases, mostly for Pacific Oyster, were recorded as being current in the **Murat Bay / Denial Bay area** (South Australian Coast and Marine Atlas, 2003; PIRSA Aquaculture Public Register, August, 2003).

Decres Bay: The zone comprises the waters below mean spring high water mark between Cape Vivonne and Cape D’Estrees within AMG Zone 53 and defined by the following points: 384021E, 6429491N (Cape D’Estrees); 377061E, 6429671N, and 375480E, 6436122N (Cape Vivonne). The zone covers the waters of Decres Bay and portion of the waters to the east of St. Peter Island. According to Ashman (1996) considerable interest has been shown in this zone for aquaculture development. There has been particular

interest in sites on a sand spit off the north eastern end of **St Peter Island**. The level of interest in the zone led PIRSA (Ashman, 1996) to place a reduced maximum on the total area available for development, to avoid excessive development in an area that had not at that time been assessed for its aquaculture potential. PIRSA (Ashman, 1996) provided for a total of 40 ha of aquaculture development in the Decres Bay Zone, excluding aquaculture within one kilometer of the mean spring high water mark between 382520E, 6435942N and 380220E 6436781N (Wittelbee Conservation Park). In 2003, 5 leases for Pacific Oyster cultivation were reported to be operational, plus one small (1ha) lease for Queen and King Scallop cultivation closer to shore, and 2 leases for Greenlip and Blacklip Abalone cultivation, at the southern end of Decres Bay (S.A. Coast and Marine Atlas, 2003; PIRSA Aquaculture Public Register, August, 2003).

Between St Peter Island and Decres Bay: In 2003, 5 Pacific Oyster leases were reported to be current on the eastern side of St Peter Island (S.A. Coast and Marine Atlas, 2003).

Waterwitch (northern Smoky Bay): The PIRSA-devised zone comprises the waters below mean spring high water mark between Cape D'Estrees and Smoky Bay within AMG Zone 53 and defined by the following points: 398275E, 6420093N; 396949E, 6418390N; 388859E, 6422137N; 382946E, 6421532N; 377061E, 6429671N and 384021E, 6429491N. This zone covers much of Smoky Bay and is partially protected by Eyre Island and Cape Missiessy to the south-east. PIRSA (Ashman, 1996) provided for a total of 80 ha of aquaculture development in the Waterwitch Zone, excluding aquaculture within one kilometer of the mean spring high water mark between 389608E, 6430612N and 387594E 6431810N (Laura Bay and Laura Bay Conservation Park). Ceduna, Denial Bay and Smoky Bay residents have interest in aquaculture development in Waterwitch / Smoky Bay area (Ashman, 1996b).

Smoky Bay: The 1993 review of aquaculture in the region allowed the relocation of the majority of leases from adjacent the coastline south of **Smoky Bay** township out to a bank near **Eyre Island**. Consensus from a public meeting held to discuss draft amendments included an undertaking to exclude Vinya Corner and associated Razorfish beds from the Smoky Bay Oyster zone. In addition the southern part of Smoky Bay was to be excluded from the Smoky Bay Oyster zone during the 1995/96 general review of the plan, if the relocation of leases out towards Eyre Island proved successful (Ashman, 1996). In 1996, the PIRSA plan had zoned the Smoky Bay area as comprising the waters defined within the following points: from a point just south of Smoky Bay township where the boundary of sections 65 and 67, hundred of Wallanippie meet the mean high water mark (399741E, 6416615N), following the mean spring high water mark south to a point adjoining the boundary of section 17 and 18 Hundred of Wallanippie (398837E, 6411900N), then in straight lines enclosed by the following points; 397893E, 6413592N; 396536E, 6415009N; 393726E, 6416230N; 393726E, 6417454N; 397256E, 6416939N; 397497E, 6415799N; 398467E, 6415151N and 399029E, 6415340N. PIRSA (Ashman, 1996b) provided for a total of 85 hectares of oyster culture in the Smoky Bay aquaculture zone. During the mid 1990s, there were 85 hectares of oyster leases operating in the Smoky Bay zone, and at that time, PIRSA recognised the need to restrict any further development in the zone until sufficient experience had been gained into the longer term productivity of the zone, and that relocations of leases within the zone may also be required over time. The oyster industry within the Smoky Bay Zone initially suffered due to unfavourable conditions caused by a build up of the marine macroalgae *Ulva australis* (lettuce weed) in the sheltered waters of the south east of the bay. This resulted in relocation of lease sites, following amendments to the 1991 Murat Bay Aquaculture Management Plan. The history of allocated lease sites and expressions of interest was detailed in Ashman (1996). Around 22 shellfish leases (mainly Pacific Oyster, in the intertidal zone) have been approved since 1988. Since 1992, at least seven expressions of interest for additional lease sites have been received by government. In 2000, a State-government supported Aquaculture Park was approved for Smoky Bay. The Aquaculture Park includes 40 individual allotments, to allow existing oyster farmers, who have facilities spread around the Smoky Bay area, to relocate within the park (ABC Country Hour media report, December 2000). In 2003, 15 leases for Pacific Oyster cultivation were listed as current for the **Waterwitch Zone** (mainly situated close to the Smoky Bay shore, except for 2 large subtidal leases, more than 1 nautical mile offshore). In 2003, there were 9 Pacific Oyster leases in the **Eyre Island Zone** (eastern side of **Eyre Island**), and 35 Pacific Oyster Leases in the **Smoky Bay Zone** (also east of **Eyre Island**, and north-east of **Cape Missiessy** (S.A. Coast and Marine Atlas, 2003; PIRSA Aquaculture Public Register, August, 2003). During the early 2000s, there were technical investigations by government and consultants, of the potential of the **Cape D'Estrees** area to support subtidal shellfish aquaculture.

St Peter Island: PIRSA devised this zone to comprise waters bounded by the following points (Map OC(FW)/5) within AMG Zone 53: 373600E, 6430600N; 374500E, 6430500N; 375200E, 6431000N; 375600E, 6430150N and 374050E, 6429700N. PIRSA (Ashman, 1996) provided for a total of two hectares of aquaculture development, as a R&D site to determine the potential for oyster fattening. Approved lease for this site was required to address and number of ecological and social issues related to the site (see

Ashman, 1996). In 2003, 5 Pacific Oyster leases were operating in the area (PIRSA Aquaculture Public Register, August, 2003).

During the early 1990s, there was a moratorium on aquaculture development in **Blanche Port (Streaky Bay)**, which was lifted in early February 1994 by the Minister for Primary Industries and the Minister for the Environment, to allow aquaculture development applications to be processed simultaneously with the development of the *Streaky Bay Aquaculture Management Plan* (Bond 1994). PISA Fisheries and DENR (see Bond 1994) zoned the following areas for aquaculture development, and recent information on leases in these areas follows the site descriptions:

Streaky Bay: The zoned area included the northern part of Streaky Bay extending from the Council's northern boundary adjacent Flagstaff Landing to Little Islands, excluding Blanche Port to Cape Bauer. In **Northern Streaky Bay**, between **Eba Island** and **Lindsay Point**, 6 Pacific Oyster leases and 2 Native Oyster leases were listed as being current in 2003, as well as 3 or 4 lease areas for Doughboy Scallops (S.A. Coast and Marine Atlas, 2003; PIRSA Public Register, August, 2003). A grow-out facility for abalone was also approved during the 1990s.

Point Gibson: A zone area was approximately 3.55km long and 0.7km wide, north of Point Gibson (out of **Blanche Port**). Bond (1994) stated that scope exists for expansion of the current defined oyster farming area north of Moores Ramp and within the intertidal zone adjacent The Spit and Point Gibson (southern side). In 2003, 10 Pacific Oyster leases were current in the **Point Gibson Zone (Southern Streaky Bay)** (S.A. Coast and Marine Atlas, 2003).

Southern Streaky Bay – Blanche Port: The zoned area comprised the whole of Blanche Port, the southernmost portion of Streaky Bay inside of Point Gibson, the sand spit enclosing Blanche Port, to the Fairway Beacon to the coast, adjacent Little Islands. Bond (1994) recommended that two shellfish culture zones be established on the western side of Blanche Port (south of Moores Landing) and the bay between Point Gibson and Moores Landing, namely, the **Blanche Port North** and **Blanche Port South** management zones. These zones were accepted by PIRSA (Ashman, 1996), and, in addition to the **Point Gibson Zone** (see above) remain the focal areas for aquaculture development in the Streaky Bay region. Bond (1994) recommended that a maximum of 60 hectares for shellfish aquaculture development be permitted in each of these zones; and that scallop ranching in shallow water south of **Pigface Island** be permitted. Bond (1994) also recommended that onshore aquaculture would be acceptable providing discharges into the sea meet PISA and the Environment Protection Authority requirements. In 2003, 6 Pacific Oyster leases were current in the **Blanche Port North Zone** (S.A. Coast and Marine Atlas, 2003). In 2003, 5 Pacific Oyster leases, 1 Native Oyster lease and 1 Greenlip Abalone aquaculture facility were listed as current in the **Blanche Port South** zone (S.A. Coast and Marine Atlas 2003; PIRSA Aquaculture Public Register, August, 2003). In 2003, there were a further 7 development applications for aquaculture lease sites.

Commercial Fishing

Ellis (1999a) described commercial fishing as a well established and economically important industry sector in the West Coast region. Percentages for regional employment and production value on Eyre Peninsula were provided by Ellis (1999a). Apart from direct employment of professional fishers in the far West Coast region, "flow-on" effects in the Rock Lobster, Western King Prawn, Abalone and Marine Scalefish sectors were considered important. Flow-on effects were greatest for the marine scalefish sector of the commercial fishing industry, since it has "relatively strong linkages with the local economy" (Ellis, 1999a).

Thevenard is the home port to a fleet of commercial fishing vessels, and fish processors market catches of whiting, Rock Lobster, prawns, shark, Garfish, calamari, Snapper, abalone, and locally farmed oysters. Australian Salmon, Tommy Ruff and crab are also brought into Thevenard by the fishing fleet.

According to an estuarine assessment of the Blanche Port area that was undertaken in the early 2000s, there were 30 commercial fishers operating from the **Streaky Bay / Blanche Port** area at that time (GeoScience Australia, 2001).

Scalefish, Sharks and Minor Invertebrates

Decres Bay and both northern and southern **Smoky Bay** are considered to be significant areas for commercial fishing (Ashman, 1996).

Whiting is an important commercial fishery in **Tourville Bay** (Hames Sharley Australia, 1989) and is described as one of the three major fisheries (along with lobster and prawns) in the **Ceduna** region, in general (Ashman, 1996).

Denial and **Smoky Bay** are commercial line fishing areas (Ashman, 1996). Hames Sharley Australia (1989) reported that **Denial Bay** is used by a small number of commercial scale fishing enterprises, operating from permanent moorings, and that it is important for professional fishing in the Ceduna area, in general (i.e. **Murat Bay / Denial Bay**), with which development such as aquaculture might conflict. PIRSA (Ashman, 1996) also recognised use of **Denial Bay** by the commercial fishing industry in an assessment of aquaculture potential (and conflicts with fishing) in the region.

Commercial fishers also moor boats at **Laura Bay** and launch from there (e.g. at the sandy beach areas at the western entrance to the bay) (Hames Sharley Australia, 1989).

Smoky Bay has been described as supporting “a significant number of commercial fisher-persons” (Hames Sharley Australia, 1989), with Razorfish from the bay being used for bait, and whiting being commonly caught on the sandy edges of the deeper water, in the centre of the bay. Salmon trolling occurs in the shallows on the eastern side (e.g. near **Pelican Point**), and near the creeks, through the mangroves on the western side. Snapper are caught off rocky points on the eastern shore (Hames Sharley Australia, 1989).

There is commercial fishing for King George Whiting, and collection of Razorfish, around **Eyre Island** and **St Peter Island** (e.g. northern side), both of which are described as “extremely popular” for commercial interests (Hames Sharley Australia, 1989).

Streaky Bay township has been described as “an important urban centre for the fishing industry” (Bond, 1994). Mooring of commercial fishing vessels occurs adjacent to the Streaky Bay township and, and the fishing industry uses the jetty and associated facilities (Bond, 1994). Both line and net fishing occur in the area. Commercial fishing is considered to be a significant industry in **Streaky Bay**, with valuable catches from the area including King George Whiting and shark (Eyre Peninsula Tourism Association, 2000).

There are concrete boat ramps at **Streaky Bay**, **Smoky Bay**, **Thevenard**, and **Ceduna** and a beach ramp at **Smoky Bay**, used for commercial fishing boat launches. The use of these ramps for commercial fishing was around 31% at Smoky Bay, 31% at Ceduna, and nearly 69% at Thevenard, during one survey period (McGlennon, 1996), indicating the importance of the **Thevenard** area for commercial fishing operations. **Thevenard** is described by Eyre Peninsula Tourism Association (1995) and other regional tourism materials, as the base port of a fleet of small commercial fishing vessels for species such as whiting, Snapper, Garfish and Southern Calamari. Commercial catches are processed at the two fish processing plants near the major slipway, at which boats up to the size of trawlers can be launched and lifted. The Thevenard Slipway was scheduled to be upgraded during the early 2000s. Southern Bluefin Tuna from Commonwealth waters are also landed at **Thevenard**.

The Ceduna Keys Marina and Coastal Centre project was in the developmental stages in 2003 - 2004. The project entails the development of a 75-berth commercial marina, with fishers' wharf facilities and associated commercial allotments. The development is expected to enhance the fishing industries in **Ceduna** area (Austin, media report, September, 2003).

Regionally, the major commercial fish species caught in the crenulate bays area between **Point Peter** and **Point Brown** (which includes **Tourville Bay**, **Denial Bay**, **Murat Bay**, **Bosanquet Bay**, **Decres Bay**, **Smoky Bay**, and shallow waters less than 10m, out to the **St Peters Island** area) are as follows:

King George Whiting: The crenulate bays area is one of the most important fishing areas for King George Whiting in S.A.. The area has regularly recorded some of the highest commercial yields per annum of all fishing blocks in the state in which King George Whiting are fished. Traditionally, hand-lines have been used. There is a commercial netting ban in the area. Recent catch figures specific to the bays listed above are not available for this report, however Fowler and McGarvey (1999) reported that the total catch of King George Whiting from Far West Coast bays in 1998 was around 108t (almost all of which was taken by hand-lines), and that total fishing effort amounted to 5661 fishing days. Fowler and McGarvey (1999) and McGarvey *et al.* (2000 and 2003) reported that (i) the hand-line catch from the Far West Coast region (i.e. Denial Bay and Streaky Bay areas combined) was 159t in 1999, 111t in 2000, 137.4t in 2001, and 103t in 2002. The handline catch in 2002 was the lowest recorded to date, for the Far West Coast bays (McGarvey *et al.*, 2003); (ii) handline effort has consistently been above 6000 fisher-days during the past four years to 2002; (iii) catch rates (kg per fisher day) in the area have gradually increased since the 1970s (in line with the long term reduction in the total number of days fished per annum), and (iv) catch rates remained high

throughout most of the 1990s relative to the long term average, but fluctuated during the early 2000s. Total catch (kg per annum) was highest during the late 1970s and early 1980s, and therefore, throughout most of the 1990s and early 2000s, the total catch was lower than the long term average.

Southern Calamari: In some recent years (e.g. mid-late 1990s), the crenulate bays region has been one of the top 10 fishing blocks in the state in terms of annual yield of calamari. Triantafillos and Fowler (2000, Figure 4a) showed that the calamari catch from the entire Far West Coast area (i.e. Fishing Blocks 8, 9, and 10 combined) increased during the 1990s, compared with the yields during the 1980s. During the 1990s, catch peaked in 1996 (around 37 tonnes, from squid jigging), and around 29t of Southern Calamari were taken from the Far West Coasts bays region in 1999. During the mid to late 1990s, fishing effort on calamari was mostly greater than 750 boat-days per annum, for jig fishing, the method used in Far West Coast waters. Large annual fluctuations in abundance of Southern Calamari are known to occur in Far West coast waters, which results in large fluctuations in catch and Catch per unit effort, despite relatively constant effort (Triantafillos and Fowler, 2000).

Other species of commercial importance in the area include:

- ♦ *Gummy Shark* and other shark species including *School Shark* and *Bronze Whaler*;
- ♦ *Ray and Stingray* species: In recent some years (e.g. mid-late 1990s), the area of the Far West Coast bays has been amongst the top 5 fishing blocks in the State, in terms of annual yield;
- ♦ *Snapper*: no specific recent information on catches is available for the Far West Coast bays, however Fowler (2000 and 2002) and Knight *et al.* (2002) provided an overview of the Snapper fishery catch and effort for the entire west coast.
- ♦ *Blue Swimmer Crabs*: Targeted periodically when abundance is high, purportedly following irregular periods of oceanographically-induced good recruitment (see Grove-Jones, 1987). In 2002/03, the landed catch of blue crabs from the West Coast bays was about 25.2t (Svane and Hooper, 2004).
- ♦ Around 20 other fish species are caught commercially in the area, in small quantities.

According to SARDI data (cited by Edyvane, 1999b), the Marine Scalefish and Shark catch from GARFIS Block 09 (crenulate bays of the Far West Coast, comprising all bays, other waters and inner islands between **Point Peter** and **Point Brown**, and including **Tourville Bay**, **Murat Bay**, **Denial Bay**, **Bosanquet Bay**, **Decres Bay**, **Smoky Bay**) was in 1995/96: a total of 113,754kg (1.09% of State total); and in 1996/97: a total of 126,154kg (1.24% of State total). On a State-wide scale, aggregated catch figures for all GARFIS Fishing Blocks in South Australia, between 1995-1997, showed that crenulate bays of the Far West Coast (Fishing Block 09) was ranked 23rd in 1995/96 and 21st in 1996/97, in the list of Marine Scalefish Fishery yields (i.e. fish, shark and invertebrates excluding the single species invertebrate fisheries), from 58 South Australian fishing blocks, at that time.

Regionally the major species commercially caught in the **Streaky Bay area** (i.e. from **Point de Mole** southwards to approximately **Point Westall / Sceale Bay** area) are:

King George Whiting is the major commercial fishery in this area, and in terms of annual yields, the region is regularly amongst the top 10 fishing blocks in South Australia in which King George Whiting are fished. Catch and effort figures specific to Streaky Bay are not available for this report, however the fishing statistics for all Far West Coast bays combined, are listed above in the description of commercial fishing in the crenulate bays area (Murat Bay, Denial Bay, Smoky Bay etc). Hand-lines and hooks are used (netting is banned in Streaky Bay), and Wilson (Fishnet, 2002) reported that commercial fishers regularly take half-tonne catches per week using hooks and lines.

Southern Calamari: In some recent years (mid-late 1990s), commercial yields of over 10 tonnes per annum have been recorded from the Streaky Bay area. See section above on Fishing Block 9, for information about the catch and effort for the Far West Coasts bays region (i.e. Blocks 8, 9 and 10 combined).

Other species of commercial importance in the area include:

- ♦ *Gummy Shark* (and other shark species including *School Shark* and *Bronze Whaler*);
- ♦ *Snapper*: No specific recent information on catches is available for the Streaky Bay area, however Fowler (2000 and 2002), Knight *et al.* (2002), and Fowler *et al.* (2003) provided an overview of the Snapper fishery catch and effort for the entire West Coast. It is noted that in 2001/2002, the total Snapper catch from West Coast waters was about 29t, and although that was 38% higher than the previous year's catch, it represented only 4.5% of the State-wide commercial catch of Snapper (Fowler *et al.*, 2003).
- ♦ *West Australian Salmon*: In some years following good recruitment, the Streaky Bay area has been

amongst the top 10 fishing blocks in S.A. in terms of annual catch. Jones (1999), Westlake *et al.* (2002) and Knight *et al.* (2002) provided overviews of salmon catch and effort for the entire West Coast region. In 2001, the Australian Salmon catch from the entire West Coast was around 48.3t, which was the third highest of 7 regions of South Australia in which salmon are commercially fished – see Westlake *et al.*, 2002);

- ♦ *Stingray and Ray* species: In some recent years (mid-late 1990s, for example), the Streaky Bay area has been amongst the top 5 fishing blocks of the State in terms of annual yields.

According to SARDI (cited by Edyvane, 1999b), the Marine Scalefish and Shark catch from GARFIS Block 10 (Streaky Bay region, Point de Mole southwards to Point Westall / Sceale Bay area) was as follows: In 1995/96: a total of 64,455kg (0.62% of State total, representing 26 fishers); In 1996/97: a total of 73,702kg (0.73% of State total, representing 28 fishers). Marine Scalefish, Restricted Marine Scalefish, and Northern Zone Rock Lobster licence holders contribute to these yields. On a State-wide scale, aggregated catch figures for all GARFIS Fishing Blocks in South Australia, between 1995-1997, showed that the Streaky Bay region (Fishing Block 10) was ranked 29th in 1995/96 and 29th also in 1996/97, in the list of Marine Scalefish Fishery yields (i.e. fish, shark and invertebrates excluding the single species invertebrate fisheries) from 58 South Australian fishing blocks, at that time.

In deeper waters from **south 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), major commercial species include:

School Shark and Gummy Shark: during the mid to late 1990s, annual yields in the dozens of tonnes, to more than 100 tonnes, were recorded. In some years the area has been amongst the top five fishing blocks in the State, in which these sharks species are fished. Note that the fishery for School Shark and Gummy Shark is managed by the Commonwealth, and has recently been rationalised (see section on **Issues for Risk and Impact Assessment**).

Pilchards: during the mid-late 1990s, yields in the tens of tonnes were recorded, with the area was ranked (at the time) amongst the top four regions of the State for Pilchard yields. It is noted that the S.A. Pilchard fishery is currently centred around southern Spencer Gulf and the waters of the Coffin Bay Peninsula, and that “large stocks” of pilchards on the West Coast are rarely fished (Ward *et al.*, 2000).

King George Whiting: In some recent years (mid-late 1990s) more than 10 tonnes per annum have been caught, however in comparison with yields from other fishing blocks at that time, the area was not ranked amongst the top 10 fishing blocks in the State in terms of annual yields of whiting.

Bronze whaler sharks: During the mid-late 1990s, annual yields of Bronze Whaler sharks were in excess of 10 tonnes per annum, ranked at that time as one of the top two regions in S.A., in terms of annual commercial yield for this species. Recent figures are not available for this report.

Stingray and Ray species: No figures are available, however it is noted that in excess of 10 tonnes of rays species were caught in at least one year during the mid-late 1990s, and at that time, the area ranked amongst the top five regions of the State in which rays are caught, in terms of annual yields;

Snook: No recent figures are available, however during the mid-late 1990s, the area ranked amongst the top 10 fishing blocks in S.A., in terms of annual yield of Snook, and was the second highest yielding area in at least one year during the mid-late 1990s.

Other commercial species caught in the deeper waters west of streaky Bay, including the Nuyts Archipelago area, include: various shark species (unspecified); *Ocean Leatherjacket* (low tonnages in mid-late 1990s); *Australian Salmon* (low tonnages during mid-late 1990s), *Southern Calamari* (e.g. several tonnes per annum recorded during the mid to late 1990s); *Sweep* (although the tonnages are small compared with some other scalefish species caught in the area, in some years the area is one of the top two regions of the State in terms of sweep yields), *leatherjacket* species, *Snapper* and *Blue Morwong*.

According to SARDI (cited by Edyvane, 1999b), the Marine Scalefish and Shark catch from GARFIS Block 8 (i.e. deeper waters from **south 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) was as follows: In 1995/96: a total of 173,574kg (1.67% of State total, representing 19 fishers); In 1996/97: a total of 196,644kg (1.94% of State total, representing 21 fishers). Marine Scalefish, Restricted Marine Scalefish, and Northern Zone Rock Lobster licence holders contribute to these yields.

On a State-wide scale, aggregated catch figures for all GARFIS Fishing Blocks in South Australia, between 1995-1997, showed that the deeper waters seaward of the West Coast bays (Fishing Block 8) was ranked 15th in both 1995/96 and 1996/97, in the list of Marine Scalefish Fishery yields (i.e. fish, shark and invertebrates excluding the single species fisheries), from 58 South Australian fishing blocks, at that time.

Abalone Fishing

Abalone has been described as one of the three major fisheries (along with lobster and whiting) in the **Ceduna** region in general (Ashman, 1996).

Abalone is considered to be one of the major species contributing to the commercial fishing significance of **Streaky Bay** (Eyre Peninsula Tourism Association, 2000).

The area described in this table encompasses abalone Map Codes 2A, 2B, 2C, 2D, 2E, 2F, 2G, 2H, 2I, and 2J, and 3A, 3B and 3C. According to Mayfield *et al.* (2001):

- ♦ there has been no statistically significant increase or decrease in fishing effort in the sub-blocks of Areas 2 or 3 over the past 10 years, to 2001;
- ♦ Area 2 was one of the five fishing areas in the Western Zone classified as “most fished” between 1988 and 1992, amounting to an average of 73.4 fishing days per year;
- ♦ Area 3 was one of the five fishing areas in the Western Zone classified as “least fished” between 1980 and 1984, amounting to an average of 19.6 fishing days per year; and
- ♦ catch rates in the sub-blocks covered by Areas 2 and 3 have been, on average, around 40kg – 60kg per hour, during the period 1996 to 2000, which is lower than catch rates from all other Map Code Areas in the Western Zone.

Mayfield *et al.* (2002) reported that:

- ♦ During 1980 to 1984, the average fishing effort, in terms of days per year, in Areas 2 and 3, amounted to 1.88% and 1.1% respectively of the total effort in the Western Zone. Between 1988 and 1992, these figures increased to 6.66% (average of 112 days per annum) in Area 2 and 4.93% (average of 83 days per annum) in Area 3, as a percentage of total effort in the Western Zone. Between 1997 and 2001, effort in Area 2 amounted to 5.5% of the total effort, and 3.6% for Area 3.
- ♦ Average fishing effort in terms of hours fished per year, amounted to 5.9% in Area 2, and 3.4% in Area 3, as a percentage of total number of hours fished per year in the Western Zone, for the period 1997-2001.
- ♦ Between 1997 and 2001, the average catch of greenlip was around 16.64t in Area 2 (= 7% of the Western Zone total catch), and around 8t for Area 3 (= 3.4% of the Western Zone total catch). In 2001, the proportions were similar (18.31t or 7.86% of total Western Zone greenlip catch taken from Area 2, and 7.52t or 3.23% from Area 3).
- ♦ Between 1997 and 2001, the average catch of blacklip was around 8.25t in Area 2 (= 2.6% of the Western Zone total catch), and around 7.47t for Area 3 (= 2.37% of the Western Zone total catch). In 2001, the proportions were similar (8.82t or 2.73% of total Western Zone blacklip catch taken from Area 2, and 8.11t or 2.51% from Area 3).
- ♦ For Area 2, percentage of total Western Zone greenlip catch has been as follows: 2.76% between 1980 and 1984; 6.39% between 1989 and 1993, and 7.86% between 1997 and 2001. For blacklip, the percentage of total Western Zone blacklip catch taken from Area 2 has been: 0.22% between 1980 and 1984; 2.44% between 1989 and 1993, and 2.62% between 1997 and 2001, with an apparent increasing catch trend between 1986 and 2001 (Mayfield *et al.* 2002, Tables 5a and 5b).
- ♦ For Area 3, percentage of total Western Zone greenlip catch has been as follows: 1.45% between 1980 and 1984; 4.62% between 1989 and 1993, and 3.23% between 1997 and 2001. For blacklip, the percentage of total Western Zone blacklip catch taken from Area 3 has been: 0.35% between 1980 and 1984; 2.16% between 1989 and 1993, and 2.37% between 1997 and 2001, with an apparent increasing catch trend between 1986 and 2001 (Mayfield *et al.* 2002, Tables 5a and 5b).
- ♦ North-west of Streaky Bay (and excluding that bay), the Far West Coast bays and offshore islands are classified as Region B of the Western Zone, in which fishers may harvest 1.8t per annum of greenlip or blacklip, or a mixture of the two.

Within these fishing areas, some previous catch figures (approximate whole weight) were provided by Shepherd (pers. comm. 2000):

- ♦ **Denial Bay and St Peter Island:** Between 1990 and 1996, recorded annual yield of Greenlip Abalone ranged between 3t and 10.7t. Yield of Blacklip Abalone fluctuated between approximately 1.5t and 10t.
- ♦ **St Francis Isles:** Between 1990 and 1996, recorded annual yield of Greenlip Abalone ranged between approximately 4.4t and 10t. Yield of Blacklip Abalone fluctuated between less than 1t and around 3.7t.

- ♦ **Smoky Bay, Cape Missiessy, north of Point Brown:** Between 1990 and 1996, recorded annual yield of Greenlip Abalone ranged from less than 250kg to around 2t. Yield of Blacklip Abalone fluctuated between less than 400kg and around 1.4t.
- ♦ **Franklin Islands:** Between 1990 and 1996, recorded annual yield of Greenlip Abalone ranged from 2.2t to around 10t. Yield of Blacklip Abalone fluctuated between less than 500kg and around 6t.

According to SARDI data (cited by Edyvane, 1999b), the total catch between 1994 and 1996, within the **Nuyts Archipelago** region and **Franklin Islands**, comprising abalone map codes 2A - H, 2J, 3C, 3D, was as follows:

- ♦ In 1994/95 a total of 20,670kg of Greenlip Abalone (9.1% of western zone catch, or 5.5% of State catch) and 21,243kg of Blacklip Abalone (6.8% of Western Zone catch, or 4.3% of State catch);
- ♦ In 1995/96 a total of 15,807kg of greenlip (7.0% of western zone catch, or 4.2% of State catch) and 16,611kg of Blacklip Abalone (6% of Western Zone catch, or 3.6% of State catch).

The total catch within the **Smoky Bay - Cape Missiessy - Point Collinson** region (map code 3A), during that period represented approximately 0.1% (1994/95) and 0.8% (1995/96) of the Western Zone catch of Greenlip Abalone or 0.06% and 0.5% of the State catch (SARDI data, cited by Edyvane 1999).

Rock Lobster Fishing (and Bycatch Species)

Southern Rock Lobster is fished from the rocky substrate throughout the area, including around the offshore islands. Rock lobster is considered to be one of the major commercial fisheries in the **Ceduna** and **Thevenard** region (Ashman, 1996; Walkabout Australian Travel Guide, 2000), and also one of several major species contributing to the commercial fishing significance of **Streaky Bay** (Eyre Peninsula Tourism Association, 2000).

The area described in this table is forms part of three Rock Lobster Marine Fishing Areas, as discussed below.

MFA 8 (i.e. deeper waters from **south 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). MFA 8 is one of the ten main fishing blocks in the Northern Zone (Ward *et al.*, 2002). According to SARDI (cited by Edyvane, 1999b), the Rock Lobster catch from MFA 8 between 1995 and 1997 was as follows: in 1995/96 a total of 54,832kg (1.07% of State total, representing 19 fishers); in 1996/97: a total of 43,345 kg (0.85% of State total, representing 18 fishers). Aggregated catch figures for all fishing blocks in South Australia, between 1995 and 1996, showed that Fishing Block 8 was ranked 11th in terms of yield (and hence value) during that period. The specific significance of this figure to the Nuyts Archipelago and St Francis Isles area described in this table is not known for this report, because Fishing Block 8 also includes deeper reef areas that are not in the vicinity of those islands. Catches have been higher than around 25t in Fishing Block 8, in all years between 1990 and 2001 (and higher than 50t in 1992, 1993 and 1995). Corresponding effort has been higher than 20,000 pot lifts per annum in all of those years (and over 35,000 pot lifts per annum in several years during the mid-1990s) (Ward *et al.*, 2002, Figure 2.5). Catch peaked at over 80t in 1975, however no catches of that size have been recorded since that time. During the late 1990's to 2001, both catch and effort decreased compared with the catch and effort during the early to mid 1990s (Ward *et al.*, 2002, Figure 2.5). This downward trend continued during the early 2000s (see Ward *et al.*, 2003). The percentage of the catch from MFA 8 that is taken from deep water (90+m) has decreased since the 1970s and 1980s (see Figure 2.12 in Ward *et al.*, 2002).

MFA 9 (crenulate bays area, comprising all bays, other waters and inner islands between **Point Peter** and **Point Brown**, and including **Tourville Bay, Murat Bay, Denial Bay, Bosanquet Bay, Decres Bay, Smoky Bay**). MFA 9 is not a major fishing area in the Northern Zone due to lack of suitable habitat for lobsters, and therefore catch and effort figures are not provided in recent stock assessment reports (e.g. see Ward *et al.*, 2002).

MFA 10 (Streaky Bay to Sceale Bay). MFA 10 is not one of the major fishing blocks in the Northern Zone, and therefore catch and effort figures are not provided in recent stock assessment reports (e.g. see Ward *et al.* 2002 (see Ward *et al.*, 2002). According to SARDI (cited by Edyvane 1999), the Rock Lobster catch from Fishing Block 10 (Streaky Bay region, Point de Mole southwards to Point Westall / Sceale Bay area) between 1995 and 1997 was as follows: in 1995/96 a total of 11,710kg (0.23% of State total, representing 17 fishers); In 1996/97 a total of 12,171 kg (0.24% of State total, representing 13 fishers). Aggregated catch figures for all Rock Lobster fishing blocks in South Australia, between 1995 and 1996, showed that Fishing Block 10 was ranked 19th in terms of yield (and hence value) during that period.

When the entire Northern Zone is considered as a whole (i.e. from the Western Australian border, through to Encounter Bay and deeper waters south of Kangaroo Island), the catch for the 2002 season was 594.8

tonnes, being the lowest catch in the Northern Zone since 1979 (Ward *et al.*, 2003).

Bycatch information specific to the Far West Coast is not available for this report. However, McGarvey *et al.* (1998) and Prescott (2001) reported that the largest proportion of bycatch in the Northern Zone as a whole, is leatherjackets and octopus. According to results of a sampling program of bycatch in 1991 and 1992, various wrasse species (Labridae family) together constituted another major component of the bycatch in the Northern Zone e.g. 1127 Labrids caught in pots during the bycatch sampling program in 1991-92 (Prescott, 2001, Table 5). Octopus are a major predator of Rock Lobster, with losses due to octopus predation equating to approximately 4% of the total number of lobsters landed (in the Northern Zone). According to McGarvey *et al.* (1998), the catches and catch rates of octopus have been sustained over time, and vary from 1 – 2.5 octopuses per 100 pot lifts. Octopus that are caught in the northern zone are sold. Rock Lobster fishers are also permitted to retain legal sized Giant Crab when caught as by-product, and this species is becoming increasingly valuable, commercially (McGarvey *et al.*, 1998). A small number of Commonwealth-endorsed Rock Lobster fishers also target Giant Crab specifically. Between 1992/93 and 2001/02, total Giant Crab catches (target and byproduct catches combined) have ranged between 7t in 1992/93, and 33t in 1998/99, with a steady decline between 1999 and 2002 due to the introduction of quotas (e.g. 31t in 1999/00; 24t in 2000/01, and 18.5t in 2001/02) (Knight *et al.*, 2003, cited by Sloan, 2003b). The fishery now operates under a quota-based management system with a total allowable commercial catch (TACC) of 13.4 and 8.7 tonnes for the Northern Zone and Southern Zone, respectively (Sloan, 2003b). Giant Crabs are caught from the edge of the continental shelf in the west coast region (McGarvey *et al.*, 1998).

Some lobster boats net sharks out of season, and some of these activities require a Commonwealth permit. Licensed Rock Lobster fishers have also had access to fish species, such as Australian Salmon, Mulloway, and Snapper (Zacharin, 1997, cited by McGarvey *et al.*, 1998).

Predators of Rock Lobster in the Northern zone include New Zealand Fur Seals, Western Blue Groper (minor) and Maori Octopus (McGarvey *et al.* 1998; S. Shepherd, pers. comm., 2004).

Prawn Fishing

The far west coast is one of three prawn fishing areas on the West Coast (see description in MacDonald, 1998, and map in Boxshall, 2001). The far west coast fishing ground encompasses most waters between 133°E and 134°E, and between 32°S and 33°S (Boxshall, 2001, Figure 1). The north-western boundary is Point Ball, and the south-eastern boundary is seaward of Sceale Bay. The trawling grounds include the islands of the **Nuyts Archipelago** (Ashman, 1996) and the **St Francis Isles**, which are in the vicinity of the major prawn fishing area of the Far West Coast (see map in MacDonald, 1998).

The trawl grounds operate mainly in waters between 30 to 50 metres deep (MacDonald 1998). The shallower waters of the crenulate bays area, such as Streaky, Murat and Denial Bays, are excluded from the fishery (N.B. prawn fishing is not permitted in waters less than 10m).

Western King Prawn is considered to be one of the major commercial fisheries in the **Ceduna** region (Ashman, 1996), and part of the fleet sets out from and unloads at **Thevenard** (Ellis, 1999a; Fairfax Publishing – F2, 2000). Prawn trawlers also load and unload at **Streaky Bay** (Ellis, 1999a). Only a small number of licences operate in the West Coast prawn trawl fishery. For example, during the late 1990s, there were three licences operating in the West Coast area (MacDonald, 1998).

In 1999/2000, around 30.8t of prawns were taken from the “**Ceduna / Olive Island grounds**” (i.e. the Far West), which was around 29% of the total West Coast fishery catch of 106 tonnes (see Carrick and Williams, 2001). For that year, the level of effort that produced that catch was not available for the Ceduna / Olive Island region, however the total West Coast fishing effort in 1999/2000 for the 3 main fishing areas combined, was approximately 2,244 hours trawled, over 92 nights (Carrick and Williams, 2001). The 1999 / 2000 annual catch per unit of effort for prawns in the West Coast fishery was 47kg/hr (Carrick and Williams, 2001). In 2001/02, the catch from the Ceduna grounds was minimal (0.3t), with a corresponding low fishing effort of 26.7 hours. In 2002 / 2003, the catch from the **Ceduna / Olive Island grounds** was reported to be an order of magnitude lower (1.375t) than the catch in 1999/2000, as was the total catch for the western zone (29.16t, from all 3 fishing grounds on the west coast). The effort level for the Ceduna / Olive Bay grounds in 2002/2003 was approximately 59.4 hours. Effort, catch and catch rates were all lower in 2002/2003 than in 1999/2000 (Svane and Barnett, 2004). The considerable variation in catches over recent years possibly reflects oceanically driven cycles of abundance (Svane and Barentt, 2004). Generally, the fishing region that comprises the Nuyts Archipelago, St Francis Isles, and upper West Coast bays (which includes the Ceduna / Olive Island grounds), is a less significant

area of the West Coast prawn fishery compared with the grounds further south (see 9.1.3 and 9.1.14 below).

The West Coast fishery yields are, on average, an order of magnitude lower than the annual yields from the Spencer Gulf fishery, and during the 1990s, represented approximately 9% - 10% of the total catch of Western King Prawn in South Australia (see catch figures in MacDonald, 1998). Prawn fishing effort and yields from the entire West Coast fishery are highly variable, and catches have ranged from 0kg to around 200t per annum during the 1990s. In 2000/01, the catch (81t) and effort from the entire West Coast Prawn fishery were the lowest since 1993/94. In 2001/02, 106t of Western King Prawns were taken in the fishery (SARDI Aquatic Sciences statistics, 2003), and in 2002/03, only 29t were taken in the West Coast fishery, all 3 fishing regions combined (Svane and Barnett, 2004).

In the West Coast fishery, the relationships between water temperature, the number of spawning adults, and subsequent recruits is reported to be complicated by the oceanic nature of the region which has resulted in periodic large declines in the number of prawns. Carrick (1996, cited by MacDonald, 1998) suggested that the large decline in the catch from the West Coast was attributable to ENSO (El Niño - Southern Oscillation) induced current changes which affected the distribution of spawners and the supply of recruits to the nurseries.

Other species taken commercially as part of the West Coast prawn fishery include Slipper Lobster (*Ibacus* species), Octopus species, Scallops (family Pectinidae), Southern Calamari, and Arrow Squid / Torpedo Squid (*Nototodarus gouldi*) (MacDonald, 1998).

Recreational Fishing

Ellis (1999a) described recreational fishing and its associated services as a well established and economically important industry sector in the West Coast region. Fishing is considered to be the recreation and tourism activity of most significance along the Far West Coast (Ashman, 1996), and recreational fishing from boats and shore has been described as “a popular and valuable activity for the district” (Ashman, 1996).

The West Coast has been described as one of the best recreational fishing locations in South Australia, and previous assessment has ranked fishing as the second most appealing feature to visitors in the region (SA Department of Tourism, 1983, cited by Hames Sharley Australia, 1989). The various sandy beaches, sheltered bays, and rocky promontories are all promoted for fishing. Popular catches in the Far west Coast area include King George Whiting, Snapper, Australian Salmon, mullet, Garfish and Southern Calamari.

Recreational jetties have been described as “the lifeblood” of some of the smaller towns along the West Coast (Ellis, 1999a) and “all jetties are of high social and recreational value” (Ellis, 1999b).

A summary of fishing activities in the **West Coast** region includes line fishing (from shore in bays and at headlands, and from boats), surf fishing (at the surf beaches), hoop netting and dab netting (in the bays), bait digging (tidal flats), “floundering” (tidal flats), crabbing (tidal flats), lobster potting (reefs), dive fishing for crustaceans and molluscs, and charter boat fishing.

McGlennon and Kinloch (1997, cited by Ellis, 1999a) reported that around 24,316 recreational boat-days per annum were spent on the West Coast during the mid 1990s, with local, State and interstate figures combined. The popularity of recreational fishing in the area, and the employment and services it generates, are important for the regional economy. The following sections describe some of the major species caught in various areas described in this table:

Rocky Point to Point Peter: The beaches and bays of the **Rocky Point** and **Point Bell** area are promoted for rock fishing and surf fishing, by Ceduna region tourism materials. Major species caught in the **Rocky Point** area include King George Whiting, Snapper, Tommy Ruff, Australian Salmon, mullet, flathead, sweep, Garfish, Mulloway, shark species, and trevally (Eyre Peninsula Tourism Association, 1995). Point James is also a recreational fishing area (Hames Sharley Australia, 1989). The area of the net closure from Point Brown to Point James is popular with recreational boat fishers (Ashman, 1996). Rock and surf fishing is popular where there is coastal access (Hames Sharley Australia, 1989; Ashman, 1996). Between Rocky Point and Point Peter, there are launching areas for boats, at the sandy beaches where vehicles can obtain access via tracks (see Hames Sharley Australia, 1989).

Tourville Bay and Davenport Creek: **Tourville Bay** is considered to be an important recreational fishing area,

with whiting salmon, mullet, Tommy Ruff and Garfish being the most sought-after species (Eyre Peninsula Tourist Association, 1995, 2000). PIRSA (Ashman, 1996) recognised “the high use made of Tourville Bay for boating and fishing, in particular Davenport Creek”, and that **Tourville Bay** is a significant boating channel in the area. The main Tourville Bay channel, and the deeper waters in the south of this zone are considered “important for boating and as fishing grounds”, and “another channel running close to the eastern shore in this zone is also important for boating access” (Ashman, 1996). Recreational fishing and boating were listed as main activities in the **Davenport Creek** area, in the description of the area as a *Wetland of National Importance* (Morelli and de Jong, 1995). The area has been described as “popular for fishing”, and “one of the finest fishing waterways available on the Eyre Peninsula, offering superb line fishing from the banks of the creek, and excellent boat fishing” (Eyre Peninsula Tourism Association, 2000). Previously, Hames Sharley Australia (1989) reported that “recreational fishers frequent **Davenport Creek** and **Nadia Landing**, mainly for fishing, crabbing and collecting Razorfish”. King George Whiting, Australian Salmon, Sea Mullet, Tommy Ruff and Garfish are some of the main species targeted and caught (Morelli and de Jong, 1995; Eyre Peninsula Tourism Association, 2000). Other species taken at **Davenport Creek** include flathead and flounder species, Blue Swimmer Crabs, Southern Calamari, Snook, Mulloway, shark species and trevally (Eyre Peninsula Tourism Association, 1995). Hames Sharley Australia (1989) reported that Snapper are also taken in the Davenport Creek area. Fishers also collect Scallops from the creeks in the Tourville Bay / Davenport Creek area (Morelli and de Jong, 1995). South of **Nadia Landing** is a fishing area for scalefish (e.g. flounder species) and Razorfish, and there is a boat launching facility there (Hames Sharley Australia, 1989).

Ceduna area (Murat and Denial Bays, and Thevenard): The area is reported to have a reputation as “a superb fishing location”, and jetty fishing, surf fishing, rock fishing and boat fishing (including charter boats) are all promoted in the area (Fairfax Publishing – F2, 2003). Recreational use of the **Ceduna** area for fishing is high, according to Hames Sharley Australia (1989). Fishing and boating access was recognised by PIRSA (Ashman, 1996) as a significant activity in the **Denial Bay / Murat Bay** area, and fishing has been described as “one of Ceduna’s biggest drawcards” (Sightseeing South Australia, 2002). The area known as **Horseshoe** (sand bar in central **Murat Bay**) was cited in particular as being important for fishers. The **Ceduna** area has been described in a national recreation guide as “having a reputation as a superb fishing location” (Fairfax Publishing – F2, 2000). Fishing and boating access are popular in the many of the channels in this area. Fishers use the beach / surf zone, rocks, jetty and boats in the **Ceduna** area. Major species caught in the **Ceduna** area include King George Whiting (large whiting over 1kg are caught in deeper waters off Ceduna), Sand Whiting, Snapper, Tommy Ruff (Australian herring), Australian Salmon, Sea Garfish, Leatherjacket species, Mullet, Flathead and flounder species, Blue Swimmer Crab, Southern Calamari, Sweep, Silver Drummer, Snook, Trevally, Samson Fish (e.g. from deeper reefs), Mulloway and “a range of sharks” including School Shark, Bronze Whalers, Hammerheads, Gummy Sharks and (presumably prior to the legislative ban) “world record White Pointers” (Eyre Peninsula Tourism Association, 1995; Fairfax Publishing – F2, 2000 and 2003; Fishnet, 2002). The **Ceduna** region is known for its large sharks and game-fishing, according to diving and fishing tourism promotion materials. Australian Salmon and Bronze Whaler sharks are caught from rocks in the area. Blue Groper, sweep and other reef fish species are caught in offshore reef areas. Sports fishers in competitions have caught Blue Groper, Mulloway, Australian Salmon and Bronze Whalers sharks of record size in waters out from **Ceduna** (e.g. see ANSA, 1999). Beach fishers often target Mulloway and Australian Salmon. There is a large boat ramp just south of Ceduna (Puckridge Boat Ramp). There is also a jetty at Ceduna, which runs out into **Murat Bay**, and is described as “ideal for fishing” (Fairfax Publishing – F2, 2000). Whiting and Snapper are two of the most popular target species for jetty and boat fishers. **McKenzie Landing (Denial Bay)** has a boat ramp and boat moorings, and a jetty, and was mapped as a fishing area by Hames Sharley Australia (1989), with whiting and Snapper being the main species of interest. Boats can be launched from the coast in **Denial Bay**, wherever there is beach access for vehicles. Tommy Ruff, Australian Salmon, Garfish, Snook, flathead, Southern Calamari and blue swimmer crabs are caught from **Thevenard Wharf** and jetties at **Ceduna** and **Denial Bay**. There are boat launching spots for shallow boats, from beaches in the **Thevenard** area, and from the boat mooring area adjacent to the major slipway at Thevenard, where “a high intensity of small boat traffic” has been recorded (Hames Sharley Australia, 1989). The **Denial Bay** jetty has been described as “excellent for fishing, crabbing and squidging”, and the area in general is described as having “rewarding fishing, and netting of blue crabs” (Eyre Peninsula Tourism Association, 2000). Other species taken from the **Denial Bay** jetty include King George Whiting, mullet, flounder, and trevally. Boat fishers catch all of the jetty species, amongst others, and whiting are caught in abundance by boat fishers in the area (Eyre Peninsula Tourism Association, 1995 and 2000). Large Mulloway (e.g. more than 1.5m) are caught in the **Ceduna** area. Razorfish are collected in patches, in a number of areas, and are often used for bait. Recreational fishing for Rock Lobster also occurs in the area, mainly by diving (Tyrer, PISA, 1994). Boat facilities are provided at the three centres.

Bosanquet Bay: There is a boat ramp and boat moorings on the northern side of the bay (near **Thevenard**). Recreation / tourism promotion materials describe the area having “good beach fishing”, and being “excellent”

for fishing King George Whiting, Snapper, Scallops, and, when in season, oysters and blue swimmer crabs. Hames Sharley Australia (1989) reported use of the northern area for small boat traffic; Snapper fishing off the rocky headlands on the eastern side of the bay, and scallop diving in the centre of the bay. Fishing is also reported in the southern area, near **Cape Vivonne**. There is reportedly “a high intensity of small boat traffic” in the area (Hames Sharley Australia, 1989).

Decres Bay and Laura Bay: Hames Sharley Australia (1989) reported that there is “infrequent” fishing from rocks, by recreational fishers, but that the beach area at **Wittelbee Point** is an attractive fishing area for tourists. However, according to Ashman (1996), “extensive use” is made of the **Decres Bay** area for recreational fishing and boating. The headland on the eastern side is reported to be a recreational fishing area, and recreational fishing is reported to be one of the major uses of the **Laura Bay** area (Hames Sharley Australia, 1989). **Decres** and **Laura Bays** are mainly boat fishing locations, but launching facilities are limited to beach areas (e.g. adjacent to the small shack settlement north of **Wittelbee Point**). Eyre Peninsula Tourism Association (2000) also reported the use of **Decres Bay** for rock fishing. Major species caught in the **Laura Bay** area include King George Whiting, Tommy Ruff, Australian Salmon, mullet, flathead, Southern Calamari, Garfish, Snook, shark species and trevally. There are boat launching areas on the western side of the entrance to Laura Bay, at sandy beaches.

St Peter Island and Eyre Island: Recreational fishing occurs within the channels around **St Peter** island (Ashman, 1996). Major species caught around Eyre Island include King George Whiting, Tommy Ruff, Australian Salmon, mullet, flathead, Southern Calamari, sweep, Garfish, Snook, shark, trevally (Eyre Peninsula Tourism Association 1995 and 2000). Razorfish are also collected around both islands, and the fishing of King George Whiting and Razorfish by recreational fishers was described as “extremely popular” by Hames Sharley Australia (1989).

Smoky Bay is considered to be a significant area for recreational fishing and boating activity (Ashman, 1996). The area is popular for annual fishing holidays, and fishing has been described as “excellent” and “great” in the Smoky Bay area (Kerr, 2000, and Far West Coast tourism promotion materials 2000-2003). Recreational fishers reportedly “make extensive use” of the jetty, beaches and boat ramps in the area (Hames Sharley Australia, 1989). The town jetty, which extends around 500 metres out into the bay, is promoted as a popular fishing spot for King George Whiting, Tommy Ruff (Australian herring) and Mulloway (Kerr, 2000). Adjacent to the Smoky Bay jetty, there is a public ramp suitable for small fishing boats, which can also be launched at various locations within the bay, including the beachfront caravan park (Hames Sharley Australia, 1989, Kerr, 2000). There is also a boat mooring area near the township. Beach fishing was described as one of the major uses in the **Smoky Bay** area, with many small boats moored adjacent to the jetty. Razorfish (often used for bait) are collected in the bay from patches in the shallows, and fishing and boating access are popular in the channels. Whiting, which is the main species sought by boat fishers in Smoky Bay (Kerr, 2000), are commonly caught on the sandy edges of the deeper water, in the centre of the bay. Garfish and calamari are also targeted. Trolling for salmon occurs in the shallow waters on the eastern side (e.g. near Pelican Point), and near the creeks, through the mangroves on the western side. Snapper are caught off the rocky points on the eastern shore (Hames Sharley Australia, 1989).

A summary of the major species caught in the **Smoky Bay** area include King George Whiting (targeted in abundance, in the whiting “holes”), Snapper, Tommy Ruff, Australian Salmon, mullet, flathead, flounder, Southern Calamari, Garfish, Snook, shark species and trevally. Main species taken from the jetty include Garfish, whiting, Tommy Ruff, trevally, Australian Salmon, Snook, mullet and blue crabs. Boat fishers catch similar species, as well as Snapper in season (Eyre Peninsula Tourism Association, 2000), and tourism promoters suggest that the best fishing results in the area come from boat fishing (Nullarbor Travel Guide, 2003). Recreational lobster fishing also occurs in the Smoky Bay area, both by diving, and using lobster pots (Tyrer, 1994).

South of Smoky Bay, **Smoky Bay Hill** and **Point Brown** have been described as recreational fishing areas (Hames Sharley Australia, 1989). **Point Brown** is considered to be “a popular surf fishing location, returning catches of salmon, trevally and the occasional Mulloway” (Eyre Peninsula Tourism Association, 2000). Major species caught include Australian Salmon, mullet, sweep, Mulloway, shark species and trevally (Eyre Peninsula Tourism Association, 1995). **Point Collinson** is also a rock / surf fishing area (Hames Sharley Australia, 1989). There are several boat launching sites at beaches in the area, where there is vehicle access.

Streaky Bay region: Streaky Bay has been described as “one of South Australia’s best fishing towns” for recreational fishers (Media report, Channel 9 *Postcards* program, undated); “one of the best fishing areas

in Australia”, and “a mecca for anglers” (Sightseeing South Australia, 2003). Streaky Bay contains a variety of fishing locations for beach, rock and boat fishers. Streaky Bay has a recognised “fishing tourism” function, and is reported that “many thousands” of recreational fishers visit the area every year (Sightseeing South Australia, 2003). Other indications of the value of Streaky Bay for recreational fishers and fishing tourists include the annual recreational fishing competition, Family Fish Day Contest, and the Whiting Carnival. Launching facilities are provided for boat fishers and the jetty is also popular for recreational fishing, including anglers fishing seasonally for large Snapper each year (Fishnet, 2002).

Popular target species for visiting fishers in the **Streaky Bay** area include King George Whiting (particularly from the shores), Snapper, West Australian Salmon, Trevally, Snook (in the seagrass meadows of Streaky Bay), Garfish, Southern Calamari and Blue Swimmer Crabs (Eyre Peninsula Tourism Association, 2000; Fishnet, 2002; Sightseeing South Australia, 2003). Whiting fishing is described as “*superb in Streaky Bay, with bag-limit catches of fish weighing around three to the kilogram, but sometimes bigger, quite common virtually throughout the year*” (Wilson, Fishnet, 2002).

Tommy Ruff, Snapper (large Snapper are taken seasonally), Australian Salmon, Snook and trevally (sometimes used as bait for Snapper) are popular targets for jetty fishers in **Streaky Bay**, and crab nets are also set in the jetty area. Razorfish are targeted in Streaky Bay for use as fishing bait and for human consumption (Bond, 1994). Sand crabs are also caught recreationally in Streaky Bay (Eyre Peninsula Tourism Association, 1995).

Snapper have traditionally been taken in the area mainly during November and December (Eyre Peninsula Tourism Association, 2000). An annual Snapper-fishing competition for boat and shore fishers has been run each summer in Streaky Bay (Fishnet, 2002). Other species caught in the Streaky Bay area include mullet, flathead, flounder, and various shark species (Eyre Peninsula Tourism Association, 1995). Great white sharks regularly visit Streaky Bay during the warmer months of the year, and (mainly prior to the legislative ban) larger white sharks have been caught from the Streaky Bay area (Fishnet, 2002).

In northern **Streaky Bay**, Hames Sharley Australia (1989) listed the western side of **Acraman Creek** (near the shacks and boat launching area) as a recreational fishing site subject to “considerable use”, as well as **Point Lindsay** to the east. There are boat launching areas in northern Streaky Bay, including beach launching at Acraman Creek, and on more exposed oceanic beaches. Boats are reportedly moored in the creek “for long periods” (Hames Sharley Australia, 1989). Species targeted and caught at **Acraman Creek** include King George Whiting, Tommy Ruff, West Australian Salmon, mullet, flathead, flounder, Blue Swimmer Crabs, Southern Calamari, Garfish, Snook and Trevally. Molluscs are also collected in the area. North Bank and Dashwood Rock are marked as recreational fishing “hotspots” by *Fish SA*. Northern Streaky Bay was recognised by Bond (1994) as being significant for recreational boating and fishing, including coastal waters that are “relatively popular for offshore fishing”. Further south, the shores of Streaky Bay, including **Perlubie Beach**, have been described as areas for “excellent beach fishing for King George Whiting”. Larger fish are caught by boat fishers further from shore (e.g. around Eba Island and the Eba Anchorage) (Eyre Peninsula Tourism Association, 2000). **Eba Island** is also accessible by foot, at low tide. Species taken from Perlubie Beach include King George Whiting, Tommy Ruff, mullet, flathead, flounder, Southern Calamari, and Garfish. Species taken from **Eba Island** waters by boat fishers include King George Whiting, Tommy Ruff, Australian Salmon, flathead, Southern Calamari, Garfish, blue swimmer crab and trevally (Eyre Peninsula Tourism Association, 1995). Bond (1994) also considered the eastern side of Streaky Bay to be important for recreational fishing. The jetty at **Haslam** is also a recognised fishing spot. The beach at **Haslam** is also used for recreational fishing (Fairfax Publishing – F2, 2002). Species targeted in the **Haslam** area include King George Whiting, Tommy Ruff, Australian Salmon, mullet, flathead, flounder, Southern Calamari, Garfish and trevally. There are beach launching sites for small boats at Perlubie Beach and Haslam (Fishnet, 2002).

Southern Streaky Bay –Blanche Port has “traditionally been used for recreational boating and fishing” (Bond 1994). According to Bond (1994), “substantial recreational fishing has been recorded” in the southern Streaky Bay – Blanche Port area, for mixed fish (particularly Snapper) and blue crabs (described as a “popular item” in the area), although blue crabs are not always available due to irregular recruitment. The southern side of **Point Gibson (Streaky Bay)** and the **Blanche Port** area are considered popular for fishing whiting, large Snapper (particularly during late spring to mid summer), Garfish, Snook, Southern Calamari, Tommy Ruff (sometimes used as bait for Snapper fishing), slimy mackerel and trevally (Bond, 1994; Fishnet, 2002). It is Snapper that “create the most interest amongst anglers” in the area, according to Wilson (Fishnet, 2002). Calamari have been described as “prolific” within the Blanche Port area at times (Fishnet, 2002). Picking of Razorfish and other shellfish such as native oysters is considered to be “a popular past time”. Razorfish in the area are usually gathered with tongs, from boat fishers in the shallows (Fishnet, 2002). Deeper water in the southern part of the **Blanche Port** area is used for access by shark

boats mooring at **Smokehouse Bay** and moving to and from the jetty (public submission, cited by Bond, 1994). Tuna are also caught seasonally in deeper waters out of southern Streaky Bay. Recreational lobster fishing also occurs in the Streaky Bay area, both by diving, and using lobster pots (Tyrer, 1994). In the **Blanche Port** area (southern **Streaky Bay**), there is an artificial reef (vehicle tyres) sited north of **Target Point**, that is fished mainly for small to medium-sized Snapper (Fishnet, 2002). There are at least three fishing “hot spots” listed by *Fish SA*, in the shallow bay adjacent to Streaky Bay township. Land-based fishing locations in **Blanche Port** include the sheltering breakwater at the boat ramp, and the **Perforated Rocks** at the entrance, particularly the inner rock, which has a ledge that drops into several metres of water (Fishnet, 2002).

There are concrete boat ramps at **Streaky Bay** (two ramps, one of which is an all-tide ramp with a sheltering breakwater, on the western side of **Blanche Port**); **Smoky Bay**; **Thevenard**; and **Ceduna** (three boat ramps); and a beach ramp at **Smoky Bay**, used for recreational fishing boat launches. The use of these ramps for recreational fishing was recorded to be around 64% at Smoky Bay; 62% at Ceduna, and 25% at Thevenard during a recreational survey period (McGlennon, 1996). Mooring sites and anchorages occur throughout the entire area, but particularly adjacent to the towns (Ashman, 1996). Recreational vessels are heavily dependent upon the boat ramps and slipways along the West Coast. There are slipways at **Thevenard** and **Streaky Bay**, and numerous other boat ramps along the West Coast. The most active boat ramps were considered by Ellis (1999a) to be those at **Thevenard** and **Smoky Bay** (Ellis, 1999a). The fishing platform at **Thevenard** was described by Ellis (1999a) as “one of the most significant shore-based fishing platforms in the State”, which presumably includes the commercial and well as recreational significance of the Thevenard area.

There are charter boat trips out of **Ceduna**, fishing around the **West Coast Bays** (e.g. **Murat Bay**, **Tourville Bay** and **Davenport Creek**) for catching King George Whiting, Snapper, Tommy Ruff, Australian Salmon, Southern Calamari, trevally, Garfish, Snook, Yellow-tail Kingfish, blue swimmer crabs, and shark species, according to regional tourism promotion materials. Charters from **Ceduna** also visit oceanic beaches, for catching large Mulloway.

There are charter boat fishing trips to **Nuyts Archipelago** and **St Francis Isles** and reefs of the **Far West Coast**, which reportedly attract local, national and international visitors. Regional tourism promotion materials and fish charter operators state that charter boats to the **Far West Coast** offshore locations catch reef fish (Snapper, Blue Morwong, sweep, red fish, Blue Groper, Harlequin Fish), and Australian Salmon, trevally, Yellow-tail Kingfish, Samson fish (i.e. sea kingfish, often accompanying Yellow-tail Kingfish, in small schools), Mulloway, pelagic species (e.g. Southern Bluefin Tuna; Barracouta) and other species (e.g. large Eagle Rays, Bronze Whaler Sharks, Gummy Sharks). Rock lobster are caught by dive charters to the two island groups. Charter fishing areas include **Evans Island**, **Flinders Reef**, **Purdie**, **Lacy** and **Franklin Islands**, **Fenelon Island**, and areas further offshore such as **Hart Island** and **Cannan Reefs**. Recreational fishing levels are likely to be lower at these islands compared with the bays closer to the coast, due to their relative inaccessibility. There are anchorages on the north coast of **St Francis Island (Petrel Cove)**, and off the **Franklin Islands**.

West of **Ceduna**, towards the Great Australian Bight, there are numerous surf fishing beaches, and Australian Salmon and Mulloway (many up to 35kg, according to Eyre Peninsula Tourism Association, 2000) are caught in the area. Point Sinclair, Fowlers Bay and Scotts Bay, are examples of these surf fishing locations.

Diving and Snorkelling

In general, diving along the West Coast, including some of the offshore shipwreck sites, has been described as a potential tourism industry (Ellis, 1999a).

Dive charter trips visit **Nuyts Archipelago** and the **St Francis Isles**. Dive sites include areas such as **Evans Island**, **Masillon Island**, **Lacy Island**, **Flinders Reef**, **Purdie Islands**, **Franklin Islands**, and surrounds. The **St Francis Isles**, such as **Lacy Island**, **St Francis Island** and **Masillon Island** have been described as “good diving” and “interesting” by dive tourism promotion materials, and are accessed via charter boat from Ceduna (Fishnet, 2002). Dive South Australia (web pages, 2004), described Nuyts Archipelago as “*one of South Australia’s diving gems....., a group of 20 unspoilt islands that attract divers worldwide*”.

Tall ship charters also run dive tours, but do not regularly visit the area due to its remoteness, according to dive promotion materials.

The coast between **Point James** and **Point Peter** has been listed as a diving area, along with **Rocky Point** and

associated beaches where there is access (Hames Sharley Australia, 1989). South of Smoky Bay, **Point Brown** and **Point Dillon** have also been described as dive sites (Hames Sharley Australia, 1989).

Decres Bay is used for shallow water snorkelling from the granite rock peninsula (Eyre Peninsula Tourism Association, 2000).

Southern Bosanquet Bay (near **Cape Vivonne**), **Wittelbee Point (Decres Bay)**, and the headland on the eastern side of **Laura Bay** have been listed as dive sites (e.g. Hames Sharley Australia, 1989).

Tourism materials (e.g. Sightseeing South Australia, 2002) have promoted diving as one of the activities at beaches in the **Ceduna** area, however details of dive locations were not provided.

The **Smoky Bay** jetty is promoted as an “interesting dive” (Dive South Australia web site, 2004).

Divers in the **Ceduna** area, **Smoky Bay**, and **Streaky Bay** target Rock Lobster (Tyrer, 1994).

Other than the points listed above, little information about dive sites in the area is known for this report. The shallow bay areas do not have a significant use for diving, and most headland reef areas of the Far West Coast and offshore islands that are more attractive for diving, are not readily accessible.

Other Marine Recreation / Tourism

In general, recreation and tourism activities that occur on the west coast include the use of coastal towns and associated facilities, fishing boat cruises, marine wildlife tours, surfing, sailing, swimming, diving and sightseeing (Ellis, 1999a). Tourism and recreation have been described as significant contributors to the regional economy of the West Coast (Ellis, 1999a), with recognition that no data were available to quantify the statement. Although no figures specific to marine usage of the upper west coast were available, Ellis (1999a) reported that approximately 65, 000 people per annum visited both the Streaky Bay and Ceduna areas during the late 1990s. Sustainable growth in the areas of coastal and marine tourism, recreation, and “eco-tourism” in particular, were considered in the GAB 1000 West Coastal Strategy (see Ellis, 1999a) to be possible and desirable.

Ashman (1996) recognised the importance of tourism and recreation along the West Coast in an assessment of aquaculture potential in the region. Apart from fishing, other recreational activities such as diving, surfing, and visiting the “varied and natural” coastal scenery, are also considered significant throughout the area (Ashman, 1996). Whale-watching is also a seasonal activity in the area of the **West Coast bays and headlands**.

There are charter boat day trips to the beaches and waters around the islands of **Nuyts Archipelago**. Apart from fishing and diving, these trips are run for the viewing of common and bottlenose dolphins, Australian sea lions, leatherback turtles, island reptiles, plants and birds. Coastal birds include Fairy Penguins, Short-tailed Shearwaters and Rock Parrots. There are plans to increase the tourism potential of the islands.

Along the coast between **Point James** and **Point Peter**, and at **Rocky Point** (and its associated beaches where access is possible), swimming, diving and beach recreation are listed activities in the area (Hames Sharley Australia, 1989), but of less prevalence than surf fishing and rock fishing. There is recreational access via 4WD to the ocean beaches close to **Point Peter**. Ceduna region tourism materials describe the beaches and bays of the **Rocky Point** and **Point Bell** area, as being popular for camping, and also used for surfing and swimming (in addition to fishing – see recreational fishing section, above).

Davenport Creek is considered to be a popular coastal camping (and fishing) area (Morelli 1995, and regional tourism promotion materials, 2002). In peak periods, around 200 people, in 60 to 80 4WD, may visit one campsite area per day (Ellis, 1999a). Davenport Creek also promoted as a coastal picnic area, and seaward of the sand hills, the area is described as a good location for surfing, body-boarding and water-skiing (Morelli and de Jong, 1995; Eyre Peninsula Tourism Association, 2000). **Point James** is also a camping area, and beaches south of **Nadia Landing** have been described as “very popular for families with young children, because of the shallow protected water” (Hames Sharley Australia, 1989).

PIRSA (Ashman, 1996) recognised the **Denial Bay** area within 1km seaward of the township for its recreational use, and the recreational and tourism use of the **Murat Bay / Denial Bay** area in general. Apart from fishing, recreational / tourism activities in the near-shore area of **Murat Bay / Ceduna** include

boating, sailing, swimming (e.g. **Alexanders Beach**, which also has a swimming platform), walking at the beach, water skiing, and windsurfing. There are boat charter cruises operating around **Murat Bay** and nearby islands, and whale-watching tours from the **Ceduna** region.

Ceduna, on Murat Bay, is described as a popular holiday destination, with fishing, boating, swimming, wind-surfing, water skiing, and whale-watching considered to be the popular activities (Sightseeing South Australia 2002 and other regional tourism materials). Ceduna is promoted as an “ideal base” for beach holidays, and exploration of the area’s “sandy coves, sheltered bays and offshore islands” (Sightseeing South Australia, 2003). There are five caravan parks and other tourist accommodation in the **Ceduna** area, and the principal area for recreation is considered to be **Murat Bay** (Eyre Peninsula Tourism Association, 2000). The Ceduna Oyster-Feast community festival is held annually over the October long weekend on the foreshore at **Ceduna / Denial Bay**. There is strong emphasis on oysters, and part of the event includes the SA Oyster Opening Championships (professional and amateur). There is also a “Big Oyster” in Ceduna (made by local oyster growers for use in the Ceduna Oyster Fest Street Parade), that is used to promote tours of the oyster farms. The oyster industry at **Denial Bay** is promoted as one of the major tourism features of the area (Eyre Peninsula Tourism Association, 2000). The jetty out into Murat Bay is also promoted as a tourism feature (Walkabout Australian Travel Guide, 2000). Hames Sharley Australia (1989) recorded the southern side of **Murat Bay** (near **Ceduna** township) as a sailing area, with access points for sailing boats and other small boat traffic. Recreational use for general boating has been described as “high in the area” (Hames Sharley Australia, 1989). The sailing club at Ceduna regularly hosts national yachting titles in **Murat Bay** (particularly the eastern side), and sailing events are regularly held at weekends during spring and summer. Although the marine values of the **Thevenard** area mainly centre upon the commercial fishing fleet, the region is reportedly also known for its “rather large sharks and game-fishing” (Aquanaut, undated).

The Ceduna Keys Marina and Coastal Centre project was in the developmental stages in 2003 - 2004. The project entails the development of a 75-berth commercial marina, with 570 residential allotments. An associated development is a Coastal Centre, including tourist interpretive centre, marine facilities and displays, walking trails and boardwalk, a recreational lake, and community recreation and leisure facilities. The developments are expected to increase tourism in the Ceduna area (Austin, media report, September, 2003).

Bosanquet Bay: At the northern end, there is a long sandy beach used for swimming and other recreation, and the area is considered popular due to its proximity to Ceduna and Thevenard townships (Hames Sharley Australia, 1989). There is access to smaller beaches between the cliffs towards **Cape Vivonne**. Diving, fishing, swimming and camping occur on the eastern shore, down to **Cape Vivonne**, and the area is described as one of “high recreational use” (Hames Sharley Australia, 1989). More recent (2003) recreation / tourism materials promote the area for its secluded beaches; beachfront accommodation (e.g. caravan park); bush-walking and camping in the bush-land close to shore; swimming and snorkelling. Attractions that are promoted in the area include whale watching and other wildlife tours, and the **Cape Wittlebee** and **Laura Bay** Conservation Parks.

South of Ceduna, **Decres Bay** has a broad beach used for swimming (Eyre Peninsula Tourism Association, 2000). Hames Sharley Australia (1989) reported that the area around **Wittelbee Point** is attractive to tourists for fishing, passive recreation, camping, swimming and diving.

Wittelbee Conservation Park: The coastal area has been described by the Australian Heritage Commission (undated) as a “pleasant picnicking area is utilised by the local residents and tourists”, with “an excellent swimming beach”.

Smoky Bay: The bay has a “seaside and holiday” function (Planning S.A., 1999; EPT, 2000). Previous estimates have included a 5-fold increase in population during tourist seasons (Hames Sharley Australia, 1989). Smoky Bay has been described as “a very popular holiday destination” (Hames Sharley Australia, 1989, and Eyre Peninsula tourism materials, 2001-2003). Apart from fishing and fishing holidays, the beach and near-shore areas are used for swimming, wind-surfing and boating. The public boat ramp is used by pleasure boats during tourist season, and “many small boats” are seasonally reported in the area (Hames Sharley Australia, 1989). Apart from fishing, the town jetty is promoted for walking and sightseeing along the beachfront, and the beaches (described as “wonderful”) are also promoted to visitors for walking and resting (Kerr, 2000, and West Coast tourism materials). The growing oyster industry in **Smoky Bay** is also a tourism attraction. There is also a foreshore caravan park, near a safe swimming beach (Kerr, 2000; EPTA, 2000).

Point Brown and Point Collinson: Recreational fishing, diving, and camping occur in the area (Hames Sharley Australia, 1989).

The wreck of the *Eleni K* (a former World War II Liberty ship, which sank between **Goat Island** and **St Peter Island** in 1966) is considered to be “an important recreational and tourism asset”, which forms part of the West Coast Maritime Heritage Trail (Arnott, 2000).

Laura Bay Conservation Park has been described by the Australian Heritage Commission (undated) as “scenically attractive, and accommodating many tourists and visitors”. Hames Sharley Australia (1989) reported that swimming, fishing and diving occur at the headland area on the eastern side of the **Laura Bay** entrance, and that passive recreation is one of the major uses of the **Laura Bay** area, particularly the Conservation Park (e.g. camping, walking, bird-watching). There is also a sheltered anchorage in **Laura Bay**, used by cruising yachts. Eyre Peninsula Tourism Association (2000) also promoted Laura Bay for swimming (in the sandy coves in the area), walking and watching birds (of which there are more than 100 species in the area).

Eba Island Conservation Park is considered to have recreation value, due to its close proximity to Streaky Bay mainland (500m offshore) (Australian Heritage Commission, undated). **Eba Island** also contains a shack zone, which has been expanding, as a holiday house zone.

Streaky Bay: The Streaky Bay township has been described as a “coastal resort” (Eyre Peninsula Tourism Association, 2000); “an important urban centre for tourism” (Bond, 1994), and a town that “provides a variety of activities for visitors, and is a popular holiday destination for families” (Sightseeing South Australia, 2003). According to Bond (1994), there is a growing tourism industry in the area. According to the District Council of Streaky Bay (2002), the attractive coastal areas and natural coastal features of the Streaky Bay region attract “substantial numbers of tourists”. There are facilities such as a large foreshore caravan park that caters for fishing holidays, and beach holiday housing. Submissions to the Streaky Bay Aquaculture Management Plan (Bond, 1994) stated that the eastern side of **Streaky Bay** is “important for recreational fishing, diving, sailing, camping and swimming”, and “the south eastern part of the bay is most suitable for water skiing”. Parts of the beach and tidal inlet system are used for water-based recreation, such as swimming and canoeing (e.g. see Connell Wagner Pty Ltd, 2003), and there are also coastal walking trails in parts of Streaky Bay. The scenic value of the area is also considered to be an asset for tourism and coastal recreation (see Bond, 1994). More recent tourism materials promote the Streaky Bay area for fishing (see section above), water sports, photography, and sightseeing (e.g. along the walking trail / bicycle track around the waterfront), and as a base for exploring other coastal tourist attractions in the West Coast region (Sightseeing South Australia, 2003).

In **northern Streaky Bay**, Hames Sharley Australia (1989) listed the western side of **Acraman Creek** as an area where, in addition to fishing (see section above), camping, swimming and bird-watching occur. **Point Lindsay** to the east is used for similar activities. Further south in the bay, a yacht club is located south of **Target Point** with regatta activities extending into **Blanche Port**. There are mooring and anchorage areas for recreational boats and yachts, east of the jetty. The waters adjacent to **Doctors Beach** have also been described as an area of tourism and recreational value (Bond, 1994). **Perlubie Beach** (approximately 20km north of Streaky Bay township) has an annual New Years Day horse race and donkey race meeting along 1.6km of the beach at low tide, which is a popular recreational and tourist attraction. **Perlubie Beach** is also used for camping, and boating regattas are also held adjacent to the beach (Bond, 1994). The area has been described as interesting for tourist drives (Sightseeing South Australia, 2003). **Little Islands** have been described as “an interesting feature with public access”. The **Haslam** foreshore area is “keenly sought after by a large number of visitors for camping”, since it is one of the few serviced camping areas on the West Coast (Ellis, 1999a). Apart from fishing, tourism materials promote the beach at **Haslam** for swimming (e.g. Fairfax Publishing – F2, 2002). There is a jetty and a caravan park at **Haslam**.

Surfing has been considered as a recreational/tourism activity of potential growth at the West Coast, with the possibility of attracting surfers through a national and/or international surfing carnival (Ellis, 1999a).

Streaky Bay, Smoky Bay, St Peter Island and Eyre Island, Murat Bay, Decres Bay, Tourville Bay are used for recreational boating (Ashman, 1996; Eyre Peninsula Tourism Association, 2000).

There are concrete boat ramps at **Streaky Bay, Smoky Bay, Thevenard**, and **Ceduna** and a beach ramp at **Smoky Bay**, used to a minor extent as launching areas for marine leisure activities other than fishing. At these locations, use of each boat ramp for recreational activities other than fishing (e.g. yachts and other pleasure boats, diving, water skis, and/or jet skis, or any other activity not involving fishing) during a 1996 survey period, was around 4% at Smoky Bay; 4% at Ceduna, and 6% at Thevenard (McGlennon, 1996).

South Australia sea canoe clubs have had expeditions (e.g. in 2002) to the **Nuyts Archipelago** Islands.

Marine Research and Marine Education

Acraman Creek has been described by the Australian Heritage Commission (undated) as an “excellent research and education site”, due to its geological / geomorphological significance, as a well preserved stranded tidal creek that is readily accessible, in excellent condition, and provides a record of sedimentation over the Holocene period.

The **Nuyts Archipelago** and **St Francis Isles** have long been the subject of marine and terrestrial studies. The Royal Society of SA has held scientific expeditions to the Archipelago in 1923 and 1971. Marine ecological studies arising from the 1971 expedition include the work of Shepherd and Womersley (1976). The marine flora of the St Francis Isles in the Nuyts Archipelago was also surveyed in 1992, as part of the SARDI's S.A. Benthic Surveys program (Edyvane and Baker, 1996a; Baker and Edyvane, 2003). More recently, a scientific expedition of the **Nuyts Archipelago** and **St Francis Isles** islands was undertaken in 2002, by scientists from SARDI Aquatic Sciences, the three South Australian Universities, the SA Museum, and National Parks and Wildlife SA . Historians, herpetologists, ornithologists, botanists, mammal and invertebrate specialists, and marine biologists conducted studies in the area. Examples of marine research during that expedition included pinniped counts; fish distribution and abundance studies (see Shepherd and Brook, 2003); studies of macroalgae (including taxonomic, ecological, physiological, distribution and abundance studies) and epiphytes; habitat mapping; invertebrate collecting and identification (Gershwin and Zeidler, 2003); intertidal zonation surveys, and others. Volume 127 part 2 of the *Transactions of the Royal Society of South Australia* was devoted to the results of this expedition.

Surveys of Australian sea lion and New Zealand fur seal colonies have been conducted periodically during the past two decades (e.g. by CSIRO, and NPWSA) at the **Nuyts Archipelago** islands.

During the past two decades, periodic fisheries research and/or fisheries monitoring work has been undertaken in the nursery areas and deeper waters of the bays and inner islands of the Far West Coast. Examples of species populations monitored have included King George Whiting, and invertebrates such as Western King Prawn and Blue Swimmer Crab (e.g. Wallner, 1985; Grove-Jones, 1987; Jones *et al.*, 1990; Carrick, SARDI, unpublished data cited by MacDonald, 1998; Boxshall, 2001). The periodic prawn trawl surveys in west coast waters, are designed to provide information on the status of the stocks, recruitment levels, relation of recruits to spawners and environmental factors; and to assess the effects of fishing, amongst other results (MacDonald, 1998). More recently, there has been a prawn tagging program in the Ceduna area. Prawn fishers tagged 10,000 prawns in 2002, and another 10,000 in 2003, to assist with an assessment of prawn migration patterns (Svane and Barnett, 2004).

Universities (particularly Flinders University), government agencies and private researchers have conducted various oceanographic studies along the far west coast. The influence of the Leeuwin current from WA (Rochford, 1986) and warm water currents that may be generated in the Great Australian Bight and travel eastwards to Eyre Peninsula (see Herzfeld 1996, 1997; Herzfeld and Tomczac, 1997) have been of particular interest. Studies on salinity and temperature anomalies have also been undertaken.

In deeper waters of the continental shelf and slope of the Bight, the Australian Geological Survey Organisation, CSIRO, the universities of Sydney and Adelaide, and other research organisations have undertaken projects to describe the benthic fauna, map habitat types, and explain biogenic sediment production in the region (e.g. Bone, 1997; Bone and James, 1998a and 1998b, AGSO, 2000).

The physical properties and biogenic compositions of the carbonate sediments that comprise **Streaky Bay** have been studied by Flinders University (see Daniel *et al.*, 1997).

The Aboriginal fish traps of various forms and constructions at **West Coast** sites were considered by Martin (1988) to be an educational resource.

In 1997, Flinders University conducted a pre-disturbance survey of the archaeological material from a whaling site at **Point Collinson** (De Lieuen *et al.*, 1997, cited by Staniforth, 1999). The whaling archaeological studies at **Point Collinson** have education value. Staff, students and volunteers from Flinders University have been involved with site survey and mapping, drawing of site plans and artefacts, photographic printing and report writing related to the whaling sites.

Aboriginal Heritage Values

Ellis (1999a) reported that Aboriginal communities continue to have a significant presence and influence along parts of the West Coast, and that, in parallel with the need to identify and protect historical Aboriginal Heritage sites, there is a need to acknowledge and protect the cultural needs of current resident Aboriginal populations and communities.

The West Coast falls within the consideration of the Wangka Wilurrara Regional Council, which has prepared a regional Strategic Plan. An important component of the Plan is the Regional Land Strategy 1995, that aimed at addressing the land and sea needs of aboriginal communities in the region (Ellis, 1999a).

There are numerous Aboriginal heritage sites along the West Coast that are worthy of nomination for listing on the *Register of the National Estate*, and during the late 1990's, Aboriginal cultural heritage sites held on the State register were in the process of re-verification, to confirm the locations and conditions of registered sites (Ellis, 1999a). The Register of the National Estate is also being reviewed, and "a lot of the currently registered sites may be removed", to focus on protection for nationally important sites only (Ellis, 1999a).

The Murat Bioregion contains areas that are considered to be the most significant regions of Aboriginal Heritage along the Eyre Peninsula Coast, due to their remote and undisturbed nature (Nicholson pers. comm., cited by Edyvane 1999b). Martin (1988) recorded 19 natural fish traps in the West Coast area, after interviewing aboriginal informants who were still in touch with the traditional Aboriginal fishing techniques in the Eyre Peninsula and West Coast region. A number of fish traps enhanced by Aborigines (i.e. "man-made") were also noted as occurring in the region, such as the placing of stones in gaps between natural reefs.

Martin (1988) considered that (i) the fishtraps of the West Coast region appeared to have more in common with those recorded in south-western Western Australia and the northern Australian coastline in terms of their construction and setting, compared with those recorded in south-eastern Australia; and (ii) the wooden fish traps preserved in the region's calcareous muds, were possibly the only such surviving remains in southern Australia.

Locations of the heritage sites include the following (from Martin, 1988, unless otherwise specified): **Eba Island**: natural rock reef fishtrap; **Blacks Lagoon**: one campsite and one natural rock reef fishtrap, with a midden of reef molluscs and fish otoliths; **Smoky Bay**: rock reef fish trap; **St Peter Island**: woven wooden barrier fishtrap; **Halfway**, and **Duckponds (Murat Bay)**: eleven sites recorded in the area (Martin, 1988, cited by Edyvane and Nias, undated), with several sites at **Duckponds** including enhanced rocky reef enclosure, shellgrit ridge barrier, natural pools, partial enclosure (used to herd fish into the shallows), woven wooden barrier traps, and freshwater well / soak dug into the sand and shell grit. At **Davenport Creek**, there are two fishtraps, which are a sublittoral pool, and natural mangrove barrier. A burial site at **Davenport Creek** has recently been conserved (Government of South Australia, 2003). The Aboriginal archaeological survey of 1987 (Martin, 1988) also uncovered surface scatters of stone tools, stone arrangements and burial sites, according to Morelli and de Jong (1995). **Rocky Point and Tourville Bay** comprise three sites, including a sub-littoral pool and two natural rock formations used for spearing Snapper. An aboriginal occupation site has also been recorded at **Tourville Bay** (see below). Ashman (1996) stated that there is also a possible fish trap site recorded by Martin (1988) at **Point Bell**. According to Edyvane (1999b, citing Martin, 1988), there is also an aboriginal fish trap at **Point Dillon - Cape Missiessy**.

Nicholson (1991, cited by Edyvane and Nias, undated, and Edyvane, 1999b) recorded significant Aboriginal occupation sites at the following locations: **Acraman Creek**: Occupation site approximately 6700 years old, and of particular significance, consisting of four middens, to be recommended for National Estate listing (Nicholson pers. comm., undated, cited by Edyvane 1999b); **Point Brown**: A recent occupation complex (approximately 400-500 years old), consisting of middens and an artefact manufacturing site. To be recommended for National Estate listing (Nicholson pers. comm., cited by Edyvane and Nias, undated); **Perlubie (near Eba Island)**: Occupation site 20m from mean high water mark, including an artefact or stone scatter. Considered to be one of the 10 largest sites in the Eyre Province (Edyvane, 1999b). **Tourville Bay**: Occupation site, with artefacts or stone scatters. The Tourville Bay site is considered to be one of the 10 largest occupation sites in the Eyre Province (Nicholson, 1991, cited by Edyvane, 1999b). The bay is considered to be of moderate Aboriginal sensitivity and significance, and the rocky coast around the bay is considered to be of high sensitivity and moderate cultural significance.

Blanche Port (southern Streaky Bay): An Aboriginal archaeological site including stone flints and campsite is

situated close to Oyster Spit south of Crawford landing (Bond, 1994).

The **Davenport Creek** area has been described as being “of concern to the Aboriginal people of the district” (Far West Aboriginal Progress Association, pers. comm., cited by Hames Sharley Australia, 1989).

Within the region described in this table, there are two Native Title applications: SC97/5 (Wirangu # 1) and SC97/6 (Wirangu # 2). Wirangu # 1 extends from northern Streaky Bay to the S.A. / W.A. border, and Wirangu # 2 extends from northern Streaky Bay southwards to Wellington Point. In 2000, Wirangu # 2 was found to comply with Section 190 requirements, the claim has been accepted, and details have been entered on the s.190 Register (National Native Title Tribunal database, 2003). The claims includes requests to obtain non-exclusive access rights to, and use of, land and sea resources in the claim areas. Under Section 190B(5)(a) of the Registration Test summary, the Wirangu are listed as the coastal people both historically and presently inhabiting the claim area, and maintaining a physical connection with that area. The claim group use and enjoy the area including camping, travelling, hunting, fishing, protecting sites and wildlife, conducting ceremonies and trading artefacts (NNTT, 2000). In 2001, Wirangu # 1 claim was found not to meet a number of requirements under s190 of the *Native Title Act 1993*, and therefore the Wirangu # 1 claim has not been accepted to date (NNTT 2001; NNTT web site, 2003)

There are several land areas along the West Coast owned by the Aboriginal Land Trust and/or the Indigenous Land Corporation, and the majority of these areas are within the vicinity of **Ceduna** and leased to Aboriginal family groups (Ellis, 1999a).

Historic / Protected Shipwrecks

(from S.A. Coast and Marine Atlas, 2001)

- ♦ **Point de Mole:** *Camilla*, wooden brigantine, 1827 – 1844, protected under Commonwealth legislation, but not found.
- ♦ **St Francis Isles:** Two vessels are protected under Commonwealth legislation. *Waitemana*, wooden schooner 1852 – 1960, wrecked at **St Francis Island**, and an unknown vessel, wrecked 1889 at **Fenelon Island**. Apart from the *Waitemana*, another historic shipwreck site is situated in a bay at St Francis Island (Robinson *et al.* 1996), but has not been found, and is not protected.
- ♦ **Nuyts Archipelago (St Peter Island):** *John and May*, wooden ketch, 1851 – 1914, protected under Commonwealth legislation (has been inspected). Unknown wooden vessel, wrecked 1875, protected under Commonwealth legislation.
- ♦ **Ceduna:** *Amy*, wooden cutter, 1860-1952, could be considered historic due to its age, but is not classified or protected.
- ♦ **Decres Bay / Wittlebee Point:** *Helena*, wooden ketch, 1875 – 1925, protected under Commonwealth legislation, not inspected.

There has been an application to the Commonwealth to declare the *Eleni K* (a former steel bulk carrier World War II Liberty ship, which sank off **Goat Island** in 1966) an historic shipwreck under the Historic Shipwrecks Act 1976. A program of corrosion monitoring is expected to assist with management recommendations for the future preservation of the site (Arnott, 2000).

There are around 40 unprotected shipwrecks within in the area, mostly modern fishing vessels, however some are older than 75 years, and thus qualify as historic.

Other European Heritage Values

The **Streaky Bay, Ceduna and Nuyts Archipelago** areas have a long maritime history due to the explorations made by Dutch explorer Pieter Nuyts and his crew, who reached the area in 1627 in the *Gulden Zeepard* (Eyre Peninsula Tourism Association, 2000). On 28th January 1802, Matthew Flinders named Nuyts' Reef and Cape Nuyts after Pieter Nuyts, and on 8th February 1802, Flinders named the Nuyts Archipelago islands.

The **Streaky Bay** area has been a site of marine industry since the middle of the 19th century. For example, in the early 1870s the native oyster beds in the **Streaky Bay** area were being harvested to the extent that a small oyster factory was established at Streaky Bay. Prior to that, a shore whaling station (possibly two) operated between 1843 and 1846, at **Point Collinson**, the north western end of Streaky Bay (Staniforth, 1999). The

Point Collinson whaling station has been registered under the *State Heritage Act 1994* (Ashman, 1996). The whaling station was part of a Hobart-based operation. The 262 ton brigantine *Camilla* travelled between southern WA, Streaky Bay and Hobart during the early 1840s. At the time the station was operating, a small number of whales were taken from along the coast and processed at Point Collinson. In April 1844 the whaling vessel *Camilla* was driven ashore in Streaky Bay and wrecked. The schooner *Bandicoot* arrived in Streaky Bay at the end of November 1844 to load materials from the wreck of the *Camilla* and three of the crew who had been left behind (*Hobart Town Courier* 17 December 1844, cited by Staniforth, 1999). Flinders University conducted a pre-disturbance survey of the archaeological material at Point Collinson in 1997 (De Lieuen *et al.*, 1997, cited by Staniforth, 1999). Kostoglou and McCarthy previously documented the existence of a whaling station at Point Collinson (Kostoglou and McCarthy, 1991). The area has a scatter of material including hoop iron, whale bone, ceramic, black glass bottle and clay pipe fragments all of which date to approximately the 1840s. Only one habitation site was found: a pile of local calcarenite stone and bricks 2.5m by 2 m, with window glass. Artefacts include copper alloy sheathing and sheathing tacks. The presence of sheathing suggests the whale vessels may have been moored for long periods, and this has consequences in terms of the extent and nature of underwater remains in the vicinity of whaling stations, because some form of permanent or semi-permanent mooring system may leave archaeological traces to the present day (Staniforth, 1999).

Kostoglou and McCarthy (1991) suggested that there may be another whaling station site at **Point de Mole**, where staff of the State Heritage Branch located "the remains of a stone hut" during a visit in 1996 (Arnott pers comm., cited by Staniforth, 1999). The possibility of a third whaling station at the mouth of **Acraman Creek** was suggested by Kostoglou and McCarthy (1991, cited by Staniforth, 1999) but there is little evidence of this site (Kostoglou and McCarthy, 1991; Staniforth, 1999).

According to Staniforth (1999), whaling activities, like shipping in the nineteenth century, was conducted at an international and inter-colonial level as well as operating within a single colony. As a result, much of the archival and newspaper documentation of sites like Fowlers Bay and **Streaky Bay** exists in Tasmanian archives and newspapers, not in South Australian ones (Staniforth, 1999).

During field surveys by Flinders University, in the general area around the **Point Collinson** site, there was clear evidence of Aboriginal usage of black glass bottles found at two sites. Staniforth (1999) reported that the sites represent some of the first contact between indigenous and European people along the Eyre Peninsula region (e.g. whaling activity dates to the 1840s), however the distance of the material from the whaling site, the presence of Edward John Eyre in the area some years before, and the fact that that no excavations have been conducted, means that no unequivocal evidence of indigenous presence actually at the whaling station site has been located (Staniforth, 1999).

Ellis (1999a) reported that along the West Coast in general, European heritage sites in both inshore and offshore waters (and on offshore islands), that are of State, national and/or international Heritage significance. A survey of European Heritage conservation values on the West Coast has been undertaken, and there is provision to identify sites for the development of an Historic Trail along the coast. This trail could be part of a proposed whale-watching trail, and would include historic former whaling stations and associated sites (Ellis, 1999a).

There was a whaling station on **St Peter Island** during the 1850s (Jones and Staniforth, 1996; Staniforth, 1998, 1999), and in 2000, the **St Peter Island** whaling sites were designated as places of archaeological significance, under the *State Heritage Register* (DEH, 2003g).

McKenzie Landing, a large square wooden platform in the water of **Denial Bay**, has been registered under the *State Heritage Act 1994* (Ashman, 1996). The existing remnants of McKenzie Landing relate to the first European settlement in the Ceduna area which occurred in the mid 1800s on the shores of Denial Bay. The settlement of Denial Bay was created to load and unload supplies. Shoreline rocks ran out into Denial Bay, and ships could come quite close to the shore, and loaded wagons could be driven out across the rocks at low tide. Rocks in the area of McKenzie Landing still show the grooves where the bullock drays were driven out to the jetty. The South Australian dingo fence also runs down to the water near McKenzie's Landing (Fairfax Publishing – F2, 2000).

Denial Bay jetty, now approximately one third of its original length, was previously the second longest jetty in South Australia (Eyre Peninsula Tourism Association 2000). The **Ceduna** jetty (out into **Murat Bay**) was built in 1903. Hames Sharley Australia (1989, citing a survey by Danvers architects, for Dept of Environment and Planning), reported that the **Denial Bay** jetty, **Ceduna** jetty, **Smoky Bay** jetty and **Thevenard** jetty are of local historical significance.

In 1911 a timber platform was constructed on the **Laura Bay** headland to load bagged grain onto ketches. The grain had been hauled in from nearby farms on horse-drawn drays. Although the platform has been removed, it is still possible to find the sight from the cuttings in the limestone (Fairfax Publishing – F2, 2003).

The annual **Perlubie Beach** horse race, along 1.6km of the beach at low tide, has been run since 1913. Stands and saddling enclosures, all weathered by the sea, are located along the beach.

Whaling shipwrecks (see above), and the site in **Denial Bay** where Baudin's longboat launch concluded, have been identified as potential Marine Heritage "icons", by SA government (2001). Baudin's longboat is reputed to have been the first European boat built in Australia. There are also shipwrecks of the sealing industry in the vicinity (pers. comm., Terry Arnott, DEH, 2001).

Wilderness/Aesthetic Values

Nuyts Archipelago and St Francis Isles: Recognised for their aesthetic values (Edyvane, 1999b), including "spectacular cliffs" (Robinson *et al.*, 1996), coves, reefs and isolated beaches. The wilderness value of the area is reflected in a nomination (in 1998) by marine conservation groups in South Australia to have the area considered for protection under the *Wilderness Protection Act 1992*. (see section below **on Previous and Current MPA / Marine Reserve Nominations**).

Eyre Island (Nuyts Archipelago): Described as "one of the more important and undisturbed island Conservation Parks in South Australia, and is a high quality coastal wilderness of mangrove channels, samphire flats and well-vegetated sand dunes" (Australian Heritage Commission, undated). Also described as "an undisturbed wilderness area" (Morelli and de Jong, 1995).

Ceduna region tourism materials describe the "long white beaches and secluded bays of the **Rocky Point and Point Bell** area, as "spectacular".

Denial Bay: The visual amenity of the bay was recognised by PIRSA (Ashman, 1996) as a significant value in the area.

Eba Island Conservation Park: Considered to have aesthetic value, due to its close proximity to Streaky Bay mainland (500m offshore) (Australian Heritage Commission, undated).

Hames Sharley Australia (1989) noted that the "emptiness and sense of wilderness" is an essential part of the scenic attraction along the **Far West Coast**, and that developments can destroy these wilderness qualities. **Laura Bay** was considered to be an example of an area that would suffer in this way if even minor developments were permitted.

Laura Bay: Described as "scenically attractive" (Australian Heritage Commission, undated), and having aesthetic values (Edyvane, 1999b). Hames Sharley Australia (1989) reported that "the high scenic quality of the bay attracts some wilderness/naturalist visitors". The "natural" (i.e. undeveloped) quality of the Laura Bay area is promoted by Eyre Peninsula tourism organisations. **Laura Bay Conservation Park** has been described as "a natural coastline which offers an insight into what the area was like before the arrival of Europeans" (Fairfax Publishing – F2, 2000).

Point Collinson - Gascoigne Bay - Point de Mole - Acraman Creek: coastline has a "wilderness character" which attracts local residents and tourists (Hames Sharley Australia, 1989). **Acraman Creek** was also described as "an attractive area".

According to Bond (1994), the coastal views of **Blanche Port / Streaky Bay** are scenically attractive, which was a factor that was stated as worthy of consideration when planning aquaculture leases in the area. Recent tourism materials also promote the Streaky Bay area for sightseeing (e.g. the walking trail / bicycle track around the waterfront "offers great views across the bay" (Sightseeing South Australia, 2003). Streaky Bay has been described as being surrounded by "a beautiful and fascinating coastline" (Fairfax Publishing – F2, 2002).

According to the District Council of Streaky Bay (2002), the Streaky Bay district has some of the most attractive coastal areas on the Eyre Peninsula, and the area is "well recognised for its natural coastal features" and attracts substantial numbers of tourists".

Towns and Other Settlements

Ceduna / Thevenard area: **Ceduna** is the western-most town in South Australia, is described as the focal point and business centre of the Far West Coast (Eyre Peninsula Tourism Association, 2000; Planning S.A., 2001c). In 2001, the ABS census recorded a population of 2,588 persons, and other sources quote a regional population of approximately 4000 (District Council of Ceduna, 2002; Flinders Ports, 2002). Ceduna provides services for the widespread farming community in the far west coast region. **Thevenard**, on the headland near Ceduna, between Murat and Bosanquet Bays, is the main grain handling port for the northerly sector of the Eyre Peninsula (see section below on **Shipping / Ports**). The Ceduna District Council Development Plan (Planning SA, 2001c) discusses the residential, industrial, recreational and other zoning in the Ceduna and Thevenard area. A commercial marina, associated Coastal Centre, and residential waterfront housing development, are planned for the area (Austin, media report, September 2003). These developments are considered likely to increase the **Ceduna** base population in addition to seasonal numbers due to tourism.

Denial Bay township is situated on the central west coast of Murat Bay. Denial Bay was historically an important transportation port for the west coast, created to load and unload supplies, prior to the later expansion of Ceduna. Denial Bay is now a smaller settlement (e.g. of less than 100 houses during the late 1990s). Most of the dwellings are situated near the jetty, with some newer development along the Ceduna road to the north.

Smoky Bay has a permanent base population of around 200 people (Kerr, 2000, and other Eyre Peninsula tourism promotion materials, 2000-2003), but the population rises seasonally during holiday periods (up to 1000 - 1200 people, according to descriptions of Smoky Bay in recent tourism materials – e.g. Kerr, 2000, and Nullarbor Travel Guide, 2003).

Streaky Bay is a service centre for the surrounding rural community. The residential population has been less than 2000 people in all years between 1991 and 2000 (District Council of Streaky Bay, 2002). In 2001, the ABS census recorded 1081 persons. Apart from rural servicing, granite mining and commercial fishing are two of the main industries in the area (Eyre Peninsula Tourism Association, 2000). The town has been variously described in tourism materials as a fishing village/ fishing town / holiday town / coastal resort / seaside resort / retirement town. There are also shack sites along the **Streaky Bay coast**. Further development of holiday housing area is occurring in the **Streaky Bay** area, including **Perlubie Landing** and **Eba Anchorage**, and several other locations between **Streaky Bay** and **Haslam** to the north. There is support through development plans and public opinion, for small coastal hamlets (cluster development) along the coast (Ellis, 1999a). **Haslam** (northern Streaky Bay) is a small but growing settlement and holiday area, and has traditionally been used mainly for fishing and camping, according to Eyre Peninsula tourism promotion materials.

Shipping / Ports

There is a shipping lane to the major deep port of **Thevenard**, through the **Yatala Cannel** (north-east of Goat Island to east of the sand shoal south-west of Thevenard) (Petruševics *et al.*, 1998). The Port of **Thevenard** is the only deep sea port in the west coast region, and, according to a 1997 estimate, around \$14 million of regional income was generated by industries using the Port of Thevenard, which represented 13% of the total income of the West Coast region (PAS 1997, cited by Ellis, 2000). In 1995/96, Thevenard was the 3rd most active port in S.A., measured by the number of national and international vessels (i.e. 94 vessels, in that year) (Ellis, 1999a). Major export cargoes handled through the port include West Coast gypsum (from the Lake MacDonnell / Penong area), grains (wheat, barley, oats), seeds and salt exports, and fertiliser is a major import. There is potential for an increase in minerals export (e.g. copper) (Ellis, 1999a). During 2001/2002, 1.5 million tonnes of cargo was moved through Thevenard (Flinders Ports 2002). The Yatala Channel is naturally shallow, but the Thevenard Port has been dredged to 8.2m (Flinders Ports, 2002). In some years, Thevenard has shipped out over one third of the entire Eyre Peninsula wheat crop, from silos with a capacity of around 200 000 tonnes.

Streaky Bay is considered to be “an important fishing port with in excess of 200 visits per year of commercial vessels of over 40 tonnes gross” (Harbour Master, personal communication, cited by Bond, 1994). At **Streaky Bay / Blanche Port**, mooring of commercial fishing vessels occur adjacent the town and jetty facilities, and the area has a shipping channel associated with the jetty (Bond, 1994).

Murat Bay / Denial Bay was recognised by PIRSA (Ashman, 1996) as a significant area for international shipping.

A number of other channels exist along the Far West Coast, providing access particularly into the bays and estuarine areas (Ashman, 1996).

Coastal Mineral Deposits and Mining

Gypsum is a major mineral resource on the Far West Coast. There are deposits at **Lake MacDonnell**, Australia's largest gypsum mine, with a deposit of around 500 Mt (Warren, 1983, cited by PIRSA, 1999f). Around 1.39 Mt were produced in 2000 (PIRSA, 1999f). Gypsum, which has a high salt content that is undesirable for plaster manufacture, is stockpiled on site for several years to allow leaching by rainwater. When the salt content has been sufficiently reduced, the gypsum is railed 64 km to a 160 000 t stockpile at **Thevenard** for loading on ships by conveyor. There is also a large undeveloped deposit at several lakes near **Streaky Bay**, with the largest known undeveloped deposit in South Australia being 26 km south of Streaky Bay. Gypsarenite resources of at least 44 Mt occur at **Lake Purdilla**, and at least 6 Mt of gypsarenite occurs at **Lake Toorna**. Additional resources of 4 Mt are indicated at each lake, and adjacent dunes contain high-grade gypsum (Olliver *et al.* 1988, cited by PIRSA 1999f). Another gypsum deposit occurs at **Bielamah (Davenport Creek)**, comprising around 5 Mt of selenite and gypsarenite up to 5 m thick. This deposit has been delineated by a plasterboard company, for use in wallboard manufacture in Sydney and Melbourne. Gypsum has been stockpiled to leach salt prior to shipment through the port of **Thevenard** (PIRSA, 1999f).

According to the GAB 1000 West Coast Strategy (1999), the onshore region of the West Coast area has potential for salt, gypsum, clays and mineral sands and building stone, and exploration has been undertaken for all of these. Granite, gypsum, salt, construction sand, silica sand, road "metal" and shell grit are all produced in the area.

Petroleum exploration in the Far West Coast area has occurred offshore, in the Poldia Basin, that extends from onshore to at least 350km offshore at the centre of the Great Australia Bight. The exploration area ranges from 30km to 40km in width, and the southern margin flanks the Flinders Island, in the Mid West Coast (GAB 1000 West Coast Strategy, 1999).

9.1.2 Baird Bay to Cape Bauer (including nearshore islands) (Murat/Eyre Bioregions Boundary)

Aquaculture

Baird Bay: Not currently zoned for aquaculture. Bond's (1994) assessment of aquaculture potential in the region recommended that no sea-based aquaculture be permitted in the Baird Bay Management Zone, due to the extreme environmental conditions (e.g. the shallow nature of the bay, high salinity, and limited tidal exchange) which mitigate against successful fish and shellfish culture. Earlier trials (see Grove-Jones, 1986) of oyster farming showed that **Baird Bay** did not promote good oyster growth due to the adverse physical and chemical conditions in the bay. According to Bond (1994), seaweed culture potential is unknown and was considered unlikely within the foreseeable future.

Cape Blanche to Cape Radstock, and Searcy Bay: Not currently zoned for aquaculture. Bond's (1994) report of aquaculture potential considered that, given the exposed coastal conditions in Searcy Bay, the coastal marine area between **Cape Blanche** and **Cape Radstock** was not considered suitable for aquaculture. In contrast, Petrusevics *et al.* (1998) suggested that **Searcy Bay** was a potentially suitable area for aquaculture, from the coastline down to the 30m contour.

Sceale Bay: Bond (1994) recommended that deeper water culture (e.g. of fish species) be considered in the area following research (such as assessment of assimilative capacity), based on the purportedly favourable physical conditions of the bay, such as deep water. A Yellow-tail Kingfish farm was proposed for **Sceale Bay** in 2000, but was not approved by government, due to the potential environmental impacts, particularly on pinnipeds from the Cape Blanche area. Previously (early 1990s), an abalone

farming licence was approved for the area, in southern Scele Bay, however the lease is no longer listed as current (South Australian Coastal and Marine Atlas, 2003).

Commercial Fishing

Scalefish, Sharks and Invertebrates

Morelli and de Jong (1995) listed commercial fishing from boats under major Land Uses in **Baird Bay**. Bond (1994) also listed commercial fishing as a major use in **Baird Bay**, which was considered to conflict with any proposed aquaculture development.

Baird Bay is one of the most significant fishing areas for King George Whiting in South Australia. King George Whiting is the major species caught commercially in significant quantities inside **Baird Bay**. In recent years, no other species has been caught commercially in similar quantities inside the bay. Figures specific to Baird Bay are not available, however McGarvey *et al.* (2000) reported the commercial catch of King George Whiting from the “Mid West Coast” (which includes Anxious Bay, Venus Bay and Baird Bay, and half of the coast south of Streaky Bay and north of Baird Bay). In 1998-99, the commercial catch of King George Whiting was around 55.3t, mostly taken by hand lines (43.9t), with a lesser catch by gill nets (9.5t) and hauling nets (1.9t). Hand line fishing effort during that period amounted to around 2560 fisher-days (higher than the long term average), and gillnet effort was around 459 fisher-days. In 2000 and 2001, the total catches were 17.8t, and 20.2t respectively, and the proportions taken by hand lines, gillnets and hauling nets were similar to those cited above for 1998-1999, with handlines being the dominant gear. Fowler and McGarvey (2003) reported that handline catch has been highly variable since 1990, but in 2000 dropped to the lowest recorded level, with only marginally higher catches in 2001 and 2002. Similar trends were observed for hauling nets and gill nets. Fowler and McGarvey (1999), and McGarvey *et al.* (2000 and 2003) showed that (i) catch and effort in the Mid West Coast region have been highly variable over time; (ii) yearly catches fluctuate well above (e.g. more than 50t) and well below (e.g. less than 20t) the long term average; (iii) catch from the Mid West Coast bays is substantially less than the catch of King George Whiting from the Far West Coast area (e.g. about 15% in 2000 and 2001, but about one third as a long term average); (iv) targetted hauling net effort and gill net effort have continued to decrease since the early-mid 1990s, however effort directed at other species has resulted in an increased by-catch of King George Whiting since the early 1990s; and (v) although hand-lines remain the dominant fishing method in the Mid West Coast bays, there has been a significant and accelerating long term decline in hand line effort.

Gummy Shark, Snapper, Garfish, and Redfish (“red Snapper”) are caught in minor commercial quantities outside Baird Bay .

In 2000, 15 commercial fishers were listed as operating in the Baird Bay area (Australian Estuaries database, cited by GeoScience Australia, 2001). According to SARDI data (cited by Edyvane, 1999b), in 1995/96 and 1996/97, 42 and 44 commercial holders, made up of Marine Scalefish, Restricted Marine Scalefish, and Northern Zone Rock Lobster license holders, collectively fished in both Venus Bay and **Baird Bays** (although no commercial fishing of Rock Lobster occurs in **Baird Bay** – see section below).

According to SARDI data, the Marine Scalefish catch from GARFIS Block 16 (**Baird Bay**) between 1995 and 1997 was as follows: In 1995/96 a total of 31.6t (0.30% of State total); In 1996/97 a total of 25.3t (0.25% of State total).

On a Statewide scale, aggregated catch figures for all GARFIS Fishing Blocks in South Australia, between 1995 and 1997, showed that the **Baird Bay** area (GARFIS Block 16) was ranked 42nd in 1995/96 and 44th in 1996/97, in the ranked list of fishing yields from 58 South Australian fishing blocks, at that time.

Fisheries information specific to the coastal area north of Baird Bay and south of Streaky Bay is not available for this report, however in the fishing block that includes Acraman Creek, Haslam, Streaky Bay and the **Back Beach (Corvisart Bay** area, as far south as the **Point Westall** and **Scele Bay area**), major species commercially caught in the area are:

- ♦ *King George Whiting*: in terms of annual yield, the fishing region that includes Streaky Bay and the coast further south, has been amongst the top 10 fishing blocks in South Australia, in recent years (e.g. mid-late 1990s). Fowler and McGarvey (1999) provided an overview of catch and effort for the entire West Coast area, and McGarvey *et al.* (2000 and 2003) provided statistics for the “Mid West Coast” region, which includes Anxious Bay, Venus Bay, Baird Bay and half of the coast south of Streaky Bay

and north of Baird Bay. Recent data are presented above, in the section on whiting catch from Baird Bay.

- ♦ *Gummy Shark* (and other shark species including *School Shark* and *Bronze Whaler*).
- ♦ *Snapper*: no specific recent information on catches is available for the mid west coast, however Fowler (2000 and 2002), Knight *et al.* (2002), and Fowler *et al.* (2003) provided an overview of the Snapper fishery catch and effort for the entire West Coast. It is noted that in 2001/2002, the total Snapper catch from West Coast waters was about 29t, and although that was 38% higher than the previous year's catch, it represented only 4.5% of the State-wide commercial catch of Snapper (Fowler *et al.*, 2003).
- ♦ *Australian Salmon*: In some years following good recruitment, the region has been amongst the top 10 fishing blocks in S.A. in terms of annual yield (see Knight *et al.* 2002 for overview of catch and effort for the entire West Coast area);
- ♦ *Ray* species: in some recent years (e.g. mid-late 1990s), the region has been amongst the top 5 fishing blocks in the State, in terms of annual yields, however the proportion of this yield that is taken from the exposed coastal areas south of Streaky Bay is not known for this report.

The Streaky Bay region fishing block for which Scaele Bay is a southern boundary, also records relatively high catches of *Southern Calamari* (e.g. in some recent years, commercial yields of over 10 tonnes have been recorded), however the proportion of the yield that is taken from the exposed coastal areas south of Streaky Bay is not known for this report: - it is likely that the bulk of the catch is taken in more sheltered waters north of the area described in this table.

The deeper waters seaward of the **Scaele Bay** area are part of the migratory route of Southern Bluefin Tuna (see Figure 2 in Klaer *et al.*, 2002), a species which is fished in S.A. waters under Commonwealth-managed arrangements.

In the large fishing region of the mid-west coast (i.e. Fishing Block 15), some of the main species caught commercially in waters south of Searcy Bay and west of the Calca Peninsula, to south and west of the Elliston area, and including the Investigator Isles) are as follows: *Gummy Shark* and *School Shark* (N.B. the mid west coast waters are one of the major fishing areas for in South Australia for these shark species), *West Australian Salmon*, *Ocean Leatherjacket*, *King George Whiting*, *Blue Morwong*, *Blue-throated Wrasse* and other species of *Wrasse*, *Sweep*, *Snapper*, *Redfish*, *Rock Ling*, *Conger Eel* and *Velvet Crab*. In some years purse seine yields of *West Australian Salmon* from the mid west coast waters are high when compared with other fishing blocks, on a State-wide scale. Other than salmon, the mid west coast waters are not a major fishing area for scalefish, when compared with many other areas in the State

According to SARDI (cited by Edyvane, 1999b), the Marine Scalefish and Shark catch from Fishing Block 15 (which includes the waters seaward of Baird Bay as a northern boundary, but also includes all of Anxious Bay and all waters between 33°S to 34°S, and between 134°E and 135°E) between 1995 and 1997, was as follows: In 1995/96 a total of 133,221kg (1.28% of State total, representing 21 fishers); in 1996/97 a total of 283,665 kg (2.79% of State total, representing 34 fishers). Marine Scalefish, Restricted Marine Scalefish, and Northern Zone Rock Lobster licence holders contribute to these yields. The proportion of the above yields that relates specifically to the Calca Peninsula area is not known for this report.

On a State-wide scale, aggregated catch figures for all GARFIS Fishing Blocks in South Australia, between 1995 and 1997, show that Fishing Block 15 was, at that time, ranked 20th in 1995/96, and 10th in 1996/97, in the list of fishing yields from 58 South Australian fishing blocks.

Prawn Fishing

Commercial prawn fishing does not occur inside Baird Bay or along the exposed coast between Cape Bauer and Cape Radstock. One of the 3 "key" prawn fishing areas on the West Coast occurs south of the area, in the deeper waters seaward of Anxious Bay, as far south-west as the Investigator Group (see MacDonald, 1998; Carrick and Williams, 2001; and map in Knight *et al.*, 2002).

Rock Lobster Fishing

There is no commercial Rock Lobster fishing in Baird Bay.

Rock Lobster fishing occurs in coastal waters of the region. Figures specific to the area between Cape

Bauer and Cape Radstock are not available for this report. The area described in this table is forms part of two Rock Lobster Fishing Blocks – the southern part of Block 10, and the north-western corner of Block 15.

Marine Fishing Area 10 is not one of the major fishing blocks in the Northern Zone (see Ward *et al.* 2002, 2003). Previously, data from SARDI (cited by Edyvane, 1999b), showed that the Rock Lobster catch from Marine Fishing Area 10 (Streaky Bay region, Point de Mole southwards to Point Westall / Sceale Bay area) between 1995 and 1997 was as follows: in 1995/96 a total of 11,710kg (0.23% of State total, representing 17 fishers); In 1996/97 a total of 12,171 kg (0.24% of State total, representing 13 fishers). Aggregated catch figures for all fishing blocks in South Australia, between 1995 and 1996, showed that Fishing Block 10 was ranked 19th in terms of yield (and hence value) during that period.

The southern part of the area described in this table comprises a small proportion of the mid-west coast Marine Fishing Area (MFA) 15 (which includes Searcy Bay, Anxious Bay, the Investigator Group isles, as well as all waters between 33°S to 34°S, and between 134°E and 135°E). Fishing Block 15 is one of the three fishing blocks in the Northern Zone in which Rock Lobster catch has consistently been higher than that from other Northern Zone fishing areas, in almost all years since 1970 (see Ward *et al.* 2002, Figure 2.5; Ward *et al.*, 2003, Figure 2.8). The largest portion of the total Northern Zone catch is taken from three fishing MFAs, of which Marine Fishing Area 15 is one. Catches have been higher than around 100t in Marine Fishing Area 15, in most years since 1986, up till the late 1990s, and corresponding effort has been higher than 60,000 pot lifts per annum in all of those years (and over 100,000 pot lifts per annum in several years during the 1990s). Catch peaked at over 150t per annum in 1990, 1991, 1995 and 1996. During the late 1990's to 2001, both catch and effort decreased compared with the all other years during the 1990s. The approximate catch in 2001 was around 75 tonnes in Fishing Block 15, from an effort level of nearly 70,000 pot lifts, and the catch in 2002 was even lower (see Ward *et al.*, 2003, Figure 2.8).

The percentage of the catch from Block 15 that is taken from shallow water (between 1m and 30m) has increased from the 1990s to the present compared with catches from that depth range during the 1970s and 1980s, and the percentage of the catch taken from deeper water (61m – 90m, and 90+m) has decreased since the 1970s (see Figure 2.12 in Ward *et al.* 2002).

An indication of the significance of the catch from Marine Fishing Area 15, relative to other fishing blocks in South Australia, was provided by SARDI data cited (cited by Edyvane, 1999b): In 1995/96, the total of 168,235kg from Block 15 comprised 3.23% of State total, representing the catch of 41 fishers; and in 1996/97, a total of 161,534kg for Block 15 comprised 3.16% of State total, representing the catch of 34 fishers. Aggregated catch figures for all fishing blocks in South Australia, between 1995 and 1996, showed that Fishing Block 15 (mid west coast waters, between 33°S to 34°S, and between 134°E and 135°E) was the 4th most important commercial lobster fishing area in South Australia during that period, in terms of yield (and hence value).

When the entire Northern Zone is considered as a whole (i.e. from the Western Australian border, through to Encounter Bay and deeper waters south of Kangaroo Island), the catch for the 2002 season was 594.8 tonnes, being the lowest catch in the Northern Zone since 1979 (Ward *et al.*, 2003).

Bycatch information specific to the coast between Cape Bauer and Cape Radstock is not available for this report. However, McGarvey *et al.* (1998) and Prescott (2001) reported that the largest proportion of bycatch in the Northern Zone as a whole, is leatherjackets and octopus. According to results of a sampling program of bycatch in 1991 and 1992, various wrasse species (Labridae family) together constituted another major component of the bycatch in the Northern Zone e.g. 1127 Labrids caught in pots during the bycatch sampling program in 1991-92 (Table 5 in Prescott, 2001). Octopus are a major predator of Rock Lobster, with losses due to octopus predation equating to approximately 4% of the total number of lobsters landed (in the Northern Zone). According to McGarvey *et al.* (1998), the catches and catch rates of octopus have been sustained over time, and vary from 1 – 2.5 octopuses per 100 potlifts. Octopus that are caught in the northern zone are sold. Rock Lobster fishers are also permitted to retain legal sized Giant Crab when caught as by-product, and this species is becoming increasingly valuable, commercially (McGarvey *et al.*, 1998). A small number of Commonwealth-endorsed Rock Lobster fishers also target Giant Crab specifically. Between 1992/93 and 2001/02, total Giant Crab catches (target and byproduct catches combined) have ranged between 7t in 1992/93, and 33t in 1998/99, with a steady decline between 1999 and 2002 due to the introduction of quotas (e.g. 31t in 1999/00; 24t in 2000/01, and 18.5t in 2001/02) (Knight *et al.*, 2003, cited by Sloan, 2003b). The fishery now operates under a quota-based management system with a total allowable commercial catch (TACC) of 13.4 and 8.7 tonnes for the Northern Zone and Southern Zone, respectively (Sloan,

2003b). Giant Crabs are caught from the edge of the continental shelf in the west coast region (McGarvey *et al.*, 1998).

Some Rock Lobster fishers net sharks out of season, and some of these activities require a Commonwealth permit. Licensed Rock Lobster fishers have also had access to fish species, such as Australian Salmon, Mulloway, and Snapper (Zacharin, 1997, cited by McGarvey *et al.*, 1998).

Predators of Rock Lobster in the Northern zone include New Zealand Fur Seals, Western Blue Groper (minor) and Maori Octopus (McGarvey *et al.* 1998; S. Shepherd, pers. comm., 2004).

Abalone Fishing

Abalone Fishing Area 4 includes the High Cliff area, Point Westall, Sceale Bay, Cape Blanche, Slade Point, and most of Searcy Bay.

Mayfield *et al.* (2002, cited by Shepherd, pers. comm. 2003) reported that the average annual catch data for Fishing Area 4, was 11.3 t of greenlip, and 15.9 t blacklip, for the period 1997-2001.

Mayfield *et al.* (2001) reported that (i) no significant increase or decrease in fishing effort has occurred in fishing area 4 during the past 10 years (to 2000); (ii) Fishing Area 4 was one of 5 fishing areas in the Western Zone in which cumulative fishing effort (days per year) was highest, during the periods 1988-1992 and 1996 – 2000; and (iii) average catch per unit effort (kg per hour) in Fishing Area 4 during the past 5 years (1996 to 2000) has been in the order of 60kg – 80kg per hour.

Catches of both greenlip and blacklip have decreased significantly since 1980 in Fishing Area 4 (S. Shepherd, pers. comm., 2003).

Abalone Fishing Area 5 includes the coast adjacent to the southern side of Searcy Bay, the **Calca Peninsula** (seaward side of Baird Bay), **Cape Radstock**, and the coastal reef areas eastwards of **Jones Island** (i.e. northern end of Anxious Bay). Commercial abalone fishing in the **Baird Bay area** takes place at the entrance, and on the protecting barrier islands and reefs (Bond, 1994).

Mayfield *et al.* (2002, cited by Shepherd, pers. comm., 2003) reported that the average annual catch data for Fishing Area 5 was 13.3 t of greenlip, and 14.6 t blacklip, for the period 1997-2001.

Mayfield *et al.* (2001) reported that (i) no significant increase or decrease in fishing effort has occurred in Fishing Area 5 during the past 10 years (to 2000); (ii) Fishing Area 5 was one of 5 fishing areas in the Western Zone in which cumulative fishing effort (days per year) was highest, during the period 1996 – 2000; and (iii) average catch per unit effort (kg per hour) in Fishing Area 5 during the past 5 years (1996 to 2000) has been in the order of 60kg – 80kg per hour.

Catches of both greenlip and blacklip have decreased significantly since 1980 in Fishing Area 4 (S. Shepherd, pers. comm., 2003).

No recent figures specific to parts of the area described here are available for this report, however aggregated figures, as a range between 1990 and 1996, are provided below for abalone (S. Shepherd, pers. comm., 2000):

- ♦ **Point Labatt:** Recorded annual yield of Greenlip Abalone between 1990 – 1996 was approximately 5t or less in all years. Yield of blacklip during that period fluctuated between approximately 8t and approximately 17t whole weight;
- ♦ **Cape Radstock – Baird Bay:** Recorded annual yield of Greenlip Abalone during 1990 – 1996 fluctuated between approximately 7.5t and approximately 13.7t. Yield of blacklip fluctuated between approximately 9t and 15.8t whole weight;
- ♦ **Cape Blanche and northern Searcy Bay:** Recorded annual yield of Greenlip Abalone during 1990 – 1996 fluctuated between approximately 3t and approximately 11t. Yield of blacklip fluctuated between approximately 4.75t and 11.75t whole weight;
- ♦ **Olive Island area:** Recorded annual yield of Greenlip Abalone ranged between less than 1t to 7.3t. Yield of Blacklip Abalone fluctuated between approximately 500kg and 8.6t.

According to figures from SARDI (cited by Edyvane, 1999b), the catch from the Yanerbie Biounit (Map Codes 4A-H; 5A-F; 6A-D: Point Westall to Venus Bay), which includes the Baird Bay area was as follows,

between 1995 and 1997 (NB these figures include other areas in addition to the area described in this table, as specified by the map codes above):

- ♦ *Greenlip*: 1994/95 = 30,222kg of greenlip (13.3% of the total Western Zone catch, or 8.02% of the State greenlip catch); 1995/96 = 33,657kg (14.9% of the total Western Zone catch, or 8.99% of the State greenlip abalone catch).
- ♦ *Blacklip*: 1994/95 = 76,707kg of blacklip (24.7% of the total Western Zone catch, or 15.52% of the State blacklip catch); 1995/96 = 77,934kg (28% of the total Western Zone catch, or 16.83% of the State Blacklip Abalone catch).

Recreational Fishing

The road to **Point Labatt** from Streaky Bay follows the isthmus of land between **Baird Bay** and the ocean. There is launching access for small boats into **Baird Bay** at various points along this track (Fishnet, 2002).

Baird Bay is promoted in regional tourism guides as a prime location for recreational fishing of King George Whiting, and a popular destination for recreational fishers (e.g. Eyre Peninsula Tourism Association 1995 and 2002; Venus Bay SA web site, 2002). Bond (1994) considered the value of the **Baird Bay** area to recreational shore and boat fishers in a discussion of aquaculture potential in the region. When the tide is in there is launching access for small boats across the beach in front of the houses. Recreational fishers sometimes fish from small boats anchored at the mooring near the housing area. According to the Eyre Peninsula Tourist Association (1993) and Fishnet (2002), species targeted and caught by recreational fishers in **Baird Bay** include: King George and large Garfish (both abundant in the bay and popular targets for recreational fishers), Snapper (also caught outside the entrance to Baird Bay, at **Jones Island**), Tommy Ruff, Australian Salmon, Snook, mullet, flathead, Southern Calamari, sweep, Silver Drummer, and trevally. There is a boat launching facility at **Baird Bay**.

Charter boat trips from **Baird Bay** fish both in the bay, and outside on the coastal reefs (e.g. **Cape Radstock** area). From the reefs off **Cape Radstock / Calca Peninsula**, species such as Snapper, large Redfish (locally called "nannigai"), large Blue Morwong, and various wrasse species are caught (Fishnet, 2002).

The beach to the north of **Point Labatt** is described as producing "good catches of salmon and the occasional Mulloway" (Fishnet, 2002). The beach at the end of the road shelves into deeper water close to the coast. The rocky outcrops in the area are sometimes used for rock fishing.

The **Cape Bauer** area and **Olive Island** are listed in Capel's (1994) guide to top fishing spots in S.A., with reef fish being the main features of the area. Major fish caught in the area include large trevally and sweep, large Blue Groper, sharks, Snapper, large Redfish (also commonly referred to as "nannigai"), Harlequin Fish, large Snook and barracouta, whiting, various rock fish species (caught in abundance in this area, including large individuals) and Dusky Morwong (Capel, 1994; Fishnet, 2002). Western Blue Groper are described as "abundant around **Cape Bauer** and other headlands in this area but they are difficult to land because of their large size and nature of the terrain" (Fishnet, 2002).

The size and abundance of reef fish in some west coast areas (e.g. **Cape Bauer**, western Streaky Bay, and **Olive Island**) has been promoted as a major attractant for recreational fishers (e.g. Capel, 1994).

There are charter boat fishing trips run to **Olive Island** and surrounding reefs, for catching reef fish (*Postcards* program, undated). The area is promoted for catching sweep (reportedly abundant in the area and described as "easy to catch"), and "very large" King George Whiting. **Olive Island** is also described as an area in which large Blue Groper (often over 30kg) can be caught using abalone or crab as bait, and Southern Bluefin Tuna are caught further seaward of Olive Island, along the tuna migratory route (Fishnet, 2002).

Tourism promotion materials list the coastal area south of Streaky Bay (i.e. **Westall Way, The Granites, Sceale Bay, Corvisart Bay (Back Beach), Searcy Bay and Baird Bay**) as providing "a wide range of fishing areas". Capel (1994) listed **Back Beach** as one of the top 20 shore fishing spots in South Australia, with targeted species including whiting, flathead, mullet, Australian Salmon, Snapper, Mulloway, Snook, Garfish, flounder, Tommy Ruff, trevally and Southern Calamari.

Eyre Peninsula Tourism Association (1995 and 2000) listed Tommy Ruff, Australian Salmon, mullet and flathead as major targeted species in the **Back Beach** area, and Fishnet (2002) reported that the

section of **Back Beach** near **Cape Bauer** is a good site for fishing salmon, and occasionally Mulloway are caught. There are boat launching facilities along some parts of the coast, and the **Back Beach / Westall Way** coast has been described as “a fisherman’s paradise” for catching King George Whiting, Snapper, trevally, Snook, salmon trout (Australian Salmon) and Garfish (Venus Bay SA web site, 2002).

Back Beach, Speeds Point, High Cliff and The Granites are used for surf fishing of Australian Salmon (Eyre Peninsula Tourism Association, 1995 and 2000). There are various rock fishing and beach fishing spots in the area including the **Smooth Pool, Yanerbie, Speeds Point, Point Labatt** and others. Whiting are taken by boat and beach fishers in the **Yanerbie** area (Fishnet, 2002), and the rocky headland adjacent to **Yanerbie** is sometimes used by rock fishers.

Windmill Beach, between **Smooth Pool** and **Speeds Point** is accessed by 4WD for fishing, and is a recognised spot for fishing large Mulloway, especially during the warmer months of the year (Fishnet, 2002). At **Speeds Point**, there is a semi-submerged rock ledge that drops off steeply close to the shore, from which anglers catch Australian Salmon, and reef fish species such as Western Blue Groper (Fishnet, 2002). Small Trevally, whiting and Australian Salmon are taken at **Smooth Pool** (Fishnet, 2002). South of Smooth Pool, there is a track to the limestone headland, which leads down to the rocks, for recreational fishing in deep water close to the shore (Fishnet, 2002).

Local farmers launch their fishing boats from **Tractor Beach** (using tractors) (Nullarbor Net Travel Guide, undated).

There is a concrete boat ramp in **Sceale Bay**, and fishers also fish from the beach. Whiting and other popular recreationally fished species (see above) are caught, and **Sceale Bay** is considered to be renown for large King George Whiting (to around 70cm) (Fishnet, 2002). The **Sceale Bay** area is also described as providing “excellent offshore fishing”, particularly the plateau that is located around eight nautical miles offshore. The offshore rise is described as “excellent for fishing Bluefin Tuna during the summer and early autumn, with 30 kg specimens fairly common” (Fishnet, 2002). Bluefin tuna of record size for recreational sports fishing have been caught in these deeper waters out of the **Sceale Bay** area (e.g. see ANSA, 1999).

At the northern end of **Sceale Bay**, small boats are launched from the sand at **Yanerbie**, where whiting are a main target. Fishers also fish from the beach at **Yanerbie**, and the prominent rocky headland sheltering **Yanerbie** is also promoted by fishing guides, for rock fishing.

Large whiting and other species are also caught in **Searcy Bay**.

Recreational fishing for greenlip and Blacklip Abalone occurs along accessible areas of the coast.

Recreational lobster fishing occurs in the area, using lobster pots in **Baird Bay**, and both pots and diving in the **Cape Blanche** area (and northwards) (Tyrer, 1994).

Shells are collected in the area (e.g. **Speeds Point**) (Fishnet, 2002), however the extent of this practice by recreational collectors is not known for this report.

Diving

Snorkelling and diving to view sea lions occurs at some coastal locations in the area (e.g. see below).

Aquanaut (undated) promoted diving in the area south of Streaky Bay. Boats for diving can be launched at **Streaky Bay**, and also from **Sceale Bay** to the south. Shore diving is promoted at **The Smooth Pool** and **Sceale Bay** (DIASA undated, Aquanaut, undated). **High Cliffs** and **Slades Point**, are also promoted as good diving spots. Boat diving is promoted in the area, because the West Coast is considered to be “largely unexplored by sport divers” (Aquanaut, undated), and “any headland or bommie south of Streaky Bay” is described as “worth a dive”.

In general diving along the West Coast, including some of the offshore shipwreck sites, has been described as a potential tourism industry (Ellis, 1999a).

Other Marine and Coastal Recreation / Tourism

There is a public platform on the cliff at **Point Labatt**, for viewing the sea lion colony below. The **Point Labatt** area has been described as one of the “few mainland breeding sites for Australia’s only endemic marine mammal to pup and for the public to have the opportunity to view Australian sea lions in their natural

habitat" (DELM, 1993; Morelli and de Jong, 1995). **Point Labatt** is also described as "an important tourist attraction of the Streaky Bay region in terms of sea lion viewing" (DELM, 1993; Morelli and de Jong, 1995). Regional, national and international tourism materials regularly promote the Point Labatt area, as a good spot to view sea lions in their natural habitat.

Seasonally, Southern Right whales can be seen close to the coast in the **Point Labatt** area, and whale-watching is also promoted as part of the tourism attraction of the area.

Bird watching is also promoted in the **Baird Bay / Point Labatt** area.

Baird Bay / Jones Island / Point Labatt area. There are charter boat trips in the area, to provide tourists with opportunity to swim and snorkel with Australian sea lions and bottlenose dolphins. Tourism promotion materials (e.g. Postcards On-line, undated b) report that around a third of the visitors who attend the **Baird Bay / Jones Island** trips to swim with sea lions and dolphins, are from overseas. Boats also can be hired from **Baird Bay**.

Cape Blanche to Cape Radstock: Tourists visit the area (Australian Heritage Commission, undated). The recent (2001-2003) promotion and formal protection of the sea lion colony off **Cape Blanche** is likely to increase the eco-tourism value of this area. In the region between Cape Blanche and Cape Radstock, coastal tracks have been established through usage from recreational fishing and local tourists (Bond, 1994).

Other areas in the vicinity listed as being of coastal tourism interest are **Little Islands, Back Beach, Hally's Beach, Cape Bauer**, and the **Westall Way** scenic drive, south of Streaky Bay (Eyre Peninsula Tourism Association, 2000). The **Westall Way** loop passes **The Granites, Smooth Pool** and **Speeds Point**, which are scenic stops for tourists.

Charter boat trips that visit **Olive Island** for fishing, also promote sea lion viewing as one of the attractions in that area (*Postcards On-line*, undated c).

Tourism promotion materials list the coastal area south of Streaky Bay (i.e. **Sceale Bay, Corvisart Bay, Searcy Bay** and **Baird Bay**) as providing "a wide range of surfing, swimming and camping areas". There are small camping sites at **Sceale Bay** (Fairfax Publishing – F2, 2003), **Baird Bay** (District Council of Streaky Bay, 2003), and other camping spots along the coast (see below). **Corvisart Bay** (= "**Back Beach**") is recommended for surfing (Australian Explorer, 2003, and other regional tourism promotion materials).

Westall Way is promoted as a scenic area, for coastal driving, camping, beach walking, coastal sightseeing / photography, and bird watching (e.g. Nullarbor Net Travel Guide, undated; Explore Oz, undated). There is a walking trail from **Tractor Beach** to **High Cliff**, and beachside camping areas at **Tractor Beach, The Granites** and other sites along the **Westall Way** coast. The granite shoreline of the **Smooth Pool** area is promoted for beach walking, coastal photography, viewing the intertidal marine life in the rock pools, picnics, and camping nearby.

There have been sea kayak expeditions (e.g. in 2000) along the coastal area, including **Baird Bay, Westall Way** and the **Dreadnoughts**, undertaken by members of various S.A. and interstate sea canoe clubs.

Scientific Research and Monitoring / Marine Education

Long term monitoring program for Australian sea lions at **Point Labatt**. Data collection on population sizes began in 1966 by Fisheries officers and was continued from 1972-1992 by SANPWS officers (Australian Heritage Commission, undated). Monitoring of sea lion and fur seal populations still occurs in the area, and a scientist from CSIRO's Division of Wildlife Ecology (P. Shaughnessy) undertook the most recent assessment, in 2001.

Abalone population dynamics and stocks are monitored in the area (e.g. **Yanerie, Sceale Bay, Baird Bay**, and other sites) (e.g. see Shepherd and Baker, 1998; Shepherd and Rodda, 2001). Abalone tagging, juvenile surveys, and reproductive studies on abalone have been undertaken in the **Sceale Bay / Smooth Pool** area (e.g. see Rodda *et al.*, 2000).

Historic / Protected Shipwrecks

Two historic shipwrecks that are protected under Commonwealth legislation, are recorded in the **Sceale Bay** area:

- ♦ *Arachne*: wooden barque, built 1809, wrecked 1848; and
- ♦ *Elizabeth Rebecca*: wooden brig, built 1828, wrecked 1845.

These two vessels were whaling ships (Staniforth and Richards, 2000). Three unprotected shipwrecks from the 20th century are known in the area, but have not been found. (South Australian Coastal and Marine Atlas, 2001 and 2003).

Other European Heritage Values

A small stone hut exists in the cliff in the **Baird Bay** area, possibly built and used by fishers, and the remains of an old limestone house exist on **Unnamed Island**. No other information is known for this report.

There is some evidence of a whaling station having existed in the **Yanerbie / Trial Bay** area (State Heritage Authority, 1999; Staniforth and Richards, 2000). Trial Bay is located approximately 25 miles south of Streaky Bay, and historical documents indicate that the Trial Bay whaling station was operated only during the year 1845, and due to lack of provisions, some of the whalers were living on shellfish. Brick remains have been located near what is believed to be the location of the whaling station at **Trial Bay**. Also included in the remains are pieces of ceramic, clay pipe stems and fragments of hoop iron (Hosking, 1973 and Kostoglou and McCarthy, 1991, cited by Staniforth and Richards, 2000).

Aboriginal Heritage Values

Nicholson (1991, cited by Edyvane and Nias, undated) reported that **The Granites** area in **Corvisart Bay** contains a discrete occupation site consisting of 3 middens, approximately 6000 - 7000 years old; and that the **Yanerbie Sandpatch** is a discrete occupation site containing cultural artefacts and animal bones.

A burial site at **Searcy Bay**, has recently been conserved (Government of South Australia, 2003).

The region described is part of Native Title application SC97/6 (Wirangu # 2), lodged with the National Native Title Tribunal in 1997. In 2000, Wirangu # 2 (northern Streaky Bay southwards to Wellington Point) was found to comply with Section 190 requirements, the claim has been accepted, and details have been entered on the S.190 Register (National Native Title Tribunal database, 2003). The claim includes requests to obtain non-exclusive access rights to, and use of, land and sea resources in the claim area. Under Section 190B(5)(a) of the Registration Test summary, the Wirangu are listed as the coastal people both historically and presently inhabiting the claim area, and maintaining a physical connection with that area. The claim group use and enjoy the area including camping, travelling, hunting, fishing, protecting sites and wildlife, conducting ceremonies and trading artefacts (NNTT, 2000).

Wilderness / Aesthetic Values

Cape Bauer has been described as "a rugged coastal cliff area providing scenic panoramas of the Great Australian Bight" (Bond, 1994).

Tourism promotion materials (e.g. Fairfax Publishing – F2, 2003; Explore Oz, undated) describe the coastline around **Streaky Bay** (particularly the exposed headland to the south) as "beautiful and fascinating" and "magnificent", and the area is described as providing "some of the most fascinating coastal sites and scenery which the Eyre Peninsula can offer".

The **Westall Way Scenic Drive** is south of Streaky Bay. The **Westall Way** area has been promoted for its scenic value (e.g. **The Granites, Smooth Pool, Yanerbie Sandhills**), and has been described as "idyllic", "excellent", "superb" and "a truly beautiful stretch of coastline" (e.g. Explore Oz, undated; Fairfax Publishing – F2, 2003). Nullarbor Net Travel Guide (undated) described the area as comprising "an amazing variety of landforms and seascapes. Dotted along Westall Way you will find rugged limestone cliffs, striking granite boulders covered in golden lichens, secluded granite pools and quite striking seascapes with foaming white breakers. The huge white Yanerbie sandhills are also well worth

a visit". There are "sweeping views" from **The Granites** beach camp site, to **High Cliff** and **The Dreadnoughts**. Bond (1994) described the **Westall Way** coastal area as "a fine example of the typical coast of Eyre Peninsula", and tourism materials promote "the dramatic cliffs, pleasant bays and rocky outcrops". The **Smooth Pool** area (part of the **Westall Way** coast) has been described as "beautiful", "magnificent" and "a seascape photographer's paradise" (Nullarbor Net Travel Guide, undated; Fairfax Publishing – F2, 2003).

The **Point Labatt** area is noted for its "spectacular coastal scenery" (DELM, 1993; Australian Heritage Commission, undated), and is described by tourism promotion materials as "magnificent", and "strikingly beautiful". The visual appeal of the sea lions basking on the rocks and sand at Point Labatt is also promoted.

Cape Blanche to Cape Radstock is considered to comprise "attractive coastal scenery" due to the high-energy conditions creating rugged beaches, coastal cliffs and reef outcrops (Bond, 1994).

Towns and Shack Settlements

- ♦ **Baird Bay:** A small settlement of less than 30 people. Shacks are clustered on the eastern shore opposite the narrow neck to the enclosed bay. **Baird Bay** is recognised by government as an urban related zone (the "Baird Bay Holiday House Zone", according to Bond, 1994), and there is a small semi-permanent population at the main shack site. Another small group of shacks exists near the entrance to the bay on the eastern shore (Bond, 1994).
- ♦ **Sceale Bay:** This small settlement has a permanent population of less than 30, which can double or treble at holiday times (District Council of Streaky Bay, 2003).
- ♦ **Searcy Bay:** Is a small settlement, mainly used for fishing and holidays. Within the bay is **Yanerie**, also a small fishing settlement with holiday housing.
- ♦ Planning S.A. has developed an Orderly Development Plan for holiday housing at **Smooth Pool** (Planning S.A., 2001)

Other Information

During the late 1990s, Coastcare funding was received by a number of community groups for projects in the area, such as coastal management and access works at **Tractor Beach / High Cliffs**, **The Granites** and **Speed Point** (organised by Streaky Bay Agenda 21 Committee); coastal habitat protection works at **Sceale Bay**; and **Surfers Beach** access control fencing and walkway works (organised by Sceale Bay Town Committee) (Coastcare project report, 1998-99).

Previously, the deep water west of **Sceale Bay** township towards **Cape Blanche** was proposed as a deep water port for loading gypsum (from nearby deposits) and grain (Bond, 1994).

9.1.3 Venus Bay and Surrounds (Eyre Bioregion)

Aquaculture

The 1994 Streaky Bay Aquaculture Management Plan (Bond, 1994) included notes on the Venus Bay area, as part of the **Anxious Bay Management Zone**. Bond's (1994) assessment of aquaculture potential in the region recommended that no sea-based aquaculture be permitted in the Anxious Bay Management Zone, due to the extreme environmental conditions (i.e. "extremely exposed coastal zone fronting Venus Bay") and was considered to be not conducive to aquaculture development. The relative isolation from infrastructure and support services was considered to be a further hindrance to the development of offshore aquaculture, and it was recommended that aquaculture requiring structures be

excluded from this management zone. However, Bond (1994) recommended that onshore aquaculture would be acceptable, providing that discharges into the sea meet PISA (now PIRSA) and the Environment Protection Authority requirements.

In 1996, PIRSA zoned the eastern side of **Venus Bay** for aquaculture (the **Port Kenny Zone**). The Port Kenny zone encompasses waters on the eastern side of the bay, from Port Kenny to Germein Island, to the Venus Bay township. This area has been zoned in PIRSA's *Elliston Aquaculture Management Plan* for aquaculture development of native species (purportedly excluding Pacific Oyster culture, and species that require supplementary feeding) (Ashman, 1996, cited by Edyvane, 1999b).

Within the Port Kenny Zone, between 1993 and 1996, 3 leases were approved for intertidal shellfish culture, according to the South Australian Coast and Marine Atlas (2001). Pacific Oyster culture did not prove to be viable in the Venus Bay / Port Kenny area during the 1980s and 1990s (see Grove Jones, 1986; Hone, 1996). However, a further three applications were received by government in 1999 for shellfish aquaculture leases in Venus Bay. According to the South Australian Coastal and Marine Atlas (2003 version) no aquaculture leases are currently operating in Venus Bay.

Applications for onshore abalone farming (on the eastern side of the entrance to Venus Bay) were received by government in 1994 and 1995.

Outside of **Venus Bay**, PIRSA has not considered the development of aquaculture in the Anxious Bay Management Zone. South of Venus Bay, the coastal area to **Talia Caves** is part of the larger Elliston Aquaculture Management Zone. Although PIRSA has approved 60ha of potential aquaculture lease sites for this zone, aquaculture in the coastal area (to 1km seaward) from **Venus Bay** and **Talia Caves** is not being considered (i.e. non-complying zone).

Commercial Fishing

Scalefish, Sharks and Invertebrates

King George Whiting and *Sea Garfish* are the major species caught commercially inside Venus Bay, in significant quantities. In some recent years (e.g. mid-late 1990s), **Venus Bay** has been amongst the top 10 fishing blocks in S.A. (in terms of yield) in which both King George Whiting and Garfish are caught.

Figures specific to Venus Bay are not available, however McGarvey *et al.* (2000) reported the commercial catch of King George Whiting from the "Mid West Coast" (which includes Anxious Bay, Venus Bay and Baird Bay, and half of the coast south of Streaky Bay and north of Baird Bay). In 1998-99, the commercial catch of King George Whiting was around 55.3t, mostly taken by hand lines (43.9t), with a lesser catch by gill nets (9.5t) and hauling nets (1.9t). Hand line fishing effort during that period amounted to around 2560 fisher-days (higher than the long term average), and gillnet effort was around 459 fisher-days. In 2000 and 2001, the total catches were 17.8t, and 20.2t respectively, and the proportions taken by hand lines, gillnets and hauling nets were similar to those cited above for 1998-1999, with handlines being the dominant gear. Fowler and McGarvey (2003) reported that handline catch has been highly variable since 1990, but in 2000 dropped to the lowest recorded level, with only marginally higher catches in 2001 and 2002. Similar trends were observed for hauling nets and gill nets. Fowler and McGarvey (1999), and McGarvey *et al.* (2000 and 2003) showed that (i) catch and effort in the Mid West Coast region have been highly variable over time; (ii) yearly catches fluctuate well above (e.g. more than 50t) and well below (e.g. less than 20t) the long term average; (iii) catch from the Mid West Coast bays is substantially less than the catch of King George Whiting from the Far West Coast area (e.g. about 15% in 2000 and 2001, but about one third as a long term average); (iv) targetted hauling net effort and gill net effort have continued to decrease since the early-mid 1990s, however effort directed at other species has resulted in an increased by-catch of King George Whiting since the early 1990s; and (v) although hand-lines remain the dominant fishing method in the Mid West Coast bays, there has been a significant and accelerating long term decline in hand line effort.

According to fisheries data, the catch of marine scalefish and sharks from GARFIS Block 17 (**Venus Bay**) totalled around 47t in 1995/96 (0.45% of State total), and around 55t in 1996/97 (0.54% of State total). During the mid-1990s, there were 5 licensed net fishers and 10 licensed hook and line fishers who operated in Venus Bay (Whibley, pers. comm., cited by Edyvane, 1999b). According to the National Land and Water Resources Audit (see GeoScience Australia, 2001), at the time of the Venus Bay estuarine assessment (i.e. 2000) there were 10 commercial fishers operating in Venus Bay.

On a State-wide scale, aggregated catch figures for all GARFIS Fishing Blocks in South Australia, during 1995 - 1997, showed that the **Venus Bay** area (GARFIS Block 17) was ranked 36th in 1995/96, and 35th in 1996/97, in the list of scalefish and shark yields from 58 South Australian fishing blocks, at that time.

Seaward of Venus Bay, the mid west coast waters are one of the major fishing areas for Gummy Shark and School Shark in South Australia. The proportion of annual shark yields that come from the coastal waters outside Venus Bay is not known for this report. Bronze Whalers and other shark species are also caught in the mid west coast region. In some years purse seine yields of Australian Salmon from the mid west coast waters are high when compared with other fishing blocks, on a State-wide scale. Other than salmon, the mid west coast waters are not a major scalefish fishing area, when compared with many other areas in the State. Some of the main species caught commercially in the mid west coast region (i.e. waters south of Searcy Bay, to south and west of the Elliston area, and including the Investigator Isles) are as follows: *Australian Salmon*, *Ocean Leatherjacket*, *King George Whiting*, *Blue Morwong*, *sweep*, various species of *wrasse*, *Snapper*, *Redfish* ("nannigai"), *Rock Ling*, *Conger Eel* and *Velvet Crab*.

According to SARDI (cited by Edyvane, 1999b), the Marine Scalefish and Shark catch from Fishing Block 15 (which includes the waters seaward of Venus Bay, but also includes all of Anxious Bay and all waters between 33°S to 34°S, and between 134°E and 135°E) between 1995 and 1997, was as follows: In 1995/96 a total of 133,221kg (1.28% of State total, representing 21 fishers); in 1996/97 a total of 283,665 kg (2.79% of State total, representing 34 fishers). Marine Scalefish, Restricted Marine Scalefish, and Northern Zone Rock Lobster licence holders contribute to these yields. The proportion of the above yields that relates specifically to the coastal areas seaward of Venus Bay is not known for this report.

On a State-wide scale, aggregated catch figures for all GARFIS Fishing Blocks in South Australia, between 1995 and 1997, showed that Fishing Block 15 was ranked 20th in 1995/96 and 10th in 1996/97, in the list of fish and shark yields from 58 South Australian fishing blocks.

Prawn Fishing

Commercial prawn trawling does not occur inside Venus Bay, however Venus Bay is part of the geographical extent of the designated West Coast prawn fishery, due to its role as a nursery area.

The "Venus Bay" (Anxious Bay) trawl grounds are located approximately 10 nautical miles offshore from Venus Bay, and cover an area of 100 nautical miles (Wallner, 1985 and Carrick pers. comm., 1993, cited by Edyvane, 1995a). The "Venus Bay grounds" – see Carrick and Williams 2001, Figure 1) extend south from Venus Bay, into the deeper waters out of Anxious Bay (particularly the southern part of Anxious Bay), and extend seaward in a west and south-westerly direction, with a boundary around 2 nautical miles north-north-east of Point Malcolm on Flinders Island (see Macdonald, 1998; Carrick and Williams, 2001, and maps in Knight *et al.*, 2002, and Svane and Barnett, 2004).

In many years, the Venus Bay / Anxious Bay grounds have produced, on average, around 70% - 80% of the entire West Coast catch per annum (Wallner, 1985; MacDonald, 1998; Carrick and Williams, 2001). Around 72.1t of Western King Prawns were taken from the "Venus Bay grounds" in 1999/2000, which was around 68% of the total West Coast fishery catch of 106.1tonnes (see Carrick and Williams, 2001). Effort level to produce that catch was not available for the Venus Bay grounds, however the total west coast fishing effort in 1999/2000 was approximately 2,244 hours trawled, over 92 nights (Carrick and Williams, 2001). According to Carrick and Williams (2001), a survey conducted in July 2000 over the Venus Bay grounds, in collaboration with industry, indicated that recruitment increased by about 116% from the low level in 1999. The increase in survey catch rate is attributable to increased recruitment of small prawns in 2000. The trawl survey of the Venus Bay grounds clearly showed that the size of prawns increased from inshore to offshore while catch rate declined with distance from shore.

In 2000 / 2001, the mid-west coast prawn fishing area recorded the highest catches of the 3 prawn fishing grounds on the West Coast (see Boxshall, 2001). The catch from the area was in the vicinity of 42 tonnes (see Boxshall, 2001), from an effort level of around 1000 hours. In 2001/02, the catch from the Anxious Bay grounds was 34.6t, from 593.8 hours. However, the catch in 2002/ 2003 from the Venus Bay / Anxious Bay grounds was an order of magnitude lower (7.4t), from a fishing effort of 235.4hrs (Svane and Barnett, 2004). It is noted that effort, catch and catch rate were lower in all of the 3 major fishing grounds of the West Coast in 2002/03 compared with the late 1990s / early 2000s, and the

Venus Bay / Anxious Bay area was not the most productive of those grounds in 2002/2003. The considerable variation in catches over recent years possibly reflects oceanically driven cycles of abundance (Svane and Barentt, 2004).

The West Coast fishery yields are, on average, an order of magnitude lower than the annual yields from the Spencer Gulf fishery, and during the 1990s, represented approximately 9% - 10% of the total catch of Western King Prawn in South Australia (see catch figures in MacDonald, 1998). Prawn fishing effort and yields from the entire West Coast fishery are highly variable, and catches have ranged from 0kg to around 200t per annum during the 1990s. In 2000/01, the catch (81t) and effort from the entire West Coast Prawn fishery were the lowest since 1993/94. In 2001/02, 106t of Western King Prawns were taken in the fishery (SARDI Aquatic Sciences statistics, 2003), and in 2002/03, only 29t were taken in the West Coast fishery, all 3 fishing regions combined (Svane and Barnett, 2004).

In addition to prawns, prawn fishers are permitted to retain and sell Slipper Lobster (*Ibacus* sp.), Octopus, Scallops, Southern Calamari, and Arrow Squid / Torpedo Squid (*Nototodarus gouldi*).

Rock Lobster Fishing

Commercial Rock Lobster fishing is negligible in Venus Bay.

Outside of Venus Bay, commercial Rock Lobster fishing occurs in the coastal waters of the region, which forms part of the mid-west coast Fishing Block 15 (which includes Searcy Bay, Anxious Bay, the Investigator Group isles, as well as all waters between 33°S to 34°S, and between 134°E and 135°E). Fishing Block 15 is one of the three fishing blocks in the Northern Zone in which Rock Lobster catch has consistently been higher than that from other Northern Zone blocks, in almost all years since 1970 (see Ward *et al.* 2002, Figure 2.5); i.e. the largest portion of the total catch is taken from three blocks, of which Fishing Block 15 is one.

Catches have been higher than around 100t in Fishing Block 15, in most years since 1986, up till the late 1990s, and corresponding effort has been higher than 60,000 pot lifts per annum in all of those years (and over 100,000 pot lifts per annum in several years during the 1990s). Catch peaked at over 150t per annum in 1990, 1991, 1995 and 1996. During the late 1990's to 2001, both catch and effort decreased compared with the all other years during the 1990s - approximate catch in 2001 was around 75 tonnes in Fishing Block 15, from an effort level of nearly 70,000 pot lifts.

An indication of the significance of the catch from Fishing Block 15, relative to other fishing blocks in South Australia, was provided in Edyvane 1999b (citing SARDI data): In 1995/96, the total of 168,235kg from Block 15 comprised 3.23% of State total, representing the catch of 41 fishers; and in 1996/97, a total of 161,534kg for Block 15 comprised 3.16% of State total, representing the catch of 34 fishers. Aggregated catch figures for all fishing blocks in South Australia, between 1995 and 1996, showed that Fishing Block 15 (mid west coast waters, between 33°S to 34°S, and between 134°E and 135°E) was the 4th most important commercial lobster fishing area in South Australia during that period, in terms of yield (and hence value).

When the entire Northern Zone is considered as a whole (i.e. from the Western Australian border, through to Encounter Bay and deeper waters south of Kangaroo Island), the catch for the 2002 season was 594.8 tonnes, being the lowest catch in the Northern Zone since 1979 (Ward *et al.*, 2003).

Bycatch information specific to the Anxious Bay coast is not available for this report. However, McGarvey *et al.* (1998) and Prescott (2001) reported that the largest proportion of bycatch in the Northern Zone as a whole, is leatherjackets and octopus. According to results of a sampling program of bycatch in 1991 and 1992, various wrasse species (Labridae family) together constituted another major component of the bycatch in the Northern Zone e.g. 1127 Labrids caught in pots during the bycatch sampling program in 1991-92 (Table 5 in Prescott 2001). Octopus are a major predator of Rock Lobster, with losses due to octopus predation equating to approximately 4% of the total number of lobsters landed (in the Northern Zone). According to McGarvey *et al.* (1998), the catches and catch rates of octopus have been sustained over time, and vary from 1 – 2.5 octopuses per 100 pot lifts. Octopus that are caught in the northern zone are sold. Rock Lobster fishers are also permitted to retain legal sized Giant Crab when caught as by-product, and this species is becoming increasingly valuable, commercially (McGarvey *et al.*, 1998). A small number of Commonwealth-endorsed Rock Lobster fishers also target Giant Crab specifically. Between 1992/93 and 2001/02, total Giant Crab catches (target and byproduct catches combined) have ranged between 7t in 1992/93, and 33t in 1998/99, with a steady decline between 1999 and 2002 due to the introduction of quotas (e.g. 31t in

1999/00; 24t in 2000/01, and 18.5t in 2001/02) (Knight *et al.*, 2003, cited by Sloan, 2003b). The fishery now operates under a quota-based management system with a total allowable commercial catch (TACC) of 13.4 and 8.7 tonnes for the Northern Zone and Southern Zone, respectively (Sloan, 2003b). Giant Crabs are caught from the edge of the continental shelf in the west coast region (McGarvey *et al.*, 1998).

Some Rock Lobster fishers net sharks out of season, and some of these activities require a Commonwealth permit. Licensed Rock Lobster fishers have also had access to fish species, such as Australian Salmon, Mulloway, and Snapper (Zacharin 1997, cited by McGarvey *et al.*, 1998).

Predators of Rock Lobster in the Northern zone include New Zealand Fur Seals, Western Blue Groper (minor) and Maori Octopus (McGarvey *et al.* 1998; S. Shepherd, pers. comm., 2004).

Abalone Fishing

Mayfield *et al.* (2002, cited by S. Shepherd, pers. comm., 2003) reported that the average annual catch data for Fishing Area 6 (which extends from the peninsula reefs outside northern Venus Bay, to the Talia Caves monument), was 5.4 t of greenlip, and 2.6 t blacklip, for the period 1997-2001.

Catches of both greenlip and blacklip have decreased significantly since 1980 in Fishing Area 6 (S. Shepherd, pers. comm., 2003).

Mayfield *et al.* (2001) reported that:

- ♦ Fishing Block 7 (the Talia Caves area south to Walkers Rocks) is one region along the West Coast in which fishing effort for abalone has increased during the past 10 years (N.B. a statistically significant increase in fishing effort, although the area is not one of the major regions of the west coast abalone fishery – see points below);
- ♦ Fishing Block 6 and its sub-blocks (from the coastal area outside northern Venus Bay, i.e. north of Weyland Point, south to the coastal monument near Talia Caves) comprise is one of 3 regions in the West Coast zone in which catch per unit effort has been high (i.e. more than 80kg / hour) during the period 1996 – 2000.
- ♦ Fishing Block 7 and its sub-blocks comprise one of 5 Western Zone fishing blocks classified as *least fished*, in which fishing effort has been low between 1988-1992 and 1996-2000 (i.e. less than 4 days fishing on average per annum, during those periods).

Aggregated figures (approximate whole weight) for parts of the area described in this table, are provided as a range, between 1990 and 1996 (S. Shepherd, pers. comm., 2000):

Point Weyland, Venus Bay and the southern peninsula: Recorded annual yield of Greenlip Abalone fluctuated between approximately 2.8t and 8.75t. Yield of Blacklip Abalone during this period fluctuated between 12.5t and 26.5t;

Anxious Bay, including Talia Caves area: yields specific to the area between Mount Camel Beach and Talia Caves are not available. However, aggregated yields for the area from Mount Camel Beach south to Walkers Rocks (southern part of Anxious Bay) are provided. Recorded annual yield of Greenlip Abalone was less than 2.5 tonnes in all years between 1990 and 1996. However, a yield as high as around 16t per annum was recorded from this area in 1979, with progressively smaller yields every year since that time. The recorded yield of Blacklip Abalone from the Anxious Bay area fluctuated between approximately 5.7t and 15t.

Recreational Fishing

Anxious Bay coast (e.g. Mount Camel Beach, Talia Caves / Talia Beach, Walkers Rocks, The Reefs): The Eyre Peninsula Tourism Association (1995, 2000) and other regional tourism promoters describe the area from Walkers Rocks northwards to Talia Caves as “excellent” for beach fishing of Australian Salmon, whiting, tailor and Mulloway, and Mount Camel Beach as “a superb surf fishing area for salmon

DEH (2001a) reported that reef fishers also use the **southern Anxious Bay coast** (e.g. **Newland Barrier** area). There is a concrete boat ramp in the area, for boat fishers who target fish on the reefs further south. The section between **Walkers Rocks** and **Talia Caves** is generally inaccessible, except by 4WD. According to the District Council of Elliston (cited by DEH 2001), the pattern for recreational fishers is to drive northward along the Anxious Bay coast at low tide, fishing the incoming tide, and then

drive back south on the next low tide. Further north, **Mount Camel Beach** is accessible by conventional vehicles. The Eyre Peninsula Tourism Association (1995) described the ocean beaches south of Venus Bay as “superb surf fishing spots”. The area has been listed amongst the state’s most popular spots for salmon fishing, and described as “an important salmon location” (Jones, 2000). According to the District Council of Elliston (cited by DEH, 2001a), around 1000 recreational fishers per year visit **Walkers Rock, The Reefs** and **Talia Caves** area.

Venus Bay: has been described as a “popular fishing locality” (Starling 1986, cited by Edyvane 1995a; Bond 1994), and “*an absolute Mecca for the small boat and jetty fisherman*” (Frog and Toad Australian Tourism Guide, 2003). The Eyre Peninsula Tourism Association (1995 and 2000) described Venus Bay as offering “*superb boat and jetty fishing, with good catches of Tommy Ruff and trevally for jetty fishers. A concrete slab ramp north of the jetty provides easy access to the sheltered waters, for boat fishing*”. Garfish and mullet are also often caught from the jetty. Fishers seek “their regular bag” of whiting during the day, and the area East of the town is also fished at night for flounder. Where access to the coast is available, beach and rock fishing is considered a popular recreational activity.

There are recreational fishing competitions held by the local angling club at **Venus Bay**, and species caught include Gummy Shark, Elephant Fish (Elephant Shark), pike, flathead species, King George Whiting, Tommy Ruff, West Australian Salmon, and mullet.

Capel’s (1994) list of top recreational fishing spots in S.A. described the sand patches out from the jetty as a good location for catching whiting, Australian Salmon, Snook, trevally, flathead and flounder. Whiting, flathead and Snook were considered to be readily available. Other parts of the bay were also described as good locations for catching these species, in addition to salmon, trevally, sweep and various rock (reef) species, as well as Tommy Ruff and Garfish near the surface waters.

According to the Eyre Peninsula Tourist Association (1995) and Sightseeing South Australia (2003), species targeted and caught by recreational fishers in the area include the following:

- ♦ **Talia Beach:** Australian Salmon, mullet, flathead, Mulloway, shark species;
- ♦ **Talia Caves coast to Walkers Rocks:** Tommy Ruff, Australian Salmon, sweep, shark species, trevally, tailor, Mulloway;
- ♦ **Newland coast** area: DEH (2001a) reported that the remote beaches (fronting the dune barrier) are prized for their recreational fishing opportunities.
- ♦ **Mount Camel Beach:** described as offering “superb fishing all year round” (Venus Bay SA web site 2003) for Tommy Ruff (including large individuals), Australian Salmon, mullet, flathead;
- ♦ **Outside the Venus Bay entrance (“The Heads”):** boat fishing for whiting, Trevally, West Australian Salmon, flathead species, Snapper and shark.
- ♦ **Venus Bay headlands:** Tommy Ruff, Australian Salmon, sweep;
- ♦ **Venus Bay jetty:** King George Whiting, Tommy Ruff, Australian Salmon, mullet, flathead species, Southern Calamari, Garfish, Snook, trevally;
- ♦ **Venus Bay (internal):** King George Whiting, Tommy Ruff, Australian Salmon, mullet, flathead, flounder, Southern Calamari, sweep, Garfish, Snook, trevally.
- ♦ **Port Kenny** is promoted by the Eyre Peninsula Tourism Association as a base for recreational fishing holidays, and described as “a perfect base for fishing expeditions, with excellent fishing grounds nearby”. The town jetty has been described as “an ideal venue for catching the many varieties of fish found in the area”. Port Kenny has been used by recreational fishers since the 1920s, when people travelled to the area to catch trevally and “trout” (presumably salmon). Other promotional materials for Eyre Peninsula describe Port Kenny as having “a great reputation for its fishing”. **Venus Bay** has been described as “an absolute mecca for the small boat or jetty fisher” (Eyre Peninsula Tourism Association 1995).

There are jetties at **Venus Bay** and **Port Kenny**. There is a boat ramp, and other boat mooring sites (e.g. anchored tyres on the beach) at **Venus Bay**. Recreational fishing boats can be hired at **Port Kenny** and **Venus Bay**.

Recreational diving for lobsters occurs around Venus Bay (Tyrer, PIRSA, 1994).

Diving

No details of recognised diving areas are available for this report, however Venus Bay is described by the Eyre Peninsula Tourism Association (1995) as being used for diving, amongst other popular marine activities.

Other Marine and Coastal Recreation / Tourism

Venus Bay: Apart from recreational fishing (see above), the Venus Bay area is reportedly used for swimming in the safe waters, water skiing, sail boarding, sailing / yachting, canoeing, SCUBA diving, and sand-boarding on the local dunes. Fishing boats and boats for sight-seeing (including what has been described as “South Australia’s first ever saltwater houseboat”) can be hired in Venus Bay.

Activities that are promoted in the **Venus Bay Conservation Park** include photography, birdwatching, beach fishing, walking and swimming (NPWSA, undated c).

Venus Bay, Port Kenny and Talia Caves areas have been described in Eyre Peninsula tourism promotion materials as an “outstandingly beautiful section of the Eyre Peninsula coastline”. Capel’s (1994) book, which discussed the top recreational fishing locations in South Australia, described **Venus Bay** as a place for “a great relaxed holiday, and many families would not go anywhere else for their vacations”. There is a coastal caravan park, cabins and shacks/holiday houses for rent at **Port Kenny**, which is promoted by the Eyre Peninsula Tourism Association as a base for recreational fishing holidays (see above). **Venus Bay** is considered popular for beach walking, exploring coastal sites such as the internal bay, islands, coastal “caves” and “tunnels” (eroded cliff faces), rock pools, arches and other coastal rock formations, and coastal photography, due to the varied coastal scenery. Surfing is promoted outside of the bay (see below) (Eyre Peninsula Tourism Association, 1995, and undated; Venus Bay SA tourism web site, 2002; Frog and Toad Australian Tourism Guide, 2003; Sightseeing South Australia, 2003).

The **South Head Walking Trail** is described as “an historical and pretty excursion”. **Needle Eye Lookout**, near Venus Bay, is promoted for its coastal marine views of high cliffs and various rock formations, and for whale watching during the winter months. The abundant wildlife, and the pods of dolphins in the bay are also listed as attractions for visitors (Sightseeing South Australia, 2003).

The exposed surf beaches outside of the bay are used for surfing (and sometimes swimming), and there are surfing beaches along the **Anxious Bay** coast (e.g. between **Venus Bay** and **Mt Camel** is one of the coastal stretches promoted for surfing) (Eyre Peninsula Tourism Association, 1995; Venus Bay SA tourism web site, 2002; Frog and Toad Australian Tourism Guide, 2003; Sightseeing South Australia, 2003).

The Eyre Peninsula Tourism Association (1995) described the **Anxious Bay coast** as having “magnificent coastal scenery”, aimed at promoting the visual appeal of the area to coastal tourists.

Mount Camel Beach is used for surfing, and is recognised in tourism promotional materials for “the size and quality of the surf”. A number of other surf breaks, within 10km of Venus Bay, are promoted in Eyre Peninsula tourism materials (see above).

Erosion formations can be seen at the **Talia Cave Tourist Drive**, about 20 minutes south of Venus Bay (Sightseeing South Australia, 2003). The **Talia Caves** coast is described as “famous” for its visual appeal, for coastal walks adjacent to the eroding cliffs, which have a conglomerate base and a calcareous top. The Talia “Caves” are large eroded areas in the cliff face, which include “The Woolshed”, formed by the erosion of the cliff by wind and water, and “The Tub”, a collapsed limestone crater. There is ocean access to the area through a tunnel in the rocks. Beyond “The Tub” is a dramatic cliff face which offers views for kilometres to the south along the **Talia Beach**. There is a marble monument to a Sister Millard who lost her life in 1924 when part of the cliff face collapsed (Fairfax Publishing -F2, 2001).

Lake Newland Conservation Park / Newland Barrier Coast: Apart from use as a base for recreational fishing (see section above), the area is used for passive recreation / walking, bird-watching, camping, and swimming and surfing at the beaches near the park. According to DEH (2001a), the park receives relatively few visitors, but is popular with local people. The District Council of Elliston (cited by DEH, 2001a) reported that around 200 visitors per year go camping, bird watching and / or bush walking in 2 or 3 areas along the lake fringe near the springs, in the Newland Head Conservation Park. The beach at **Walkers Rocks** (on the coast, at the southern end of **Lake Newland**) is reported to be popular for swimming, and other family beach activities (DEH, 2001a). According to DEH (2001a), the **Newland**

coastal area is an attractive area that provides an opportunity for travellers along the west coast of Eyre Peninsula to deviate to the coastline for spectacular scenery and high quality recreation on their journey. The scenic and recreational opportunities provided by the coastline in the **Lake Newland** / southern **Anxious Bay** region are actively promoted by the District Council of Elliston, and day visit and camping facilities have been established at **Walkers Rocks** (DEH, 2001a). DEH's (2001a) management plan for the area promoted low-impact camping as a suitable recreational use within the park.

Scientific Research and Monitoring / Marine Education:

Research and monitoring studies have been conducted by SARDI, into the recruitment of western king prawn in **Venus Bay** (e.g. see Carrick 1993, cited by Edyvane 1999). **Venus Bay** and the adjacent coastal waters have been the site of studies into the life cycle and movements of some commercial fish species, such as King George Whiting (see Jones 1980, Jones *et al.* 1992).

Abalone populations along the mid-west coast are monitored by SARDI (e.g. see Shepherd and Rodda 2001; Mayfield *et al.* 2001).

Part of **Anxious Bay** has been the site of an annual marine litter survey, initiated by Professor Nigel Wace in 1991. The survey has been partly funded during the 1990s by Coastcare, and is run annually by SARDI and community volunteers, such as youths from area schools and training centres. The survey of Anxious Bay is the longest-running survey of ocean litter in Australia, and provides information on the quantities, composition and sources of ocean litter such as hard and soft plastics, glass, metal, and other litter (e.g. see Dalgetty and Hone, 1993; Edyvane and Dalgetty, 1997; Higham, 1999; SARDI, 2001a; Edyvane *et al.*, 2003, Stuart and Marsh, 2003).

DEH undertakes beach profile surveys in the **Venus Bay** area and other parts of the west coast, to provide information on the changes in the active beach zones, including dunes, beach, and offshore zones, in terms of sand loss or gain. In recent years dune vegetation along the profiles, and near-shore benthic flora have also been monitored by DEH, to show changes in vegetation cover over time. The Venus Bay profile was resurveyed by DEH in 2002 (Coastal Protection Board, 2002).

A habitat restoration project for the Venus Bay islands was undertaken during the late 1990s by the Friends of Streaky Bay and District Parks, through Coastcare (NHT web site, undated)

Historic/ Protected Shipwrecks

Fire Fly, a cutter wrecked in 1866, near Anxious Bay.

Other European Heritage Values

There was a whaling station at **Venus Bay**, established in the 1820s (Fairfax Publishing - F2, 2001).

Venus Bay and **Port Kenny** have been bases for both commercial fishing (particularly Venus Bay) and recreational fishing since the 1920s, and the commercial fishing industry in Venus Bay earlier last century was considered to be the main factor leading to the revitalisation of the town at that time (Fairfax Publishing – F2, 2001).

During the early 1900s **Port Kenny** and **Venus Bay** were important (although small) ports for handling the grain and wool, which was produced in the hinterland. Grain was still being shipped from Port Kenny and Venus Bay until the late 1950s (Fairfax Publishing - F2, 2001).

Aboriginal Heritage Values

The following extract is from a report by A. Prescott, on management of **Lake Newland Conservation Park** (see DEH, 2001a): "At present there are no Dreaming stories interpreted within Lake Newland Conservation Park and the full extent of Aboriginal heritage is largely unknown to NPWSA. However, the Lake Newland area is recorded by anthropologists as being within the lands traditionally associated with the desert Gaguda (Kokata, Kukatha, Kockata) peoples, who moved north and south between the

Gawler Ranges and the coast (Berndt, 1985, cited in DEH, 2001a) and also with the Nauo / Barngarla people, who occupied the southern part of Eyre Peninsula. Anecdotal information such as the Elliston Centenary Committee book indicates that there was seasonal use of the lakes and coastline for hunting and fishing. A basic archaeological survey for evidence of occupation along the Eyre Coast by A. Nicholson (1991) included some sites in Lake Newland Conservation Park. The survey provided indicative information about the use of the **coastal areas** and **Lake Newland** itself. A traverse of the dunes from the coast to landward just south of Lake Newland Section 201 recorded several open campsites. Nicholson noted less midden material than might have been expected from the landscape, topography and resources. Campsites were also found located near **Three Springs** and other freshwater springs. Although one might expect the springs to act as foci for occupation, few archaeological remains were found in their vicinity by Nicholson. These areas have been subject to disturbance through agricultural activity. It may be expected that a more comprehensive survey would provide better understanding of the extent of the use of the park by Aboriginal people.

Knowledge of the cultural and spiritual associations which Aboriginal people may have with the **Lake Newland** coastal area is not well established in the public domain. Many archaeological deposits have cultural significance for Aboriginal people today and many may have scientific significance. Certain sites have landforms that are more likely to contain evidence of Aboriginal pre-historic occupation than others do. These include, generally: *Claypans, lakes and estuaries* (stone artefact scatters, shell middens, rock art, stone arrangements, campsites or ovens); *Rocky outcrops* (quarries, rock art, rock holes, stone arrangements, ceremonial religious sites, stone artefact scatters); *Dunes* (stone artefact scatters, shell middens, burials, campsites or ovens), and *Bush or forested areas* (stone artefact scatters, campsites or ovens). A site may also be important for historic events that occurred there. Such places may contain no archaeological evidence, but can have great significance to Aboriginal people (DEH, 2001a).

Although no known sites or objects from the Lake Newland area are listed on the Register of Aboriginal Sites and Objects (*Aboriginal Heritage Act 1988*), DEH (2001a) considered there to be “undoubtedly numerous sites of social and cultural significance to Aboriginal people in the region”. “Geomorphological activity such as erosion or sedimentation (soil or sand build up) and the presence of vegetation can cause archaeological material to be obscured. As a result, many (sites and objects) of significance are yet to be discovered and placed on the Register of Aboriginal Sites and Objects. Consequently, the Register cannot be relied upon as a comprehensive guide for management decisions regarding the reserve, and NPWSA should consult with relevant Aboriginal authorities before commencement of any development works” (DEH, 2001a).

Nicholson’s 1991 survey of cultural sites in the **Venus Bay** area (cited by Edyvane, 1999b) identified one midden, an artefact / stone scatter, and seven open coastal campsites in Venus Bay, together constituting an occupation site complex.

In 1997, a land title claim (Wirangu No. 2) for the mid-western coastal area of Eyre Peninsula, extending from the northern part of Streaky Bay south to Elliston, was lodged by descendants of the Wirangu, coastal people inhabiting the claim area since at least since earliest white settlement. The claim area extends inland approximately 30km from the coast in the northern part, and around 70km inland in the southern part (S.A. Coast and Marine Atlas, 2001), and includes a sea claim as part of the total area. Part of the Wirangu No. 2 claim includes the coastal and marine area described in this table. The application for registration reported that members of the claim group use and enjoy the area including camping, travelling, hunting, fishing, protecting sites and wildlife, conducting ceremonies and trading artefacts, as their ancestors did. In 2000, the claim was accepted by NNTT for registration, pursuant to s.190A of the *Native Title Act 1993* (NNTT, 2000).

Wilderness and/or Aesthetic Values

National Parks and Wildlife SA (1999) stated that wilderness is part of the attraction of **Venus Bay**.

Venus Bay has been described as a “quiet peaceful place” having a “unique contrast in scenery”, making the area popular for “nature-lovers” and photographers due to surf beaches, caves, rock pools, natural arches and “spectacular rock formations” (Eyre Peninsula Tourism Association 1995). Venus Bay has also been described as “an area of particular natural beauty” (Edyvane 1995a); a “beautiful”, “tranquil” and “picturesque” area with “gorgeous” views (Sightseeing South Australia, undated); and “a picturesque seaside holiday town” with “tranquil sheltered waters”, and “breathtaking views of towering cliffs and booming surf” (Frog and Toad Australian Tourism Guide, 2003).

Venus Bay, Port Kenny and Talia Caves areas have been described in Eyre Peninsula tourism promotion materials as an “outstandingly beautiful section of the Eyre Peninsula coastline” (e.g. Fairfax Publishing -F2, 2001), and the largely undeveloped nature of the coast has some wilderness significance.

Needle Eye Lookout near Venus Bay has been described as “a breathtaking view of towering cliffs and surf from the Great Australian Bight” and “spectacular views of natural rock formations, rugged cliffs, and breathtaking coastline” (Eyre Peninsula Tourism Association, 1995; Edyvane, 1995a; Venus Bay SA web site, 2002). The **Needle Eye Lookout** is also promoted for viewing Southern Right Whales during the months of June – October, as they migrate to the Great Australian Bight (Venus Bay SA web site, 2002).

Anxious Bay: The Eyre Peninsula Tourism Association (1995) described the Anxious Bay coast as having “magnificent coastal scenery”.

Talia Caves and the associated beach area are described as having “great aesthetic appeal because of their natural, pristine state” and being “a spectacular unspoilt wilderness” (Edyvane, 1995a and 1999b).

According to DEH (2001a), the attractions of **Lake Newland Conservation Park** include its remoteness, its size and the diversity and integrity of its landforms. Lake Newland is considered to be one of a number of attractive coastal areas along the length of the west coast of Eyre Peninsula, being a combination of limestone cliffs and rocky headlands, intermixed with sand dunes and sandy beaches. The coastline is relatively remote and provides visitors with an opportunity to experience the special, and increasingly rare, qualities of a coastal wilderness (DEH, 2001a).

Urban / Holiday Shack Settlement

Venus Bay: Small town with an emphasis on tourism, and a variable population according to season. There are often around 100 people in the town at any one time, including 20 to 30 permanent residents, however the population increases up to 1000 during the summer tourist season (Elliston Council, pers. comm. to DEH, 2003).

Port Kenny: Population around 50 residents. There is both permanent and holiday housing at Venus Bay and Port Kenny.

Talia: A small settlement south of **Venus Bay**. Talia had a larger population earlier last century (e.g. until the 1940s), but is now a scenic reserve and tourist area, with no permanent residents (Elliston Council, pers. comm. to DEH, 2003).

There are also cabins and holiday housing in the area, in addition to the settlements listed above.

9.1.4 Investigator Group of Islands (Eyre Bioregion)

Aquaculture

An aquaculture lease for Blue Mussel farming has been approved in waters approximately 0.6 nautical miles north of **Waldegrave Island** (S.A. Coast and Marine Atlas, 2003).

Commercial Fishing

Scalefish, Sharks and Minor Invertebrates

Sharks: The mid west coast waters are one of the major fishing areas for Gummy Shark and School Shark in South Australia. The fishery has recently been re-regulated by the Commonwealth (see AFMA, 1999b; AFMA, 2003a), and the proportion of annual shark yields in S.A. that come from the Investigator Group islands is not known for this report. Bronze Whalers and other shark species are also caught in the region.

Scalefish: In some years purse seine yields of Australian Salmon from the mid west coast waters are high when compared with other fishing blocks, on a State-wide scale. Other than salmon, the mid west coast waters are not a major scalefish fishing area, when compared with many other areas in the State. Some of the main species caught commercially in the mid west coast region (i.e. waters south of Searcy Bay, to south and west of the Elliston area, and including the Investigator Isles) are as follows: *Australian Salmon*, *Ocean Leatherjacket*, *King George Whiting*, *Blue Morwong*, various species of *wrasse* and *sweep*, *Snapper*, *Redfish* (“*nannigai*”), *Rock Ling*, *Conger Eel* and *Velvet Crab*.

According to SARDI (cited by Edyvane, 1999b), the Marine Scalefish and Shark catch from Fishing Block 15 (which includes the Investigator Groups islands, but also includes Anxious Bay and all waters between 33°S to 34°S, and between 134°E and 135°E) between 1995 and 1997 was as follows: In 1995/96 a total of 133,221kg (1.28% of State total, representing 21 fishers); in 1996/97 a total of 283,665 kg (2.79% of State total, representing 34 fishers). Marine Scalefish, Restricted Marine Scalefish, and Northern Zone Rock Lobster licence holders contribute to these yields. The proportion of the above yields that relates specifically to the Investigator Islands is not known for this report.

On a State-wide scale, aggregated catch figures for all GARFIS Fishing Blocks in South Australia, between 1995 and 1997, showed that Fishing Block 15 was ranked 20th in 1995/96 and 10th in 1996/97, in the list of total scale fish and shark fishing yields from 58 South Australian fishing blocks.

Abalone Fishing

Little recent information on the abalone catch from the area is available, however the following aggregated figures are provided for the area (S. Shepherd, pers. comm., 2000):

Ward Islands: Between 1990 and 1996, recorded annual yield of Greenlip Abalone ranged between approximately 4t and approximately 14.5t. Yield of blacklip fluctuated between approximately 3t and approximately 22.5t whole weight.

Pearson Islands: Between 1990 and 1996, recorded annual yield of Greenlip Abalone ranged between approximately 250kg and approximately 1.1t. Yield of blacklip fluctuated between less than 100kg and approximately 250kg whole weight.

Edyvane (1999b) reported that the total catch within the Investigator Islands region comprising abalone Map Codes 9A-H, 8P, 10C, including **Flinders Island**, the **Hotspot**, **Ward Islands** and **Pearson Islands**, was, in 1994/95: 52,236kg greenlip (23% of western zone catch, or 13.87% of State catch) and 30,681kg blacklip (9.9% of western Zone catch, or 6.21% of State catch, at that time); In 1995/96: 62,819kg greenlip (27.8% of western zone catch, or 16.78% of State catch) and 40,947 kg blacklip (14.7% of western Zone catch, or 8.84% of State catch, at that time).

Mayfield *et al.* (2001) reported that: (i) the northern section of the Investigator Group (i.e. fishing blocks north, south, east and west of Flinders Island) is one of the 2 regions along the West Coast in which fishing effort for abalone has increased significantly during the past 10 years; (ii) the Investigator Group islands (i.e. fishing blocks around Flinders Island, and the Pearson Islands) is one of 3 regions in the West Coast zone in which catch per unit effort has been high (i.e. more than 80kg / hour) during the period 1996 – 2000; (iii) The sub-blocks of Fishing Block 9 (i.e. the islands of the **Investigator Group**), and Fishing Block 8 (the **Elliston / Cape Finniss** area, including **Waldegrave Islands**, **Topgallant Island** and “**The Watchers**”) collectively comprise two of 5 major fishing blocks in the Western Zone in which fishing effort has been highest between 1996 and 2000, and the bulk of the Western Zone abalone catch is taken from the 5 blocks.

Prawn Fishing

One of the three main trawling grounds along the west coast (Macdonald, 1998), the “Venus Bay grounds” – see Carrick and Williams, 2001, Figure 1) occurs in the deeper waters out of Anxious Bay, and extends south-west, with a boundary around 2 nautical miles north-north-east of the northern tip of Flinders Island (i.e. Point Malcolm), part of the Investigator Group. Most of the Investigator Group islands (i.e. Ward Island, on the western side of Flinders Island, as well as the Pearson Islands, Veteran Islands and Dorothee Island) are not near the mid-west coast fishing ground (see Macdonald, 1998; Carrick and Williams, 2001, and map in Knight *et al.*, 2002).

Approximately 72.1t of prawns were taken from the “Venus Bay grounds” in 1999/2000, which is around 68% of the total West Coast fishery catch of 106.1tonnes (see Carrick and Williams, 2001). Effort level to produce that catch is not available for the Venus Bay grounds, however the total west coast fishing effort in 1999/2000 was approximately 2,244 hours trawled, over 92 nights (Carrick and

Williams, 2001). According to Carrick and Williams (2001), a survey conducted in July 2000 over the Venus Bay grounds, in collaboration with industry, indicated that recruitment increased by about 116% from the low level in 1999. The increase in survey catch rate is attributable to increased recruitment of small prawns in 2000. The trawl survey of the Venus Bay grounds clearly showed that the size of prawns increased from inshore to offshore while catch rate declined with distance from shore.

In 2000 / 2001, the mid-west coast prawn fishing area recorded the highest catches of the 3 prawn fishing grounds on the West Coast (see Boxshall, 2001). The catch from the area was in the vicinity of 42 tonnes (see Boxshall, 2001), from an effort level of around 1000 hours. The catch and effort from the entire West Coast Prawn fishery in 2000 / 2001 were the lowest since 1993/94.

Rock Lobster Fishing

Figures specific to the Investigator Islands area are not available for this report. The Investigator Group forms part of the mid-west coast Fishing Block 15 (which includes the Investigator Groups islands, but also includes Anxious Bay and all waters between 33°S to 34°S, and between 134°E and 135°E). Fishing Block 15 is one of the three fishing blocks in the Northern Zone in which Rock Lobster catch has consistently been higher than that from other Northern Zone blocks, in almost all years since 1970 (see Ward *et al.*, 2002, Figure 2.5); i.e. the largest portion of the total catch is taken from three blocks, of which Fishing Block 15 is one.

Catches have been higher than around 100t in Fishing Block 15, in most years since 1986, up till the late 1990s, and corresponding effort has been higher than 60,000 potlifts per annum in all of those years (and over 100,000 pot lifts per annum in several years during the 1990s). Catch peaked at over 150t per annum in 1990, 1991, 1995 and 1996. During the late 1990's to 2001, both catch and effort decreased compared with the all other years during the 1990s - approximate catch in 2001 was around 75 tonnes in Fishing Block 15, from an effort level of nearly 70,000 potlifts.

An indication of the significance of the catch from Fishing Block 15, relative to other fishing blocks in South Australia, was provided by Edyvane (1999b, citing SARDI data): In 1995/96, the total of 168,235kg from Block 15 comprised 3.23% of State total, representing the catch of 41 fishers; and in 1996/97, a total of 161,534kg for Block 15 comprised 3.16% of State total, representing the catch of 34 fishers. Aggregated catch figures for all fishing blocks in South Australia, between 1995 and 1996, showed that Fishing Block 15 (mid west coast waters, which includes the Investigator Groups islands, and also includes Anxious Bay and all waters between 33°S to 34°S, and between 134°E and 135°E) was the 4th most important commercial lobster fishing area in South Australia during that period, in terms of yield (and hence value).

When the entire Northern Zone is considered as a whole (i.e. from the Western Australian border, through to Encounter Bay and deeper waters south of Kangaroo Island), the catch for the 2002 season was 594.8 tonnes, being the lowest catch in the Northern Zone since 1979 (Ward *et al.*, 2003).

Bycatch information specific to the Investigator Group is not available for this report. However, McGarvey *et al.* (1998) and Prescott (2001) reported that the largest proportion of bycatch in the Northern Zone as a whole, is leatherjackets and octopus. According to results of a sampling program of bycatch in 1991 and 1992, various wrasse species (Labridae family) together constituted another major component of the bycatch in the Northern Zone e.g. 1127 Labrids caught in pots during the bycatch sampling program in 1991-92 (Table 5 in Prescott 2001). Octopus are a major predator of Rock Lobster, with losses due to octopus predation equating to approximately 4% of the total number of lobsters landed (in the Northern Zone). According to McGarvey *et al.* (1998), the catches and catch rates of octopus have been sustained over time, and vary from 1 – 2.5 octopuses per 100 potlifts. Octopus that are caught in the northern zone are sold.

Rock Lobster fishers are also permitted to retain legal sized Giant Crab when caught as by-product, and this species is becoming increasingly valuable, commercially (McGarvey *et al.*, 1998). A small number of Commonwealth-endorsed Rock Lobster fishers also target Giant Crab specifically. Between 1992/93 and 2001/02, total Giant Crab catches (target and byproduct catches combined) have ranged between 7t in 1992/93, and 33t in 1998/99, with a steady decline between 1999 and 2002 due to the introduction of quotas (e.g. 31t in 1999/00; 24t in 2000/01, and 18.5t in 2001/02) (Knight *et al.*, 2003, cited by Sloan, 2003b). The fishery now operates under a quota-based management system with a total allowable commercial catch (TACC) of 13.4 and 8.7 tonnes for the Northern Zone and Southern Zone, respectively (Sloan, 2003b). Giant Crabs are caught from the edge of the continental shelf in the

west coast region (McGarvey *et al.*, 1998).

Some Rock Lobster fishers net sharks out of season, and some of these activities require a Commonwealth permit. Licensed Rock Lobster fishers have also had access to fish species, such as Australian Salmon, Mulloway, and Snapper (Zacharin, 1997, cited by McGarvey *et al.*, 1998).

Predators of Rock Lobster in the Northern zone include New Zealand Fur Seals, Western Blue Groper (minor) and Maori Octopus (McGarvey *et al.* 1998; S. Shepherd, pers. comm., 2004).

Recreational Fishing

Charter boats visit the Investigator group for recreational fishing of scalefish, sharks and Rock Lobster (Edyvane, 1999b). Little information is available about recreational fishing in the Investigator Group. At Flinders Island, which is part of the Investigator Group, the Eyre Peninsula Tourism Association (1995) reported that a variety of species that are taken by recreational fishers in the area include: King George Whiting, Snapper, Tommy Ruff, Australian Salmon, mullet species, flathead species, Southern Calamari, sweep species, Silver Drummer, Garfish, Snook, shark species, Yellow-tail Kingfish, tuna and trevally species. Many of these species may also be caught around other islands in the Investigator Group, but specific information is not available for this report.

Diving

Diving at some of the islands in the Investigator Group has been described by the Diving Industry Association of S.A. as “unparalleled temperate water diving”. Dive charter boats and a charter ship visit the area. Private boats also visit the area, although this is a limited practice, since the islands are relatively inaccessible compared with dive spots closer to the mainland.

Flinders Island, **Pearson Island** (e.g. “**The Dice**”, on the south-east side of the island), and **Topgallant Island** (e.g. “**Bonny and Clyde**” dive site) have been recommended dive sites in a recent on-line dive directory to S.A. dive sites (Aquanaut, undated), and many caves, tunnels and “swim-throughs” around **Topgallant** have been described as “some of the best diving in Australia” (Aquanaut, undated) .

Dive charters occasionally visit **Pearson Island**.

Other Coastal / Marine Recreation

Little information is available for this area, for this report. Charter boats and private boats visit the **Investigator Group** islands, mainly for fishing scalefish and sharks, diving (see sections above), and recreational harvesting of Rock Lobster, but other marine tourism activities in the area include “shark spotting” and viewing the scenery (Edyvane and Baker, 1999c). Camping occurs irregularly on the few sheltered beach sites. Sea kayak trips to the Investigator Island group have been undertaken by sea canoe clubs in recent years.

Flinders Island, which is predominantly an area for sheep-grazing, is also used as a holiday retreat (Robinson *et al.*, 1996).

Historic / Protected Shipwrecks

A Commonwealth-protected shipwreck site is known from **Flinders Island** (*Vulcan*, a wooden schooner lost in 1845, and protected under Commonwealth legislation, but not found). More recently, in 1942, the steel steamship *Kapara* (which is not historic, or protected) ran on to a reef on the south-east of Flinders Island, and remains of two of the ships boilers are still visible (Robinson *et al.*, 1996). There are no other recorded shipwrecks on the other islands in the Investigator Group, according to available sources for this area, for this report.

Other European Heritage

There is some evidence of whaling and sealing having occurred at **Flinders Island**, during the early – mid 1800s. Early maps show a whaling station off a small cove on the south-east coast during the 1850s, and remains of a whaling station have been found, including a dry stone granite wall (see Robinson et al., 1996 and Staniforth and Richards, 2000).

From the 1840s onward, Flinders Island was developed as a pastoral area (Robinson et al., 1996).

There are remains of a guano mining enterprise (undertaken in the late 1800s and early 1900s) in a cave on the north-east coast (Robinson et al., 1996).

There was a seal skin harvesting operation at **Flinders Island** during the 1820s, undertaken by an Irish sealer (Robinson et al., 1996).

Aboriginal Heritage

No information known for this report (see Robinson et al., 1996).

Scientific Research

The marine environments of the Investigator Group, and particularly around Pearson Island, have been the subject of biological surveys and ecological studies of marine plants, invertebrates and fish (e.g. Twidale, 1971; Shepherd and Womersley, 1971; Burn, 1973; Seed, 1973; Watson, 1973; Kuitert, 1983a; Branden et al., 1986; Edyvane and Baker, 1996a and 1999c; amongst others). The islands have attracted the interest of researchers due to their unusual geological and oceanographic conditions, high species diversity of a number of the major marine groups, and presence of rare, uncommon, endemic species, and species with tropical affinities. The undisturbed nature of the islands also makes them suitable for study of ecological processes.

Researchers from CSIRO and National Parks and Wildlife in S.A. monitor Sea Lion and Fur Seal populations in the area (e.g. Gales et al., 1994; Shaughnessy et al., 1994; Shaughnessy, 2002).

Fisheries stock assessment work is undertaken in the mid west coast region, mainly for Abalone (see Mayfield et al., 2001), Southern Rock Lobster (e.g. see Ward et al., 2002) and Western King Prawn populations, but the extent of these activities in the Investigator Group is not known for this report.

Biological studies (e.g. growth, reproduction) of abalone are undertaken in the Investigator Island groups (see Mayfield et al., 2001).

Aesthetic / Wilderness Values

Topgallant Island, Ward Island and Pearson Islands: According to the Australian Heritage Commission's *Register of the National Estate* listing (undated), the islands of the Investigator Group are "some of the most scenically spectacular of all South Australia's offshore islands".

The **Investigator Group Islands** are promoted, in tourism materials for the Eyre Peninsula, for their "unspoilt nature, tranquillity and beauty".

Mining

During the early 2000s, a diamond mining operation was being developed on **Flinders Island**. This is discussed in the section below, on ***Issues for Risk and Impact Assessment***

9.1.5 Thorny Passage (Eyre Bioregion)

Aquaculture

Previously, potential for aquaculture development North of Little Island / Lewis Island area had been expressed. Assessment of site suitability for offshore aquaculture (Petrusevics *et al.*, 1998) suggested that the coastal waters (excluding a 1km buffer around Lincoln National Park) would be suitable for offshore aquaculture development. Proposed areas included Taylor and Grindal Island, and the northern end of Thistle Island. Aquaculture Group, PISA – Fisheries (1997) also suggested that Taylor and Grindal Island would be suitable for trials of tuna farming and other aquaculture development in exposed sites, to a maximum of 40 hectares around Taylor Island, and six hectares around Grindal Island. Applications for aquaculture development (finfish, and Rock Lobster) in the Thorny Passage area were received during the 1990s, but none have been approved to date.

During the early to mid 2000s, there were no aquaculture leases in Thorny Passage (S.A. Coast and Marine Atlas, 2003; PIRSA Aquaculture Public Register, 2004), and no provision for any in future. The nearest aquaculture zone is the Boston Bay Aquaculture Zone (PIRSA Aquaculture, 2003), north of the northern boundary of the Lincoln National Park. There is a 1km “buffer” around Lincoln National Park, including the northern coast facing Proper Bay and Spalding Cove, in which no aquaculture development is permitted.

Commercial Fishing

Scalefish, Sharks and Minor Invertebrates

Lincoln National Park – Thorny Passage: The region is a major fishing area for Pilchards (more than 1000 tonnes per annum, in recent years). The current quota for the Pilchard fishers, mostly operating out of Port Lincoln on the Eyre Peninsula is around 15 percent of the calculated biomass. Thistle Island is a major fishing area for Pilchards. Figures specific to the entire Thorny Passage area not available for this report.

Other major fisheries in **south-western Spencer Gulf**, in terms of yield are:

- ♦ *Australian Salmon* (a purse seine fishery for 2 - 6 year old Salmon operates in deeper Spencer Gulf waters east of the bays);
- ♦ *Sharks* (*Gummy Shark* is a major fishery in the area in terms of yield, but *School Sharks* and *Bronze Whalers* are also caught commercially);
- ♦ *King George Whiting*, *Calamari*, *Tommy Ruff*, *Garfish* and *Snapper*, are considered to be the main fin-fish species taken in South-West Spencer Gulf (Aquaculture Group, PISA – Fisheries, 1997).

- ♦ No recent information specific to **Thorny Passage** is available, however the following information is provided for “southern Spencer Gulf” as a whole, which includes both the eastern and western sides (see Fowler, 2002, for fishing blocks that collectively refer to this region): the total catch of King George Whiting from the entire Southern Spencer Gulf area was 150.3 tonnes in 1998 (McGarvey *et al.*, 2000), 117.8t in 2000, and 115.7t in 2001 (McGarvey *et al.*, 2003). About 80% of the catch is taken by hand lines, 10% - 15% by hauling nets, and 25 – 3% by gill nets. McGarvey *et al.* (2000) reported that (i) the long term average catch for hand lines in Southern Spencer Gulf is around 120t per annum, though the catch has regularly fluctuated above and below this average during the past 20 years; (ii) although the hand line catch has been highly variable over the past two decades in Southern Spencer Gulf, there appears to be no long term trend evident, despite a consistent and substantial reduction in effort using hand lines (which, since the early 1990s, has been annually decreasing). Although catches have been highly variable over time, there are periodic peaks at approximately 5 year intervals. Handline catches in southern Spencer Gulf have decreased substantially in recent years, from 131t in 1997, to 83t in 2002. Also in 2002, the hauling net catch (7.7t) was less than half of that recorded in 1999, and over the same period, the gill net catch fell from 17t to 2.6t (McGarvey *et al.*, 2003). In the period 2000 - 2002, the haul net catch was the lowest ever recorded for Southern Spencer Gulf. Combined effort corresponds roughly to the peaks and troughs shown in catch, however there has been a consistent trend in declining effort since 1992. There has been a long term decline in targeted effort from the hauling net sector, which reportedly accounts for the reduction in catch from this sector during the past decade. Hand line effort was about 4,998 fisher-days in 2002 (a decrease from the peak of 8,713 fisher-days in 1992), and gill net effort was about 136 fisher-days in 2002 (a decrease from a peak of 957

fisher-days in 1999) (McGarvey et al., 2003).

- ◆ McGlennon and Kinloch (1997c, Figure 7) reported that, according to results from a recreational boat fishing survey during the mid 1990s, commercial line fishing made up the largest portion (i.e. more than half) of the combined commercial and recreational catch of King George Whiting catch in the south-western Spencer Gulf / south-eastern Eyre Peninsula area during that time;
- ◆ For the entire “Southern Spencer Gulf” region, Fowler (2002) reported that the targetted fishery for Snapper, using hand lines, has increased annually since 1994/1995. The Snapper catch from southern Spencer Gulf was the highest ever recorded for the region in 1999/2000 and again in 2000/2001 and 2001/2002 (Fowler, 2002; Fowler et al., 2003), due to a strong 1991 year class making its way through the fishery (Fowler, 2000). The commercial Snapper catch from Southern Spencer Gulf in 2000/2001 was around 220t, the majority of which was caught by hand lines (Fowler, 2002). In 2002/2003, the catch rose to 264t, representing about 41% of the entire State catch (Fowler et al., 2003). The sequence of annual catches of Snapper by hand lining in Southern Spencer Gulf since 1994/95 is as follows: 14.8t, 29.9t, 32.6t, 57.9t, 84.5t, 130.5t, 179.9t and 222t. Corresponding targetted hand line effort during those years has ranged from 355 boat days in 1994/95, to 821 boat days in 2001/2002. The long line catch is, on average, an order of magnitude lower than the hand line catch in the Southern Spencer Gulf region (e.g. 17.8t in 2000/2001, and 23.9t in 2001/2002). During the period 1999 to 2002, the annual targetted catch from long lining has been the highest ever recorded. Catch rates for both hand lining and long lining during the past few years (i.e. since the late 1990s) have been the highest ever recorded for the Southern Spencer Gulf region. In previous years (e.g. early 1980s), targetted effort was higher for an equivalent yield compared with the present, and catch rates were thus lower during the 1980s than currently (see Fowler, 2002, Table 3.4, and Fowler et al., 2003, Figure 3.5);
- ◆ McGlennon and Kinloch (1997c, Figure 22) reported that, during the mid 1990s, commercial net fishing for Tommy Ruff (i.e. Australian Herring) made up the largest portion (more than three quarters) of the combined commercial and recreational yield of this species in the south-western Spencer Gulf / south-eastern Eyre Peninsula area.

Due to netting restrictions introduced in 1995, the haul net catch of Southern Calamari was low (less than 2 tonnes per annum) in South-Western Spencer Gulf during the late 1990s, however the jig catch has ranged between approximately 16t and 35t per annum between 1990 and 1999 (see Figure 4b in Triantafillos and Fowler 2000), an increase in annual catch from this region compared with the 1980s. McGlennon and Kinloch (1997c, Figure 15) reported that, according to results from a recreational boat fishing survey during the mid 1990s, commercial jig fishing for calamari made up the largest portion (more than three quarters) of the combined commercial and recreational yield of this species in the south-western Spencer Gulf / south-eastern Eyre Peninsula area.

For Australian Salmon, no data specific to the Thorny Passage are available for this report, however recent stock assessment reports (Jones, 1999; Westlake *et al.*, 2002) showed that the total commercial catch of Australian Salmon from Southern Spencer Gulf was 100.6t in 1998/99 and 133.5t in 2000/2001, with the majority of the catch being taken by hauling nets. Of the 6 aggregated regions in S.A. in which Australian Salmon is taken, Southern Spencer Gulf catches are the second highest, and constitute one of the two main fishing regions for this species in the state. The proportion of the “Southern Spencer Gulf” salmon yield that is taken specifically from the Thorny Passage area is not known for this report, however the region described as “Southern Spencer Gulf” comprises several fishing blocks, and encompasses both sides of the mid and lower gulf.

Mixed wrasse species, Tommy Ruff; Snook and southern Blue Morwong are also caught commercially in the area. Around 17 other fish species are caught commercially but in minor quantities (SARDI, unpublished data).

Net fishers catch a variety of scalefish species. Net fishing contributes a significant portion of the total scalefish catch in south-west Spencer Gulf (NRC, 1994, cited by Aquaculture Group, PISA – Fisheries, 1997).

According to Aquaculture Group, PISA - Fisheries (1997), **Thorny Passage** is one of the 5 notable fishing areas around the lower Eyre Peninsula for commercial line fishing. Net fishing activity in lower Eyre is concentrated near **Thistle** and **Taylor Island** (Aquaculture Group, PISA – Fisheries, 1997).

No recent aggregated catch data specific to the Thorny Passage area are available for this report. However, the area forms part of GARFIS Block 30, which encompasses south-western Spencer Gulf, between 34° 30' and 35° S latitude, including Thorny Passage as far south as West Point at the bottom on the

Jussieu Peninsula, but also includes a large part of south-western Spencer Gulf, as far north as 34° 30', and as far east as approx. 136° 30' - 137° in parts. Previously, according to SARDI data (cited by Edyvane, 1999b), the Marine Scalefish and Shark catch from GARFIS block 30, was as follows: In 1995/96 a total of 931,386kg (8.96% of State total, representing 72 fishers); In 1996/97 a total of 1,716,478kg (16.93% of State total, representing 69 fishers). Marine Scalefish, Restricted Marine Scalefish, and Northern Zone Rock Lobster licence holders contributed to these yields. More recently, DEH (2003a, citing SARDI Aquatic Sciences data) reported that the average annual catch in Marine Fishing Area 30 (previously called GARFIS Block 30), over the period 1989 to 1999, was 132.5t. This figure includes fish, sharks, and invertebrates, but excludes the Pilchard catch from 1989/90, and excludes the single species fisheries such as prawns, abalone and rock lobster. The proportion of the above yields that relates specifically to the Thorny Passage area is not known for this report. On a State-wide scale, aggregated catch figures for all GARFIS Fishing Blocks in South Australia, between 1995 and 1997, showed that the south-western Spencer Gulf area (Fishing Block 30) was ranked 2nd in 1995/96, and 1st in 1996/97, in terms of quantity yielded, from 58 South Australian fishing blocks. The dominance of this fishing block in terms of scalefish yields is principally due to the high tonnages of pilchards compared with other scalefish species.

Prawn Fishing

The closest major trawling ground to the Thorny Passage region encompasses the eastern (i.e. gulf) and northern side of Thistle Island. The Thistle Island area has been depicted as one of the three key fishing areas in Spencer Gulf, where large prawns are caught between March and May (see MacDonald, 1998). DEH (2003, Figure 14) showed that the fishing block (98) which is bounded in the west by the gulf side of Thistle Island, has been fished in 9 of the past 11 years to 1999/2000, and that the catch range is more than 10t but less than 30t per annum from that fishing block. Prawn fishing does not occur between Thistle Island and the Eyre Peninsula mainland, nor around the islands of Thorny Passage.

Rock Lobster Fishing (and Bycatch Species)

According to Aquaculture Group, PISA - Fisheries (1997), Thorny Passage and Thistle Island are of the eight areas on the lower Eyre Peninsula where Rock Lobster fishing effort is concentrated.

Figures specific to the entire Thorny Passage area are not available for this report, but the area is known to be less significant than the southern foot of Eyre Peninsula in terms of yield. According to SARDI (cited by Edyvane, 1999b), the Rock Lobster catch from GARFIS Block 30 (south-western Spencer Gulf, between 34° 30' and 35° S latitude, which includes Thorny Passage as far south as West Point at the bottom on the Jussieu Peninsula, but also includes a large part of south-western Spencer Gulf, as far north as 34° 30', and as far east as approx. 136° 30' - 137° in parts) is as follows: in 1995/96 a total of 7671kg (0.15% of State total, representing 11 fishers); in 1996/97 a total of 3673 kg (0.07% of State total, representing 12 fishers).

When the entire Northern Zone is considered as a whole (i.e. from the Western Australian border, through to Encounter Bay and deeper waters south of Kangaroo Island), the catch for the 2002 season was 594.8 tonnes, being the lowest catch in the Northern Zone since 1979 (Ward *et al.*, 2003).

Bycatch information specific to the Thorny Passage area is not available for this report. However, McGarvey *et al.* (1998) and Prescott (2001) reported that the largest proportion of bycatch in the Northern Zone as a whole, is leatherjackets and octopus. According to the results of a sampling program of bycatch in 1991 and 1992, various wrasse species (Labridae family) together constituted another major component of the bycatch in the Northern Zone e.g. 1127 Labrids caught in pots during the bycatch sampling program in 1991-92 (Table 5 in Prescott 2001). Octopus are a major predator of Rock Lobster, with losses due to octopus predation equating to approximately 4% of the total number of lobsters landed (in the Northern Zone). According to McGarvey *et al.* (1998), the catches and catch rates of octopus have been sustained over time, and vary from 1 – 2.5 octopuses per 100 potlifts. Octopus that are caught in the northern zone are sold.

Rock Lobster fishers are also permitted to retain legal sized Giant Crab when caught as by-product, and this species is becoming increasingly valuable, commercially (McGarvey *et al.*, 1998). A small number of Commonwealth-endorsed Rock Lobster fishers also target Giant Crab specifically. Between 1992/93 and 2001/02, total Giant Crab catches (target and byproduct catches combined) have ranged between 7t in 1992/93, and 33t in 1998/99, with a steady decline between 1999 and 2002 due to the

introduction of quotas (e.g. 31t in 1999/00; 24t in 2000/01, and 18.5t in 2001/02) (Knight *et al.*, 2003, cited by Sloan, 2003b). The fishery now operates under a quota-based management system with a total allowable commercial catch (TACC) of 13.4 and 8.7 tonnes for the Northern Zone and Southern Zone, respectively (Sloan, 2003b). Giant Crabs are caught from the edge of the continental shelf in the west coast region (McGarvey *et al.*, 1998).

Some Rock Lobster fishers net sharks out of season, and some of these activities require a Commonwealth permit. Licensed Rock Lobster fishers have also had access to fish species, such as Australian Salmon, Mulloway, and Snapper (Zacharin, 1997, cited by McGarvey *et al.* 1998).

Abalone Fishing

Thorny Passage and its associated islands are major fishing areas in the state for Greenlip Abalone. **Thorny Passage**, Thistle Island and Dangerous Reef represented 15.8% - 19.6% of the State greenlip catch in 1994 – 1996. The yield of Blacklip Abalone represented 3% - 3.5% of the State catch in 1994 - 1996 (Edyvane, 1999b) .

Aggregated approximate figures for yield (S. Shepherd, pers. comm., 2000) for the area, in whole weight are:

- ♦ **West Point:** Annual yield of Greenlip Abalone fluctuated between around 2.8t and 7.1t from 1990 and 1996. Yield of blacklip fluctuated between 1.5t and 6.2t;
- ♦ **Southern Thorny Passage:** Annual yield of Greenlip Abalone fluctuated between approximately 26t and 35t from 1990 and 1996. Yield of blacklip fluctuated between around 6.2t and 5t whole weight;
- ♦ **The Gap (Hopkins Island):** Between 1990 and 1996, recorded annual yield of Greenlip Abalone fluctuated between approximately 18t and 26t. Yield of blacklip fluctuated between approximately 5.5t and 12.5t;
- ♦ **Thistle Island:** Between 1990 and 1996, recorded annual yield of Greenlip Abalone fluctuated between approximately 6.2t and 16t. Yield of blacklip fluctuated between around 2.4t and 9t;
- ♦ **Northern Thorny Passage:** Between 1990 and 1996, recorded annual yield of Greenlip Abalone fluctuated between approximately 3t and 10t. Yield of blacklip fluctuated between 0kg and around 3.7t whole weight.

According to Aquaculture Group, PISA - Fisheries (1997), Thorny Passage and Thistle Island are particularly important areas in the lower Eyre Peninsula region for the abalone fishery. Blacklip abalone is taken in waters up to 25m deep, and Greenlip Abalone from waters between 5m and 40m deep.

Edyvane (1999b) reported that the total catch within the region of **Thorny Passage, Thistle Island** and Dangerous Reef (comprising abalone Map Codes 18 C, H, J, L, and 19 A – E) were as follows: 1994/95: 74,976kg Greenlip Abalone (representing 32.6% of western zone catch, or 19.66% of State catch) and 15, 120kg blacklip (representing 4.9% of western Zone catch, or 3% of State catch); 1995/96: 59,262kg Greenlip Abalone (representing 26.3% of western zone catch, or 15.8% of State catch) and 16, 336kg Blacklip Abalone (representing 5.9% of western Zone catch, or 3.53% of State catch).

According to Mayfield *et al.* (2001):

- ♦ the south-eastern tip of Eyre Peninsula and lower Thorny Passage (including the lower Thorny Passage islands) is one of the fishing areas in the Western Zone in which abalone fishing effort has exceeded an average of 75 trips per year, between 1980-1984, 1988-1992, and 1996-2000; and
- ♦ the sub-blocks of Fishing Block 18 (i.e. the south-eastern tip of Eyre Peninsula as far west as Jussieu Bay; Williams Island; Thorny Passage Islands – Hopkins, Lewis, Little, Grindal, Smith and Thistle Island) collectively comprise one of 5 fishing blocks in the Western Zone in which fishing effort has been highest between 1996 and 2000, and the bulk of the Western Zone catch is taken from these 5 blocks.

Recreational Fishing

Recreational fishing activities specific to most of the **Thorny Passage** area are not available for this assessment. According to recreational fishing and regional tourism promotion materials, surf fishing for Australian Salmon occurs from the beaches on the Lincoln National Park coastline. Whiting (in large numbers, in some cases, and including large fish greater than 35-40cm) are caught from Taylor Island and

other locations (e.g. Black Rock) by line fishers. Other fish known to be caught in the Taylor Island area include flathead and leatherjackets.

In a regional summary: between Port Lincoln and **Sleaford Bay** (which includes **Thorny Passage**), boat, jetty and shore fishing occur, with major species targeted including King George Whiting, Sand Flathead, yellow-eye mullet, Australian Salmon, Snapper, Snook, Garfish, Tommy Ruff and Southern Calamari (SARDI recreational fishing survey data, cited by Edyvane 1999b).

McGlennon and Kinloch (1997c, Figure 7) reported that, according to the results of a recreational boat fishing survey during the mid 1990s, recreational catch of King George Whiting accounted for around one quarter of the entire combined commercial and recreational yield of this species in the south-western Spencer Gulf / south-eastern Eyre Peninsula area, and recreational fishing for Southern Calamari accounted for less than one quarter of the entire Southern Calamari yield from that area.

The Eyre Peninsula Tourist Association (1995) listed the following areas and main species targeted and caught:

- ♦ **Taylor Island:** King George Whiting, Tommy Ruff, Southern Calamari, sweep, Garfish, Snook, shark species;
- ♦ **Grindal Island:** King George Whiting, Snapper, Tommy Ruff, Southern Calamari, sweep, Silver Drummer, Garfish, Snook, shark species. There is a jetty at Grindal Island;
- ♦ **Hopkins Island:** King George Whiting, Tommy Ruff, Southern Calamari, sweep, Garfish, Snook, shark species;
- ♦ **Thistle Island:** King George Whiting, Snapper, Tommy Ruff, Australian Salmon, flounder, Southern Calamari, sweep, Silver Drummer, Garfish, Snook, shark species and Yellow-tail Kingfish;
- ♦ **Memory Cove:** King George Whiting, Tommy Ruff, Southern Calamari, Sea Garfish, shark species;
- ♦ **Sleaford Bay:** Australian Salmon, mullet, flathead, sweep, shark species;
- ♦ **Whalers Way:** sweep, shark species.

The bay on the Eastern side of **West Point** is a popular fishing spot overlooking **Williams Island** (DEH, 2000b).

Charter boat fishing for whiting, Snapper and other species, also occurs in the area (according to regional tourism promotion materials), and has become increasingly popular during the past decade.

Recreational divers take Rock Lobster and abalone. "Some" recreational lobster fishing (using pots) occurs around the Port Lincoln coastline (Tyrer, 1994).

Diving

Dive South Australia (web site, 2004) described the area as follows: "the temperate, crystal blue waters of **Lincoln National Park's** coastline are a favourite dive location for many locals". A number of recognised dive sites exist in the area, including: **Taylor Island, Thistle Island, Hopkins Island;** the **Lincoln National Park** coast (**Memory Cove** to **Cape Catastrophe** is one example), **Whalers Way** (bottom of Lincoln National Park coast) and **Wanna** (in the **Sleaford Bay** area – see section 8.14, on southern Eyre Peninsula), and the wrecked tuna boat *Degei* on the northern side of Donington Island, amongst others (Christopher, 1988; DIASA, undated; Aquanaut, undated; Dive South Australia, 2004).

Dive promotion materials for the Eyre Peninsula area (e.g. *Dive Australia*, and *Australia On-Line* diving web sites) describe Port Lincoln's outer islands, reefs, underwater cliffs and drop-offs as "ideal for scuba exploration and photography".

There are dive charter trips from Port Lincoln to **Thistle Island** (Aquanaut, undated).

Other Recreation / Tourism

There are various coastal tours operating throughout **Lincoln National Park**, for coastal walking, viewing coastal scenery, visiting historic sites (**Memory Cove**) etc. There is a coastal walking trail around the northern end of the Jussieu Peninsula, that passes coastal locations such as **Taylor's Landing**,

MacLaren Point, September Beach, and Cape Donington. The coastal area of the Lincoln National Park is also promoted for camping, coastal day trips, sightseeing, beachwalking, and surfing off some of the beaches (Australian Explorer, 2003; Australian Tourism Net, 2003; DEH Parks web site, 2003). Examples of camping areas within the park include **Carcase Rock, MacLaren Point, September Beach, and Taylor's Landing.** The **Memory Cove** area is used for coastal walking, whale watching (during the winter months), and bird watching (DEH, 2000b).

Yachts and other recreational cruises (both charter and private) are popular in the **Thorny Passage** region. **Taylor Island** and other **islands of Thorny Passage** are promoted in various tourism materials as places to visit, and there are charter boats and yachts that visit the islands (for fishing and diving, visiting sea lion colonies and penguin colonies, viewing dolphins, visiting the island beaches, shore-based activities etc). There is a charter operation that offers an opportunity for "snorkelling with the seals at **Hopkins Island**" (Port Lincoln Visitor Information Centre, 2004). Sea canoe trips through Thorny Passage also occur.

Aquanaut's (undated) diving guide to S.A. also promoted **Whalers Way** as "a popular tourist region", due to "relics from the early whaling industry, magnificent coastal scenery, abundant wildlife and a rare sea eagles nest".

According to Marchant (Southern Fisheries, 1995), sea lions are one of the attractions of the Sir Joseph Banks Group and **Thorny Passage**, and "many yachties" are beginning to swim with sea lions in these areas.

Historic / Protected Shipwrecks

The most significant wreck in the area is the cutter lost in **Thorny Passage** whilst Matthew Flinder's party were exploring the coastline in the vicinity of Port Lincoln, in 1802. The water party, comprising officers Thistle and Taylor and a crew of six left the *Investigator* in a cutter, to land on the mainland, and none were seen again after the cutter capsized in Thorny Passage (Loney, 1993, cited by Stone, undated).

Three other historic shipwrecks are known for the region, which are:

- ♦ *Alternative*, wooden cutter, wrecked in 1884 near Memory Cove, but not found;
- ♦ *Red Rover*, cutter, disappeared near Port Lincoln in 1887;
- ♦ *Athens*, cutter, disappeared near Port Lincoln in 1887 (Loney, 1993, cited by Stone, undated).

The wrecks are not protected under legislation.

Other European Heritage Values

The region has European heritage value relating to explorations by Matthew Flinders, and the loss of one of Flinder's cutters and its crew – see section above on **Historic Shipwrecks**. Historical burial sites are located along the Lincoln National Park coast, and the islands in **Thorny Passage** are named after those lost in Flinder's cutter, in 1802. There are historic gravesites on the Lincoln National Park coast. The cultural value was the basis of a Marine Park Proposal from the *Southern Eyre Encounter 2002 Committee*, described in the **Notes on Current Protection and Management within the Recommended Areas**.

In the **Memory Cove** area are inscriptions carved into the granite, known as the "Whaler's Post Office", a site where crews of early ketches left messages for other boats (DEH, 2000b). Flinders Monument and the Memory Cove Tablet Site are listed on the State Heritage Register (DEH, 2003g).

There are remains of a whaling station at **Horny Point on Thistle Island**. The South Australian Company had investigated the possibilities of whaling in South Australian waters before settlement took place. A report in 1834 revealed that Thistle Island had plentiful numbers of black whales, sperm whales and seals and in 1838 a station was established at Thistle Island. The South Australian Company hired 35 men to operate 4 boats, and employed the Company ship Victoria to supply the station. Around 65 tons of oil were taken in the first and only season. There was a second attempt at whaling the following year (1839) however when the station failed again, the whaling station was abandoned altogether. An archaeological survey identified four buildings, composed of limestone nodules, and all except one remain in scatter form. Approximately 250m metres east of the accommodation area, a natural rock platform was used as the flensing platform and trying out facilities. A try pot was also previously found in

the flensing area. Artefacts recovered included clay pipes and bottle glass fragments, iron and copper nails, a knife blade and fish and bird bones (Kostoglou and McCarthy, 1991; State Heritage Branch, 1993; Staniforth and Richards, 2000).

Aboriginal Heritage Values

Lincoln National Park contains “significant Aboriginal ... heritage sites ... within the park boundaries, including (burial sites), middens, and fish traps (Aquaculture Group PISA – Fisheries, 1997). Details of locations within the park will not be listed in this report.

The Barnjarla Claim for Native Title on Eyre Peninsula was lodged in 1996 with the National Native Title Tribunal (NNTT). The claim, which covers eastern Eyre Peninsula and the Gawler and Flinders Ranges, also includes Thorny Passage and associated islands, and the coast of south-western Spencer Gulf. Following amendments in late 1999 and early 2000, the claim was accepted by the federal court for registration, pursuant to s190A of the *Native Title Act 1993* (National Native Title Tribunal web site, 2003).

Scientific Research and Monitoring

A number of sites are used for scientific research and monitoring (e.g. islands in Spencer Gulf, east of Lincoln National Park, are regularly used for abalone population monitoring (e.g. Shepherd *et al.* 1999; Shepherd and Rodda, 2001), and abalone research projects such as reseeding (e.g. Preece *et al.*, 1997), and population dynamics studies (e.g. references by Shepherd *et al.*, 1992). White shark population research and monitoring of pinniped populations also occurs in the region. Research on Rock Lobster puerulus settlement has occurred in recent years at Taylors Landing and McLaren Point (e.g. Prescott *et al.*, 1998a, 1998b). Populations of various scalefish species (e.g. Snapper, King George Whiting) are also monitored in southern Spencer Gulf, and pilchard egg surveys are also undertaken.

Wilderness and/or Aesthetic Values

The undeveloped nature of the coast (Lincoln National Park) is considered to be of wilderness (spiritual / inspirational) and aesthetic value. The wilderness value of the **Lincoln National Park** area is commonly reported in documentation of the natural history, ecology and tourism/recreation opportunities of this area. The wilderness value of the coastal area is reflected in the Wilderness Protection Area nominations that were developed by both conservation groups and government during the late 1990s (see section below on **Current and Proposed Levels of Protection**).

The aesthetic and wilderness qualities are recognised by a variety of sectors, such as marine management agencies, conservationists, and recreational groups. The ocean views off the **Lincoln National Park** have been described as “spectacular” and “breathtaking” (DEH, 2002). Aquaculture Group PISA - Fisheries (1997), considered the **Lincoln National Park** area to provide “scenic amenity” and be of significant conservation value. Aquanaut (undated) described **Whaler’s Way** as having “magnificent coastal scenery”. **Lincoln National Park** has been described as “containing spectacular coastal wilderness, some of the last in South Australia” (Wilderness Society, 2002).

In 2003, the southern end of the Lincoln National Park was declared as the **Memory Cove Wilderness Area** under the *Wilderness Protection Act 1994*. The area stretches southwards from **Taylors Landing** to the tip of the peninsula at **West Point** (and includes coastal locations such as **Shag Cove**, **Memory Cove** and **Cape Catastrophe**), and extends inland to the centre of the peninsula. The Memory Cove Wilderness Area is described as having “magnificent scenery”; a “spectacular open ocean coastline”, including views to offshore islands; and “beauty, tranquility and wilderness qualities” (DEH, 2000b).

Cape Catastrophe and **Memory Cove** in Lincoln National Park are promoted also in tourism materials as “wilderness areas” (Australian Tourism Net, 2003). **Memory Cove** is also described as being a “placid, scenic bay with a beautiful sandy beach”, surrounded by “magnificent wilderness” (Tourism Eyre Peninsula, 2003). **Lincoln National Park** is promoted for its “untouched wilderness and breathtakingly rugged coastline of sheer cliff faces, sheltered coves, and impressive surf beaches” (Frog and Toad Australian Tourism Guide, 2003).

There has also been a nomination by all marine-affiliated community groups in South Australia, to declare the *marine and coastal environment* in this region as a Wilderness Area (see section below, on **Previous and**

Current MPA / Reserve Nominations).

Other Uses

Navigation: Thorny Passage is a major area for marine traffic, to and from Port Lincoln.

There is an automatic light on **Williams Island**, mounted on the western summit and serviced by helicopter (Robinson et al., 1996).

Defence Use (Restricted Area): A submarine trial area, which is not accessible during trials, appears to be four nautical miles in diameter, according to available maps, positioned near the south-eastern section of Thistle Island (Horny Point area).

9.1.6 Sir Joseph Banks Group and Dangerous Reef (including Tumby Bay) (Eyre Bioregion)

Aquaculture

Previously, PISA Fisheries – Aquaculture Group's (1996) Spencer Gulf Management Plan excluded the Sir Joseph Banks Islands and Dangerous Reef from aquaculture development. A report by Petrusевич *et al.* (1998) on recommended sites for aquaculture in S.A., also considered National Parks and Wildlife's two nautical mile "buffer" around the Sir Joseph Banks Conservation Park as an exclusion area.

Aquaculture is growing in the south-western Spencer Gulf region (PIRSA, 2002d). In 2002, Planning South Australia declared a 13,900 ha zone specifically for finfish aquaculture in Lower Eyre Peninsula, extending seaward into south-western Spencer Gulf, from Boston and Louth Bays. The existing two nautical mile "buffer zone" (previously designated by National Parks and Wildlife SA) around the Sir Joseph Banks Group was retained as an exclusion zone in which no aquaculture will be permitted (see Planning S.A., 2002a, 2002b). The finfish farming zone, which Planning SA (2002b) called the *Aquaculture (Finfish / Port Lincoln) Management Zone*, is situated north-east of Boston Island and south-east of Louth Island, and extends seaward into **south-western Spencer Gulf** waters, with the following co-ordinates as eastern boundaries: 603322E and 6158274N = south-eastern boundary; 603145E and 6173135N = north-eastern boundary (Planning S.A., 2002b). Marine finfish aquaculture has been assigned the status of Category 1 Development within the *Aquaculture (Finfish / Port Lincoln) Management Zone* (Planning S.A., 2002b).

In 2002, PIRSA (2002d, and PIRSA Aquaculture, 2003) defined a geographically similar area to that described by Planning S.A., but with slightly different co-ordinates (see below), in a revision of PISA's previous two aquaculture management plans, for Spencer Gulf (1996) and Lower Eyre Peninsula (1997). The proposed *Lincoln Finfish Farming Zone* encompasses about 3000ha previously on the western edge of what was known as the Sir Joseph Banks Zone (SJBZ) of the Spencer Gulf Aquaculture Management Plan. Although the former SJBZ has been reduced to 115,000 ha from the original 118,000 ha, almost 40% (1200ha) of the 3000ha transfer now serves as a shipping channel, as requested by the Department of Transport to improve navigational safety, and that area will not accommodate any aquaculture (PIRSA Aquaculture, 2003).

The focus of the new *Lincoln Policy Area* is shellfish culture inshore, and finfish cages in the new Offshore Lincoln Management Zone (PIRSA, 2002d). In contrast to the *Aquaculture (Finfish / Port Lincoln) Management Zone* designated by Planning SA (2002a, 2002b), the eastern boundary co-ordinates of what PIRSA (2002d) described as the *Offshore Lincoln Aquaculture Zone*, are 603567E, 6173297N; and 603567E, 6160291N (PIRSA, 2002d). Closer to shore, the two other Management Zones in the Lincoln Policy Area (defined by PIRSA, 2002d) are the *Boston Bay Aquaculture Zone*, and the *Louth Aquaculture Zone*. The policies of the Lincoln Policy Area will permit a maximum level of 557 hectares of shellfish and 9,200 tonnes of finfish production (PIRSA, 2002d). The Offshore Lincoln Management Zone will accommodate the bulk of the finfish production less the tonnage of finfish held in Louth and Boston Bay Management Zones which require supplementary feed. According to PIRSA Aquaculture (2003), the *Off Shore Lincoln Aquaculture Zone* is bound by the co-ordinates: (603567E, 6173297N), (591233E, 6173297N); (591233E, 6165333N); (592520E, 6165333N); (593508E, 6163666N);

(586882E, 6163666N); (586882E, 6160291N); (603567E, 6160291N) and returning to point of origin. The main focus for farming in this zone is Southern Bluefin Tuna, and lease and corresponding licenses will be issued for the introduction of up to 5,600 tonnes per annum of Southern Bluefin Tuna in the *Offshore Lincoln Aquaculture Zone*. Tuna and other finfish may not be farmed together under the same lease. Other forms of polyculture will be assessed by PIRSA Aquaculture on an individual basis. Lease and corresponding licenses to farm tuna will be issued once proof of access to a minimum of 60 tonne of quota has been supplied. Area will be allocated at a rate of one hectare for every three tonne of accessible quota. The maximum stocking rate is based on 6 tonne of stock per hectare. However farms established in an area with a depth of less than 20 metres may have reduced stocking rates which will be determined on a case by case basis by PIRSA Aquaculture (PIRSA, 2002d and 2002f; PIRSA Aquaculture, 2003). It is intended that eventually all finfish culture in the Lincoln Policy Area (with the possible exception of finfish nurseries) will be located within the new zone. All temporary licence holders, new lease and corresponding licenses holders or operators wishing to expand their current operations will be required to locate their cages within the new *Offshore Lincoln Management Zone*. PIRSA (2002d) recognised the historical use of certain areas within Boston Bay and around Boston and Bickers Islands, to accommodate the permanent licence holders producing finfish in these areas (PIRSA 2002d, 2002f).

North of **Tumby Bay**, PISA Fisheries – Aquaculture Group (1996) defined the Tumby Management Zone as waters extending 1km offshore of the mean spring high water mark between the following points: (638007E, 6237441N); (638641E, 6236667N); (609749E, 6199141N); and (609004E, 6199838N), and the boundaries of the Tumby Bay Policy Area (see Map OC(SG)/2 in PISA Fisheries – Aquaculture Group 1996). The waters adjacent Port Neill and **Lipson Island Conservation Park** were included in the zone. Provision was made for a total of 30ha of aquaculture development in the Tumby Management Zone.

South of **Tumby Bay**, PISA-Fisheries Aquaculture Group (1996) previously made provision for aquaculture development west of the Sir Joseph Banks Islands, in an area comprising all waters bounded by the following points (see Map OC(SG)/2 in PISA Fisheries – Aquaculture Group, 1996): (606372E, 6180151N); (607559E, 6180007N); (607120E, 6186245N); (608383E, 6186231N); and the boundaries of the Tumby Policy Area. In the Offshore Tumby Management Zone, PISA Fisheries – Aquaculture Group (1996) made provision for licences to a total of 60 hectares of finfish culture.

According to the South Australian Coast and Marine (2003) and PIRSA Aquaculture's Public Register (2004), leases in the south-western Spencer Gulf region (N.B. south of Tumby Bay) include the following:

- ♦ One current *Abalone* lease of 20ha, positioned around 5km off the Red Cliff coast, 11.5km south-east of Tumby Bay;
- ♦ One current *Yellow-tail Kingfish* lease of 20ha, between Point Bolingbroke and Red Cliff. The lease is positioned around 5km east of the coast, 16.5km south-south-east of Tumby Bay, and around 8km west-north-west of Partney Island, one of the northern islands in the Sir Joseph Banks Group;
- ♦ One current 10ha lease for Blacklip Abalone, around 1km off Point Bolingbroke.
- ♦ One previous lease for *Snapper*, around 5km east of the coast, and around 7.4km west-north-west of Marum Island, at the northern end of the Sir Joseph Banks Group;
- ♦ West of the central and southern part of the Sir Joseph Banks archipelago, there are at least 30 leases for *Southern Bluefin Tuna* currently operating in the zones of the Lincoln Sub-Region policy area (PIRSA Aquaculture, 2003). Some of the leases are large (e.g. 85ha, 100ha, 215ha), and collectively, the seaward leases east of Rabbit Island and east of Boston Island together covered around 1800ha in 2003.

Commercial Fishing

Scalefish, Sharks and Minor Invertebrates

Figures specific to the **Tumby Bay** area and the **Sir Joseph Banks Group** are not available for this report.

Most of the islands in the **Sir Joseph Banks Group** form part of GARFIS Fishing Block 30, with the northern end of the group bordering GARFIS Block 29. **Tumby Bay** is in the south-western section of GARFIS Block 29 (DEH, 2003a, Figure 15). GARFIS Block 29 comprises all coastal waters between 34° 30' and 34° S latitude, from approximately Red Cliff to Dutton Bay, including the Tumby Bay area and the northern end of the Sir Joseph Banks Group, and all waters of Spencer Gulf as far east as central Spencer Gulf

137°E, between the 'forementioned latitudinal range.

GARFIS Block 30 encompasses south-western Spencer Gulf, between 34° 30' and 35° S latitude, which includes most of the Sir Joseph Banks Group as part of the total area, but also includes an additional large section of south-western Spencer Gulf waters, as far south as 35°, and as far east as approx. 136° 30' - 137° in parts (see DEH, 2003a, Figure 15).

The average commercial catch of marine scalefish, sharks and minor invertebrates from GARFIS Block 29 and GARFIS Block 30 over the 10 year period from 1989 to 1999, was around 70t and 157t per annum respectively (SARDI data, cited by DEH, 2003a, Figure 15).

According to SARDI (cited by Edyvane, 1999b), the Marine Scalefish and Shark catch from GARFIS Block 29 during the mid 1990s was as follows: In 1995/96 = 35,347kg (0.34% of State total, representing 25 fishers); In 1996/97 = 52,710kg (0.52% of State total, representing 30 fishers). Marine Scalefish, Restricted Marine Scalefish, and Northern Zone Rock Lobster licence holders contributed to these yields. On a State-wide scale, aggregated catch figures for all GARFIS Fishing Blocks in South Australia, between 1995 and 1997, showed that Fishing Block 29 was ranked 40th in 1995 – 1996, and 37th in 1996 – 97, in the list of annual yields of scale fish and sharks from 58 South Australian fishing blocks.

Previously, according to SARDI (cited by Edyvane, 1999b), the Marine Scalefish and Shark catch from GARFIS Block 30 during the mid 1990s was as follows: In 1995/96 a total of 931,386kg (8.96% of State total, representing 72 fishers); in 1996/97 a total of 1,716,478kg (16.93% of State total, representing 69 fishers). Marine Scalefish, Restricted Marine Scalefish, and Northern Zone Rock Lobster licence holders contributed to these yields. On a State-wide scale, aggregated catch figures for all GARFIS Fishing Blocks in South Australia, between 1995 and 1997, show that in 1996-97, the yield (kg) from the south-western Spencer Gulf area (Fishing Block 30) was the highest of all yields from 58 South Australian fishing blocks during that period, and the second highest during 1995-96. This status was based largely on the major yields of pilchards annually recorded from GARFIS Block 30 during some years of the mid to late 1990s (see below). More recently, DEH (2003a, citing SARDI Aquatic Sciences data) reported that the average annual catch in Marine Fishing Area 30 (previously called GARFIS Block 30), over the period 1989 to 1999, was 132.5t. This figure includes fish, sharks, and invertebrates, but excludes Pilchard data from 1989/90, and also excludes the single species fisheries such as prawns, abalone and rock lobster. Note that much of the yield of Pilchards and other scalefish from south-western Eyre Peninsula is taken from areas further south of the Sir Joseph Banks Group, and therefore the specific commercial fishing significance of Sir Joseph Banks Group on a State-wide scale cannot be determined for this report.

King George Whiting, Southern Calamari, Tommy Ruff, Garfish and Snapper, are considered to be the main finfish species taken in South-West Spencer Gulf (PISA Fisheries – Aquaculture Group, 1997). Sharks are also taken.

Some of the major species (in terms of yield) caught commercially in south-western Spencer Gulf are detailed below:

- ♦ *King George Whiting*. During some years of the past decade, GARFIS Blocks 29 and 30 have been amongst the top 15 fishing blocks in S.A. in which this species is caught commercially, in terms of yields. Recent catch figures specific to **Thorny Passage** are not available, however the following information is provided for "southern Spencer Gulf" as a whole, which includes both the eastern and western sides (see Fowler, 2002, for fishing blocks that collectively refer to this region): the total catch of King George Whiting from the entire Southern Spencer Gulf area was 150.3 tonnes in 1998 (McGarvey *et al.*, 2000), 117.8t in 2000, and 115.7t in 2001 (McGarvey *et al.*, 2003). About 80% of the catch is taken by hand lines, 10% - 15% by hauling nets, and 25 – 3% by gill nets. McGarvey *et al.* (2000) reported that (i) the long term average catch for hand lines in Southern Spencer Gulf is around 120t per annum, though the catch has regularly fluctuated above and below this average during the past 20 years; (ii) although the hand line catch has been highly variable over the past two decades in Southern Spencer Gulf, there appears to be no long term trend evident, despite a consistent and substantial reduction in effort using hand lines (which, since the early 1990s, has been annually decreasing). Although catches have been highly variable over time, there are periodic peaks at approximately 5 year intervals. Handline catches in southern Spencer Gulf have decreased substantially in recent years, from 131t in 1997, to 83t in 2002. Also in 2002, the hauling net catch (7.7t) was less than half of that recorded in 1999, and over the same period, the gill net catch fell from

17t to 2.6t (McGarvey et al., 2003). In the period 2000 - 2002, the haul net catch was the lowest ever recorded for Southern Spencer Gulf. Combined effort corresponds roughly to the peaks and troughs shown in catch, however there has been a consistent trend in declining effort since 1992. There has been a long term decline in targetted effort from the hauling net sector, which reportedly accounts for the reduction in catch from this sector during the past decade. Hand line effort was about 4,998 fisher-days in 2002 (a decrease from the peak of 8,713 fisher-days in 1992), and gill net effort was about 136 fisher-days in 2002 (a decrease from a peak of 957 fisher-days in 1999) (McGarvey et al., 2003).

Gummy Shark: No recent data are available, however during the mid-late 1990s, yields from one of the two fishing blocks in south-western Spencer Gulf were amongst the top 10 of approximately 50 areas in the state where Gummy Shark were fished. The fishery for School Shark and Gummy Shark in South Australia is managed by the Commonwealth, and has recently been rationalised (see AFMA, 2002a; AFMA, 2003, and section below on **Issues for Risk and Impact Assessment**).

Pilchards: In some recent years, the southern end of south-western Spencer Gulf area, has been one of several major fishing areas for pilchards in South Australia (e.g. between 800 – 1500 tonnes per annum were landed in the south-western Spencer Gulf area, in two of the years during the mid to late 1990s). The State-wide quota for the 14 pilchard fishers operating out of Port Lincoln on the Eyre Peninsula is reported to be around 15 percent of the calculated biomass, and amounted to 36,000t in 2003 (Anon., 2002).

Southern Calamari: Triantafillos and Fowler (2000) reported that the majority of the yield of calamari in the South-Western Spencer Gulf region is taken by jig fishers. The South-Western region includes GARFIS Block 30 (of which the Sir Joseph Banks group is part) and Block 31 (Port Lincoln area). Due to netting restrictions introduced in 1995, the haul net catch of Southern Calamari was low (less than 2 tonnes per annum) in South-Western Spencer Gulf during the late 1990s, however the jig catch has ranged between approximately 16t and 36t per annum between 1990 and 1999 (see Figure 4b in Triantafillos and Fowler, 2000), an increase in annual catch from this region compared with the 1980s. Corresponding jig fishing effort has increased substantially since 1990, and has amounted to more than 750 boat days per annum during all but one year of the 1990s (see Triantafillos and Fowler, 2000, Figure 4b). Triantafillos and Fowler, 2000) considered that increases in catch in the region during 1999 (compared with the previous two years) may be attributed to a shift in effort towards targetting calamari instead of King George Whiting. More recent catch and effort figures (in the early 2000's) are not available for this report.

Snapper: Recent figures specific to south-western Spencer Gulf are not available for this report; however, during some years of the mid-late 1990s, yields from the either of the two blocks in the area were amongst the top 10 areas of the state in which the species is fished. For the entire "Southern Spencer Gulf" region, Fowler (2002) reported that the targetted fishery for Snapper, using hand lines, has increased annually since 1994/1995. The Snapper catch from southern Spencer Gulf was the highest ever recorded for the region in 1999/2000 and again in 2000/2001 and 2001/2002 (Fowler, 2002; Fowler et al., 2003), due to a strong 1991 year class making its way through the fishery (Fowler, 2000). The commercial Snapper catch from Southern Spencer Gulf in 2000/2001 was around 220t, the majority of which was caught by hand lines (Fowler, 2002). In 2002/2003, the catch rose to 264t, representing about 41% of the entire State catch (Fowler et al., 2003). The sequence of annual catches of Snapper by *hand lining* in Southern Spencer Gulf since 1994/95 is as follows: 14.8t, 29.9t, 32.6t, 57.9t, 84.5t, 130.5t, 179.9t and 222t. Corresponding targetted hand line effort during those years has ranged from 355 boat days in 1994/95, to 821 boat days in 2001/2002. The long line catch is, on average, an order of magnitude lower than the hand line catch in the Southern Spencer Gulf region (e.g. 17.8t in 2000/2001, and 23.9t in 2001/2002). During the period 1999 to 2002, the annual targetted catch from long lining has been the highest ever recorded. Catch rates for both hand lining and long lining during the past few years (i.e. since the late 1990s) have been the highest ever recorded for the Southern Spencer Gulf region. In previous years (e.g. early 1980s), targetted effort was higher for an equivalent yield compared with the present, and catch rates were thus lower during the 1980s than currently (see Fowler, 2002, Table 3.4, and Fowler et al., 2003, Figure 3.5).

Garfish: No recent data specific to south-western Spencer Gulf are available for this report, however the area is not one of the major fishing areas for Garfish in the state. For example, during the mid-late 1990s, the fishing blocks in south-western Spencer Gulf were not amongst the top 10 areas in S.A. in which Garfish are commercially fished. Jones *et al.* (2002, Chapter 3) provided a regional overview of the fishery. Knight *et al.* (2002) reported that hauling nets take the majority of the catch in the Spencer Gulf region.

Australian Herring (Tommy Ruff): Recent figures specific to south-western Spencer Gulf are not available for this report. The majority of the Australian herring catch is taken by hauling nets. Dimmlich and Jones (1997, Figure 10) showed that the catch from southern Spencer Gulf decreased from a high of more than 100t during the early 1990s, to less than 50t in 1996/97. During the mid to late 1990s, the catches from Southern Spencer Gulf were the lowest recorded for the area since the early 1980s (see Dimmlich and Jones, 1997, Figure 10). Overall, Spencer Gulf as a whole (including the northern part of the gulf) is one of the two major fishing regions in S.A. for Australian herring, and non-target fishing using hauling nets accounts for the majority of the yield. The targetted catch for the whole of Spencer Gulf in 2000/01 amounted to around 23.5t (more than half of the total targetted catch from all state waters), and the non-targetted catch was 121.1t (which amounted to more than 60% of the State yield, and was around twice the size of the non-target yield of Australian herring from Gulf St Vincent (see stock assessment in Westlake *et al.*, 2002).

Australian Salmon: a purse seine fishery for 2 - 6 year old salmon operates in deeper Spencer Gulf waters east of the bays. More than 30t of salmon was caught from the south-western Spencer Gulf area in at least one year of the mid-late 1990s. No recent data specific to the south-western Spencer Gulf area are available for this report, however recent stock assessment reports (Jones, 1999; Westlake *et al.*, 2002) showed that the total commercial catch of Australian Salmon from Southern Spencer Gulf was 100.6t in 1998/99 and 133.5t in 2000/2001, with the majority of the catch being taken by hauling nets. Of the 6 aggregated regions in S.A. in which Australian Salmon is taken, Southern Spencer Gulf catches are the second highest, and constitute one of the two main fishing regions for this species in the state. The proportion of the "Southern Spencer Gulf" salmon yield that is taken specifically from the south-western Spencer Gulf area is not known for this report, however the region described as "Southern Spencer Gulf" comprises several fishing blocks, and encompasses both sides of the mid and lower gulf.

School Shark and *Bronze Whaler Shark* are also caught in the region. No recent catch and effort figures are available for this report, however during the mid to late 1990s, the south-western Spencer Gulf was not a major fishing area for these species, compared with other parts of the State.

Other species caught in the lower part of south-western Spencer Gulf include:

- ♦ *Snook*: recent data are not available, however several tonnes per year were recorded in at least one year of the mid-late 1990s from this area;
- ♦ Mixed *wrasse* species: *Blue-Throated* and *Brown-Spotted* are two of the species caught commercially in S.A., and several tonnes or more per annum of wrasse have been landed in south-western Spencer Gulf during recent years – e.g. mid to late 1990s);
- ♦ *Bronze Whaler Shark*: recent data are not available, however more than 5 tonnes per year was recorded in at least one year of the mid-late 1990s from this area;
- ♦ *Blue Morwong*: This is not a target species, and recent data are not available, however around 1 tonne was recorded in one year of the mid-late 1990s from this area;
- ♦ various *Ray* and *Skate* species; recent data are not available, however around 1 tonne was recorded in at least one year of the mid-late 1990s from south-western Spencer Gulf.

Other Information on Commercial Fishing for Scalefish, Shark and Minor Invertebrates:

In a survey of boat ramp use during the mid-1990s, McGlennon (1996) reported that approximately 12% of the use of the concrete boat ramp associated with the marina development south of the **Tumby Bay** township, was for commercial fishing.

Net fishers catch a variety of scalefish species in the area, and net fishing (e.g. for Australian Salmon) has contributed a significant portion of the total scalefish catch in South-West Spencer Gulf (Netting Review Committee 1994, cited by PISA Fisheries – Aquaculture Group 1996). Netting restrictions were introduced in 1995, and net fishing is now less significant as a method for catching some species (e.g. calamari).

Abalone

The **Tumby Bay** area is a very minor fishing area for abalone. Figures were provided by S. Shepherd (pers. comm., 2000), for Mapcodes 20A and 20C (Lower West Spencer Gulf, which includes the stretch of coast between Boston Island and Cowell): In all years between 1979 and 1998, less than 350 kg per annum of greenlip, and less than 40kg per annum of blacklip, was yielded from that area.

The **Sir Joseph Banks Group** is a minor fishing area for both greenlip and Blacklip Abalone, and abalone yields are higher at Dangerous Reef, Porter Rock, and the reefs between Dangerous Reef and Taylor Island. In terms of yield from the Western Zone and the State as a whole, the proportion of catch from all of the aforementioned areas is minor.

Mayfield *et al.* (2001) reported that Fishing Area 20 (of which the **Sir Joseph Banks Group** are part) was one of the 5 *least fished* areas in the Western Zone, between 1980-1984, 1988-1992, and 1996-2000, with average number of fishing days being less than 4 days per year during all of those periods. However, Mayfield *et al.* (2001) also reported that despite the low level of effort, there has been a statistically significant increase in fishing effort (days per year) in Fishing Area 20 during the past 10 years. There has been a statistically significant decrease in fishing effort in Fishing Area 19 (of which **Dangerous Reef** is one part) during the past decade.

Previous aggregated figures (values approximate whole weight) for parts of the area were provided by S. Shepherd (pers. comm., 2000): **Sir Joseph Banks Group**: Between 1990 and 1998, recorded annual yield of Greenlip Abalone fluctuated between 0kg and around 816kg. Blacklip abalone yield fluctuated between 0kg and around 165kg. **Dangerous Reef and Porter Rock** (also includes the reef areas west of Dangerous Reef, as far south as Taylor Island, and as far north as Cape Donington): Between 1990 and 1998, recorded annual yield of Greenlip Abalone fluctuated between around 730kg and 4.3t. Yield of Blacklip Abalone fluctuated between 0 kg and around 1.4t.

Rock Lobster

Figures specific to the **Tumby Bay** area are not available for this report, but the area is considered to be insignificant for commercial lobster fishing.

Figures specific to the **Sir Joseph Banks Group** are not available for this report, but the area is known to be not as important when compared to the southern foot of Eyre Peninsula, in terms of yield. According to SARDI (cited by Edyvane 1999b), the Rock Lobster catch from GARFIS Block 30 (south-western Spencer Gulf, between 34° 30' and 35° S latitude, which includes Thorny Passage as far south as West Point at the bottom on the Jussieu Peninsula, but also includes a large part of south-western Spencer Gulf, as far north as 34° 30', and as far east as approx. 136° 30' - 137° in parts) was as follows: in 1995/96 a total of 7671kg (0.15% of State total, representing 11 fishers); in 1996/97 a total of 3673 kg (0.07% of State total, representing 12 fishers). The proportion of this yield that pertains to the Sir Joseph Banks Group and Dangerous Reef is not known for this report.

When the entire Northern Zone is considered as a whole (i.e. from the Western Australian border, through to Encounter Bay and deeper waters south of Kangaroo Island), the catch for the 2002 season was 594.8 tonnes, being the lowest catch in the Northern Zone since 1979 (Ward *et al.*, 2003).

Bycatch information specific to the area is not available for this report. However, McGarvey *et al.* (1998) and Prescott (2001) reported that the largest proportion of bycatch in the Northern Zone as a whole, is leatherjackets and octopus. According to the results of a sampling program of bycatch in 1991 and 1992, various wrasse species (Labridae family) together constituted another major component of the bycatch in the Northern Zone e.g. 1127 Labrids caught in pots during the bycatch sampling program in 1991-92 (Table 5 in Prescott, 2001). Octopus are a major predator of Rock Lobster, with losses due to octopus predation equating to approximately 4% of the total number of lobsters landed (in the Northern Zone). According to McGarvey *et al.* (1998), the catches and catch rates of octopus have been sustained over time, and vary from 1 – 2.5 octopuses per 100 potlifts. Octopus that are caught in the northern zone are sold.

Some lobster boats net sharks out of season, and some of these activities require a Commonwealth permit. Licensed Rock Lobster fishers have also had access to fish species, such as West Australian Salmon, Mulloway, and Snapper (Zacharin, 1997, cited by McGarvey *et al.*, 1998).

Western King Prawn

The closest major trawling ground to the area described in this table occurs south-east of the Sir Joseph Banks group, and north and north-east of Thistle Island. The area north and north-east of Thistle Island is depicted as one of the three key fishing areas in Spencer Gulf, where large prawns are caught

between March and May (MacDonald, 1998).

The Sir Joseph Banks Group are part of Prawn Fishing Blocks 81 and 90, but these areas are not fished by industry. Prawn Fishing Block 77 is situated north of Tumby Bay, and fishing Block 79 is situated north-east of the Sir Joseph Banks Group, but these blocks also are not fished (SARDI data, cited by DEH, 2003a, Figure 14). South-east of the Sir Joseph Banks Group, Prawn Fishing Block 92 has recorded an average of 31 to 50 tonnes of prawns per annum, between 1989/1990 and 1999/2000, and was fished in all of those years. Between Dangerous Reef and Thistle Island, Prawn Fishing Block 98 has recorded an average of between 11 and 30 tonnes of prawns per annum, between 1989/1990 and 1999/2000, and was fished in 7 to 9 of those 11 years (SARDI data, cited by DEH, 2003a, Figure 14).

Of the total prawn landings for the Spencer Gulf fishery in 1999/00 (1914 tonnes over 61.5 nights trawled, or 21,459 hours), the Southern grounds produced around 405 (around 21%) tonnes of the total catch. Annual catch rate was around 85kg / hr (Carrick and Williams, 2001).

The fleet exerts high local (or spatial) depletion rates with the estimated mean exploitation rate being 49.9%, which is close to the target limit of 50%. Monitoring indicators and research surveys for the 1999/2000 year showed a good size composition of the prawn catch; "highly satisfactory catch rates" of adult prawns; and a large settlement of post-larval prawns (which results in strong recruitment to grounds the following season) (Carrick and Williams, 2001).

Prawn fishers in Spencer Gulf are permitted to take slipper lobster and Southern Calamari as commercial bycatch during prawn trawling operations (MacDonald, 1998b).

Recreational Fishing

There are sites for recreational boat fishing throughout the region. Recreational fishers also visit the **Sir Joseph Banks Group** area in charter boats and yachts. The Sir Joseph Banks Group islands have been described as being "famous for their fishing grounds, they are developing a reputation for sport fishing" (Tumby Bay Telecentre 2000). The **Sir Joseph Banks Group** islands are promoted in government and commercial tourism materials as a location at which the following species are targeted and caught, mainly by boat fishing: King George Whiting (particularly large whiting, for which the area is renowned), Snapper, sweep, Australian Salmon and "salmon trout", Tommy Ruff, mullet, Garfish, Southern Calamari, Snook, Silver Drummer, trevally, flathead, and shark species (Eyre Peninsula Tourist Association 1995, 2000; Fish Eyre Peninsula web site, 2003). Rock lobster are also taken by recreational fishers.

Some recognised fishing spots in the **Sir Joseph Banks Group** include the following (from recreational fishing reports, and Tumby Bay Telecentre, 2000):

- ♦ **Reevesby Island**: a popular fishing spot, because it contains 5 sheltered bays, and the best anchorage spots in the island group. Both line and net fishing are known to occur at **Reevesby Island**, both on bare sand and vegetated bottom
- ♦ **Winceby Island** (described in fishing promotion materials as having "prolific whiting", as well as "abundant Snapper" at **Judith Shoals**, north-east of Winceby Island);
- ♦ **Kirkby Island**: There is a rocky landing on the northern edge of the island; recreational fishers target species such as rock fish species, Garfish, whiting and flathead, and divers target Scallops;
- ♦ **Roxby Island**, where fishers target both reef fish and sand-dwelling species. The sandy landing areas on the western and southern sides of Roxby Island are promoted to fishers.
- ♦ **Spilsby Island**, which is privately owned and reportedly off-limits to itinerant yachts and power boats, but has 3 public anchorages. The anchorages are at the Hawknest Bay; Butterfish Bay; and the north-west side of the island.
- ♦ **Stickney Island**, for reef fishing in deeper waters around the island. The northern anchorage is promoted, because it provides the protection from rough seas and winds. There is a rock reef extending 400 metres to the south-east, with its outer extremity marked by a 2 metre high exposed rock at **Linklater Point**

One of the commonly recognised recreational fishing spots (markers) is "**Buffalo Reef**", approximately 8km south-east of **Spilsby Island**, out of the Park area. There are several reef fishing locations (with coordinates recognised by *Fish SA*) in the **Buffalo Reef** and **Rosalind Shoals** areas. Regional tourism promotion materials report that charter boats visit **Buffalo Reef**, where Snapper is a common target.

At **Dangerous Reef**, the Eyre Peninsula Tourist Association (1995 and 2000) listed the following main species targeted and caught by boat fishers: King George Whiting (particularly large whiting to 45-50cm), Snapper, Tommy Ruff, Australian Salmon, Southern Calamari, sweep, flathead, Silver Drummer, Garfish, Snook, sharks and trevally.

Yacht and boat charters departing from Port Lincoln and **Tumby Bay** visit **Sir Joseph Banks Group** and **Dangerous Reef** for game-fishing expeditions and day fishing. Charter boat fishing (for whiting, Snapper, sweep, Garfish, calamari and other species) has become increasingly popular during the past decade. Recent tourism promotion materials (e.g. Tumby Bay tourism web sites) have described the **Sir Joseph Banks Group** islands as being “famous for their fishing grounds” and “developing a reputation for sports fishing”.

Recreational divers at the **Sir Joseph Banks Group** take Southern Rock Lobster, Scallops, abalone and native oysters. “Some” recreational lobster fishing (using pots) occurs around the Port Lincoln coastline (Tyrer, PIRSA, 1994), but the extent of pot fishing at Sir Joseph Banks Group and Tumby Bay is not known for this report.

The **Tumby Bay** area is a popular fishing location, for both local fishers and seasonal tourists. Fishing has been described as one of the most popular attractions in **Tumby Bay** (Tumby Bay Telecentre, 2000), for both locals and seasonal visitors, many of which make repeat fishing trips to Tumby Bay for annual holidays. There are two jetties at Tumby Bay, and fishers use the jetties, and also fish from boats, rocky headlands, and the sandy beach areas. There is a community-built boat ramp for boating and fishing. Charter boat fishing trips depart from Tumby Bay.

Generally, the more popular species caught from jetties, boat, beach and rock fishing at **Tumby Bay**, include: King George Whiting, Snapper, Tommy Ruff, West Australian Salmon, mullet, flathead, sweep, Southern Sea Garfish, Snook, rock fish species and Southern Calamari (Eyre Peninsula Tourism Association, 1995; Tumby Bay Telecentre, 2000; recreational fishing reports 2000-2001; Fish Eyre Peninsula web site, 2003).

Fish caught from the shore in the **Tumby Bay** area include whiting, West Australian Salmon, Tommy Ruff (Australian Herring), sweep, Snook, Snapper, Garfish, flathead, mullet and rock species (LEEP-Land Tourism Association, 2003).

Crabs, oysters and Scallops are also collected by recreational fishers in the **Tumby Bay** area.

The Eyre Peninsula Tourist Association (1995 and 2000) described the inshore grounds close to **Tumby Bay** as a good spot for catching “large numbers” of King George Whiting. The *Scaberia* (corkweed) beds of the **Tumby Bay Reef** attract large King George Whiting, popularly targeted by boat fishers. The town jetty is commonly used at most times of the year for catching Tommy Ruff (sometimes in quantities of a few dozen per fisher), Garfish, Snook, Southern Calamari and smaller Snapper. Bronze whalers are sometimes taken from the jetty, and by boat fishers. **First Creek** is used frequently by boat fishers as an outlet channel to gain access to the sea. A boat harbour channel was dredged in 1978 in the Tumby Bay township, which connects to First Creek and serves as an area to moor or launch boats (Eyre Peninsula Tourism Association, 1995).

According to McGlennon (1996), in a survey of boat ramp use during the mid-1990s, recreational fishing accounted for approximately 83% of the use of the concrete boat ramp associated with the marina development south of the **Tumby Bay** township.

There is an annual recreational fishing tournament held at **Tumby Bay**.

Recreational and charter boat fishers visiting the Sir Joseph Banks Group often leave from **Tumby Bay**, which is known to fishers as the “Gateway to the Group” (Eyre Peninsula Tourist Association 1995). Charter boats from Tumby Bay catch King George Whiting, Snapper and other fish (see above), and the area is increasingly being recognised for sports-fishing (Eyre Peninsula Tourism Association, 2001).

North of Tumby Bay are **Lipson Island** and **Lipson Cove**, described as “a popular fishing spot (LEEP-land Tourism Association, 2003), where anglers catch large Snapper, King George Whiting, Tommy Ruff, Garfish, Australian Salmon (and salmon “trout”), Mullet, Sweep, Silver Drummer (Eyre Peninsula Tourism Association web site 2001; Fish Eyre Peninsula web site 2003). North-east of Tumby Bay, at **Ponta** and **Cowley's** beaches, catches include Snapper, whiting and Bream (LEEP-Land Tourism

Association, 2003).

Diving / Dive Tourism

Dive charters to **Dangerous Reef** regularly occur, for cage diving near Great White sharks. The area is recognised at State, national and international levels as one of the prime locations for cage diving to view white sharks.

Yacht and boat charters for diving around the **Sir Joseph Banks Group** operate from the Eyre coast (**Tumby Bay** and Port Lincoln area). Dive charters in the area promote the sea lions, the variety of fish, and dive-fishing for Rock Lobster, Abalone, and Scallops.

Dive Australia and *Australia On-Line* dive promotional materials both described **Sir Joseph Banks Islands** as "a favoured spot for SCUBA diving".

The Lincoln Marine Science Centre's promotional material (1998) described the Sir Joseph Banks Group as being "renowned for scenic scuba-diving".

The reefs around **Stickney Island** were listed in Christopher's Diver's Guide to S.A. (1988). Adelaide dive shops occasionally run dive trips to **Spilsby Island**, where diving has been described as "superb" (Aquanaut, undated). **Spilsby Island** is promoted for its clear waters and prolific marine life, amongst other features (Aquanaut, undated).

Previously, **Tumby Bay** was described in Christopher's (1988) Diver's Guide to S.A. as "a good base from which to visit the Sir Joseph Banks group for diving". The **Tumby Bay jetty** was listed by DIASA (undated) and Dive South Australia (2004) as a place for "pleasant day diving and excellent night diving". Diving at Tumby Jetty is also mentioned in tourism promotion material for Tumby Bay (e.g. Tumby Bay Telecentre, 2000). Features of the Tumby area of relevance to divers are described in the section on **Popular Dive Sites**, in Part 1 of this table. **Lipson Cove** (north of Tumby) was also listed by DIASA, for shore diving and snorkelling, and boat diving, using the beach to launch.

Other Marine Recreation / Tourism

Tumby Bay has been described as a "holiday resort" (PISA Fisheries – Aquaculture Group (1997), and a "popular seaside holiday town" (Walkabout Travel Guide web site, 2001) and an "attractive and pleasant Eyre Peninsula holiday destination" (Fairfax Publishing – F2, 2001). Many of the seasonal visitors to Tumby Bay return regularly to the area for holiday periods. PISA Fisheries – Aquaculture Group (1997) considered the recreational value of the Tumby Bay township, in the designation of an aquaculture exclusion zone around this area. According to PISA Fisheries – Aquaculture Group (1997), Tumby Bay is located near scenically attractive swimming beaches (the long, crescent beach and white sand are promoted in tourism materials), and the adjacent coastal area has high recreational value. Leisure activities include fishing (see section above on **Recreational Fishing**); swimming in the bay; water skiing; diving (particularly at one of the two jetties – see above); viewing the museum and monuments on the beachfront; walking along the beaches, jetties and walking trail in the area; admiring the views from the scenic lookouts; and taking the scenic drive south along the coast from Tumby Bay. There is a caravan park on the beachfront, and a foreshore recreation area (PISA Fisheries – Aquaculture Group, 1997; Tumby Bay Telecentre, 2000; Fairfax Publishing – F2, 2001; LEEP-land Tourism Association, 2003).

The Tumby Bay Marina development (see Tumby Bay Development Plan – Planning S.A., 2000), was intended to enhance the tourist nature of the township, and to increase tourism/visitor opportunities, apart from increasing residential development in the area. The economic viability of the proposal was considered to hinge upon the creation and sale of waterfront allotments (Minister for Transport and Urban Planning 1998). Much of the waterfront housing development, and the shacks, cabins, caravan parks and camping in the area are associated with the marine recreational value of the Tumby region.

Yachting also occurs in the **Tumby Bay** area. There is a marina and yacht club at Tumby Bay, and yacht charters also leave from Tumby Bay for sailing to the **Sir Joseph Banks Group**, amongst other areas. There are yachting trips for fishing, diving, sight-seeing, and sail training. The Tumby Bay mangrove boardwalk is also described in tourism promotional materials (e.g. Tumby Bay Telecentre, 2000).

Tumby Island also has recreational significance. Promoted activities include walking along the beach area, and walking out to the island along the sandbar at low tide, to see the bird populations and rock formations. The area is also promoted for fishing and boating (LEEP-Land Tourism Association, 2003).

North of Tumby Bay is **Lipson Cove**, promoted as a fishing and camping area, and **Lipson Island**, which is a conservation park. The island can be visited at low tide, to view the bird life (Eyre Peninsula Tourism Association web site, 2001; LEEP-Land Tourism Association, 2003), such as gulls, terns and Little Penguins.

Tumby Bay is also widely promoted as being the main access point to the **Sir Joseph Banks Group** of Islands, which are also popular for marine leisure activities such as charter boat fishing; watching dolphins, sea lions and birds; and visiting the beaches.

The Lower Eyre Peninsula Aquaculture Management Plan (PISA Fisheries – Aquaculture Group 1997) recognised the “high recreational and conservation values of the (**Sir Joseph Banks Group**) islands and their surrounding waters”.

According to PISA Fisheries - Aquaculture Group (1997), the Sir Joseph Banks Islands are a popular destination for various boats. Snorkelling, swimming, and diving are some of the popular recreational activities.

Boating tourism materials indicate that the Sir Joseph Banks Group has been popular for yachting since at least the 1970s, and both private and chartered commercial yacht trips occur. The major anchorages are around **Reevesby Island**, but **Spilsby** is also used for recreational vessels. Sea kayak/canoe trips to Sir Joseph Banks groups have also occurred.

There are yacht and boat charter trips (including day trips) to both **Sir Joseph Banks Group** and **Dangerous Reef**, for fishing; diving; viewing sea lions, dolphins and sharks; and for general sight-seeing. Cruise trips to **Dangerous Reef** operate (for both shark cage diving, and for viewing great white sharks from the viewing platform), depart mainly from Port Lincoln.

Apart from fishing, exploring the islands and watching the fauna (particularly bird-watching), are common activities at the **Sir Joseph Banks Group**. Marine wildlife viewing is often promoted for the **Sir Joseph Banks group** (e.g. *Aquanaut*, *Dive Australia* and *Australia On-Line* diving web sites; Tumby Bay Telecentre, 2000; Fairfax Publishing – F2, 2003; Australian Explorer, 2003; LEEP-Land Tourism Association, 2003). Promoted examples include the sea lions, dolphins, and birds (particularly the large flocks of Cape Barren geese, but also including sea eagles, rock parrots, pied cormorants, eastern reef egrets, crested terns, albatrosses, and various waders, including migratory species).

The bays and reefs of Sir Joseph Banks Group are promoted as tourism features (Australian Explorer, 2003).

Viewing and swimming with dolphins and sea lions has also been promoted in recent years. According to Marchant (1995), sea lions are one of the attractions of the **Sir Joseph Banks Group** and Thorny Passage, and “many yachties” are beginning to swim with sea lions in these areas. Day trips to the Sir Joseph Banks Islands for viewing dolphins and sea lions (e.g. at **Langton Island**) are promoted by regional tourism associations.

The historic farming homesteads are also promoted. In the past, guests have been accommodated on **Spilsby Island**, which is privately owned and run as a sheep station, but the tourism operation is spasmodic (Aquanaut, undated). One of the original station homesteads on **Reevesby Island** has been restored, and is also promoted as one of the features of interest to island visitors (Tumby Bay Telecentre, 2000). Camping is also permitted on **Reevesby Island**, on the beach of Home Bay or near the homestead.

Marine Research and Education

In the **Tumby Bay** area, there is a 70m-mangrove boardwalk at **First Creek**, with interpretative signs explaining the ecology of mangroves. Visitors and school groups use the mangrove walk. Edyvane (1999b) described this education facility as a “key destination” for tourists and students from local and regional centres, who are interested in mangroves and estuaries. Local community Landcare and Coastcare groups established the boardwalk and interpretative centre. In 2000, restoration work was

undertaken on the mangroves at **Tumby Bay**, under the Fisheries Action Program.

Regionally, research and monitoring work includes regular catch and effort monitoring for major commercial species (e.g. western king prawns; whiting, Snapper and other marine scalefish; and Southern Calamari); and monitoring of larval fish stocks. **Reevesy Island** has also been one of the sites at which King George Whiting were sampled, for a study on long term changes to reproduction (Cockrum and Jones, 1992).

White shark populations in the area (particularly **Dangerous Reef**) have been the subject of nationally and internationally significant population and behavioural research involving State, national and overseas researchers, for at least 30 years. Much of the research also has commercial significance, since a number of films, videos, books and other media productions have resulted from work undertaken at Dangerous Reef. The area remains important for shark studies today, including tagging and tracking work, and has been a key monitoring site for shark studies by national (e.g. CSIRO) and international researchers.

The **Sir Joseph Banks Group** islands are used by a number of groups for educational activities (PIRSA, 1997).

The White Shark research and media work (for producing films, videos, web sites and books etc) that occurs at **Dangerous Reef** has educational value at State, national and international levels.

Populations of "various organisms" have been studied on islands in the Sir Joseph Banks Group (Australian Heritage Commission, undated). A benthic survey was undertaken in the area in 1992 (SARDI data, unpublished). Previous studies have included the McCoy expedition during the early 1930s, results of which were published in the Transactions of the Royal Society of Victoria (S. Shepherd, pers. comm., 2004).

The Australian Sea Lion colony on **Dangerous Reef** has been the site of long term population monitoring and breeding studies, by pinniped biologists (e.g. P. Shaughnessy, CSIRO, and researchers from NPWSA).

Aboriginal Heritage Values

There is an Aboriginal fish trap complex at **Salt Creek**, at the northern end of **Tumby Bay** (Martin, 1988). The area south of Tumby Bay (Point Bollingbroke) is considered to be of high Aboriginal Heritage significance, due to the large number of Aboriginal fish traps, as well as the presence of campsites.

The Barngarla Claim for Native Title on Eyre Peninsula was lodged in 1996 with the National Native Title Tribunal (NNTT). The claim, which covers eastern Eyre Peninsula and the Gawler and Flinders Ranges, also includes **Tumby Bay**, the **Sir Joseph Banks Group** and **Dangerous Reef**. The Barngarla Claim includes adjacent coastal waters to at least 12km – 18km from the coast, depending upon the point of measurement. Following amendments in late 1999 and early 2000, the claim was accepted by the federal court for registration, pursuant to s190A of the *Native Title Act 1993* (National Native Title Tribunal web site, 2003).

According to Robinson *et al.* (1996), it is possible that Aborigines occupied the Sir Joseph Banks Group, but if so no clear evidence remains, and no details have apparently been recorded.

Historic Shipwrecks

Wrecks protected under Commonwealth or State legislation are not known for the **Tumby Bay** or **Sir Joseph Banks Group** area.

Historic but unprotected shipwrecks in the area include the following (from South Australian Coast and Marine Atlas, 2000):

- ♦ *Malcolm*, wooden ketch built 1875, wrecked 1928 near **Cape Euler**, south of **Tumby Bay**. The wreck has been found and inspected by heritage officials.
- ♦ *Governor Gawler*, a wooden schooner built 1840, wrecked in 1847, has apparently been located between McCoy Bay and Haystack Bay off **Reevesy Island**, and inspected by heritage officials;

- ♦ *Eleanor*, an iron schooner built 1864, wrecked 1930 at **Kirkby Island**, has been found;
- ♦ *Edith*, a wooden cutter built 1871, wrecked 1897 at Spilsby Island;
- ♦ *Ina*, wooden ketch, built 1903, wrecked 1917 at Sibsey Island; and
- ♦ *Annie Brown*, wood brigantine, built 1867, wrecked 1904 at Sibsey Island

At least four other unprotected vessels are known to have been wrecked in the Sir Joseph Banks area, 1 of these being a cutter from the early 1900s. An historic but unprotected wreck is known from **Dangerous Reef** (the *Ark*, a wooden ketch built in 1873, wrecked 1881).

Other European Heritage Values

The “old” and “new” jetties at **Tumby Bay** have been listed by Planning S.A. (2000) as *Local Heritage Places*, in the Tumby Bay Development Plan. The jetty that was built at Tumby Bay in 1874, became the shipping port of the Burrawing Mine. There is the old tram at the end of the jetty that was originally used to take bags of wheat from the drays to the boats berthed at the end of the pier (Fairfax Publishing – F2, 2001).

Tumby Bay was originally a port for wool and grain, and sailing ketches and cargo steamers operated from there (Australian Tourism Net, 2001). In the 1850s, people who came to **Tumby Bay** were carried ashore from sailing boats, to an area that comprised sandhills, scrub and “wurlies”. There were no regular services, and boats called only when there was cargo offering. By the time the jetty was built in 1874, there was still no sign of a permanent settlement. There is an old tram at the end of the jetty, that was originally used to take bags of wheat from the drays to the boats berthed at the end of the pier. The low rainfall in the area meant that the European population in the area grew very slowly. It wasn’t until 1900 that the town was gazetted and even then it was really only a port where supplies could be landed and bags of grain could be shipped out (Fairfax Publishing – F2, 2001).

Sir Joseph Banks Group: Apart from shipwrecks (see above), some of the numerous historic sites that are present on islands in the **Sir Joseph Banks Group** have maritime connections. Examples include lighthouses, guano mines (e.g. on **Sibsey, Marum, Langton** and **Winceby Islands**) and fishermen’s huts (e.g. **Lusby Island**, and others). Full details of the heritage significance of remains on the islands are available from the Australian Heritage Commission.

Wilderness / Aesthetic Values

The **Sir Joseph Banks Group** has been described as “beautiful” and as having “pretty bays” and “wonderful reefs” (Australian Explorer, 2003). The group has been described as a “beautiful chain of islands” with “lovely sheltered bays, golden sandy beaches and reefs, teeming with marine life” (LEEP-Land Tourism Association, 2003). **Reevesby Island** has been described as having “picturesque settings, pristine beaches and crystal clear water” (Tumby Bay Telecentre, 2000).

The waters in the **Sir Joseph Banks Group** area are renowned for their clarity, an attribute recognised by divers and boaters who use the area. The water clarity of the area is promoted in regional tourism promotion materials, and dive guides to South Australian sites.

Tumby Bay is described by Eyre Peninsula tourism materials as an “attractive”, “charming” and “pretty” area. Tourism materials promote the “beautiful beaches” and “beautiful clear water of the bay”. At **Tumby Bay**, the **Island Lookout** provides “spectacular, panoramic views” of the offshore islands, foreshore, jetties and beaches, and the **Mine Hill Lookout** overlooks the Tumby Bay coastline (Australian Tourism Net, 2001; Eyre Peninsula Tourism Association web site, 2001; LEEP-land Tourism Association, 2003).

North of Tumby Bay, the coast has been described as “rugged and beautiful” (LEEP-land Tourism Association, 2003). South from **Tumby Bay** is a scenic drive, along the coastline past **Second Creek** and **Trinity Haven** to **Red Cliffs** and **Thuruna**. Features of the drive include “secluded sandy beaches, sheltered bays, interesting rock formations and excellent fishing spots” (Eyre Peninsula Tourism Association web site, 2001).

Towns and Settlements

Tumby Bay: The population is reported to be around 1,228 (ABS statistic, 2001), with approximately 2,700 in the council district (Local Government Association web site, 2001). However, during the summer holiday season, the population increases due to tourism / temporary visitors. It is possible that population will increase during the early 2000s, due to the recent construction of a marina and associated waterfront housing.

Other Information

According to the Spencer Gulf Aquaculture Management Plan (Aquaculture Group – PISA Fisheries, 1996), **Tumby Bay** is one part of a main circuit for maritime traffic in the Spencer Gulf area.

In 2003, the Tumby Bay District Council enforced a commercial net fishing ban the **Tumby Bay** district. Commercial fishing was banned from the inner part of Tumby Bay during the 1990s, inner part of Tumby Bay, but the Council has temporarily extended the ban to all waters in the district, following concern that commercial power hauling and netting in the area may deplete fish stocks, and adversely affect the tourism industry and the residential value of the region, which rely heavily on recreational fishing. During 2003, **Tumby Bay** was one of the areas being considered in a commercial fisheries policy review (Ewendt, 2003).

Between 1942 and 1944, **Langton Island** in the Sir Joseph Banks Group was mined for the mineral wolfram, a source of tungsten, and the small deposit was completely removed (Robinson *et al.*, 1996).

There is an 8m high lighthouse on **Winceby Island**, which is designated as a Lighthouse Reserve, and excluded from the Conservation Park (Robinson *et al.*, 1996).

The SA government issued a Petroleum Exploration Licence for Spencer Gulf (PISA fisheries – Aquaculture Group, 1997). The granted exploration area covered 5597 square km of southern Spencer Gulf, but excluded the Sir Joseph Banks Group. The western border of the exploration area was approximately 12km - 13km east of the nearest islands in the Sir Joseph Banks Group (i.e. Boucat and Spilsby Islands). The licence was due to expire in 2000 (South Australian Coast and Marine Atlas, 2001).

South-western Spencer Gulf waters contain shipping lanes which are designated by Transport SA and Flinders Ports as exclusion zones, in which activities such as aquaculture are not permitted (PIRSA, 2002d). Port Lincoln is one of the busiest ports in South Australia, and the facilities there serviced 92 international vessels during 1999/2000, shipped more than 100 million tonnes of exported produce, and more than 200,000 tonnes of imported goods (PIRSA, 2002d). There are two major shipping lanes, east of Point Boston and east of Cape Donington. These two lanes meet further seaward, near **Sibsey Island**. According to PIRSA (see Figure 4 and Table 1 in PIRSA, 2002f), the most easterly boundary in the vicinity of the Sir Joseph Banks Group, where the two shipping lanes meet, has the following co-ordinates: 604990E, 6167318N; and 609433E, 6162972N.

9.1.7 Neptune Islands Group (Eyre Bioregion)

Commercial Fishing

Scalefish and Sharks

No information that is specific to the Neptune Islands area is available for this report. Regionally, the major commercial fish and shark species that are caught south of Spencer Gulf (i.e. around the Gambier Isles, Neptune Islands, Thistle Island, and north-western and western Kangaroo Island) include School Shark and Gummy Shark (which dominate the commercial fish/shark yields from the area), and Ocean Leatherjacket (particularly during the early and mid 1990s, however catches have declined during the past decade – see Knight *et al.*, 2002). Bronze Whaler sharks, Red Snapper (Redfish), Blue Morwong, King George Whiting, and Blue Groper are also caught in the area, and other species in minor quantities (see **Part 1** of this table).

According to SARDI (cited by Edyvane, 1999b), the catch from GARFIS Block 39 (bottom of Spencer Gulf = 35° S, southwards to south-western Kangaroo Island to latitude 36° S, and spanning between 136° E and 137° E, with the exclusion of north-western Investigator Strait and the western foot of Yorke Peninsula) is as follows: In 1995/96 a total of 66,188kg (0.64% of State total, representing 21 fishers); in 1996/97 a total of 86,753kg (0.86% of State total, representing 31 fishers). Note that this figure encompasses a large area between southern Spencer Gulf and south-western Kangaroo Island, and is therefore unlikely to adequately reflect the scalefish and shark fishing yields from the Neptune Islands.

On a Statewide scale, aggregated catch figures for all GARFIS Fishing Blocks in South Australia, between 1995 and 1997, show that the bottom of Spencer Gulf to western Kangaroo Island, and including islands (Fishing Block 39) was ranked 28th in 1995/96, and 23rd in 1996/97, in the list of fishing yields from 58 South Australian fishing blocks, at that time. However, in some recent years, the area encompassed by Fishing Block 39 has been amongst the top 10 in the State, in terms of school and Gummy Shark yields.

South, south-west and west of the Neptune Islands, part of the Commonwealth SESSF (formerly called the Southern Shark and South East Non-Trawl fisheries) operates over a broad area in Commonwealth waters. The fishery is not discussed here, however information on species caught in the fishery is discussed for **Locations 12a, 16** and **17** of this report.

Abalone Fishing

Aggregated figures (approximate whole weight) for the area are provided: for Neptune Islands, between the years 1990 and 1996, recorded annual yield of Greenlip Abalone fluctuated between less than 1t and approximately 7.3t. Yield of Blacklip Abalone fluctuated between 0kg and approximately 2.5t (S. Shepherd, pers. comm., 2000).

The 1994/95 greenlip yield (7.31t) represented 3.2% of the total Western Zone Greenlip Abalone catch, or 1.94% of the total State catch. The 1994/95 Blacklip Abalone yield (1.04t) represented 0.3% of the total Western Zone blacklip catch, or 0.21% of the total State catch (Edyvane 1999). The 1995/96 Greenlip Abalone yield (687kg) represented 0.3% of the total Western Zone catch, or 0.18% of the total State catch (Edyvane, 1999b).

Rock Lobster Fishing

No information specific to the Neptune Islands is available. The area discussed here is part of Fishing Block 39, which includes Gambier Isles, Neptune Islands, southern part of Thistle Island, western and north-western Kangaroo Island, and all waters in between. Fishing Block 39 is one of the two fishing blocks in the Northern Zone in which catch has consistently been higher than that from other Northern Zone fishing blocks, in almost all years since 1970 (see Ward *et al.*, 2002, Figure 2.5). Catches have been higher than around 120t per annum in Fishing Block 39, in at least 25 of the years since 1970, up till the late 1990s, and corresponding effort has been higher than 100,000 potlifts per annum in almost of those years. Catch peaked at over 200t per annum in three years (1987, 1991, 1999). During the late 2000 and 2001, both catch and effort decreased - approximate catch in 2001 was around 85 tonnes in Fishing Block 39, for an effort level of around 100,000 potlifts (according to Figure 2.5 in Ward *et al.*, 2002). Note that these figures encompasses a large area between southern Spencer Gulf and south-western Kangaroo Island, and are therefore do not reflect the Rock Lobster fishing yields specifically from the Neptune Islands area. An indication of the significance of the catch from fishing Block 39, relative to other fishing blocks in South Australia, is provided in Edyvane 1999 (citing SARDI data): In

1995/96 and 1996/97, the total of 108,867kg and 136,826kg respectively, from Block 39 comprised around 2.1% to 2.76% of State total, representing the catch of between 47 and 51 fishers. Aggregated catch figures for all fishing blocks in South Australia, between 1995 and 1997, showed that Fishing Block 39 was the 8th most important commercial lobster fishing area in South Australia at that time, in terms of yield.

When the entire Northern Zone is considered as a whole (i.e. from the Western Australian border, through to Encounter Bay and deeper waters south of Kangaroo Island), the catch for the 2002 season was 594.8 tonnes, being the lowest catch in the Northern Zone since 1979 (Ward *et al.*, 2003).

Rock lobster bycatch information specific to the Neptune Islands area is not available for this report. However, McGarvey *et al.* (1998) and Prescott (2001) recorded that the largest proportion of bycatch in the Northern Zone as a whole is leatherjackets and octopus. According to the results of a sampling program of bycatch in 1991 and 1992, various wrasse species (Labridae family) together constituted another major component of the bycatch in the Northern Zone e.g. 1127 Labrids caught in pots during the bycatch sampling program in 1991-92 (Table 5 in Prescott, 2001). Octopus are a major predator of Rock Lobster, with losses due to octopus predation equating to approximately 4% of the total number of lobsters landed (in the Northern Zone). According to McGarvey *et al.* (1998), the catches and catch rates of octopus have been sustained over time, and vary from 1 – 2.5 octopuses per 100 potlifts. Octopus that are caught in the northern zone are sold.

Rock Lobster fishers are also permitted to retain legal sized Giant Crab when caught as by-product, and this species is becoming increasingly valuable, commercially (McGarvey *et al.*, 1998). A small number of Commonwealth-endorsed Rock Lobster fishers also target Giant Crab specifically. Between 1992/93 and 2001/02, total Giant Crab catches (target and byproduct catches combined) have ranged between 7t in 1992/93, and 33t in 1998/99, with a steady decline between 1999 and 2002 due to the introduction of quotas (e.g. 31t in 1999/00; 24t in 2000/01, and 18.5t in 2001/02) (Knight *et al.*, 2003, cited by Sloan, 2003b). The fishery now operates under a quota-based management system with a total allowable commercial catch (TACC) of 13.4 and 8.7 tonnes for the Northern Zone and Southern Zone, respectively (Sloan, 2003b). Giant Crabs are caught from the edge of the continental shelf in the west coast region (McGarvey *et al.*, 1998).

Predators of Rock Lobster in the Northern zone include New Zealand Fur Seals, Western Blue Groper (minor) and Maori Octopus (McGarvey *et al.* 1998; S. Shepherd, pers. comm., 2004).

Recreational Fishing

Tall ship charters provide fishing trips to the **Neptune Islands** (e.g. South Neptune). Examples of fish caught include reef species such as large Western Blue Groper, Blue-throated Wrasse and other wrasse species, Snapper, trevally, Blue Morwong, and Redfish ("red Snapper"). Large whiting are also caught in the area. Examples of other species caught include Yellow-tail Kingfish, Swallowtail, Barracouta, Mackerel, Rock Cod, Sergeant Baker (the latter being an example of some of the deeper water reef fish species that are caught but not targeted).

A reef described as a "6 metre rock" is marked by *Fish SA* as a recreational fishing location, south-east of North Neptune Island, outside of the marine extension of the conservation park. Few recreational fishers visit the Neptune Islands due to the relative inaccessibility of the area, and the dangerous sea conditions. It is not known for this assessment whether tour groups visiting the Neptunes for shark viewing engage in recreational fishing in the inshore area. *No other information is currently available.*

Diving / Recreation / Tourism

Neptune Islands is the major site of dive charter services that offer cage-viewing of Great White sharks. Shark viewing expeditions have been for several decades, and attract international, national and State tourists. According to dive promotional materials (e.g. *Diving in Australia*), more than 100 shark-viewing expeditions to the Neptunes have occurred to date. One of the major tour operators provides seven trips per annum, each of approximately 7 - 9 days duration.

Diving/snorkelling with seals also occurs as part of shark-viewing tourism charters, according to shark diving tourism promotion materials.

Shore visits to the Neptune Islands also occur during shark-viewing tourism charters, so that visitors may

observe fur seal colonies.

There is little other recreation in the area due to the remoteness of the islands and the oceanically- exposed nature of much of the area, although sea kayak trips to the Neptune Islands are occasionally undertaken by sea canoe clubs.

Historic / Protected Shipwrecks

Frances, wooden cutter built 1839, wrecked 1840 at South Neptune Island. Protected under the *Commonwealth Historic Shipwrecks Act 1976*, but not found.

Other European Heritage

Some terrestrial features are listed on the *State Heritage Register* (i.e. South Neptune Island Lighthouse Complex, which includes foundations, buildings, lighthouse foundations and other structures, and the jetty) (PISA Fisheries - Aquaculture Group, 1996; DEH, 2003f).

Aboriginal Heritage

Not known for this report. It is noted that mapping of the geographical distribution of Native Title claims lodged in 1996 and 1997 for southern Eyre Peninsula (i.e. Barngarla and Nauo), does not include the Neptune Islands (S.A. Coast and Marine Atlas, 2001).

Scientific Research

Population studies of Great White Shark are undertaken, including work at international, national and state levels (e.g. Cousteau Society, university researchers from North America, CSIRO, SARDI etc). Shark research at the Neptunes has significantly contributed to knowledge of shark population dynamics and behaviour during the past 3 decades. Recent work at Neptune Islands has included white shark tracking using electronic archival tags (CSIRO and National White Shark Research Group's project, 1999). Satellite monitoring of sharks is currently being undertaken by CSIRO, and the Neptune Islands is likely to be a major site for this work.

Populations of Australian Sea Lion, New Zealand Fur Seal (e.g. by CSIRO Wildlife and Ecology staff), abalone and Southern Rock Lobster are also monitored at the **Neptune Islands**.

Marine Education

White Shark viewing activities at the Neptune Islands have attracted shark film-makers and photographers, marine researchers, nature and tourist writers and photographers for several decades. The activities at the Neptune Islands are considered by some (e.g. Fox, submission to SA Department of Fisheries, 1992) to have significantly contributed to worldwide knowledge of shark physiology and behaviour, because film, video, television and print media associated with shark viewing and research activities at the Neptune Islands, have reached a very large global audience (in the millions).

9.1.8 Gambier Islands Group (Eyre Bioregion)

Aquaculture

The Gambier Island Group has been excluded from consideration in the Spencer Gulf Aquaculture Management Plan (PIRSA 1996). PIRSA considered that aquaculture development around these islands may have the potential to disturb seabird breeding colonies, and that fin fish culture may also have potential to negatively impact on resident sea lion colonies (e.g. entanglement in nets, and habituation to caged fish as food sources). Resident sea lions may also negatively impact aquaculture operations in the area, as predators of the stock. PIRSA also considered the area unsuitable for aquaculture due to remoteness from

shore-based facilities, deep waters and exposure to waves and swell. In light of these factors, PIRSA (1996) recommended that licences not be issued for aquaculture within two nautical miles of the Gambier Islands.

Commercial Fishing

Scalefish and Sharks

There is no specific information for the Gambier Islands area available for this report. Regionally, the major commercial fish and shark species that are caught south of Spencer Gulf (i.e. in the area that encompasses the Gambier Isles, Neptune Islands, Thistle Island, and north-western and western Kangaroo Island) have traditionally included *School Sharks* and *Gummy Sharks*, and *Ocean Leatherjacket*. School and Gummy Sharks dominated the commercial fishing yields from the area during the mid to late 1990s, however the fishery has recently been re-regulated by the Commonwealth, particularly in light of declining School Shark populations in south-eastern Australia (see Section 9.2, and references by AFMA in bibliography). *Bronze Whaler sharks*, *Red Snapper (Redfish)*, *Blue Morwong*, *King George Whiting*, and *Western Blue Groper* are also caught in the area. Both line fishing and netting occur in the area, but netting is prohibited between Wedge and North Islands (see **Legislated Conservation Measures** below).

The Gambier Isles are included as part of GARFIS Fishing Block 39 (i.e. bottom of Spencer Gulf - 35° S, southwards to south-western Kangaroo Island - 36° S latitude, and spanning between 136° E and 137° E, with the exclusion of north-western Investigator Strait and the western foot of Yorke Peninsula). According to SARDI data (cited by Edyvane 1999), the catch from GARFIS Block 39 during 1995 – 1997 was as follows: In 1995/96 a total of 66,188kg (0.64% of State total, representing 21 fishers); in 1996/97 a total of 86,753kg (0.86% of State total, representing 31 fishers). Note that this figure encompasses a large area between southern Spencer Gulf and south-western Kangaroo Island, and is therefore unlikely to adequately reflect the scalefish and shark fishing yields from the Gambier Islands, but is provided as a regional indicator of fishing.

On a State-wide scale, aggregated catch figures for all GARFIS Fishing Blocks in South Australia during 1995 - 1997, showed that the bottom of Spencer Gulf to western Kangaroo Island, and including islands (Fishing Block 39) was ranked 28th in 1995 - 96, and 23rd in 1996 – 97, in the list of fish and shark yields from 58 South Australian fishing blocks. However, in some years during the 1990s, the area encompassed by Fishing Block 39 was amongst the top 10 fishing blocks in the State, in terms of school and Gummy Shark yields.

Abalone Fishing

Between 1990 and 1996, recorded annual yield of Greenlip Abalone from around **Gambier Islands** fluctuated between approximately 3t and 10.7t. Yield of Blacklip Abalone during this period of time was variable, fluctuating between approximately 0kg and 1.1t, although slightly higher yields (e.g. > 2t) have been recorded in other years (Shepherd, SARDI, pers. comm., 2000). Edyvane (1999b) reported that the Greenlip Abalone catch from the Gambier Islands was 7230 kg in 1994/95 and 6312 kg in 1995/96 (representing 3.2% and 2.8% respectively of the Western Zone catch, or 1.92% and 1.69% of the entire State yield for those years). Note that annual Greenlip Abalone yields from **Wedge Island** have been increasing since 1979 (up to 88% increase by 1998, as a percentage of the original production, according to Shepherd and Rodda, 2001). PIRSA (1996) considered the waters surrounding **Wedge Island** to be important to the commercial abalone fishery. According to Mayfield *et al.* (2001), the Gambier Islands are one of the fishing areas in the Central Zone in which fishing effort has exceeded an average of 30 trips per year, between 1988-1992 and 1996-2000.

Rock Lobster Fishing

There is an anchorage at **Wedge Island** for Rock Lobster fishing boats, which work in the area (PIRSA 1996).

No catch and effort information specific to the Gambier Islands is available for this report. The area discussed here is included in Fishing Block 39, which includes Gambier Isles, Neptune Islands, southern part of Thistle Island, western and north-western Kangaroo Island, and all waters in between. Fishing Block 39 is one of the two fishing blocks in the Northern Zone in which catch has consistently been higher than that from other Northern Zone fishing blocks, in almost all years since 1970 (see Ward *et al.*, 2002, Figure 2.5). Catches have been higher than around 120t per annum in Fishing Block 39, in at least 25 of the years since 1970, up till the late 1990s, and corresponding effort has been higher than

100,000 potlifts per annum in almost all of those years. Catch peaked at over 200t per annum in three years (1987, 1991, 1999).

During the late 2000 and 2001, both catch and effort decreased - approximate catch in 2001 was around 85 tonnes in Fishing Block 39, for an effort level of around 100,000 potlifts (according to Figure 2.5 in Ward *et al.*, 2002).

Note that the figures cited above encompass a large area between southern Spencer Gulf and south-western Kangaroo Island, and therefore do not reflect the Rock Lobster fishing yields specifically from the Gambier Islands area. An indication of the significance of the catch from Fishing Block 39, relative to other fishing blocks in South Australia, is provided in Edyvane 1999b (citing SARDI data): In 1995/96 and 1996/97, the total of 108,867kg and 136,826kg respectively, from Block 39 comprised around 2.1% to 2.76% of State total, representing the catch of between 47 and 51 fishers. Aggregated catch figures for all fishing blocks in South Australia, between 1995 and 1997, showed that Fishing Block 39 was the 8th most important commercial lobster fishing area in South Australia during that period, in terms of yield.

When the entire Northern Zone is considered as a whole (i.e. from the Western Australian border, through to Encounter Bay and deeper waters south of Kangaroo Island), the catch for the 2002 season was 594.8 tonnes, being the lowest catch in the Northern Zone since 1979 (Ward *et al.*, 2003).

Bycatch information specific to the Gambier Islands is not available for this report. However, McGarvey *et al.* (1998) and Prescott (2001) reported that the largest proportion of bycatch in the Northern Zone as a whole, is Leatherjacket species, and Maori Octopus. According to the results of a sampling program of bycatch in 1991 and 1992, various wrasse species (Labridae family) together constituted another major component of the bycatch in the Northern Zone e.g. 1127 Labrids caught in pots during the bycatch sampling program in 1991-92 (Table 5 in Prescott 2001). Octopus are a major predator of Rock Lobster, with losses due to octopus predation equating to approximately 4% of the total number of lobsters landed (in the Northern Zone). According to McGarvey *et al.* (1998), the catches and catch rates of octopus have been sustained over time, and vary from 1 – 2.5 octopuses per 100 pot lifts. Octopus that are caught in the northern zone are sold.

Rock Lobster fishers are also permitted to retain legal sized Giant Crab when caught as by-product, and this species is becoming increasingly valuable, commercially (McGarvey *et al.*, 1998). A small number of Commonwealth-endorsed Rock Lobster fishers also target Giant Crab specifically. Between 1992/93 and 2001/02, total Giant Crab catches (target and byproduct catches combined) have ranged between 7t in 1992/93 and 33t in 1998/99, with a steady decline between 1999 and 2002 due to the introduction of quotas (e.g. 31t in 1999/00; 24t in 2000/01, and 18.5t in 2001/02) (Knight *et al.*, 2003, cited by Sloan, 2003b). The fishery now operates under a quota-based management system with a total allowable commercial catch (TACC) of 13.4 and 8.7 tonnes for the Northern Zone and Southern Zone, respectively (Sloan, 2003b). Giant Crabs are caught from the edge of the continental shelf in the west coast region (McGarvey *et al.*, 1998).

Some Rock Lobster fishers net sharks out of season, and some of these activities require a Commonwealth permit. Licensed Rock Lobster fishers have also had access to fish species, such as Australian Salmon, Mulloway, and Snapper (Zacharin 1997, cited by McGarvey *et al.* 1998).

Predators of Rock Lobster in the Northern zone include New Zealand Fur Seals, Western Blue Groper (minor) and Maori Octopus (McGarvey *et al.* 1998; Shepherd, pers. comm., 2004).

Prawn Fishing

The Gambier Isles are within prawn fishing Block 97, however prawns are not fished around the Gambier Islands (see DEH 2003, Figure 14). The closest prawn fishing area to the Gambier Islands is fishing Block 98, which encompasses waters North East of **Thistle Island**, in the vicinity of one of several major prawn trawling grounds for the Spencer Gulf prawn fishery (see Figure 1 and page 7 in Macdonald 1998; Prawn Fishermen's Association web site; and DEH 2003, Figure 14).

Recreational Fishing

Both private and charter boats (e.g. charters from Kangaroo Island and Yorke Peninsula) and tall ships visit the Gambier Islands for fishing, and recreational diving for Rock Lobster and abalone also occurs.

Fishing occurs from the beach at Wedge Island, the rocks and rock platforms, and from boats, according to tourism and fishing promotion materials, and unpublished recreational fishing records.

There is also a charter plane company that runs fishing trips to **Wedge Island**.

Game fishers also visit the area, to catch and tag Southern Bluefin Tuna and other gamefish.

Major species targeted by recreational fishers and charters visiting the Gambier Islands area and surrounding waters include whiting, Southern Calamari, West Australian Salmon, Snapper, Redfish, Blue Morwong, Samson Fish, Yellow-tail Kingfish, sweep species, Trevally, flathead species, Western Blue Groper and other wrasse species, Rock Lobster, and abalone. Examples of other species caught that are not targeted include Swallowtail, various Leatherjacket species, and other reef fish such as Sergeant Baker.

Redfish (i.e. Red Snapper, or “nannigai”) and Blue Morwong are caught mainly in the deeper waters (e.g. 30 - 50+m) off the islands. Large schools of Redfish in the area are popular targets for charter boat fishers, according to regional tourism and fishing promotional materials.

The bay at **Wedge Island** is considered to be “a popular anchorage” for fishing boats (Robinson *et al.*, 1996)

Away from the islands, recognised fishing marks listed by Fish SA include a location approximately 6km south-west of **South-west Rocks**, and a location approximately 7.5km south east of Peaked Rocks.

Diving

Wedge Island is listed in DIASA’s (undated) guide to the best dive sites in S.A, and Christopher’s (1988) divers’ guide to S.A., and in more recent on-line diving guides to SA (e.g. Dive Oz dive site directory 1998-2003, and Aquanaut, undated) and other dive promotion materials. Diving at the Gambier Islands has been described as “spectacular” (Dive Oz, 1998-2003). Charter vessels and tall ships visit the **Gambier Islands** for diving, snorkelling and swimming. There are dive charter trips to the wreck of the *Glenpark* (see Dive Oz, 2003). The submarine caves at **Wedge Island** are also known to cave divers. Tourism materials promote the clear water and “pristine” nature of the diving at the Gambier Islands.

Other Recreation / Tourism

Wedge Island is privately owned and part of the island operates as a tourist resort. There are charter trips to **Wedge Island** for fishing, diving and snorkelling, swimming, beach walking, and sightseeing etc, through plane and yacht charter companies. The bay at **Wedge Island** is considered to be “a popular anchorage” for cruising yachts (Robinson *et al.*, 1996). Sea canoe clubs also have trips to **Wedge Island**.

Historic / Protected Shipwrecks

- ♦ *Glenpark*, 3-masted steel ship built 1897, wrecked 1901, approximately 5km North of **North Islet**. The figurehead (removed from the site) has been declared a *Historic Relic* under State legislation. (State Heritage Branch, DEP, undated). *Glenpark* is protected under *Commonwealth Historic Shipwrecks Act 1976*, according to S.A. Coast and Marine Atlas, 2001.
- ♦ *Stranger*, wooden cutter built 1884, wrecked 1898 on the southern side of Wedge Island. Protected under Commonwealth Historic Shipwrecks Act 1976, but has not been found.
- ♦ *Albatross*, wrecked 1937, is of the age to be classified as historic, but has not been found and is not protected.

According to PIRSA (1996), the wreck of the *Frances* is located in the easterly bay of one of the Gambier Islands (601485 E, 6089404 N). It sank in August 1840 and is protected under the *Commonwealth’s Historic Shipwrecks Act 1976*.

Other European Heritage

Much of the relevant European heritage of the Gambier Islands is terrestrial, relating to the pastoral use of

Wedge Island during the past 135 years.

There is a lighthouse on the south-east point of Wedge Island, but its heritage significance is not known for this assessment.

Aboriginal Heritage

Not known for this area, for this report.

Scientific Research

Populations of Australian Sea Lion and New Zealand Fur Seals are monitored in the area (Gales *et al.*, 1994; Shaughnessy *et al.*, 1996, Shaughnessy, 2002). Other monitoring work has included abalone catch data (e.g. Shepherd and Rodda, 2001) and Rock Lobster. The State government (e.g. SARDI, and the former Department of Fisheries) has conducted a number of research projects in regards to scalefish in the area (e.g. fish tagging during the 1970's, fish population dynamics research in the late 1990s, such as King George Whiting spawning population research - see Fowler and McGarvey, 1997, for example).

Wilderness / Aesthetic Values

The area is promoted for coastal sightseeing by various tourism materials, due to coastal views (cliffs; island views etc).

Mining

No mining leases are known for the area, for this report. The nearest exploration licence location has a south-western boundary that is approximately 25km North of **North Islet**, and the licence expired in 2000 (PIRSA map of exploration leases, in SA Coast and Marine Atlas databases, 2001).

Other Uses

The **Wedge Island** and **North East Rock** area is periodically used for bombing by the Royal Australian Air Force, and public access is restricted in this area during these times (PIRSA, 1996) (see section on **Issues for Risk and Impact Assessment**).

There is a considerable amount of maritime traffic moving in and out of Spencer Gulf, and across to Port Lincoln, but the extent of shipping and boating traffic in the vicinity of the Gambier Islands are is not known for this report.

Other Information

Access to **Wedge Island** is available by charter plane, and by boat at the jetty facilities on the north coast.

9.1.9 Franklin Harbor and Surrounding Waters (Spencer Gulf/North Spencer Gulf Bioregions Boundary)

Aquaculture

Oysters

Franklin Harbour is one of several major regions for commercial oyster growing in South Australia (Morelli and de Jong, 1995; PIRSA Aquaculture website, 2002). Aquaculture development in the Franklin

Harbour area has occurred since approximately 1988. Intertidal farming of Pacific Oysters is the primary aquaculture activity in the Franklin Harbour area (Smallridge, 1995), and finfish farming is a new industry in the area. The District Council of Franklin Harbour has been involved with planning approval for aquaculture development in the region. The largest oyster leases are situated on the southern side of the Harbour, which is more productive for oyster culture (Smallridge, 1995). This area comprises around 2,200ha and (during the early-mid 1990s), had a “virtual complete cover of seagrasses” (Smallridge, 1995). The other region within the bay, the North Eastern Basin, comprises around 2,400 ha. Oyster farmers considered that this sub-zone did not have the same potential for oyster farm development as the southern zone. The two sub-zones together comprise the Franklin Harbour Aquaculture Zone.

The District Council allocated a total area for development of 112.5 hectares (Smallridge, 1995) or 119.5 hectares (Aquaculture Group - PISA Fisheries, 1996) as an upper limit, within which leases could be allocated. An additional 5ha of leases for non-filter feeding organisms were to be allocated under the PISA plan, following successful research and development lease site operation.

The majority of approved oyster leases are in the South Western Basin (Smallridge, 1995), which amounted to 114.5ha during the late 1990s (Edyvane, 1999b). In 1995, only 22.5 ha of intertidal leases had been approved in the North Eastern Basin. The specifications for lease allocation and relocation were discussed in Smallridge (1995) and Aquaculture Group - PISA Fisheries (1996). Under the zoning scheme devised during the 1990s, licences would not be granted adjacent to the town of Cowell, nor the harbour entrance or the shipping channel.

According to the *Franklin Harbour Development Plan* (Planning S.A., 2000), the District Council of Franklin Harbour proposes to “undertake a redrafting of the sections of the *Development Plan* relating to shellfish cultivation and other aquaculture, after the completion of a management study into shellfish cultivation and aquaculture in Franklin Harbour, proposed to be conducted jointly by (PIRSA and Planning S.A)”.

Knight *et al.* (2002) provided oyster production figures for **Franklin Harbour**. Around 573 thousand dozen oysters from Franklin Harbour production were sold in 2000/2001. During that time, around 13,582,311 Pacific Oysters were imported as spat for grow-out at Franklin Harbour (Knight *et al.* 2002). Madigan and Clarke (2000) reported that annual production of adult oysters, in terms of dozens, between 1995 and 1999 was as follows for **Franklin Harbour**: in 1995 and 1996, annual production was slightly over 200,000 dozens; in 1997 production was over 350,000 dozens; in 1998 production was over 450,000 dozens, and in 1999, around 350,000 dozens. Import of oyster spat has increased for the **Franklin Harbour** area during the 1990s, from less than 4,000,000 during the early 1990s, to more than 13,000,000 in 1997, and around 9,000,000 in 1999 (Madigan and Clarke, 2000).

According to PIRSA Aquaculture’s Public Register (August, 2003) and the S.A. Coast and Marine Atlas (March, 2003), 23 oyster leases are currently operating in the **Franklin Harbour** area, including 2 leases near the entrance, off **Victoria Point**. The number of oyster leases in the area has increased since 1995, when there were 13 leases operating in the **Franklin Harbour** area (Smallridge, 1995). There are also 3 oyster leases in the **Shoalwater Point** area (PIRSA Aquaculture Public Register, August 2003). There have been at least 9 relocations in the Franklin Harbour area since 1988 (South Australian Coastal and Marine Atlas March 2001 and 2003).

During the early 2000s, there was interest expressed by industry, in expanding aquaculture production in the area, including waters outside the harbour (e.g. **Lucky Bay**), which prompted technical investigations of the potential of the area to support subtidal shellfish production.

Finfish

In the recent past, Snapper have been grown out in cages in **Franklin Harbour** (see PIRSA, 2002a). There are finfish cages for Snapper and Tommy Ruff in the northern part of Franklin Harbour (South Australian Coast and Marine Atlas, 2003), and other applications have been received by government during the late 1990s – early 2000s, for finfish cages outside the harbour. Apart from Snapper grow-out facilities, **Franklin Harbour** now receives Yellow-tail Kingfish fingerlings from the hatchery at Port Augusta, for grow-out in Franklin Harbour area (see PIRSA, 2002b).

PIRSA (2002c) stated that interest in culturing Snapper is now declining, due to increased success in grow-

out of faster growing finfish species (e.g. Yellow-tail Kingfish).

In deeper water outside of **Franklin Harbour** (approx. 15m deep, and around 3 nautical miles from the coast, according to S.A. Coast and Marine Atlas, 2003), a Yellow-tail Kingfish cage lease site has been approved. There is also an approved Kingfish cage lease south of **Point Germein** (S.A. Coastal and Marine Atlas, 2003), and a number of approved sites for caged fish aquaculture between **Point Gibbon** and Cape Driver (e.g. Mills Beach and Arno Bay area – leases for Mulloway, Snapper, Yellow-tail Kingfish and Bluefin Tuna (South Australian Coast and Marine Atlas, 2003). According to the PIRSA Aquaculture Public Register (August, 2003), the two licences operating in the **Franklin Harbour** area have Australian Herring (Tommy Ruff), Snapper and Yellow-tail Kingfish endorsed for grow-out, and King George Whiting is also an approved species for one of the two current grow-out leases. PIRSA's Aquaculture Public Register (August, 2003) also reported that the finfish grow-out cage facilities in the **Port Gibbon** area, have the following species endorsed on the licence: Black Bream, Mulloway, Snapper and Yellow-tail Kingfish.

Previously, the Spencer Gulf Management Plan (Aquaculture Group - PISA Fisheries, 1996) provided for a maximum of 40ha of aquaculture development in the **Shoalwater Point Zone**, which is defined as the waters extending from the northern council boundary near **Munyaroo Conservation Park**, south to **Germein Point**, at the entrance of **Franklin Harbour**, covering waters to three nautical miles offshore. It comprises all waters within the following points: 721246 E, 6309918 N; 726848 E, 6308038 N; 686203 E, 6260528 N; 682280 E, 6264457 N; 684272 E, 6266255 N and the boundaries of the Franklin Policy Area (See Map OC(SG)/3 in Aquaculture Group – PISA Fisheries 1996). Licences may be issued within this area, except within 1.5 miles of the submarine cable 704176 E, 6272700 N to 740586E, and 6248180 N, in which structures are not permitted. The Spencer Gulf Management Plan provided for a maximum of 40 ha of aquaculture development in the **Point Gibbon Zone**, which is defined as the waters extending from **Germein Point** at the southern portion of the entrance to **Franklin Harbour** to the southern most council boundary, adjacent **Poverty Bay**. The Zone extends to three nautical miles offshore, and comprises waters bounded by the following points: 682280 E, 6264457 N; 686203 E, 6260528 N; 658885 E, 6246356 N; 654877 E, 6250384 N and the boundaries of the Franklin Policy Area (Map OC(SG)/3). Licences may be issued within this area, except a 1km sub-zone between **Germein Point** and **Point Gibbon**, which is considered to be of high recreational value and use (Aquaculture Group - PISA Fisheries 1996). The recreation zone comprises waters one kilometre seaward of mean spring high water mark between the following points: 666690 E, 6258100 N; 667639 E, 6257253 N; 682280 E, 6264457 N; and 682987 E, 6263750 N.

Commercial Fishing

Scalefish, Sharks and Minor Invertebrates

Tourism promotion material describes Franklin Harbour as having “a profitable fishing industry”.

The main species caught commercially in the **Franklin Harbour area** are:

Blue Swimmer Crab: yields in the low dozens of tonnes per annum have been recorded in some recent years (e.g. mid to late 1990s). Three other fishing blocks in Spencer Gulf and 2 fishing blocks in Gulf St Vincent record larger catches per annum than the annual yield taken from this area;

Garfish: catches of less than 10t were recorded during the mid to late 1990s, however the area was not one of the top 10 fishing blocks in S.A. for Garfish, at that time.

Other scalefish caught commercially in lesser quantities in **Franklin Harbour** include *King George Whiting* and *Tommy Ruff* (= *Australian Herring*) (less than a few tonnes per annum of each species, during the mid 1990s, for example); *Yellow-fin Whiting* and *Snook*. *Southern Calamari* is also caught commercially in the area (in small quantities, by State standards). Minor yields (e.g. less than 1 tonne per annum in some recent years) from Franklin Harbour area include *Leatherjacket* species, *Australian Salmon*, and *Snapper*.

Blood Worms are also commercially fished in Franklin Harbour, particularly the “swarms” that occur in surface waters after the full moon (Westlake *et al.*, 2002).

South-west of Franklin Harbour, to approximately Dutton Bay, major fish species known to be caught commercially in the area include *King George Whiting*, *Garfish*, *Snapper* and *Snook*. Smaller quantities are taken in the area compared with the area North and East of Franklin Harbour (see below).

The area of Spencer Gulf with a northern boundary of approximately Munyaroo Conservation Park and an eastern boundary to the centre of Spencer Gulf, east of Franklin Harbour, includes important fishing areas for *Blue Swimmer Crabs*, *Tommy Ruff*, *Snapper*, *Garfish*, *King George Whiting*, *Giant Cuttlefish*

and *Snook*, all of which are abundant in the area and are regularly taken in significant quantities. In some recent years (e.g. mid-late 1990s), the area has been one of the top 5 fishing blocks in South Australia, in terms of Blue Swimming Crab, Snapper and Tommy Ruff yields.

In the entire “southern Spencer Gulf” region (defined as being South of 34° S), Fowler (2002) reported that the targetted fishery for *Snapper*, using hand lines, has increased annually since 1994/1995. The Snapper catch from southern Spencer Gulf was the highest ever recorded for the region in 1999/2000 and again in 2000/2001 and 2001/2002 (Fowler, 2002; Fowler et al., 2003), due to a strong 1991 year class making its way through the fishery (Fowler, 2000). The commercial Snapper catch from Southern Spencer Gulf in 2000/2001 was around 220t, the majority of which was caught by hand lines (Fowler, 2002). In 2002/2003, the catch rose to 264t, representing about 41% of the entire State catch (Fowler et al., 2003). The sequence of annual catches of Snapper by *hand lining* in Southern Spencer Gulf since 1994/95 is as follows: 14.8t, 29.9t, 32.6t, 57.9t, 84.5t, 130.5t, 179.9t and 222t. Corresponding targetted hand line effort during those years has ranged from 355 boat days in 1994/95, to 821 boat days in 2001/2002. The long line catch is, on average, an order of magnitude lower than the hand line catch in the Southern Spencer Gulf region (e.g. 17.8t in 2000/2001, and 23.9t in 2001/2002). During the period 1999 to 2002, the annual targetted catch from long lining has been the highest ever recorded. Catch rates for both hand lining and long lining during the past few years (i.e. since the late 1990s) have been the highest ever recorded for the Southern Spencer Gulf region. In previous years (e.g. early 1980s), targetted effort was higher for an equivalent yield compared with the present, and catch rates were thus lower during the 1980s than currently (see Fowler, 2002, Table 3.4, and Fowler et al., 2003, Figure 3.5).

Mid western Spencer Gulf contains a significant commercial (and recreational – see section below) fishery for *King George Whiting*. Small fish are caught in the bays (e.g. Franklin Harbour), and larger, older King George Whiting that have moved out of the bays, are targetted in deeper waters.

McGlennon and Kinloch (1998c, Figures 7, 11 and 22) showed, in a comparison of commercial and recreational fishing yields based on a recreational survey conducted during the mid 1990s, that in the mid-west Spencer Gulf area, commercial net and line fishing together accounted for slightly more than three quarters the total catch of *King George Whiting*; commercial net and dab fishing accounted for more than 90% of the total yield of *Garfish* from the region; and commercial net fishing accounted for more than 90% of the total yield of *Tommy Ruff* (= *Australian Herring*) from mid-western Spencer Gulf.

Other species caught in significant quantities in the deeper waters East and North of Franklin Harbour in recent years, include *Yellow-fin Whiting*, *Leatherjacket* species, *Striped Perch* (not a targetted species, but used for bait), and *Southern Calamari*. *Bronze Whaler* and other shark species are also caught in the area. Note, however that this fishing region is larger than either of the fishing areas discussed above, and the majority of the region covers a portion of Spencer Gulf that is not included in the area discussed in this table, but is provided as a regional overview only.

Net fishing is prohibited in all waters inside **Franklin Harbour**, enclosed within a line between the two entrance headlands (**Victoria Point** and **Germein Point**) (PIRSA, 1999).

Shoalwater Point to Germein Point (southern side of Franklin Harbour entrance): Commercial netting occurs in this region in waters less than 5 metres deep (Smallridge, 1995; Aquaculture Group - PISA Fisheries, 1996).

According to SARDI data (Edyvane, 1999b; DEH, 2003a), the Marine Scalefish catch from the region is as follows:

- ♦ GARFIS Block 20 (Franklin Harbour): In 1995/96 a total of 52,098kg (0.50% of State total, representing 10 fishers); In 1996/97 a total of 30,230kg (0.30% of State total, representing 7 fishers). Marine Scalefish and Restricted Marine Scalefish licence holders contribute to these yields. More recently, DEH (2003a, citing SARDI Aquatic Sciences data) reported that the average annual catch in Marine Fishing Area 20 (previously called GARFIS Block 20), over the period 1989 to 1999, was 44.4t. This figure includes fish, sharks, and invertebrates, but excludes Blue Swimmer Crab data from 1997-1999, and excludes the single species fisheries such as prawns, abalone and rock lobster.
- ♦ GARFIS Block 19 (South west of Franklin Harbour, to approximately Dutton Bay): In 1995/96 a total of 17,709kg (0.17% of State total, representing 13 fishers); In 1996/97 a total of 15,119kg (0.15% of State total, representing 10 fishers). Marine Scalefish and Restricted Marine Scalefish licence holders contribute to these yields. The proportion of the above yields that relates specifically to the area described here (i.e. between Point Gibbon and Shoalwater Point) is not known for this report. More recently, DEH (2003a, citing SARDI Aquatic Sciences data) reported that the average annual catch in Marine Fishing Area 19 (previously called GARFIS Block 19), over the period 1989 to 1999, was 14t. This figure includes fish, sharks, and invertebrates, but excludes Blue Swimmer Crab data from 1997-1999, and excludes the single species fisheries such as prawns, abalone and rock lobster.
- ♦ GARFIS Block 22 (The area of Spencer Gulf with a northern boundary of approximately Munyaroo Conservation Park and an eastern boundary to the centre of Spencer Gulf, east of Franklin Harbour): In 1995/96 a total of 268,869kg (2.58% of State total); In 1996/97 a total of 234,084kg (2.31% of State

total). More recently, DEH (2003a, citing SARDI Aquatic Sciences data) reported that the average annual catch in Marine Fishing Area 22 (previously called GARFIS Block 22), over the period 1989 to 1999, was 218.7t. This figure includes fish, sharks, and invertebrates, but excludes Blue Swimmer Crab data from 1997-1999, and excludes the single species fisheries such as prawns, abalone and rock lobster.

Marine Scalefish and Restricted Marine Scalefish licence holders contribute to these yields, but the number of fishers operating in Block 22 is not available for this assessment.

The proportion of the above yields that relates specifically to the area described here (i.e. between Point Gibbon and Shoalwater Point) is not known for this report.

On a State-wide scale, aggregated catch figures for all GARFIS Fishing Blocks in South Australia, between 1995 and 1997, show that:

- ♦ Franklin Harbour (Fishing Block 20) was ranked 34th in 1995/96 and 42nd in 1996/97, in the list of fishing yields from 58 South Australian fishing blocks, at that time;
- ♦ The area south-west of Franklin Harbour, to approximately Dutton Bay (Fishing Block 19) was ranked 49th in both 1995/96 and 1996/97, in the list of fishing yields from 58 South Australian fishing blocks, at that time; and
- ♦ The area North (to approx. Munyaroo Conservation Park) and East (to the centre of Spencer Gulf) of Franklin Harbour (Fishing Block 22) was ranked 10th in 1995/96 and 11th in 1996/97, in the list of fishing yields from 58 South Australian fishing blocks, during that time. Note that this area is larger than either GARFIS Block 19 or 20, and the majority of GARFIS Block 22 covers a portion of Spencer Gulf that is not included in the area discussed in this table.

Prawn Fishing

Waters deeper than 10m, north, east and south of Franklin Harbour, are mapped as the mid-western section of one of the 3 key prawn fishing areas in Spencer Gulf (see map in Macdonald, 1998). Spencer Gulf as a whole, has the largest production of Western King Prawns in Australia (PIRSA, 2003d).

DEH (2003a, Figure 14) reported that the Franklin Harbour area (prawn Fishing Block 115) has been fished in 4 to 6 years out of the past 11 years to 1999/2000, and that the annual yield from the area has been within the range of 6 to 10 tonnes. The deeper waters in mid-Spencer Gulf between Cowell and Wallaroo contain some major prawn fishing blocks (including the "Cowell grounds"). For example, in 2001/02, catches from Fishing Blocks 40, 50 and 51 in the central gulf (in deeper waters east of the Cowell / Franklin Harbour coast) were 41.4t, 38.2t and 32.2t respectively, during the period in which these blocks were opened to fishing (Carrick, 2003).

Prawn fishers in Spencer Gulf are permitted to take Slipper Lobster and Southern Calamari as commercial bycatch during prawn trawling operations (MacDonald, 1998).

Tourism promotion materials describe the **Franklin Harbour** area as having "a profitable prawn fishing industry".

There is an area of permanent closure to prawn fishing in the shallow coastal waters south of Cowell, which aims to protect small prawns that occur there, and juvenile fish (Aquaculture Group - PISA Fisheries, 1996). The prawn fishing blocks directly north and south of Franklin Harbour (i.e. fishing blocks 119/120 and 114, respectively) are reported not to be fished (DEH, 2003a, Figure 14). It is noted that the prawn trawling grounds out of Franklin Harbour are closed in some years (e.g. there was a recent closure in 2002), as a means of protecting small prawns, and optimising the spatial management of prawn fishing effort in the Spencer Gulf fishery (Carrick, 2003).

In general, prawn trawling purportedly does not occur in waters less than 10m deep in Spencer Gulf.

Abalone Fishing

According to Aquaculture Group - PISA Fisheries (1996), Blacklip Abalone are taken from waters along the coastal headland areas of rocky reef to waters 12 metres deep (approximately 100 metres offshore), and there is some fishing effort along the coast of Spencer Gulf to the south of **Shoalwater Point** and Wallaroo, including waters around offshore islands and reefs. Aquaculture Group - PISA Fisheries (1996) also stated that Greenlip Abalone are taken in waters greater than five metres deep out from

Franklin Harbour.

According to figures provided by S. Shepherd (2000, pers. comm.), the **Franklin Harbour** area appears to be a minor fishing area for abalone. Figures were provided for Mapcodes 20A and 20C (Lower West Spencer Gulf, which includes the stretch of coast between Boston Island and Cowell / Franklin Harbour). Reportedly, in all years between 1979 and 1996, less than 250 kg of Greenlip Abalone, and less than 30kg of Blacklip Abalone, were yielded per annum from this area (Map Codes 20A and 20C).

According to S. Shepherd (pers. comm., 2003), research surveys of the **Cowell / Franklin Harbour** area showed stunted populations of Greenlip Abalone, not in large numbers, and very little is taken from the area. "Fishdowns" in other parts of the southern Spencer Gulf have occasionally produced higher catches in the past (e.g. 18 t taken in 1989, when the size limit was reduced to 120 mm, however catches have averaged < 300 kg per annum at the normal size limit since that time (S. Shepherd, pers. comm., 2003). The majority of the Central Zone catch is taken from the opposite side of Spencer Gulf, at Tiparra Reef (see Mayfield and Ward, 2002).

Rock Lobster Fishing

Figures specific to the Point Gibbon to Shoalwater Point area are not available for this report, but the area is considered to be insignificant for commercial fishing for Rock Lobster.

Recreational Fishing

Franklin Harbour is considered to be a "very popular fishing area and many tourists gather to fish off the jetty or on boats, in or out of the harbour" (CAS Franklin Harbour Information Page, 2002). Morelli and de Jong (1995), also reported the popularity of the sheltered waters of **Franklin Harbour** as fishing grounds, providing boat and jetty fishers with a wide variety of fish, such as King George Whiting (a very popular target fish in the area), Garfish, Tommy Ruff, Snapper, Snook, and Southern Calamari. Recreational fishing for whiting and other finfish is considered to be particularly popular within the South Western Basin (Smallridge, 1995).

The Eyre Peninsula Tourist Association (1995) described **Franklin Harbour** as "one of the safest and best fishing areas in South Australia", and that many recreational fishing boats and pleasure craft have access to the waters of the Harbour. Cowell, and particularly Franklin Harbour, is considered to be a popular place for fishing holidays, and there are fishing boats for hire in the area, and two boat ramps (one of which is by the causeway, off The Esplanade at Franklin Harbour). Recreational outboard dinghies for fishing are hired in the area (Eyre Peninsula Tourist Association, 1995).

A fishing survey in **Franklin Harbour** (Jones and Retallick, 1990a, 1990b) showed that: (i) the recreational catch of King George Whiting in the area is significant, and comprised between 46% to 57% of the total catch of whiting, according to tagging and creel surveys; (ii) recreational fishers aggregate at times of the year and in areas where whiting that have recruited to the fishery are relatively abundant; (iii) recreational fishing effort is seasonally high; (iv) recreational catch rates were high for only a relatively small proportion of recreational fishers targeting whiting in Franklin Harbour.

McGlennon and Kinloch (1998c, Figure 7) showed that in the mid-west Spencer Gulf area, recreational fishing accounted for almost a quarter of the total catch of King George Whiting.

Franklin Harbour is a significant fishing area for local fishers, but is also utilised by fishers from other parts of the State, and interstate. Creel and tagging surveys of recreational fishing for King George Whiting (Jones and Retallick, 1990a, 1990b), showed that between 41% to 63% of recreational fishers using Franklin Harbour were from the local Cowell area; between 15% to 19% were from other parts of Eyre Peninsula, 7% to 9% came from Adelaide, and 1% - 13% came from interstate (N.B. Note the differences in results between survey types).

Main fish species targeted and caught in **Franklin Harbour** include King George Whiting, Yellow-fin Whiting, Snapper, Snook, Tommy Ruff, Mullet, Flathead, Garfish, Southern Calamari, and Razorfish. Mulloway are also present in the area (Morelli and de Jong, 1995; Australian Heritage Commission, undated; Eyre Peninsula Tourist Association, 1995 and 2002). "Night crabbing" for blue crabs in shallow waters of Franklin Harbour was listed as one of the special attractions of Franklin Harbour. The main species taken by boat fishers at **Franklin Harbour** include whiting, Snapper, Garfish and Snook. Edyvane (1995b, citing SARDI recreational boat survey data by McGlennon and Kinloch) listed Trevally

and Toothbrush Leatherjackets as additional species taken in the area. Main species taken from the jetty include Tommy Ruff, Garfish and blue crabs. Southern calamari can be taken easily in the area.

Recreational fishers' reports, fishing marker listings, and tourism promotion materials, indicate some of the major species sought and caught by recreational fishers in the coastal area outside of Franklin Harbour:

- ♦ Main species taken from **Germein Point**: Whiting species, West Australian Salmon, Snook and Tommy Ruffs.
- ♦ **Flat Rock Beach, The Knob Beach** and **The Knob** itself (a rocky point): Snapper, Whiting species, West Australian Salmon, Snook, Mullet species and Tommy Ruff.
- ♦ **Port Gibbon**: Snapper, whiting species, West Australian Salmon, Snook, Mullet species and Tommy Ruff.
- ♦ The **Point Gibbon** area was considered by Aquaculture Group - PISA Fisheries (1996) to be of high recreational value (which included recreational fishing and other activities). There is a boat ramp and jetty at **Point Gibbon**.
- ♦ **Lucky Bay**: Snapper, Whiting species, West Australian Salmon, Snook, Mullet species and Tommy Ruff.
- ♦ **Shoalwater Point**: Whiting species, Snook and Snapper.

There are recognised fishing spots, listed by *Fish SA*, in the waters between 5m and 10m deep off **Victoria Point**, including the shallow seagrass beds seaward of the Point; the wreck site south of the Point, and a patch reef at around 10m. South-west of **Germein Point**, there is a recognised fishing spot on sandy bottom, around 3 nautical miles from the coast.

Diving/ Dive Tourism

Diving is listed by in some Eyre Peninsula tourism promotion materials as an activity that is available in the Cowell area, however recognised dive sites are not known in the area, for this report. Along the coast out of Franklin Harbour there are patch reefs promoted as good snorkelling spots (CAS Franklin Harbour Information Page, 2002).

Other Recreation / Tourism

There are shack developments at **Lucky Bay** and **Shoalwater Point** (Aquaculture Group - PISA Fisheries, 1996).

Tourism promotion materials describe **Franklin Harbour** as a popular place for holidays (mainly associated with recreational fishing – see section above). Recreational pleasure boats use the waters of **Franklin Harbour** (Eyre Peninsula Tourist Association, 1995). There are boats for hire (for fishing, sightseeing, holidays etc) in **Franklin Harbour**.

Aquaculture Group - PISA Fisheries (1996) considered the area between **Germein Point** and **Point Gibbon** to be of high recreational value and use.

The Eyre Peninsula Tourist Association (1995 and 2002) stated that one of the activities for visitors to the **Franklin Harbour** area is “exploring the swamps and shallows south of Cowell, and observing the many types of marine life and bird life which inhabit these areas”. The beaches at **Entrance Island** are also used for recreation activities.

The marine area to 1km seaward between **Germein Point** (southern entrance of Franklin Harbour) southwards to **Point Gibbon** was considered by Aquaculture Group - PISA Fisheries (1996) to be of high recreational use and value. The area includes the waters adjacent to Point Gibbon, and waters adjacent to the recreation and camping reserves along the coast. Apart from recreational fishing, other activities occurring in the Point Gibbon area include surfing and pleasure boating (PISA Fisheries, *op.cit.*).

Lucky Bay has been described as “a very popular resort” (Eyre Peninsula Tourism Association, 1995, 2002), and is promoted for swimming (including safe swimming beach for children), fishing, relaxing on the beaches, and hiking.

The Knob, 13kms south of Cowell, is promoted for its sheltered beach with nearby rocks and sand hills, and as a good area for fishing and camping.

The Eyre Peninsula Tourism Association promoted the area between Cowell and Port Gibbon for scenic coastal drives. **Port Gibbon** is promoted as being an “an old shipping port”, with recreational attractions such as a “wide clean beach with backdrop of cliffs”, and **Point Price** area has been promoted for the “very high white sandhills” and nearby surf beach (Eyre Peninsula Tourism Association, 1995, 2002).

Point Gibbon, 5kms from Port Gibbon, is promoted for its scenery (white sand hills at the end of the cliff line, and reefs), and for viewing the small colony of sea lions. Tourism materials describe the area in terms of its “excellent sand dunes and coastline”. The **Point Gibbon** area was considered by Aquaculture Group - PISA Fisheries (1996) to be of high recreational value (which included recreational fishing and other activities), and the area has been promoted for its “beautiful coastline” and “great” beaches (Australian Explorer, 2003). There is a surfing and fishing beach at **Poverty Beach**, north of Arno Bay.

Historic / Protected Shipwrecks

Wrecks protected under Commonwealth or State legislation are not known for this area. Two historic but unprotected wooden ketch shipwrecks are known in the area:

- ♦ *Lillie Hawkins*, a wooden ketch built 1875, wrecked 1917 north of **Point Gibbon**, and
- ♦ *Britannia*, built 1896, wrecked 1905, off **Shoalwater Point**, but not found.

The wheat ketch *Milford Crouch* (not protected, and not historic) was wrecked in 1959, in the **Point Gibbon** area (Eyre Peninsula Tourism Association, 2002). Several more modern wooden fishing vessels have also been wrecked in the Franklin Harbour and Point Gibbon areas, but they are not historic and not protected.

Other European Heritage Values

(Other significant European heritage values are not known for this area, for this report).

Aboriginal Heritage Value

Aboriginal fish traps No. 1 and No. 11, both on the northern side of **Franklin Harbour**, are listed on *the Register of the National Estate*. There is some discrepancy in published references as to the exact number and location of fish traps in the area. According to Morelli and de Jong (1995), the **Franklin Harbour area** contains outstanding examples of Aboriginal stone barrier fish traps in the mid Eyre Peninsula region. Aquaculture Group - PISA Fisheries (1996) stated that the remains of three stone fish traps have been recorded near **Point Gibbon (Mills Beach)**, and that they are the only examples of stone enclosures on rocky headlands recorded in this area (Aquaculture Group - PISA Fisheries, 1996, citing Martin, 1988). According to Edyvane (1995b), the fish traps at **Franklin Harbour** and **Searle Hill** are two outstanding examples of stone barrier fish traps, and one fish trap has been recorded at **Point Gibbon**.

Department of State Aboriginal Affairs undertook site protection work in the **Port Gibbon** area, in 2001/2002.

The Barnjarla Claim for Native Title on Eyre Peninsula was lodged in 1996 with the National Native Title Tribunal (NNTT). The claim, which covers eastern Eyre Peninsula and the Gawler and Flinders Ranges, also includes **Franklin Harbour** and **adjacent coastal waters** to at least 14km – 16km from the coast, depending upon the point of measurement (SA Coast and Marine Atlas, 2003). Following amendments in late 1999 and early 2000, the claim was accepted by the federal court for registration, pursuant to s190A of the *Native Title Act 1993* (National Native Title Tribunal web site, 2003).

Marine Research

Fish nursery area sampling, fish tagging and commercial and recreational fishing surveys have been conducted in **Franklin Harbour** (e.g. see Jones and Retallick, 1990a, 1990b; McGlennon and Jones,

1997). There is a major prawn survey area (**Cowell** and **Western Gutter** – see Macdonald 1998, and map in Carrick, 1997) in the deeper waters (> 10m) seaward of Franklin Harbour. Information on prawn size, catch weight and bycatch is recorded. Regionally, in the mid Spencer Gulf area, catch and effort monitoring for major commercial species (e.g. Snapper, King George Whiting, Tommy Ruff, Southern Calamari) occurs.

Marine Education

Cowell Area School has an experimental oyster lease site in Franklin Harbour, and the school supports aquaculture education for all year levels of students.

A Coastcare grant was issued to a local community group during 1999-2000 to implement a Franklin Harbour Mangrove Awareness and Protection Project. There is a mangrove boardwalk in the area.

Aesthetic Values

The **Entrance Island** area near Franklin Harbour has been described as having “attractive beaches” (Eyre Peninsula Tourism Association, 1995).

The aesthetic value of the coastal area between Cowell / **Franklin Harbour** and **Port Gibbon** / Point Gibbon has been promoted by the Eyre Peninsula Tourism Association (2002) and other tourism organisations (e.g. Australian Explorer tourism web site, 2003) e.g. “beautiful beaches” ; “white sandhills”; “cliffs”, “reefs”, “pretty landscape backed by large sand dunes”, and “beautiful coastline”.

Mining

The SA government has issued a Petroleum Exploration Licence for Spencer Gulf (Aquaculture Group - PISA Fisheries, 1996). The licence excludes the Franklin Harbour area. The northern border of the potential Spencer Gulf exploration area is approximately 35km - 40km south of the Franklin Harbour coast.

Ports, Harbours and Navigation

Franklin Harbour has been proclaimed under the *Harbours and Navigation Act, 1993*. The maritime traffic area for Franklin Harbour is defined as *subadjacent land underlying, and the adjacent land extending from, the waters, rivers, creeks and inlets to high water mark of Franklin Harbor and within a straight line from Germein Point to Victoria Point, and 100 metres to seaward of any point on that line*. Physical obstructions to maritime traffic within this area are not permitted. There are numerous navigation marks, and recognised boating lanes within the bay (e.g. areas of deeper water, greater than 5m, and higher flow), and commercial and recreational fishing demands require unrestricted waters for the shipping channels (Smallridge, 1995; Aquaculture Group - PISA Fisheries, 1996). Franklin Harbour is recognised as one of the 10 main areas in Spencer Gulf that are part of the maritime traffic circuit (Aquaculture Group - PISA Fisheries, 1996).

Towns / Settlements

There is an urban settlement at **Cowell**, on Franklin Harbour. In 2001, **Cowell** had a population of approximately 792 (ABS statistic, 2001). There is a small settlement at **Franklin Harbour**, and beach shacks at **Lucky Bay** (which also has a water tower) and **Shoalwater Point**.

Other Information

There is a submarine fibre optic cable that runs across Spencer Gulf from Shoalwater Point to Point Riley. Anchoring of boats and aquaculture structures and fishing are prohibited within 1.5 nautical miles of either side of the cable (Aquaculture Group - PISA Fisheries, 1996).

9.1.10 Upper Spencer Gulf (North Spencer Gulf Bioregion)

Aquaculture

Whyalla and Fitzgerald Bay area (including Crag Point)

There is a land-based aquaculture licence for the production at **Whyalla** of microalga *Dunaliella salina* (PIRSA Aquaculture Public Register, August, 2003), a species from which beta-carotene is extracted (see below). The crustacean Marron is also farmed in land-based facilities in the **Whyalla** area.

North of Whyalla, Aquaculture Group - PISA Fisheries previously (1996) defined the Fitzgerald Bay Management Zone as all waters within the following points in Fitzgerald Bay: 757765 E, 6352169 N; 760845 E, 6352466 N; 761062 E, 6348769 N; 759294 E, 6348900 N (Map OC(SG)/5 in Aquaculture Group - PISA Fisheries, 1996). The Spencer Gulf Aquaculture Management Plan (1996) provided for a total of 100 hectares of commercial aquaculture development within the **Fitzgerald Bay** Management Zone. Previously, during the mid 1990s, there were two research and development (R and D) leases in northern Spencer Gulf, at **Whyalla** and **Fitzgerald Bay**. The R and D licence for **Whyalla** was granted in 1995, for development at the old BHP marina site at Whyalla; and in the Fitzgerald Bay area, a 30 hectare lease for aquaculture R and D was approved in the Fitzgerald Bay Management Zone. At **Fitzgerald Bay**, the Snapper aquaculture facility began operating during the mid 1990s, initially as an R and D lease (Aquaculture Group – PISA Fisheries, 1996). Snapper aquaculture in the area has used small snapper hatched at a facility at **Port Augusta**, and grown out at the cage facilities in **Fitzgerald Bay**. The R and D licences in the Whyalla and Fitzgerald Bay area initially involved trials for the cultivation of Snapper and King George Whiting in sea cages (Aquaculture Group – PISA Fisheries, 1996). Since 1998, additional cage grow-out facilities for finfish in **Fitzgerald Bay** have been approved. Since the 1990s, considerable research and development into finfish cage culture in **Fitzgerald Bay** has been undertaken. According to Aquaculture Group - PISA Fisheries (1996), the Northern Spencer Gulf Aquaculture Enterprises (an organisation with both government and private funding) and its associates, together with the Northern Regional Development Board and the City of Port Augusta, have made an extensive commitment to aquaculture in the area. Caged culture of Yellow-tail Kingfish is a developing industry in Fitzgerald Bay.

In 2004, PIRSA Aquaculture released the *Fitzgerald Bay Aquaculture Management Policy*, to update the management of aquaculture in **Fitzgerald Bay**, specifically the farming of marine finfish. The zones of the 2004 policy supercede the previous Fitzgerald Bay Management Zone in the 1996 plan. The following zones were proposed in the 2004 plan:

Western Fitzgerald Zone: reported to be closely aligned with the previous Fitzgerald Bay Aquaculture Management Zone, and designated primarily to accommodate existing finfish farming, with a maximum of 150ha allocated to finfish culture. There is provision for individual sites to be a maximum of 30 hectares, with a maximum of 350 tonnes of fish per site permitted, at a maximum stocking density of 10kg/m³. A buffer of about 1km between each site is also required (PIRSA Aquaculture, 2004b). The zone has also been designated to allow for “limited growth of existing farms”, and incremental increases in tonnage would be “linked to environmental monitoring results for both Western Fitzgerald Zone and Eastern Fitzgerald Zone”. Under the policies for the new zone, additional tonnage will first be allocated proportionately to new sites created within the boundaries of the Western Fitzgerald Zone (PIRSA Aquaculture, 2004b). In 2004, PIRSA was seeking applications for finfish aquaculture operations within the waters of the Western Fitzgerald Bay Aquaculture Zone. The zone covers an area of 1704 hectares, and has the following coordinates (GDA 1994 datum):

137° 45' 25.74" -32° 56' 09.78"
137° 46' 58.97" -32° 55' 39.43"
137° 48' 24.16" -32° 55' 37.52"
137° 48' 28.76" -32° 58' 03.05"
137° 46' 38.54" -32° 58' 05.51"
137° 46' 04.41" -32° 57' 26.60"

Eastern Fitzgerald Zone: designated for “further grow-out” of caged finfish, with greater stocking rates than those permitted inshore, and available for long-term development of the finfish farming industry (PIRSA Aquaculture, 2004b). A maximum of 150ha will be allocated for finfish farming. Leases up to 15ha are permitted within the zone, with each operator required to maintain a minimum of 2 lease areas to accommodate appropriate fallowing practices. A maximum of 50% of each lease holder’s lease sites may be occupied by finfish at any one time, and the maximum permitted tonnage per 15ha lease is 200t of fish. Each lease site must be a minimum of 1km from any other lease site. The maximum stocking density permitted is 10kg/m³. Incremental increases in tonnage would be “linked to environmental monitoring results for both Western Fitzgerald Zone and Eastern Fitzgerald Zone”. The zone covers a total area of 1445 hectares, over a depth range of about 18m to 22m, and has the following coordinates (GDA 1994 datum):

137° 49' 08.35" -32° 56' 19.91"

137° 49' 07.39" -32° 53' 26.58"

137° 50' 51.49" -32° 53' 26.58"

137° 50' 52.48" -32° 56' 19.73"

- ♦ *Fitzgerald Shellfish Zone:* to “allow trials and possible future production” of shellfish (PIRSA Aquaculture, 2004b). The zone borders the Eastern Fitzgerald Zone, on the seaward side, and is designated to determine and monitor potential productivity of the area for growing filter-feeding molluscs for commercial use, and as a means of removing increased nutrients from the water that may result from the adjacent finfish leases. The zone has the following co-ordinates (GDA 1994 datum):

137° 49' 19.83" -32° 52' 38.02"

137° 51' 23.21" -32° 52' 38.02"

137° 51' 24.50" -32° 57' 08.34"

137° 49' 20.82" -32° 57' 08.48"

137° 49' 21.17" -32° 56' 20.00"

137° 49' 19.83" -32° 53' 26.58"

137° 50' 51.49" -32° 53' 26.58"

137° 50' 52.48" -32° 56' 19.73"

- ♦ *Fitzgerald Exclusion Zone:* a zone in which no aquaculture will be permitted, in order to “protect conservation, navigational, fishing and amenity values” (PIRSA Aquaculture, 2004b). Parts of the exclusion zone include the beach and shallow waters around Backy Point, and the Point Lowly area. Specifically, the exclusion zones comprise: all waters within one kilometre of mean spring high water mark around the mainland, between (137° 47' 37.97", -32° 53' 57.59") to (137° 45' 07.74" -32° 56' 02.08"), and between points (137° 46' 38.87" -32° 58' 44.79") to (137° 46' 08.58" -32° 59' 39.73") (GDA 1994 datum).

As at 2004, there were 5 finfish cage leases of 20ha each for Yellow-tail Kingfish and Snapper, operating in the **Fitzgerald Bay** area, south of **Lowly Point** and **Backy Point** (S.A. Coast and Marine Atlas, 2003; PIRSA Aquaculture Public Register, December, 2004), with a further 4 applications in process. During the early 2000s, the stocking level in **Fitzgerald Bay** was reported to be less than 1000 tonnes, although the area was licenced to carry 1,500t at that time. The Yellow-tail Kingfish grow-out facilities in **Fitzgerald Bay** are part of a recent increase in the popularity, marketing, and production of this species. Yellow-tail Kingfish has become a new export for the aquaculture industry in the **Port Augusta** and **Whyalla** areas. There are plans to expand research and development in the Yellow-tail Kingfish aquaculture industry in S.A., and a research and development plan is being prepared (SARDI media release, 2003). The Kingfish industry in South Australia as a whole, has expanded in recent years, to an expected total production level of about 2000 tonnes in 2002 – 2003 (SARDI Media Release, February, 2003). Considerable interest has been expressed by industry, in expanding aquaculture (for both finfish and shellfish), in both the inshore and offshore areas of **Fitzgerald Bay**, during the 2000s.

Between **Crag Point** and **Douglas Point**, there were previously 2 pilot leases for farming Pacific Oysters

(S.A. Coast and Marine Atlas, 2003), however, in 2004, only 1 pilot lease was listed as operating (PIRSA Aquaculture Public Register, December, 2004).

Douglas Point area

The *Douglas Management Zone* (between **Douglas Point** northwards to a point south of the **Blanche Harbour - Douglas Bank Aquatic Reserve**) was defined by Aquaculture Group - PISA Fisheries (1996) as all waters within the following points: 762296 E, 6366783 N; 762977 E, 6366752 N; 763389 E, 6363113 N; 762819 E, 6363128 N and the boundaries of the Far Northern Spencer Gulf Policy Area (see Map OC(SG)/5 in Aquaculture Group - PISA Fisheries, 1996).

Aquaculture Group - PISA Fisheries (1996) provided for research and development of intertidal shellfish culture in the Douglas Management Zone, recognising the closures of the adjoining land area to the public during Army Training exercises. Aquaculture Group - PISA Fisheries (1996) considered potential licensing for a total of 3 x 2 hectare sites for research and development (R and D) of intertidal oyster culture, within the Management Zone. Upon successful completion of an R and D program (addressing environmental impact such as water quality and site suitability, and commercial viability), licences would be considered for a maximum of 10 hectares for commercial development at each site.

Point Paterson area

The *Paterson Management Zone* (extending from the bay south of **Point Paterson**, northwards to **Snapper Point**) was defined by Aquaculture Group - PISA Fisheries (1996) as the waters of the policy area bounded by the following points: 761115 E, 6396049 N; 761115 E, 6384181 N; 767587 E, 6384174 N and the boundaries of the Far Northern Spencer Gulf Policy Area (see Map OC(SG)/5 in Aquaculture Group - PISA Fisheries, 1996). The Zone includes the inlet and outlet channels to the **Port Augusta Power Station**. Initially, there were two aquaculture enterprises operating within the channels, and Aquaculture Group - PISA Fisheries' Spencer Gulf Management Plan (1996) provided for continued research to be undertaken by the two enterprises. PISA (now PIRSA) considered licences for 16 hectares of R and D leases within the Patterson Zone. R and D programs in the area were required to address issues of environmental and social impact. Aquaculture Group - PISA Fisheries (1996) approved the culture of Pacific Oysters, but only within the confines of the inlet water channel to the Port Augusta Power Station. Also, operations requiring supplementary feeding were approved, but only within the confines of the inlet and outlet water channels of the Port Augusta Power Station.

Port Augusta is now the base of a developing export business in Yellow-tail Kingfish (Department of Foreign Affairs and Trade, 2001), which are bred at the **Port Augusta** hatchery, and sent southwards to be grown out at **Fitzgerald Bay** near **Whyalla**. Snapper have also been bred at the **Port Augusta** hatchery.

There was a previous lease for intertidal shellfish on the eastern side of **Far Northern Spencer Gulf**, however this is no longer operating (PIRSA Aquaculture Map, June 2003; PIRSA Aquaculture Public Register, August, 2003).

According to the PIRSA Aquaculture Public Register (August, 2003), the **Northern Power Station at Port Augusta** is a site for a land-based licence, with permitted species for production comprising Black Bream, King George Whiting, Snapper, Blue Swimmer Crab, Yellow-tail Kingfish, Yellow-fin Whiting and Dolphin Fish. **Port Augusta** Secondary School also has a land-based lease for growing Murray Cod, Silver Perch and Yabbies.

Other Aquaculture Information

Aquaculture Group - PISA Fisheries (1996) considered sea-based aquaculture to be suitable in the **Whyalla** and **Port Pirie** areas, as indicated in the stated Management Goals for the **Whyalla - Pirie** Policy Area (i.e. "to provide for sustainable aquaculture development"). Aquaculture development was stated as a goal, despite recognition of the existing uses / values (e.g. fishing, navigation, industry, recreation, wetland conservation) and impacts (industrial effluent) of significance in the area. Note that Aquaculture Group - PISA Fisheries (1996) did not specify Management Policies for aquaculture development in the **Whyalla** or **Pirie** area, and therefore no figures for the total acreage of potential aquaculture leases were provided.

During the mid 1990s, a project was undertaken by the PISA (Eyre) and the Eyre Regional Development

Board to prepare feasibility and business plans for a variety of species suitable for aquaculture for the Eyre Peninsula (Aquaculture Group - PISA Fisheries, 1996). At that time, the City of Port Augusta was interested in undertaking a feasibility study in the far north of Spencer Gulf, regarding potentially suitable sites and species for aquaculture development. The study planned to include an environmental assessment and community study to investigate the current uses of the area (Aquaculture Group - PISA Fisheries, 1996).

In the past there have been trial sites at **Chinaman Creek** in upper Spencer Gulf for oyster growing. These sites were not successful, and oysters exhibited the slowest growth rates of all areas in the trial (Grove-Jones, 1986, cited by Aquaculture Group - PISA Fisheries, 1996). The area is now included in the **Winninowie Conservation Park**. In 1996, Aquaculture Group - PISA Fisheries' Spencer Gulf Aquaculture Management Plan excluded the Winninowie area (and other far northern Spencer Gulf locations that formed part of the so-called Augusta Zone) from potential aquaculture development, mainly due to conservation values and navigation, commercial, fishing, recreational and tourism uses.

In 1989, a report was undertaken by Australian Groundwater Consultants Pty Ltd, which discussed the feasibility of aquaculture development in the **Port Pirie** area. The report highlighted the potential in this area for development of aquaculture on land (Aquaculture Group - PISA Fisheries, 1996).

During the early 2000s, technical investigations were undertaken to determine the potential of areas south of Whyalla, such as the **Cowled's Landing / Murninnie Beach** area, to support aquaculture development, including both finfish and subtidal shellfish farming.

Other Marine-Related Industries

There is a microalgal culture operation in the **Whyalla** area, run by the world's largest beta-carotene production company Betatene Ltd. (Dept Foreign Affairs and Trade, 2001). Microalgae from saline coastal lakes are harvested and exported for use in dietary supplements and the food industry.

The microalgae extraction plant (see above) is located near salt lakes, to the north of a salt production plant. Salt production by solar evaporation started in the **Whyalla** area in 1951. In 1979, a processing plant was built. The salt works are at the head of **False Bay**. Seawater is pumped into several lakes, and the evaporated salt is used for both domestic and export markets. In 1999, 46,554t were produced from 240ha of brine ponds and 20ha of crystallisers (Minerals and Petroleum S.A., 2001, cited by DEH, 2003a).

Commercial Fishing

Scalefish, Sharks and Minor Invertebrates

Commercial fishers who fish in northern Spencer Gulf operate from **Whyalla, Port Pirie, Port Augusta**, and **Port Germein**. Commercial fishing is listed as one of the major industries at **Port Germein**, by promotional materials for the area.

The principal commercial species are the Southern Sea Garfish *Hyporhamphus melanochir*, King George Whiting *Sillaginodes punctata*, Snapper *Pagrus auratus*, Yellow-fin Whiting *Sillago schomburgkii*, Tommy Ruff (Australian Herring) *Arripis georgiana*, Snook *Sphyraena novaehollandiae* and Australian Salmon *Arripis truttacea* (Morelli and de Jong, 1995, and see fisheries statistics below).

There are concrete boat ramps at **Port Augusta, Port Pirie**, and **Whyalla**, used for launching commercial fishing boats. A fishing survey conducted in 1996, reported that the use of these ramps for commercial fishing was around 11% at **Port Pirie**, 7% at **Whyalla**, and 2% at **Port Augusta** (McGlennon, 1996).

The area forms a large part of Marine Fishing Area 21, and the marine scalefish sector's total annual catch in this area is substantial. Previously, the Marine Scalefish fishery catch from GARFIS Block 21 (i.e. north of a line joining **Plank Point** and **Wood Point**, including all waters northwards to the **Douglas Point** area) during the mid-late 1990s, was as follows: In 1995/96 a total of 660, 899kg (6.36% of State total, representing 57 fishers); In 1996/97 a total of 869,656kg (8.58% of State total, representing 61 fishers) (SARDI data, cited by Edyvane, 1999b). Marine Scalefish and Restricted Marine Scalefish licence holders contributed to these yields. On a State-wide scale, aggregated catch figures for all GARFIS Fishing Blocks in South Australia between 1995 and 1997, showed that GARFIS Block 21 was ranked 4th in the list of fish, shark and minor invertebrate yields from 58 South Australian fishing blocks

in both 1995/96 and 1996/97. More recently, DEH (2003a, citing SARDI Aquatic Sciences data) reported that the average annual catch in Marine Fishing Area 21 (previously called GARFIS Block 21), over the period 1989 to 1999, was 614.5t. This figure includes fish, sharks, and invertebrates, but excludes Blue Swimmer Crab data from 1997-1999, and excludes the single species fisheries such as prawns, abalone and rock lobster.

In the **Northern Spencer Gulf** area, northwards of a line joining Plank Point and Wood Point, to the Douglas Point area, the major scalefish and invertebrate species that are caught commercially are as follows:

Blue Swimmer Crab: The species is fished commercially in Spencer Gulf from Port Broughton to Port Pirie and from Cowell to Whyalla. Since the 1990s, there have been 8 or fewer crab pot fishers licensed across South Australia, under the *Scheme of Management (Gulf Waters Experimental Crab Fishery) Regulations 1988*. The majority of crab pot fishers (5 fishers in 2002/03) operate in Spencer Gulf, and there has been a slight increase in the number in recent years, compared with the early 1990s (Svane and Hooper, 2004, Figure 6). Additionally, a number of Marine Scalefish Fishery (MSF) licence holders fish for Blue Swimmer Crabs in Spencer Gulf, in waters up to five metres deep (Aquaculture Group - PISA Fisheries, 1996). In South Australia, between 1996/97 and 2003/04, the number of MSF licence holders endorsed to catch Blue Swimmer Crabs steadily declined, from about 29 down to 14 (Svane and Hooper, 2004, Figure 6), and only one of those MSF fishers operates in Spencer Gulf. Since 1996/97, there has been an annual total allowable commercial catch (TACC) for the pot sector and MSF sector combined. The initial TACC in 1996/97 was 520t. In 2002/03, the TACC for the entire fishery (pot and MSF sectors, in both Spencer Gulf and Gulf St Vincent) was 626.8t, similar to the two previous years (Svane and Hooper, 2004), but 106t larger than the TACC in 1997/97. For the entire fishery, about 89% of the TACC was taken in 2002/03 (representing an increase in catch of about 4% from the previous year), and the majority of which was taken by the crab pot sector. At a State-wide scale, effort in the crab pot sector increased from 152,315 pot lifts per annum in 2001/02 to 196,646 in 2002/03 (a 29% increase). In 2002/03, the crab pot sector took almost all of its allocated quota (i.e. nearly 94% of the 2002/03 crab pot sector quota of 549.6t), representing the highest pot sector catches since the implementation of the TACC in 1996/97 (Svane and Hooper, 2004). During the 1999/2000 year, the total annual catch in Spencer Gulf by the *crab pot sector*, to the end of February 2000, was reportedly 164.5 tonnes from 579 boat days, however given the lack of availability of complete catch and effort data during that period (see Boxshall *et al.*, 2000), the estimate may not be accurate. As a comparison with previous years, the annual *crab pot sector* catch of Blue Crabs in 1992 / 1993 from the upper Spencer Gulf area was 273.4 tonnes (Baker and Kumar, 1994). For confidentiality reasons, no data specific to the *crab pot sector* in Spencer Gulf were provided in a more recent fishery assessment report (Svane and Hooper, 2004). In previous years, the highest per annum yields of Blue Swimmer Crab taken by the *MSF sector* in South Australia have come from northern Spencer Gulf area, however catch and effort by this sector has declined in recent years since quota allocations. For example, according to Boxshall *et al.* (2000) the total Blue Swimmer Crab catch in the Spencer Gulf *MSF sector* during 1999 / 2000 was 4.8 tonnes from 76 boat days. This is considerably less than the *MSF sector* catch in Spencer Gulf during the early 1990s (e.g. around 31.3t in 1992 / 1993 – see Baker and Kumar, 1994). For confidentiality reasons, no data specific to the *MSF sector* in Spencer Gulf were provided in a more recent fishery assessment report (Svane and Hooper, 2004).

Giant Cuttlefish: Prior to the cuttlefish spawning area closure which commenced at the end of the 1998 season, northern Spencer Gulf was also the major region in the State for commercial fishing of *Giant Cuttlefish*, particularly during the mid to late 1990s. The area is still the most significant in the State for the capture of this species. Hall (2000) reported that since the closure, the annual yield from the northern Spencer Gulf area has declined from 235t in 1997, to 146t in 1998, and 14t or less in each of 1999 and 2000. Even with the closure in place, over 80% of the targetted catch of *Giant Cuttlefish* in South Australia came from this area (which is part of GARFIS Block 21). Fewer than 5 fishers targetted *Cuttlefish* in the northern Spencer Gulf area in 2000, which is over an 80% reduction, compared with the 1998 season prior to the closure. The targetted effort has declined from 535 fisher days in 1998, to 98 fisher days in 1999, and 63 fisher days in 2000 (Hall, 2000).

Snapper: Northern Spencer Gulf (NSG) is regularly the top fishing area in S.A., in terms of commercial yield per annum. Snapper are caught mainly on hand lines and long lines in this area. For reporting purposes "Northern Spencer Gulf" refers to a number of fishing blocks (GARFIS Blocks 11, 19, 20, 21, 22 and 23 – see McGlennon and Jones, 1999), some of which are south of the area discussed in this table. However, of those areas, GARFIS Block 21 is one of several significant fishing areas for this species in Northern Spencer Gulf, in terms of annual yield. During 1999/2000, NSG fishing blocks collectively

accounted for 59.8% of the total commercial catch of Snapper in S.A. waters (Fowler, 2000), and in 2000/ 2001 and 2001/2002, NSG accounted for 49.9% and 45.9% respectively of that total catch (Fowler, 2002; Fowler et al., 2003). A summary of catch and effort from NSG was provided by Fowler (2002) and Fowler et al. (2003). The targeted hand line catch was as follows: 131.8t in 1995/96; 114.9t in 1996/97; 162.3t in 1997/98; 238.8t in 1998/99; 300.7t in 1999/00, 244.5t in 2000/01 and 260.7 in 2001/02. The hand line catches for the last three years to 2002, are the highest recorded to date (Fowler et al., 2003). The targeted long line catch of Snapper in NSG was as follows: 79.7t in 1995/96; 70.2t in 1996/97; 79.8t in 1997/98; 30.8t in 1998/99; 34.9t in 1999/00, 25.6t in 2000/01, and 27.1t in 2001/02. Long line catch in NSG has declined during the past decade. During the period 1995/96 to 2001/02, the annual sequence of *hand line* targetted effort (in boat days) has been 1643; 1409; 1562; 1852; 1713; 1575, and 1501 boat days, and the annual sequence of long line targetted effort has been 1159; 1107; 1123; 677; 560; 479, and 414 boat days in 2001/2002, the latter figure being the lowest recorded effort for long lines in NSG since 1983/84 (Fowler, 2002; Fowler et al., 2003).

Garfish: In some recent years (e.g. mid-late 1990s), one of the Northern Spencer Gulf fishing blocks has been one of the top two fishing blocks in S.A., in terms of commercial yield per annum. Recent catch and effort data specific to Northern Spencer Gulf are not available for this report.

Yellow-fin Whiting: The species is mostly taken by hauling nets. Northern Spencer Gulf is regularly amongst the top two areas in S.A., in terms of commercial yield per annum. According to Ferguson (2000), historically the main contribution to the total State catch of yellow-fin whiting has come from the Northern Spencer Gulf area.

King George Whiting: In some years (e.g. mid-late 1990s), Fishing Block 21 has been amongst the top 3 areas in S.A. in terms of yield, of around 36 to 40 fishing blocks in which whiting is commercially fished. McGarvey *et al.* (2000 and 2003) reported that hauling net is the dominant gear type for catching this species in "Northern Spencer Gulf" (an aggregate area comprising several GARFIS fishing blocks, including areas south of the region discussed in this table), and the hauling net catch has declined considerably since 1992. The *total* catches of King George Whiting from Northern Spencer Gulf in 1998, 1999, 2000, 2001 and 2002 respectively, were 97.85t; 86.87t; 70.2t; 56.6t, and 52.4t (Fowler and McGarvey, 1999; McGarvey *et al.*, 2000, 2003). Annual catch from the area represents about 14% - 17% of the State-wide catch. The hauling net catches between 1999 and 2002 were the lowest since 1982. Hand line catches have also declined marginally since the early 1980s, associated with a substantial reduction in effort, and the hand line catches in 2000, 2001 and 2002 were the lowest on record for that region (McGarvey *et al.*, 2003). There has been a consistent decrease in fishing effort, particularly during the period 1994 - 2001. The reduction in hand line effort was particularly evident between 1994 - 1999, but there was a marginal increase in 2002. The catch and effort from the gill net sector are very low. The gill net effort in northern Spencer Gulf during recent years represented less than 2% of the total gill net effort in S.A., in terms of fisher days spent catching King George Whiting (Fowler and McGarvey, 1999; McGarvey *et al.*, 2000 and 2003). For hand lines and haul nets, both targetted and non-targetted effort appear to have decreased substantially over time, since 1988 (McGarvey *et al.*, 2000), and the CPUE has also declined in this area since 1990, for both targetted and non-targetted effort (McGarvey *et al.*, 2003).

Tommy Ruff (Australian Herring): Northern Spencer Gulf is one of several major fishing areas in S.A. for Australian herring, in terms of annual yield. Catches of more than 100t per annum were recorded during the early-mid 1990s from one fishing block in northern Spencer Gulf. Catches have fluctuated since the early 1980s, with the highest catch during the period 1983 to 1997 being around 190t, during one year of the mid 1980s (see Dimmlich and Jones, 1997, Figure 10).

Snook: In some recent years (mid-late 1990s), one of the fishing blocks in Northern Spencer Gulf has been amongst the top 5 fishing blocks in S.A. in terms of annual yield. Recent catch and effort figures are not available for this report.

Other scalefish, invertebrates and elasmobranchs caught in the area include *Southern Calamari*, *Yellow-eye Mullet*, *Leatherjacket species*, *Australian Salmon*, *Eagle Ray*, *Fiddler Ray* and other ray species, *Striped Trumpeter* (not often targetted, but caught by net fishing), *Bronze Whaler Shark* and other shark species.

Previously, in **Far Northern Spencer Gulf**, the Marine Scalefish fishery catch from GARFIS Block 11

(including all waters north of Douglas Point) during 1995 – 1997 was as follows: In 1995/96 a total of 10, 829kg (0.10% of State total, representing 7 fishers); In 1996/97 a total of 11,730kg (0.11% of State total, representing 6 fishers). (SARDI data, cited by Edyvane 1999b). Marine Scalefish and Restricted Marine Scalefish licence holders contributed to these yields. On a State-wide scale, aggregated catch figures for all GARFIS Fishing Blocks in South Australia, between 1995 and 1997, showed that the Far Northern Spencer Gulf area (GARFIS Block 11) was 52nd in the ranked list of yields of fish, sharks and minor invertebrates from 58 South Australian fishing blocks in 1995-96, and 50th in 1996-97, in terms of annual quantity yielded. More recently, DEH (2003a, citing SARDI Aquatic Sciences data) reported that the average annual catch in Marine Fishing Area 11 (previously called GARFIS Block 11), over the period 1989 to 1999, was 16t. This figure includes fish, sharks, and invertebrates, but excludes Blue Swimmer Crab data from 1997-1999.

In the **Far Northern Spencer Gulf area** (e.g. **north of Douglas Point**), the scalefish, elasmobranchs and minor invertebrates that are caught commercially include:

Snapper: In some years (e.g. mid-late 1990s) Far Northern Spencer Gulf has been one of the top 10 fishing areas for Snapper, in terms of annual yield on a State-wide scale, however yields are an order of magnitude lower than those in the key Snapper fishing blocks in South Australia.

Fiddler Ray, *Eagle Ray* and other ray species: No recent catch and effort figures are available for this report, however, one to two tonnes per annum were caught in the area during the mid – late 1990s.

Other species such as *Striped Perch*, *Gummy Shark*, *Southern Calamari*, *Bronze Whaler* and other *shark* species, *King George Whiting*, *Snook* and *Tommy Ruff (Australian Herring)* have all been caught in minor quantities in Far Northern Spencer Gulf in recent years (e.g. mid –late 1990s). Recent catch and effort figures for these species are not available for this report.

Prawn Fishing

Northern Spencer Gulf is positioned at the northern end of the Spencer Gulf Prawn Fishery trawl grounds. Trawling for western king prawn occurs throughout the southern and middle section of the Gulf, south of a line from Point Lowly across to Ward Spit, and fishing effort is concentrated in water depths greater than 10 metres (Aquaculture Group - PISA Fisheries, 1996).

Maps in reports by MacDonald (1998) and DEH (2003a, Figure 14) show the approximate position of the prawn trawling areas in Spencer Gulf. North of a line from Port Davis Creek across the gulf (Yarraville Shoal / Musgrave Shoal area), to the Cowleds Landing area, are fishing blocks 1 to 15, with the northern-most being Fishing Block 4 (just south of Lowly Point). Prawn trawling occurs in Fishing Blocks 4, 5, 7, 8, 9, 10, 13, 14, 15, all of which are in deeper central waters of northern Spencer Gulf, south-east of Whyalla and west of the Port Pirie creeks area. The fishing blocks near the coast on both sides of Northern Spencer Gulf (i.e. Fishing Blocks 1,2, 3, 6, 11, 12) are not fished, and no trawling occurs north of Point Lowly.

Of those blocks in northern Spencer Gulf that are fished, Block 9 has yielded between 51 and 100t per annum, and has been fished in 7 to 9 of the past 11 years to 1999/2000. Blocks 10, 13 and 14 have each yielded between 31 and 50t per annum. Block 14 has been trawled in almost all of the past 11 years to 1999/2000; block 10 has been trawled in 4 to 6 of the past 11 years, and block 13 has been trawled in 7 to 9 of the past 11 years to 1999/2000 (DEH, 2003a, Figure 14). Blocks 4 and 5, south of Point Lowly, are minor fishing areas (6 to 10t per annum, and less than 6t per annum, respectively, and both have been fished in 1 to 3 of the past 11 years). West of the Point Jarrold / Port Davis Creek area, block 7 is also minor fishing area, having been trawled in 1 to 3 of the past 11 years, and yielding less than 6t per annum. To the north-west and west of block 7, in deeper waters, blocks 8 and 15 have yielded between 16t and 30t per annum, and have been fished in 10 or 11 of the past 11 years to 1999/2000 (DEH, 2003a, Figure 14).

Of the total prawn landings for the Spencer Gulf fishery in 1999/2000 (1914 tonnes over 61.5 nights trawled, or 21,459 hours), the Northern region of the fishery (which includes a larger number of fishing blocks compared with those specified above) yielded 505.7 tonnes (around 26%) of the annual catch. Annual catch rate was around 85kg / hr (Carrick and Williams, 2001).

The fleet exerts high local (or spatial) depletion rates, with the estimated mean exploitation rate being 49.9%, close to the target limit of 50%. Monitoring indicators and research surveys for the 1999/2000

year showed a good size composition of the prawn catch; “highly satisfactory catch rates” of adult prawns; and a large settlement of post-larval prawns (which normally results in strong recruitment to grounds the following season) (Carrick and Williams, 2001).

Record large settlement of post-larval prawns occurred at **False Bay** in April 2000. Comparison of the mean number of juveniles at False Bay in 1993 (base year), 1999 and 2000 over 3 sampling periods (February, March and April) indicated significant differences in numbers over each month with the mean in April 2000 being twice as large as that in the base year (1993) (Carrick and Williams, 2001).

Prawn fishers in Spencer Gulf are permitted to take Slipper Lobster and Southern Calamari as commercial bycatch during prawn trawling operations (MacDonald, 1998).

A permanent closure exists north of **Point Lowly**, which aims to protect small prawns that occur there for most of the year, and juvenile fish (MacDonald, 1998).

Rock Lobster Fishing

No commercial Rock Lobster fishing occurs in the Northern Spencer Gulf region.

Abalone Fishing

Abalone is not caught commercially in the Northern Spencer Gulf region.

Recreational Fishing

Northern Spencer Gulf is a significant recreational fishing location in South Australia, and is widely promoted by recreational and tourism associations, facilities and media. Morelli and de Jong’s (1995) collation of the values of Northern Spencer Gulf for the listing of Wetlands of National Importance described the area as “a very popular fishing ground”.

Whyalla has a number of jetties, boat ramps, and a marina (eight hectare area with 34 floating moorings, pile moorings for an additional 36 vessels, and a 4-lane boat launching ramp).

There are concrete boat ramps at **Port Augusta** and **Whyalla**, and beach facilities for boat launching at **Port Augusta**, **Whyalla**, and **Point Lowly**. A 1996 survey in the region, found that the use of these areas for launching recreational fishing vessels was around 68% at **Port Augusta**, 87% at **Whyalla** and 93% at **Point Lowly** (McGlennon, 1996). The **Whyalla** boat ramps can be seasonally busy (e.g. 250+ boats launching per weekend). The marina at **Whyalla** is also a popular site for launching fishing boats (e.g. 100+ per weekend, dependent on time of year). Recreational fishers also use the boat ramp at **Fitzgerald Bay**. **Cowleds Landing**, approximately 20 kilometres south of Whyalla, is also used for boat launching, and on the eastern side of the gulf north of **Port Pirie**, a number of boat ramps and launching sites exist at **Weeroona Island** (Aquaculture Group – PISA Fisheries, 1996). Northern and far northern Spencer Gulf areas (e.g. **Fitzgerald Bay**, **Douglas Point**, and **Chinaman Creek**) have been described as “popular areas for fishing” (Aquaculture Group - PISA Fisheries, 1996) and there are boat ramps and beach areas for launching vessels in these areas. In Far Northern Spencer Gulf, there is a boat ramp near the outlet channel to the **Port Augusta** power station.

According to a boat fishing survey during April 1994 – March 1996 (see McGlennon and Kinloch, 1997a, 1997c), more than one third of the total catch of King George Whiting from Northern Spencer Gulf (GARFIS Block 21 area) was taken by recreational fishers. In far northern Spencer Gulf (GARFIS Block 11), the total catch of King George Whiting was minimal compared to other areas of Spencer Gulf, and the majority of this small annual catch was taken by recreational fishers. According to the 1994 – 1996 boat survey, the recreational boat catch of Garfish in northern Spencer Gulf is minor, compared with the commercial catch (see McGlennon and Kinloch, 1997c, Figure 11). Results of the survey also showed that the recreational catch Southern Calamari from northern Spencer Gulf was less than one quarter of the commercial catch during that period (McGlennon and Kinloch, 1997c, Figure 15). The recreational catch of Blue Swimmer Crabs amounted to 11% (= 45.5t) of the total combined recreational and commercial catch in Spencer Gulf (McGlennon and Kinloch, 1997c, Figure 18; Boxshall *et al.*, 2000), with the majority of the catch taken in northern, north-eastern and north-western Spencer Gulf waters, where the species is abundant. Note that the survey discussed above did not include jetty and other shore-based fishing, which is significant in some areas (see below). Specific data for Spencer Gulf, from the more recent National Recreational and Indigenous Fishing Survey (Henry and Lyle, 2003), are not available, however the survey reported a total State-wide recreational catch of 389.8t of Blue Swimmer Crabs during the period May 2000 to April 2001, about 32% of which was released after capture (due to

the crabs being under legal size, or due to catches being over the legal bag limit) (Anonymous, 2003d, cited by Svane and Hooper, 2004). Specific and recent catch and effort figures for all recreational fishing in the Northern Spencer Gulf area are not available for this report.

Within the area described in this table, some of the recognised fishing marks (Fish SA, 2000) include the following areas:

- ♦ between **Redcliff Point** and **Mangrove Point**: edges of sandbanks (“drop-offs”) in the sand “mega-ripple” channel habitat;
- ♦ north of **Redcliff Point - Mangrove Point** (to **Point Paterson**): the artificial reef (tyres), and the edges of sandbanks in the shallow channel;
- ♦ between **Snapper Point** and **Point Paterson**: edges of sand ledges (“drop-offs”) in the sand channel area;
- ♦ out of **Germein Bay**: **Ward Spit**; the **Anden** wreck; and various locations in the vicinity of **Cockle Spit**, in sandy and “broken bottom” (patch reef habitat);
- ♦ south and east of **Ward Spit** (sand spits, depressions, and the edges of seagrass patches);
- ♦ major sandbanks between **Whyalla** and **Germein Bay** (e.g. **Fairway Bank**, **Eastern Shoals** etc);
- ♦ **False Bay**: the artificial reef (wreck), the spoil grounds/mud banks, ledges and “broken bottom” (reef patches).

There are numerous other recognised fishing spots in northern Spencer Gulf, particularly the stretch of gulf waters between **Whyalla** and **Port Pirie**, and the western side of **Far Northern Spencer Gulf**, south of **Port Augusta**. Geo-coordinates are available for these recognised fishing locations. Examples include Kemp’s Ground (particularly for whiting and Southern Sea Garfish); “Stanley’s”; “Hawlies”; Blast Furnace; The Entrance; “Ruggers”; South Havelburg at Whyalla (a deeper rock and artificial wreck site, around 30m deep, promoted for Snapper, whiting species, Snook, and Trumpeter fishing); North Havelburg (promoted for fishing Snapper and Trumpeter); Manik’s Reef; McIntosh Bank; “Deep Hole”; Western Shoal and Eastern Shoal (all shoals popular for Snapper fishing); “Neil’s Spot” (Snapper, King George Whiting); “Dion’s” spot; “Pinnacle” (promoted for Snapper and whiting), and the Wave Recorder (a patch reef / “broken bottom” site of around 12m deep, promoted for fishing Snapper and whiting). (FishInternet Australia, 2000; Fishing South Australia, 2001; Fishnet, 2002).

Recognised fishing spots / markers in **Far Northern Spencer Gulf** include **Snapper Point** (a channel and ledge area, for Snapper fishing); **Tyre Reef** (whiting species, Snapper); **Flinders Channel** and **Redcliff** (“drop-offs”, for Snapper fishing); **The Point** (a channel area, for fishing Snapper and Southern Calamari); **Pat’s** (a “whiting hole”); **Seagate’s** (a drop-off for fishing “rigger” Snapper); the **Power Station** (“lumpy” bottom, for fishing Snapper and Kingfish); and **Flinders** (a channel area, for fishing Snapper) (Fish SA, 2003).

More specific details about recreational fishing are provided below, according to region:

Western Side

A summary of fishing activities in the area includes line fishing, netting, hoop netting, dab netting, crab trapping, dive fishing / collecting molluscs (Bryars, 2003).

The **Whyalla** area is recognised as having Australia's biggest Snapper (Morelli and de Jong, 1995; Krawczyk, 1996). The Australian Amateur Snapper Fishing Championship is held annually at the marina at **Whyalla**, attracting recreational fishers from S.A., Victoria, and NSW. The competition has attracted more than 800 entries and 300 boats in recent years. Large Snapper are targeted at local fishing spots such as **Fitzgerald Bay**, **Point Lowly**, **Mudbanks**, and the **Leeton wreck**, amongst other sites (some of which are listed below). Information is collected on any tagged Snapper that are caught during the competition. Other fish targeted during the competition include Snook, King George Whiting, Australian Salmon, Mulloway, leatherjackets, mullet, Tommy Ruff, Garfish, flathead, blue swimmer crab and striped trumpeter. Examples of other annual fishing competitions held in the **Whyalla** area include the State-

based Sportsfisher of the Year, the ANSA Championship, and the Steel City Sportfishing Club Competition.

The importance of the **Whyalla** area for Snapper fishing is indicated by Slater (South Australian *FishInternet* web site, 2001) in which he stated in 1999 that “*Perhaps the most notable event for the past few years occurred in mid-1998, when I estimate, and I stress that this is only my estimate, that the professionals and amateurs during a 12 week period, caught approximately 8000 Snapper, averaging more than 10kg each - that's 80,000kg or 200,000lb of Snapper, valued at around \$1,000,000 on the retail market*”.

There are several recreational and sports fishing clubs, and fishing and boating associations, based in the **Whyalla** area, and some of these are also involved with fish tagging program for some of the major species, such as Snapper, King George Whiting and Australian Salmon (Fish Internet Australia, 2001).

There are several fishing charter boats operating out of **Whyalla**, targeting Snapper, whiting and some of the other species discussed below. Catching large Snapper is one of the major features of charter operations in the area. Some of the charter boats are involved with a Snapper tagging program (e.g. see Fish Internet Australia, 2001). Charter boats in the area attract both South Australian and interstate fishers.

During the past 10 years, the waters around **Whyalla** (e.g. **Point Lowly, Fitzgerald Bay**) and **Port Augusta** (e.g. power station) have become more popular with game fishers targeting Yellow-tail Kingfish, which attain large sizes in the upper Spencer Gulf. The large kingfish seasonally visit the area to feed on smaller coastal fish (Garfish, Tommy Ruff) and cephalopods.

Some of the popular species for *land-based anglers* in the **Whyalla** area include Garfish, Australian Herring (Tommy Ruff), Southern Calamari, Australian Salmon, mullet and Blue Swimmer Crabs.

Some of the major recreational fishing areas and species caught in the **Whyalla** area are outlined below:

Whyalla: A general description of fishing areas close to the city of Whyalla include the local waters, which are used for boat fishing, and shore spots such as the **Whyalla jetty, boat ramp, rocks, marina wall / breakwater, North Beach** and other **foreshore areas**. In these areas, fishers catch small and large Snapper (e.g. from the tyre modules and other reefs, mud banks, and other areas of benthic relief); King George Whiting (mainly targeted by boat fishers all around the northern Spencer Gulf area, and often caught in deeper waters, but also taken from the foreshore and jetty); Blue Swimmer Crabs (commonly targeted at inshore areas such as the jetty, and the **Silt Grounds**; large specimens are caught at some near-shore areas around **Whyalla**); Southern Calamari and Giant Cuttlefish (both often targeted from the jetty, and also **Point Lowly** area, and various rocks close to shore); large and small Australian Salmon; Tommy Ruff (the species is caught all along the coast, including large fish in some areas; Tommy Ruff are also commonly targeted at the jetty, and regularly form aggregations in the foreshore area, where they are at times caught in large numbers); Silver / Sand Whiting (near the foreshore, and in sand patches along the coast, and including large fish, in some areas); small and large Garfish (caught in a number of areas along the coast, and including very large specimens); Yellow-fin Whiting; Yellow-tail Kingfish (particularly during the summer months); Mullet (sometimes caught in very shallow water near the shore, and at the **Point Lowly** boat ramp); flathead species (both small and large specimens, particularly in the sandy areas); Snook (caught in a number of areas, including the jetty, and large fish up to 1m are sometimes caught in the Whyalla area); Striped Trumpeter (e.g. from the “mud banks”) and Leatherjackets (both trumpeter and leatherjackets are often found in high abundance, and caught as non-targeted catch); Mulloway (less commonly caught, but targeted when periodically moving through the area); and various shark species (Bronze Whaler, School Shark, Hammerhead). The **Steelworks Breakwater** is promoted for catching Australian Salmon, whiting, stingray species, and Razorfish. Species which are sometimes caught in the Whyalla area but not usually kept, include stingrays, Eagle Ray, and Port Jackson Shark.

Beaches in the area: flathead species, Silver / Sand Whiting, Yellow-fin Whiting, Australian Salmon, King George Whiting, Blue Swimmer Crab;

Point Lowly, False Bay and surrounds: Australian Salmon, large and small Snapper (e.g. from tyre reefs in the area such as the modules near the Lighthouse, as well as from coastal rocks, the boat ramp, the “rip”, and other locations); Australian Herring (Tommy Ruff); Garfish (sometimes in schools, and regularly caught by fishers from rocks fishing the inshore waters of the area); small and large Yellow-fin

Whiting (e.g. targeted in the sand patches and other foreshore areas), Yellow-tail Kingfish (including large fish, and schools are seasonally present); King George Whiting (e.g. in False Bay and silt grounds), Southern Calamari (e.g. often caught near shore, by fishing from rocks, and also near the boat ramp), Mullet (including large fish); Giant Cuttlefish (caught from rocks near shore), Snook (e.g. False Bay and the silt grounds, and at Point Lowly); Blue Swimmer Crab; Striped Trumpeter (regularly caught but not targeted), flathead species (e.g. at silt grounds and from boat ramp), Mulloway (less common in the area, but large and small specimens are seasonally caught, e.g. at tyre reefs and other locations in the Point Lowly area);

Mudbanks out of Whyalla: small and large Snapper, Blue Swimmer Crab (including large specimens), Striped Trumpeter, and some of the species discussed above for Whyalla;

Eight Mile Creek (Cowleds Landing area): Blue Swimmer Crabs (N.B. fishing for all species other than blue swimmer crabs is prohibited, because the area is an Aquatic Reserve);

Merek's (= Marek's) Tyre Reef: King George Whiting, small and large Snapper, striped trumpeter.

Black Point: small Snapper, Garfish (sometimes in schools), cuttlefish, Striped Trumpeter, Yellow-tail Kingfish, King George Whiting (including large fish), Tommy Ruff, Australian Salmon, Snook; large Mulloway (less common in the area).

Backy Point: Australian Salmon, small and large (2+m) Yellow-tail Kingfish, Snapper (including large specimens), King George Whiting, Snook, Blue Swimmer Crab, mullet, and flathead species.

Fitzgerald Bay: large and small Snapper, Yellow-fin whiting, Australian Salmon, small and large Garfish, King George Whiting, Snook, small and large Tommy Ruff, Striped Trumpeter, mullet, flathead species;

Leeton Wreck, Eastern Shoal, Fairway Banks and other deeper channel and bank areas: Large and small Snapper, King George Whiting and other whiting species, Southern Calamari, Snook, Striped Trumpeter, leatherjacket species, Garfish, Australian Herring, flathead species, and Dusky Morwong;

Redbanks: Small Mulloway, and some of the species listed above for the areas seaward of Whyalla. (Pescatore and Ellis, 1998; Fish SA, 2000; FishInternet Australia, 2001; Fishing South Australia, 2001, and regional fishing and tourism promotion materials).

Eastern Side

Winninowie Conservation Park is used for mainly for recreational fishing and crabbing (DEH, 2000a), and provides key access point to Northern Spencer Gulf for fishing. Within the reserve, **Chinaman Creek** and **False Creek** provide one of the few coastal access points for boat launching into the waters of the upper east side of Spencer Gulf. The camping facility at **Chinaman Creek** is used mainly by recreational fishers, because it contains a landing and boat ramp (DEH, 2000a). Recreation, particularly fishing, provides an economic return to the region, the value of which has not been quantified (DEH, 2000a).

Blue Swimmer Crabs, Snapper, Snook, whiting species, and small Australian Salmon (salmon trout) are popular targets at fishing spots in the **Port Pirie** area. Examples of fishing areas around **Port Pirie** include **Second** and **Third Creek** (for whiting and Salmon trout, and Blue Swimmer Crabs, seaward of the creeks), and **Cockle Spit** (for Snook and other species, on the eastern side) (FishInternet Australia, 2000; Fishing South Australia, 2001; Australian Fish News, 2003). **Port Germein** is also used by recreational fishers. There is a long jetty (used for fishing) and sites for boat launching in the area. At low tide, the eastern side of the beach gives vehicle access to the deeper water. Many of the species listed for the Whyalla area also occur at **Port Germein** and the **Weeroona Island** area (e.g. King George Whiting are taken from **Weeroona Island** and other areas in the vicinity of **Port Pirie**). Snapper and Australian Salmon are caught from the **Port Germein Reef** and **Port Germein Community Wreck** (FishInternet Australia, 2001). Other areas where Snapper are regularly targeted include the sand flats and "the Pipes" in the **Port Germein** area, and further south at the edge of the shipping channel at **Port Pirie**. Calamari, flathead, Yellow-eye Mullet, Snook, Garfish, Tommy Ruff, and Trevally are also caught in the area. The area is popular for recreational crab fishing, which are taken by netting from the jetty, and also by collecting using various devices in the shallow coastal waters (Australian Tourism Net, 2001; FishInternet Australia, 2001; Fishing SA, 2001, and other regional fishing and tourism materials and recreational fishing reports).

A summary of the fishing activities in the **Germein Bay** area includes line fishing, netting, hoop netting, crab trapping, and dive-fishing (e.g. for molluscs) (Bryars, 2003).

Far North

In Far Northern Spencer Gulf (e.g. **Douglas Point to Port Augusta** area, including the beaches, **Chinaman Creek, Concrete Creek, Blanche Harbour, Power Station** outlet, and the tyre nodules) some of the main species caught by recreational fishers include King George Whiting (e.g. in the sandy patches, and particularly plentiful from autumn to late spring), shark species, ray species, Yellow-tail Kingfish (including very large specimens), Snook, Garfish, Sand Whiting, Southern Calamari, Blue Swimmer Crabs, Australian Salmon, Snapper (particularly during spring, south of the power station, in the channel on the western side), mullet, Yellow-fin Whiting, Black Bream, Mulloway, and species of flathead and flounder (FishInternet Australia, 2000; Port Augusta City Council, undated; RHBS Multimedia productions, 2003b, and regional fishing and tourism promotion materials).

During the past 10 years, the waters around **Port Augusta** (including the power station) have become more popular with game fishers targeting Yellow-tail Kingfish, which attain large sizes in Northern Spencer Gulf. The large wild kingfish seasonally visit the area to feed on smaller coastal fish (Garfish, Tommy Ruff) and cephalopods. In recent years, there has been a local fishing competition in **Port Augusta** for Yellow-tail Kingfish (FishInternet Australia, 2000; Port Augusta City Council, undated; and regional fishing and tourism promotion materials). There are charter boat trips out from **Port Augusta**, for fishing both shallow and deep waters. Seasonally, there are 2-day charter trips for catching Yellow-tail Kingfish (RHBS Multimedia Productions, 2003b).

Artificial Reefs, Wrecks, and Other Fish-Aggregating Devices

Artificial reefs in the northern Spencer Gulf area are generally established to increase the number of fish for recreational fishers and divers in those local areas (Aquaculture Group - PISA Fisheries, 1996).

The importance of recreational fishing as a tourist attraction has been highlighted by the installation of nine artificial reefs within the waters of the Spencer Gulf, some of which exist in the northern Spencer Gulf region. The reefs were installed by PIRSA (Fisheries) and other organisations such as fishing clubs (Aquaculture Group – PISA Fisheries, 1996).

There is an artificial reef located out from the **Whyalla** foreshore (742717 E, 6334512 N), used for both fishing and diving (*see section below*). **Nowark's Reef** was reportedly the first official artificial reef in Spencer Gulf, constructed by the Whyalla Sport Fishing Club to provide an extra fishing ground for the local community and visitors (Aquaculture Group - PISA Fisheries, 1996). There are at least two other tyre reefs in the **Whyalla** area (**Fitzgerald Bay**: 775696 E, 6344456 N and 760034 E, 6344990 N).

An artificial reef is located in the waters adjacent **Blanche Harbour** (758106 E, 6382305 N).

There are two artificial reefs (tyres and sunken pipes) located in the waters adjacent **Port Pirie / Port Germein** (770775 E, 6335657 N, and 778787 E, 6338978 N). Wrecks in the area are also used for fishing (e.g. **Leeton** wreck). Also, a number of unofficial “drops” of large metal objects (to attract fish such as Snapper) exist throughout the area.

There is also a tyre module reef at **Port Augusta**.

A number of wrecks in the northern Spencer Gulf area attract fish, particularly Snapper, and are regularly used by fishers. Some of the popular wrecks for fishing include the abandoned tug **Leeton** (a deeper wreck site which is particularly popular for fishing Snapper, but other species are also caught, such as whiting and leatherjacket species); **Port Germein Wreck / Community Wreck** (Snapper, Australian Salmon, and other species), and the relatively shallow **Illusion** wreck (for Snapper, whiting species, flathead species, Snook, sharks and other species).

There are numerous artificial “Snapper drops” in upper Spencer Gulf, comprising abandoned car wrecks, and white goods and other hard objects. These have been placed (illegally) over the years, to aggregate Snapper and other reef fish. Some examples of “drops” that have been placed in the waters of upper Spencer Gulf, particularly for catching aggregating species such as Snapper, include the “Bus Drop”, “Car Bodies” and “Cars”, “Pittman’s Drop”, and “Old Artificial West”.

Local fishers in Spencer Gulf report that the power station at **Port Augusta** has a fish-aggregating function similar to artificial reefs. Recreational fishers reports large quantities of baitfish being attracted to the warm water outlet during the cooler months of the year, which attract other (larger) coastal fish to the outlet. At this time, several species of larger predatory fish (including Yellowtail Kingfish) aggregate around the outlet to feed on the smaller fish attracted to the area.

Diving and Snorkelling

The **Point Lowly / False Bay / Black Point** area has become significant since the 1990s, as a place for divers to observe the spawning aggregation activities of hundreds of thousands of Giant Cuttlefish, between May and September. Hall (1999 and 2000, citing Whyalla Diving Services) reported that approximately 1260 dives by non-local persons were made in 1999, and 900 dives by locals. In 2000, the number of dives increased to 3,500 by non-local dives, and 1,000 by locals, principally due to the presence of the cuttlefish. The Whyalla Sports Divers Club (2000) estimated that the number of divers visiting Whyalla to dive with cuttlefish has doubled each year since 1998. There is increasing interest in the area as an dive tourism destination for visitors from interstate and overseas, with numbers of non-local divers increasing since the mid 1990s, following promotion of the spawning aggregation phenomenon. Dive South Australia (2004) promoted the Giant Cuttlefish spawning as a “spectacular event” for divers to witness. The Giant Cuttlefish spawning event is also promoted in coastal tours of the area (Postcards On-line, undated e). Diving organisations report that divers are also attracted to the **Point Lowly / False Bay / Black Point** area due to the abundant fish and invertebrates species found in the shallows.

There are dive charter trips in the **Whyalla** area, which include the deeper channel areas (where the larger attached invertebrates are an attraction); the cuttlefish spawning grounds at the **Point Lowly / Black Point** area (see above); a fish farm at **Whyalla**; and night dives at various locations in the area (e.g. to view the abundant crustaceans and other invertebrates, and bottom-dwelling fish and elasmobranchs) (Hummock Hill Communications 1999 - 2002, and other regional dive promotion materials). Previously, Christopher’s (1988) diving guide to S.A. listed **Point Lowly** (e.g. shore-entry diving, and the tyre reef) and the old iron ore jetty at **Whyalla**, as two of the best dive spots in the area.

Port Germein has been described by tourism promotion materials as a site for diving (South Australian Tourism Commission, 2000), but no details are available for this report. It is likely that the diving in this area relates to spear-fishing (see Bryars, 2003).

Apart from the value for fishing, the **artificial reefs** installed in upper Spencer Gulf were also created to provide “a diverse area for recreational divers” (Aquaculture Group - PISA Fisheries 1996). The tyre module reef at 18m off **Point Lowly** is listed by DIASA (undated) and Christopher (1988) as being amongst the top dive locations in S.A.

Apart from the designated artificial reefs in the area (see section on **Recreational Fishing**), a number of other artificial reefs have been created by individuals, and wreck sites in the area are also used for diving, although their main use is as fish-attracting devices for fishers (e.g. the **Leeton** wreck - see FishInternet Australia, 2001).

Other Marine Recreation / Tourism

Generally, tourism is considered to be a major industry along the coastal area of Spencer Gulf, with the majority of visitors travelling from within South Australia. Tourism is largely seasonal, with peak times during school and public holidays, especially during the summer months. Tourism relies mainly upon coastal marine recreational activities such as fishing, boating and diving (see sections above), and the historical significance of a number of the towns. The number of holiday shacks in this area is also significant (Aquaculture Group - PISA Fisheries, 1996). Shack settlements are described in a separate section of this table.

Winninowie Conservation Park is considered to be “a locally important tourism asset, also providing one of the few access points to the marine environment of eastern Upper Spencer Gulf” (DEH, 2000a). Apart from fishing (see above) **Winninowie Conservation Park** and the surrounding coast is used for recreational pursuits including geological and wildlife study (e.g. bird watching), boating, canoeing, swimming (e.g. **False Creek** and the wharf area) and walking / beach-combing (DEH, 2000a). There is an increasing number of visitors to the area (DEH, 2000a). The Management Plan for Winninowie (DEH, 2000a) aimed to promote appreciation and understanding of the reserve’s terrestrial and marine

ecosystems and conservation values, particularly emphasising mangroves and salt-marsh, by increasing the facilities and interpretative materials for low impact, passive recreational and educational activities.

Chinaman Creek is accessed through the **Winninowie Conservation Park**. Trailer boats are used to explore the extensive tidal creek system in the mangrove forests, and to reach fishing spots. There is a camping area at **Chinaman Creek**, adjacent to **False Creek**. An estimated 300 campers per year use this site. Most campers are recreational fishers who fish and camp overnight, typically for one night's duration. The campsite and roads to Chinaman Creek are subject to tidal inundation several times per year (DEH, 2000a).

Yatala Harbour is promoted by tourism operators as a safe, shell-sand beach which is good for beachcombing, and for swimming when the tide is high. 4WD vehicles also use the sand beach.

As discussed in other sections of this document, much of the marine recreation / tourism value in the **Whyalla** area involves the two main activities of recreational fishing and diving. Dive trips, fishing charter boats, fishing competitions, and fishing holidays, attract interstate and international visitors as well as South Australians (see sections above on **Recreational Fishing**, and **Diving**). Other marine activities around Whyalla include yachting and swimming (e.g. at **North Beach**) and wind surfing. Wind surfing spots around Whyalla include the foreshore (described as Whyalla's most popular sailing spot during summer); **Point Lowly** (lighthouse beach); **False Bay**, and **Cowled's Landing** area (Brokken and Hoffmann, undated).

There is a camping area and holiday shacks near the beach in the **Fitzgerald Bay** area, and shacks also occur at various points along much of the western side of **northern Spencer Gulf**, up to **Port Augusta**.

The Yellow-tail Kingfish farming at **Fitzgerald Bay** near **Whyalla**, is part of a tourism promotion called the *Eyre Peninsula Seafood and Aquaculture Trail*. Other attractions that are part of tours of the area include a track walk to the historic **Point Lowly Lighthouse**, and promotion of the Giant Cuttlefish spawning event (Postcards On-line, undated e).

Most of the tourist attractions at **Port Pirie** are not marine-related, however some of the coastal and marine activities include swimming, walking and picnics at **Solomontown Beach**; and boating, fishing and water sports on **Port Pirie's** waterways (Fairfax Publishing – F2, 2001; TotalTravel.com travel guide, 2003). Boats moor in the **Port Pirie River** (Bryars, 2003). There is an annual *Blessing of the Fleet* ceremony on the 2nd Sunday of September, when the statue of Madonna Dei Martiri is carried to the local wharves by members of the Italian community, and the town's fishing fleet is blessed (Fairfax Publishing – F2, 2001; TotalTravel.com travel guide, 2003).

Port Germein has been variously described as a “quiet holiday town” ; a “peaceful seaside town”; a “family holiday destination”; a “popular resort town with many holiday shacks”; a “popular location for holiday homes, with safe swimming beaches”; and a “tranquil and safe holiday haven, especially for families with young children” (South Australian Tourism Commission, 2000; Fairfax Publishing – F2, 2001; TotalTravel.com travel guide, 2003, and other regional tourism promotion materials). The beaches at Port Germein have been described as having “moderate recreational use” (Aquaculture Group - PISA Fisheries, 1996). The tidal beach at **Port Germein** is often promoted as a destination for families. As with other coastal settlements in the area, there is recreation and tourism value associated fishing and crabbing (see section above on **Recreational Fishing**). Apart from fishing and crabbing, other marine recreation / tourism promoted in the area includes activities such as swimming at the shallow tidal beaches in the **Germein** area; beach-combing / searching for crabs in the tidal pools; picnics and local seafood barbecues at the beach; boating and yachting; water skiing; walking along the Port Germein Jetty (the longest jetty in S.A.); and admiring the views from the lookout on **Weerona Island** (South Australian Tourism Commission, 2000; Fairfax Publishing – F2, 2001; TotalTravel.com travel guide, 2003). There are tourism and progress associations in the Port Germein area. Land yachting is also considered to be a popular pastime in the beach area, at low tide. There is an annual *Festival of the Crab* held at **Port Germein** on New Year's Eve, to celebrate the significance of blue crabs in the local area (e.g. Fairfax Publishing – F2, 2001; Australian Tourism Net, 2001; TotalTravel.com travel guide, 2003, and other regional tourism promotion materials).

Apart from recreational fishing (see section above), the sheltered and easily accessible waters of **Port Augusta** are promoted for water skiing, boating, yachting / sailing (Port Augusta City Council, undated; South Australian Tourism Commission, 2000). There are charter boat trips for sightseeing and evening

cruises, as well as for fishing (see section above on **Recreational Fishing**). New projects in the area include waterside accommodation and a marina, which were in the planning stages in 2003 (Media Report, September 2003), and such developments are likely to increase the tourism and recreation value of Port Augusta. There is a major tourism information and cultural centre in the town (Wadlata Outback Centre), which is visited by many travellers heading north, south, east and west from the highway “crossroads” at Port Augusta.

In recent years there has been a significant increase in the number of beach shacks in the area between **Blanche Harbour** to 15km south of **Port Augusta**. This area now has over 300 beach shacks, which are used for recreation / holidays by both residents of Port Augusta, and visitors (Port August City Council, undated).

There are concrete boat ramps at **Port Augusta** and **Whyalla**, and beach launching facilities for boats at **Port Augusta**, **Point Lowly** and **Whyalla**, used to various extents as launching areas for marine leisure activities (other than fishing). At these locations, a survey in 1996 showed that use of each boat ramp for recreational activities other than fishing was around 29.5% at Port Augusta, 6% at Whyalla and 6% at Point Lowly (McGlennon, 1996). The list of “other activities” included yachts and other pleasure boats, diving, water skis, and/or jet skis, or any other activity not involving fishing. There is a yacht club at **Whyalla**, based at the marina, and a marine sports association.

Marine and Coastal Education

Winninowie Conservation Park, including the intertidal creek system and mangrove areas, is used by local school groups for nature study and canoeing education (DEH, 2000a), and by universities and colleges, for a variety of environmental studies, particularly aquatic / marine studies. The government’s Management Plan for Winninowie (DEH, 2000a) aimed to promote appreciation and understanding of the reserve’s terrestrial and marine ecosystems and conservation values, particularly emphasising mangrove and salt-marsh communities, by increasing facilities and interpretative materials for educational activities. According to DEH (2000a), **Winninowie Conservation Park’s** high conservation values and its relative accessibility from Adelaide and nearby regional centres, have attracted the attention of a number of societies, associations, educational institutions and other groups whose primary interest in visiting the reserve is conservation research and/or education.

DEH’s (2000a) management plan for **Winninowie Conservation Park** aimed to work co-operatively with the Nukunu people to raise awareness of, protect, and interpret Aboriginal cultural heritage values and sites, including development of interpretive / educational material about the Aboriginal culture of the area.

The spawning aggregation phenomenon of Giant Cuttlefish in the **False Bay - Black Point - Point Lowly - Fitzgerald Bay** area has attracted documentary film and video makers, and marine educational reporters for books, magazines and television media. There is also an educational and promotional web site describing the phenomenon of cuttlefish spawning in the area, and the web facility attracted around 262,000 “hits” between June 1999 - Nov 2000 (see Hall, 1999, 2000; Whyalla Sports Divers’ Club, 2000).

Coastal and Marine Research and Monitoring

The former S.A. Department of Fisheries, as well as SARDI, and some fishers / fishing groups from the northern Spencer Gulf community, have been involved with several Snapper-tagging programs in the area, to monitor Snapper growth and movements. Information about tagged Snapper is also recorded by charter boats, and during Snapper fishing competitions, when tagged Snapper are caught. The Austag tagging program also operates in S.A., including the northern Spencer Gulf area, and members from several sports fishing / recreational fishing clubs in the **Whyalla / Port Pirie** area are involved with tagging for that program, with efforts concentrated on Snapper, King George Whiting, Australian Salmon, Mulloway and Black Bream. Statistics such as the date, location, and length of caught fish are recorded, to assist with stock monitoring studies, such as growth and movement.

The spawning aggregation phenomenon of Giant Cuttlefish in the **False Bay - Black Point - Point Lowly - Fitzgerald Bay** area has attracted researchers at State, national and international levels, with at least 11 participants involved with scientific research during the past few years (involving 133 dives in 1999 and

142 dives in 2000 (e.g. see Hall, 1999, Table 3d; Hall, 2000, Table 3c).

There is also regular catch and effort monitoring by government, of several major commercial fisheries in the region (Western King Prawn, King George Whiting, Snapper, Blue Swimmer Crab, Southern Calamari, and other species), and regular research and monitoring of larval and juvenile fish, prawn and crab stocks. There are numerous examples of both past and recent studies. Examples of the former include a study on long term changes to reproduction in King George Whiting (Cockrum and Jones, 1992), for which Douglas Bank was one of the sampled sites. Whyalla and Port Pirie were two of the sites at which sampling was undertaken to determine the impact of netting and line fishing on undersized King George whiting (Kumar et al., 1995). Surveys of juvenile snapper abundance were also undertaken in northern Spencer Gulf during the early 1990s (Jones, unpublished data; Baker, pers. obs., 1992). Examples of more recent fisheries-related research include the work of Fowler and Jennings (2002), who described spatial and temporal patterns in recruitment of 0+ aged Snapper, and elucidating aspects of the early life-history, and larval and juvenile ecology. Recruitment and growth surveys of juvenile Snapper were conducted in northern Spencer Gulf in 2000, 2001 and 2002. Recruitment studies have also been undertaken on Southern Calamari in northern Spencer Gulf (Triantafillos and Fowler, 2000). Giant Cuttlefish, which was previously fished heavily in Northern Spencer Gulf, has also been the subject of ongoing research in recent years, including studies of the spawning aggregation phenomenon (e.g. see Hall and Hanlon, 2002). Research into the status of Blue Swimmer Crab populations has been periodically undertaken in northern Spencer Gulf, and both researchers and fishers contribute data. One recent example is the surveys undertaken in 2002 and 2003 on the spatial abundance and size composition of adult and juvenile blue crabs (to determine a pre-recruit index), and a study on the reproductive stage of female blue crabs (Svane and Hooper, 2004).

Numerous marine ecological and benthic habitat studies have been conducted in the area, from the 1970s to the present. Examples of previous studies include the benthic investigations of Department of Fisheries, 1973; Shepherd, 1974, 1983a, 1983b; Johnson, 1976 and 1979; Shepherd and Branden, 1974; Johnson, 1981c; Shepherd and Hails, 1984; Kinhill Stearns, 1985a; and Kinhill Engineers, 1987, amongst others. Recent research work by SARDI and Flinders University, supported by the Commonwealth's Natural Heritage Trust, and Spencer Gulf industries, involves investigation of the ecological role of seagrasses of different forms, densities and locations, and documents the differences in fauna between different seagrass habitats (e.g. see McDonald, 2000).

To date, there have been at least 80 scientific studies, including some major collaborative projects, investigating oceanographic, chemical, geological, geomorphological, ecological and biological features of Northern Spencer Gulf. Some of the major interdisciplinary studies were associated with environmental impact assessments, for existing and proposed developments. Major studies into metal contamination at Port Pirie have been undertaken, mainly by CSIRO / ILZRO (e.g. Ward *et al.*, 1982 and 1986). In 1981, SANTOS Ltd. prepared an impact statement for port / terminal facilities at Stony Point. During 1972-1983, several major regional studies were undertaken on the proposed petrochemical plant development at Redcliff, which was later abandoned, largely based upon the major environmental impacts that the development was likely to cause. There have also been EIA studies following the 1992 *Era* oil spill (Wardrop *et al.* 1993; Edyvane, Baker and Seddon, unpublished SARDI data; Connolly and Jones, 1996). More than 30 environmental impact studies and risk analyses have been undertaken in the region since the 1970s.

Other research has included geological studies, 12 of which were published in a special issue of the *Marine Geology* journal in 1984. More recent work includes that of Cann *et al.* (2002) in the **Port Pirie area**, who analysed Holocene marine sediment core samples, and reported facies that represent shallow subtidal *Posidonia* seagrass, and intertidal sand flat, mangrove, and back-storm ridge coastal lagoon environments, on the basis of lithological characteristics and their preserved foraminifera. The contents of the sediment cores exhibited an ecological succession which could be related to decreasing intervals of tidal inundation and increasing salinity. The quantitative foraminiferal biofacies analysis confirmed and refined the sedimentological interpretation of intertidal sediment facies from observations of the core materials. The study also provided independent estimates of the elevation of key facies boundaries in cores, and confirmed a general relative fall in sea level in **Northern Spencer Gulf** over the past 7000 years (Cann *et al.*, 2002). Previously, Cann and Clarke (1993) compared foraminifera and molluscs in biogenic sediments at Esperance (WA) with similar fossilised remains found in **Northern Spencer Gulf**, to describe the palaeo-environments that relate to these assemblages (Cann and Clarke, 1993). The study by Cann and Clarke (1993) showed that in south-west WA, the large foraminifer *Marginopora*

vertebralis is dominant in bioclastic carbonates in relatively protected areas of algal turf and seagrasses, and the abundance of this normally tropical foraminifer at southern latitudes has been attributed to the Leeuwin Current, which brings warm waters from the tropics to south-western Australia, and then eastwards, past Esperance into the Great Australian Bight. Sediments in the Glanville Formation (calcreted shell beds) from the last interglacial in **Northern Spencer Gulf**, host an assemblage of fossil foraminifera which is similar to that of the modern environment at Esperance, especially the presence of *M. vertebralis*. Two bivalve molluscs, *Anadara trapezia* and *Pinctada carchariarium*, both characteristic of warm waters, are also present as fossils in Northern Spencer Gulf. Cann and Clarke (1993) reported that *M. vertebralis* and other faunal elements migrated to South Australia by means of the last interglacial equivalent of the Leeuwin Current, which apparently had greater definition at that time. The authors inferred that, during other times of global warming and corresponding higher sea levels, the palaeo-Leeuwin current had greater ecological influence across the continental shelf of Southern Australia. Thus, warm-water marine fossils in Northern Spencer Gulf do not necessarily signify last interglacial water temperatures for the open Southern Ocean, beyond the continental shelf. Similarly, it cannot be assumed that these fossils necessarily indicate a last interglacial climate for terrestrial southern Australian that was warmer than presently prevails (Cann and Clarke, 1993).

In addition to the numerous oceanographic, geological, biological and ecological studies in the area, a project has been undertaken to assess the coastal vulnerability of **Northern Spencer Gulf**, due to sea level rise and associated factors (Harvey *et al.*, 1995). Other work in this field includes Barnett *et al.*'s (1997) studies of Holocene sea level change at **Port Pirie**, based on a coastal sedimentary succession.

There is an environmental research station at **Chinaman Creek, Winninowie Conservation Park**. The area, particularly **Redcliff**, was a major focus for marine studies (oceanographic, geomorphological and marine ecological and benthic studies) in northern Spencer Gulf during the 1970s (see above). During the 1980s, the station was used for climatological, oceanographic, fisheries and benthic studies, and monitoring of seismic activity in the area is currently undertaken at the facility. A body of physical, biological, ecological and cultural information pertaining to the local area of upper Spencer Gulf has also been compiled by this facility (e.g. see references by D. Reilly, in DEH, 2000a).

Winninowie Conservation Park's high conservation values and its relative accessibility from Adelaide and nearby regional centres, have attracted the attention of a number of societies, associations, educational institutions and other groups whose primary interest in visiting the reserve is conservation research and/or education (DEH, 2000a).

Northern Spencer Gulf was listed during the early 1990s on the *Register of the National Estate* as an *Indicative Place*, meaning that it is to be assessed for potential inclusion in the National Heritage Register. Although most of the features in the Statement of Significance were ecological and biological, the value of the area as a long term research site was also highlighted.

Historic Shipwrecks

Historic but formally unprotected shipwrecks in the area include the following (from S.A. Coast and Marine Atlas, 2001, and Stone, undated)

- ♦ **Douglas Bank** area: *Apollo*, iron barque, built 1884, wrecked 1889;
- ♦ south-east of **Mangrove Point**: *Alpha*, wooden cutter, built 1879, wrecked 1921;
- ♦ **Redcliff Point**: *Letty*, wooden vessel, built 1863 as a paddle steamer in Victoria, and later converted to sail and brought to S.A.. The *Letty* was wrecked at Redcliff Point in 1866, and brought to Port Augusta to be broken up (Stone, undated).
- ♦ **Point Lowly**: *Parara*, wooden vessel, built 1814. Washed ashore in a gale near Point Lowly in 1882;
- ♦ **Point Lowly**: *Sarah*, wooden barge, wrecked 1876;
- ♦ **Ward Point**: *James and Margaret*, wooden cutter, wrecked 1878;
- ♦ **Port Germein**: *Annie Watt*, cutter. Destroyed by fire in 1886.

Wrecked vessels from the 20th century also occur in the area. For example, the *Rooganah*, a wooden auxiliary schooner, built 1909, was carrying cargo (including benzene) into **Whyalla**, when her engine backfired and set her alight in August 1927 (Stone, undated). The *Rooganah* remains are off **Cowled's Landing**. Also in that area is the wreck of the tug *Leeton*, a popular site for fishing (e.g. for Snapper). The launch *Angler*, was wrecked at **Point Lowly** in 1913.

Other European Heritage Values

All of the three major settlements Northern Spencer Gulf (**Port Pirie**, **Whyalla**, and **Port Augusta**), as well as the smaller settlement of **Port Germein**, have historic significance as trading ports since the 1800s. Port Augusta no longer has this function (due to road and train transport), and Port Germein is also no longer a major port.

The lighthouse and building complex at **Lowly Point** are listed as heritage items on the *Register of the National Estate* (Australian Heritage Commission, undated) and the *State Heritage Register*. The **Lowly Point** lighthouse was built in 1883 after the conditions were found to be unsatisfactory for the continued use of a lightship in that locality. The lighthouse is the oldest building in the **Whyalla** area, and was used to assist ships going to **Port Augusta** and **Port Pirie**. The original structure was 15m high and was made from local sandstone. After a number of incidents the height of the light was raised by 7.6 metres to its current level, in 1909. The light became automatic in 1973, after the installation of battery-powered beacon. In 1979 the light was connected to mains electricity. The light was turned off in 1993 by the Australian Maritime Safety Authority as it believed it was no longer necessary. After much negotiation the lighthouse was purchased by the Whyalla City Council in 1995 with assistance from the SA State Government. Once under their control the light was re-activated (Lighthouse Computer Training & Development, 1998; Lighthouses of Australia Inc., 2002). The lighthouse at **Lowly Point** has more recently been listed as a potential "icon" for Spencer Gulf under the Marine Heritage category, as part of the S.A. government's *Encounter 2002* program.

Yatala Harbour was identified as a suitable port location in the 1850s. The coastal area has been used as a transport route since the 1860s. Coins from 1865 onwards have been discovered in beach sands and sediments adjacent to **Chinaman Creek**. During the 19th century, **Chinaman Creek** was the site of an export trade in native sandalwood, run by Chinese merchants in the area. The Chinese harvested and exported "sandalwood", directed at Chinese markets. It is believed that both quandong, *Santalum acuminatum*, and "false sandalwood", *Myoporum platycarpum*, were used. Large stands of these species were discovered at the site of what is now Winninowie Conservation Park. However, it is also likely that the actual sandalwood species, *Santalum spicatum*, was exported. This species has now almost disappeared from the district and only a few trees are known to remain in the reserve. It is assumed that Chinaman Creek was named after the sandalwood collectors who shipped the felled timber back along the creek to the beach (Ross and Jeffrey, 1975, cited by DEH, 2000a).

Port Pirie was first explored in 1802 when Captain Matthew Flinders travelled up the Spencer Gulf. The muddy creek upon which the town's port was based was originally known as **Samuel's Creek** after its discoverer, Samuel Germein. Around 1845 the schooner *John Pirie* made its way up the creek and managed to take on board a flock of sheep which was transported across Spencer Gulf to near Port Lincoln. It was as a result of this that Governor Robe named the site **Port Pirie**, and by the late 1840s, land for settlement was being sold in the area. Settlement of the town was slow until 1871, when the town was surveyed, and five years later it was declared a municipality. The critical event in the town's history was the construction of the smelting works in 1889, which ensured the town's future. It was greatly compounded by the completion of the Broken Hill Associated Smelters Pty Ltd smelting works in 1915. By 1934 Port Pirie was the largest single-unit lead-smelting works in the world. Around 1900, the connection between Port Pirie and Broken Hill was strong, and residents of Broken Hill would travel to Port Pirie for seaside holidays. In 1937 the broad gauge railway line to Adelaide was completed and by 1953, Port Pirie was declared South Australia's first provincial city. Today it is South Australia's second largest port (Fairfax Publishing – F2, 2001).

Port Augusta was charted by Matthew Flinders in 1802, and later developed as a major port for primary industries (Wilmap 1999; Fairfax Publishing – F2, 2002). The harbour was located in 1852 by Alexander Elder and John Grainger, who named it Port Augusta. Two years later, land around the port was being sold for £100 an acre. Because of its strategic location at the head of the Gulf, Port Augusta quickly grew into a major service centre. By 1854 the first wool had been shipped through the port, and by the 1860s it was a vital transport node. In 1860, 10,000 bales of wool were despatched from the port. The town was officially proclaimed in 1875, and the railway from Adelaide arrived in 1882. From the start of mining in the Flinders Ranges, ore had been transported by bullock teams to **Port Augusta**. From there it went by ship to Port Adelaide where it either went to England or was smelted at the *English and Australian Copper Company* at Port Adelaide, where smelters were built by 1861. During the late 1800s there were persistent calls for a smelter to be established at Port Augusta, to process ore from Blinman and other areas (FRR, 2001). The smelting works were also requested to assist the shipping trade, by including more practical and profitable

types of ballast, such as bringing in wood for the smelters, and exporting ore. A copper smelter operated during the early 20th century. Grain and flour were also shipped out of Port Augusta, to Queensland, New South Wales and Victoria (FRR, 2003). The first power station was opened in 1954 and was supplied with coal from Leigh Creek. This became the basis of an expansion which saw Port Augusta become a city in 1963 (Fairfax Publishing – F2, 2002). Because Port Augusta is located on the train line from Adelaide to Perth, the port became an important outlet for wool, wheat and minerals from the east and north of the Flinders Ranges, earlier in the 1900s (Harris and O'Brien, 1998). However, the post-war industrial developments in Spencer Gulf bypassed Port Augusta, and by 1973, it ceased to be a major port for commercial shipping.

The wharf at **Port Augusta** is listed on the State Heritage Register (DEH, 2003a).

Port Germein was originally settled as a sea trading port in the late 1800's, mainly for shipping wheat (South Australian Tourism Commission, 2000; TotalTravel.com travel guide, 2003). The **Port Germein jetty**, built in 1881, was the longest jetty in the southern Hemisphere (1.6km when built), during the time when the town was a major seaside port for wheat shipping. Although the jetty has been shortened by storms to 1.2km, it is still considered to be the longest wooden jetty in Australia. The first annual Festival of the Crab (in 1982) occurred to raise money to restore the jetty to its original state (Fairfax Publishing – F2, 2001).

The **Port Germein jetty** is listed on the *State Heritage Register* (Aquaculture Group - PISA Fisheries, 1996), and has more recently been listed as a potential "icon" for Upper Spencer Gulf, under the Marine Heritage category, as part of the S.A. government's *Encounter 2002* program.

Aboriginal Heritage Values

An Aboriginal Heritage Zone was classified for part of **Winninowie Conservation Park** (i.e. **Miranda - Back Beach** area) by DEH (2000a), based upon the cultural and spiritual value of the area to the Nukunu tribe, but also in recognition of the Pangkala (= Banggala) group, who visited the region. The Aboriginal Heritage Zone extends to the coastal boundary of the park. Nukunu people reportedly have a strong relationship with the area. Four Aboriginal campsites have been located within the reserve and a further 10 campsites have been recorded in the reserve's near vicinity (Ross and Jeffrey, 1975, cited by DEH, 2000a). The extent to which the cultural values are related to the intertidal and subtidal areas off Winninowie is not known for this report. DEH (2000a) reported that consultation will be maintained with the Nukunu community, and their comment and involvement sought on Winninowie protection and management matters in which they have an interest. **Port Augusta** is also an important area for the Nukunu.

A study by Martin (1988, cited by Aquaculture Group - PISA Fisheries 1996) recorded two Aboriginal sites at **Fitzgerald Bay**. There is a fish trap located in a tidal creek at the head of Fitzgerald Bay. Another stone arrangement was identified along the southern part of the shingle beach, although this was thought to be of ceremonial origin rather than a fish trap. These two sites are recorded on the Aboriginal Heritage Register.

According to Kinhill Stearns (1986, 1987), there were a number of coastal caves and rock sites in the nearshore area at **Whyalla**, which were of spiritual significance to the Pangkala (=Barrngala) people. However, most of these sites have been destroyed during the 20th century by development in the area, apart from a rock at the coastal margin below the cliff face at Hummock Hill.

A management plan for **Whyalla Conservation Park** (DEHAA and FWCP, 1998), reported that the Whyalla area was traditionally Pangkala land (Tindale, 1974). Their territory extended from Franklin Harbour in the south, north-west to the Gawler Ranges, north-east to Lake Torrens and east to Edeowie. The Pangkala's northern neighbours were the Kokatha. Tindale (1974) believed that pressure from the Kokatha, possibly for food resources, resulted in modifications to the Pangkala's northern boundary, which gradually moved southwards. This movement southward was accelerated by drought, closer European settlements and the development of the Woomera Restricted Area. During this time the numbers of Pangkala people declined. A small number of Pangkala continued to live in the Gawler Ranges. They were joined by groups of Kokatha and the two groups have since become closely linked through marriage. Other Pangkala lived at the ration depot established at Iron Knob as well as at the tiny

settlement of Hummock Hill (later to become **Whyalla**), and on the outskirts of **Port Augusta**. Tribal ceremonies and traditional lifestyles were gradually abandoned as the land was no longer available to them, and the last initiations among Pangkala men took place in 1938-39 (Potter and Jacobs 1981 unreferenced, in DEHAA and FWCP, 1998). Pangkala people are now few in number with most of the remaining individuals of Pangkala descent living in **Whyalla**. The Kokatha population is more numerous. For the Pangkala, the most important sites are those associated with the travel myths of the Dreamtime figures, (i.e. the Moon, the Seven Sisters and the Rainbow Serpent (Potter and Jacobs, 1981 unreferenced, in DEHAA and FWCP, 1998). Often the sites are associated with resource-rich areas. For instance, a site may be the location of a water-hole that provided a reliable water source, or it may be a source of ochre, which was widely used for decoration and in ceremonies. Other important sites are associated with unusual natural features: '.....in this basically flat country, hills stand out very prominently; most hills and major topographical features ... have significance' (Potter and Jacobs, 1981 unreferenced, in DEHAA and FWCP, 1998). While the presence of the Kokatha in the **Whyalla / Port Augusta** region is relatively recent, they, and Adnjamathanha people of the Flinders Ranges, also have traditional associations with the Whyalla area through their mythic song cycles. One of the natural features which is believed to be of significance is Wild Dog Hill. It takes its name from a story told by the Adnjamathanha people.

In 1974, an Aboriginal archaeological survey of the **Redcliff** site uncovered 18 Aboriginal campsites. These sites contained remains of Aboriginal cooking fires and a wide range of Aboriginal artefacts / implements (Morelli and de Jong, 1995).

The historic record of indigenous net fishing in **Northern Spencer Gulf** has recently been listed as a potential "icon" for Upper Spencer Gulf, under the Indigenous Culture category, as part of the S.A. government's Encounter 2002 program.

The Wadlata Outback Centre at Port Augusta provides a comprehensive guide to the local Aboriginal history of **Port Augusta** region.

There are two native land title claims in Northern Spencer Gulf, what have a marine component. The *Barngarla* (= Banggala = Pangkala) claim, which covers the entire **eastern side of Eyre Peninsula / western side of Spencer Gulf** and the Gawler and Flinders Ranges, includes all coastal waters on the western side of the area discussed in this table, as far north as the northern end of **Blanche Harbour**, where the claim area meets that lodged by the Nukunu (S.A. Coast and Marine Atlas, 2001). The Barngarla claim for Native Title on Eyre Peninsula was lodged in 1996 with the National Native Title Tribunal (NNTT). Following amendments in late 1999 and early 2000, the claim was accepted by the federal court for registration, pursuant to s190A of the Native Title Act 1993 (NNTT, 2000, and National Native Title Tribunal web site, 2003).

The marine component of the *Nukunu* claim area includes waters from Fisherman Bay (Port Broughton), **Port Pirie, Port Germein**, northwards to the head of **Port Augusta**, and also extends inland on the northern and eastern sides of Spencer Gulf. Neither claim includes the most central waters of Spencer Gulf between Port Pirie and Whyalla, however the coastal waters on both sides are included (in the Nukunu and Barngarla claims respectively). The land title claim lodged by the Nukunu in 1996, was accepted in 2000 for registration, pursuant to s190A of the *Native Title Act 1993* (NNTT, 2000). It has been accepted that members of the Nukunu Native Title Claim Group remain in occupation and possession of the land and waters in the claim area (see NNTT, 2000). Examples of the Nukunu's uses and activities include residing on Nukunu land; travelling through the land and waters, and enjoying the resources of the area, by hunting, gathering bush foods and fresh water, fishing, and crabbing. The Nukunu are involved with managing the resources, and maintaining, protecting and rehabilitating the natural environment. Some of the other numerous activities and involvements of cultural significance with which the Nukunu are involved, include: (i) managing, protecting, preserving and interpreting their heritage, cultural and intellectual property; (ii) protecting places and objects of significance to the Nukunu, as well as protecting and sustaining spiritual aspects of Nukunu sites and other significant areas; recording sites of significance and implementing physical protective and / or rehabilitation programmes; and (iii) transmitting knowledge and information about Nukunu land and waters to younger generations, according to Nukunu traditional laws and customs, and educating their children and others in Nukunu culture and traditions associated with the land and waters (see NNTT 2000, 2002).

Wilderness and/or Aesthetic Values

Aquaculture Group - PISA Fisheries (1996) described the **Far Northern Spencer Gulf** area as having

“scenic values”.

McLellan Lookout at **Port Augusta** provides “excellent views” of Spencer Gulf, from where Flinders stepped ashore in March 1802. There is also a lookout across the bridge to the west of the town (Water Tower Lookout), which also offers views across Spencer Gulf (Wilmap, 1999; Fairfax Publishing – F2, 2002). **Winninowie Conservation Park** is considered to “contain land with scenic qualities generally not visually impinged upon by human activities or constructions” (DEH, 2000a).

The lookout on **Weerona Island** is described as providing a “wonderful view” (TotalTravel.com travel guide, 2003).

Major Settlements

In the vicinity of the area, there are three key population centres, which are often referred to as provincial cities. These are **Whyalla**, **Port Augusta**, and **Port Pirie**, and all are major industrial centres (Aquaculture Group - PISA Fisheries 1996). The three centres form the Upper Spencer Gulf Enterprise Zone, and an Enterprise Zone policy has been developed by government and the Upper Spencer Gulf Common Purpose Group, to help broaden the economic bases in these regions (Government of South Australia, 2003).

Port Pirie was S.A.’s first provincial city, and is a major industrial and commercial centre in the region. The economy of Port Pirie is driven by the Pasmenco smelter, which mainly processes raw ore brought from Broken Hill; and by the large bulk port, which provides transportation for lead and zinc ores and concentrates, as well as rural products (e.g. wheat, barley, sheep and cattle) from the northern agricultural areas (Harris and O’Brien, 1998; Fairfax Publishing – F2, 2001). The Pasmenco lead smelter has an annual output of around 9.6 million tonnes (Harris and O’Brien, 1998). During 2001 / 2002, 1.15 million tonnes of cargo was moved through Port Pirie (Flinders Ports, 2003). Much of this was lead and zinc concentrates from the Pasmenco plant, but other exports include grains and seeds. The principal imports comprise minerals, coal and ores (Flinders Ports, 2003). The smelter (Pasmenco) is the largest lead smelter in the world, and, in addition to lead, also produces significant volumes of zinc, silver, copper and gold. Value of production at the Port Pirie Smelter is around \$280 million per year of which \$70M is exported. Production has increased slightly through the 1990s, however, the direct labour force employed by Pasmenco has fallen from 1,330 in 1990 to 730 in 1998 (Port Pirie Regional Development Board, 2001). During the early 2000s, the population of Port Pirie was 13,263 (ABS statistic, 2001) or around 14, 000 (Eryl Morgan Publications, 2003).

Whyalla is one of the largest provincial cities in the State, and a highly industrialised area due to the iron ore deposits near Iron Knob, Iron Monarch, and Iron Baron. Whyalla is home to the BHP (now OneSteel) steel rolling mill, the major industry in the town. The **Port Bonython** LPG treatment and storage facility is near **Point Lowly**, approximately 17km from Whyalla. The population of Whyalla has decreased since the closure of ship-building facilities during the late 1970s, and the “down-sizing” of BHP (now OneSteel) during the following decades. During the 1970s, the population was in the 30,000s. In the early 2000s, **Whyalla** had a population of 21,271 (ABS statistic, 2001) or 22,441 (Corporation of the City of Whyalla, undated).

Port Augusta had a population of 13,194 or 13,516 in 2001 (ABS statistics, 2001), which rose to 13,853 by 2003. In 2002, the Port Augusta economy consisted of predominantly service industries, with a smaller component of manufacturing, and minimal primary industries. The city’s power generation is a major industry in the area, and has been important for the economy of the town since Port Augusta ceased to be a major shipping port (Fairfax Publishing – F2, 2002). In recent years, there has been population growth in the Port Augusta area, and there is a focus in city planning on retail, commerce, tourism, and new developments (particularly on the foreshore). Various new residential projects, as well as a marina and waterfront housing, are in the planning stage (Media Report, September 2003).

Minor Settlements

The largest concentration of shacks (approximately 280 shack sites during the mid 1990s) occurs along the upper western side, from **Blanche Harbour** to within eight kilometres of **Port Augusta**, over a distance of approximately 20 kilometres (Aquaculture Group - PISA Fisheries, 1996).

There are a number of other shacks on the western side of the Northern Spencer Gulf region, for example, north and west of **Point Lowly**, and southwards, at **Cowleds Landing**, where there is a row of beach shacks. There is also some residential area at **Black Point**, and **Port Bonython** (Bryars, 2003). There are also shacks along the coast north and south of **Fitzgerald Bay**, and shack areas to the north and south of **Douglas Point**.

On the eastern side, the township of **Port Germein** (population around 279, according to the ABS census, 2001) lies less than 30km north of Port Pirie, and holiday shacks are abundant in the area. Fishing is a major industry at **Port Germein**, as well as rural industries (sheep, wheat etc) (South Australian Tourism Commission, 2000). **Port Germein**, which was originally a deep sea trading port in the late 1800's, is now a seaside town that serves the local farming (and fishing) community, and also caters for beachside holidays, and eco-tourism in the surrounding area (South Australian Tourism Commission, 2000; TotalTravel.com travel guide, 2003).

There are both shacks and permanent housing at **Weeroona Island**, which is connected to the mainland via a gravel causeway (Aquaculture Group - PISA Fisheries, 1996).

There is a small coastal shack settlement, **Miranda**, sited on the coastal boundary of **Winninowie Conservation Park** (DEH, 2000a). There are shacks at **Chinaman Creek**, also in the vicinity of **Winninowie Conservation Park**. Although most of the vacant land subdivisions in the area were incorporated into the Winninowie Conservation Park in 1990, a "large number" remain just outside the reserve boundary. These are freehold tenure and many allotments have existing shacks and permanent dwellings. According to DEH (2000a), "many dwellings" have been constructed in recent years and this trend appears likely to continue. North of Winninowie, there are shacks at **Yatala Harbour**.

Ports, Harbours and Navigation

There are major harbour facilities, and ports proclaimed under the *Harbours and Navigation Act 1993*, located at **Port Augusta**, **Port Bonython**, **Port Pirie**, and **Whyalla** (see also section above, on **Major Settlements**). The harbour at **Port Augusta** extends from high water mark to a line drawn across the gulf from **Point Paterson** to **Commissariat Point**, and includes all navigable waters to the extreme northern extent of the Gulf. The harbour at **Port Augusta** has a single 350m long berth, dredged to a depth of 6.1 m. The approach channel is dredged to a depth of 5m, is 6 km long and at least 80m wide. There is also a jetty at the Thomas Playford Power Station, which has depths of 7 to 10 m alongside (AUS Chart 778, cited by Harris and O'Brien, 1998). The dredged channel at **Port Pirie** is 6.4 m in depth, with a minimum width of 91m, and it follows a circuitous route for about 15 km across the extensive shoal area of **Germein Bay** (AUS Chart 778, cited by Harris and O'Brien, 1998). The 10 berths at **Port Pirie** all have a dredged depth alongside of 8.2 m and can accept vessels of up to 193m x 32m in size (Harris and O'Brien, 1998). The port and anchorage at **Whyalla** includes an ore-loading jetty and a harbour wharf (known as "Blast Furnace Wharf"). The ore-loading jetty is 170m long and is connected to the shore by a causeway. The berth is 250m long, and the water depth alongside is 11.6m. Blast Furnace Wharf is a continuous land-backed wharf situated on the north side of the harbour basin. It has four berths: No. 1, used for coal, coke and tar, is 175m long and the water depth alongside is 10.7m; No. 2, used for limestone, salt and coke breeze, is 175m long and the water depth alongside is 10.7m; No. 3, used for steel and general cargo, is 167m long and the water depth alongside is 10.7m.; and No. 4, used for steel and roll on / roll off operations, is 183m long and the water depth alongside is 10.7m (Harris and O'Brien, 1998).

There is also a substantial amount of maritime traffic throughout the Spencer Gulf. One of the main circuits for maritime traffic in this area is between **Port Augusta**, **Port Pirie**, and **Whyalla**. Commercial vessels carry oil, phosphates and other chemicals, grain and other products. In 2001 and 2002, the number of international ships that berthed at **Port Pirie** was 100 and 87 respectively (Flinders Ports website, 2003), and 28 ships berthed at **Port Bonython**.

There are navigation lights at **Western Shoal** and **Yarraville Shoal**.

Other Coastal Information

A gas pipeline runs across the gulf from **Douglas Point** to the eastern side (762842 E, 6361350 N to 772663 E, 6360712N). The pipeline contains flammable hydrocarbons under pressure, and is considered

a hazard, to be avoided by marine users and activities (Aquaculture Group - PISA Fisheries, 1996).

The El Alamein Army Training Reserve is located north of **Douglas Point**, and abuts the coastal area between **Blanche Harbour - Douglas Bank Aquatic Reserve**, southwards to **Douglas Point**. There is no public access through the army reserve at any time, and the waters adjacent this reserve are closed for an average of a few days every month during training exercises (Aquaculture Group - PISA Fisheries, 1996). The Baxter Detention Centre is also located in this area.

The Cultana Army Training Area, on the upper western side near **Port Augusta**, is used periodically for artillery firing training exercises, and the adjacent waters are closed to the public during these times. Public access to the adjacent land is prohibited at all times (Aquaculture Group - PISA Fisheries, 1996).

9.1.11 South-Eastern Spencer Gulf (Spencer Gulf Bioregion)

Aquaculture

According to the South Australian Coast and Marine Atlas (March 2003 version), there are three intertidal oyster leases at the eastern side of **Wardang Island** (i.e. two leases for Pacific Oyster, and one for native oyster), and two leases near **Point Pearce** (one north-east of **Point Pearce**, for farming native oyster, and one north-west, for farming Pacific Oyster). Three of the leases in the area are operated by the Point Pearce Community Council / Goretta Aboriginal Corporation. An application for an onshore abalone farm at **Island Point** has also been approved (PISA Fisheries Aquaculture Group, 1996; S.A. Coast and Marine Atlas, 2001).

There are no other aquaculture leases to the south of the Wardang area (i.e. as far south as Corny Point), or north to Port Hughes (S.A. Coast and Marine Atlas, 2003).

Aquaculture Group - PISA Fisheries' (1996) Spencer Gulf Management Plan defined the Central Yorke Peninsula Policy area, as comprising the coastal waters adjacent to the District Councils of Central Yorke Peninsula, Minlaton, Yorketown, and Warooka, from Cape Elizabeth to Corny Point. It included the waters surrounding Wardang, Goose, Little Goose, White Rock and Green Islands (see Map OC(SG)/7 in Aquaculture Group - PISA Fisheries, 1996). The area was defined as all waters enclosed by mean spring high water mark of the coast and the following points: 725760 E, 6219871 N; 720412 E, 6221594 N; 683870 E, 6136800 N; and 682149 E, 6142072 N; to mean spring high water mark around the islands. Limited aquaculture development was specified for the zone (other than that outlined below), in recognition of the need to protect or maintain:

- ◆ proclaimed conservation areas and areas identified as having high conservation significance in the **Central Yorke Peninsula Policy Area**;
- ◆ the residential qualities of the townships of **Port Victoria** and **Point Turton** and the shack areas in the **Central Yorke Peninsula Policy Area**;
- ◆ navigational safety;
- ◆ recreational and scenic values of the **Central Yorke Peninsula Policy Area**; and
- ◆ the interests of existing fisheries.

Within the Central Yorke Peninsula Policy Area, Aquaculture Group - PISA Fisheries (1996) previously defined the **Port Victoria** Management Zone, located in the waters adjacent to Port Victoria (see Map OC(SG)/7 in PIRSA 1996). The zone comprised all waters bounded by the following points: 718062 E, 6182901 N; 721721 E, 6184043 N; 723390 E, 6181338 N; 721230 E, 6176407 N; 716811 E, 6176337 N, and the boundaries of the Policy Area. Within that Zone, Aquaculture Group - PISA Fisheries (1996) made provision for 40 hectares of intertidal oyster and nori algae culture, and also recognised, in addition to that allocation, the existing (at the time) 10 hectare lease for intertidal oyster culture in **Port Victoria Bay**, which did not form part of the PIRSA zone. According to PISA Aquaculture Group (1996), any licences to be issued within the Port Victoria Management Zone must be positioned more than 500m away from the following wrecks: *Moorara*, historic wreck (718930 E, 6182274 N); *Maid of*

Australia, historic wreck remains (718864 E, 6181659 N); *SS Australian*, historic wreck (716997 E, 6176030 N)

Aquaculture Group - PISA Fisheries (1996) also previously defined the **Hardwicke Bay** Zone, delineated as those waters of the Policy Area not covered by the Port Victoria Management Zone. Licences would not be considered in the Hardwicke Bay Zone, due to the desire to preserve the existing navigational, commercial, fishing, recreational, tourism, and conservation values in that Zone.

During the late 1990s, the Yorke Regional Development Board was undertaking an aquaculture site suitability study in the waters of the Central Yorke Peninsula Policy Area defined by Aquaculture Group - PISA Fisheries (1996). It was PISA's intention to review, following completion of the study, the policies stated in the Spencer Gulf Aquaculture Management Plan for the Central Yorke Peninsula Policy Area and associated zones.

In 2003, the reported zoning for the mid-eastern and south-eastern Spencer Gulf area had not altered, and the Port Victoria – Wardang Island area was the only part of the region zoned for aquaculture at the time (see DEH, 2003a, Figure 16). However, during the early 2000s, assessments were also being undertaken (by government and consultants) to investigate the aquaculture potential of the area **west of Wallaroo** and **north-west of Bird Island**, for both finfish (Yellow-tail Kingfish) and subtidal shellfish culture in waters 10m – 20m. A shellfish aquaculture development application has been lodged for an area north of the Bird Islands. During the early 2000s, there were also technical investigations of the aquaculture potential of the area from **Balgowan to Port Victoria** (for shellfish leases), and south-east of **Wardang Island**. Also, although **Hardwicke Bay** and **Corny Point** were previously excluded from consideration for aquaculture development (see Aquaculture Group – PISA Fisheries, 1996), technical investigations and site surveys were undertaken during the early 2000s, to investigate the potential of these areas to support both offshore finfish aquaculture, and intertidal (oyster) and subtidal shellfish aquaculture.

Commercial Fishing

Scalefish, Sharks and Minor Invertebrates

Mid-eastern and south-eastern Spencer Gulf are important commercial fishing areas for a variety of species, as described below. The average total catch of Marine Scalefish fishery species (excluding pilchards and blue crabs), between 1989 and 1999, was 157.3t per annum for **Fishing Block 32** (between Warburto Point southwards to Reef Point, and including all waters westward into the gulf, to approximately 137°E), and 232t per annum for **Fishing Block 33** (all coastal waters between 34° 30' and 35° S latitude, from approximately Port Victoria south to approximately Gleeson's Landing, and all waters of Spencer Gulf as far west as central Spencer Gulf - approx. 136°40E to 137°E) (see DEH, 2003a, Figure 15).

Major species taken in the **mid-eastern Spencer Gulf** (between Warburto Point southwards to Reef Point, and including all waters westward into the gulf, to approximately 137°E) and **south-eastern Spencer Gulf** (all coastal waters between 34° 30' and 35° S latitude, from approximately Port Victoria south to approximately Gleeson's Landing, and all waters of Spencer Gulf as far west as central Spencer Gulf – approx. 136°40E to 137°E) are:

Southern Calamari: Although calamari is widely fished across the state in at least 30 fishing blocks, both mid-eastern and south-eastern Spencer Gulf together comprise one of several major fishing areas in the State for this species. Triantafillos and Fowler (2000) reported that the majority of the yield of Southern Calamari in the region described as "South-Eastern Spencer Gulf" (which also includes mid-eastern Spencer Gulf) is taken by jig fishers, and that jig fishing has annually increased since the 1980s. The jig catch in the mid-eastern / south-eastern Spencer Gulf in 1999 was the highest ever recorded for the region (58t), as were the jig catches in the previous two years (both over 50t). Similarly, jig fishing effort has increased significantly since 1990, and has amounted around 1000+ boat days per annum during the past 4 years to 1999 (see Triantafillos and Fowler, 2000, Figure 4d). The haul net catch has been smaller than the jig catch since the early 1990s, and amounted to around 13t or 14t per annum during the past 3 years to 1999. During the late 1990s, the catch per unit effort in south-eastern Spencer Gulf was the highest ever recorded for any region in which Calamari are commercially fished. Triantafillos (1998, cited by Triantafillos and Fowler, 2000) considered that the high catch rates in recent years may be mainly due to jig fishers targetting previously unexploited parts of the stocks.

King George Whiting: South-eastern Spencer Gulf is a very significant area for commercial yields of whiting, over a state-wide scale. In recent years (e.g. mid-late 1990s) annual tonnages in the south-eastern Spencer Gulf area were the second highest of all fishing blocks in S.A. in which this species is fished. Further north, mid-eastern Spencer Gulf has been amongst the top 10 fishing blocks in S.A. for this species, in terms of yields. Catch statistics specific to south-eastern Spencer Gulf are not available for this report, however the following information is provided for "southern Spencer Gulf" as a whole, which includes both the eastern and western sides (see Fowler, 2002, for fishing blocks that collectively refer to this region): the total catch of King George Whiting from the entire Southern Spencer Gulf area was 150.3 tonnes in 1998 (McGarvey *et al.*, 2000), 117.8t in 2000, and 115.7t in 2001 (McGarvey *et al.*, 2003). About 80% of the catch is taken by hand lines, 10% - 15% by hauling nets, and 25 - 3% by gill nets. McGarvey *et al.* (2000) reported that (i) the long term average catch for hand lines in Southern Spencer Gulf is around 120t per annum, though the catch has regularly fluctuated above and below this average during the past 20 years; (ii) although the hand line catch has been highly variable over the past two decades in Southern Spencer Gulf, there appears to be no long term trend evident, despite a consistent and substantial reduction in effort using hand lines (which, since the early 1990s, has been annually decreasing). Although catches have been highly variable over time, there are periodic peaks at approximately 5 year intervals. Handline catches in southern Spencer Gulf have decreased substantially in recent years, from 131t in 1997, to 83t in 2002. Also in 2002, the hauling net catch (7.7t) was less than half of that recorded in 1999, and over the same period, the gill net catch fell from 17t to 2.6t (McGarvey *et al.*, 2003). In the period 2000 - 2002, the haul net catch was the lowest ever recorded for Southern Spencer Gulf. Combined effort corresponds roughly to the peaks and troughs shown in catch, however there has been a consistent trend in declining effort since 1992. There has been a long term decline in targetted effort from the hauling net sector, which reportedly accounts for the reduction in catch from this sector during the past decade. Hand line effort was about 4,998 fisher-days in 2002 (a decrease from the peak of 8,713 fisher-days in 1992), and gill net effort was about 136 fisher-days in 2002 (a decrease from a peak of 957 fisher-days in 1999) (McGarvey *et al.*, 2003).

Tommy Ruff (Australian Herring): Recent figures specific to mid-eastern and south-eastern Spencer Gulf are not available for this report; however in some recent years (e.g. mid-late 1990s), yields from both mid-eastern and south-eastern Spencer Gulf were amongst the top 5 to 10 of around 25 to 30 fishing blocks in which Australian herring were fished at that time. The majority of the Australian herring catch is taken by hauling nets. Dimmlich and Jones (1997, Figure 10) showed that the catch from southern Spencer Gulf decreased from a high of more than 100t during the early 1990s, to less than 50t in 1996/97. During the mid to late 1990s, the catches from Southern Spencer Gulf were the lowest recorded for the area since the early 1980s (see Dimmlich and Jones, 1997, Figure 10). Overall, Spencer Gulf as a whole is one of the two major fishing regions in S.A. for Australian herring, and non-target fishing using hauling nets accounts for the majority of the yield. The targetted catch for the whole of Spencer Gulf in 2000/01 amounted to around 23.5t (more than half of the total targetted catch from all state waters), and the non-targetted catch was 121.1t (which amounted to more than 60% of the State yield, and was around twice the size of the non-target yield of Australian herring from Gulf St Vincent (see stock assessment in Westlake *et al.*, 2002).

Snapper: Mid-eastern and south-eastern Spencer Gulf together constitute one of several major commercial fishing area for Snapper in S.A.. Recent figures specific to mid-eastern and south-eastern Spencer Gulf are not available for this report; however, for the entire "Southern Spencer Gulf" region, Fowler (2002) reported that the targetted fishery for Snapper, using hand lines, has increased annually since 1994/1995. The Snapper catch from southern Spencer Gulf was the highest ever recorded for the region in 1999/2000 and again in 2000/2001 and 2001/2002 (Fowler, 2002; Fowler *et al.*, 2003), due to a strong 1991 year class making its way through the fishery (Fowler, 2000). The commercial Snapper catch from Southern Spencer Gulf in 2000/2001 was around 220t, the majority of which was caught by hand lines (Fowler, 2002). In 2002/2003, the catch rose to 264t, representing about 41% of the entire State catch (Fowler *et al.*, 2003). The sequence of annual catches of Snapper by *hand lining* in Southern Spencer Gulf since 1994/95 is as follows: 14.8t, 29.9t, 32.6t, 57.9t, 84.5t, 130.5t, 179.9t and 222t. Corresponding targetted hand line effort during those years has ranged from 355 boat days in 1994/95, to 821 boat days in 2001/2002. The long line catch is, on average, an order of magnitude lower than the hand line catch in the Southern Spencer Gulf region (e.g. 17.8t in 2000/2001, and 23.9t in 2001/2002). During the period 1999 to 2002, the annual targetted catch from long lining has been the highest ever recorded. Catch rates for both hand lining and long lining during the past few years (i.e. since the late 1990s) have been the highest ever recorded for the Southern Spencer Gulf region. In previous years (e.g. early 1980s), targetted effort was higher for an equivalent yield compared with the present, and catch rates were thus lower during the 1980s than currently (see Fowler, 2002, Table 3.4, and Fowler *et al.*, 2003, Figure 3.5).

Sea Garfish: In recent years (e.g. mid-late 1990s), Sea Garfish yields from mid-eastern and south-eastern Spencer Gulf have been amongst the top 5 to 10 of around 34 fishing blocks in S.A. in which Garfish are commercially fished. According to PISA Fisheries Aquaculture Group (1996), commercial net fishers utilise **Port Victoria Bay**, primarily for catching Garfish, and the species is also caught in other areas of mid-eastern and south-eastern Spencer Gulf (e.g. **Hardwicke Bay**). No recent figures are available specifically for the mid-eastern and south-eastern Spencer Gulf area are available; however Jones *et al.* (2002, Chapter 3) provided a regional overview of the fishery. Knight *et al.* (2002) reported that hauling nets take the majority of the catch in the Spencer Gulf region, and that the combined catch of Garfish by all gear types from the Spencer Gulf and Coffin Bay (on southern Eyre Peninsula) region, has been more than 200t per annum in all except one year since 1984/1985. The catch in 2000/2001 from Spencer Gulf / Coffin Bay combined region was 241.4t (Knight *et al.*, 2002).

Other species caught commercially in **mid-eastern** and **south-eastern Spencer Gulf** include:

Gummy Sharks and **School Sharks** have also been caught commercially in recent years in the south-eastern Spencer Gulf area, and in minor quantities in mid-eastern Spencer Gulf. No recent data are available, however during the mid-late 1990s, yields from south-eastern Spencer Gulf were amongst the top 20 of approximately 50 areas in the state where Gummy Shark were fished during those years. On the State-wide scale, south-eastern Spencer Gulf is not a major fishing area for School Shark or Gummy Shark. The fishery for School Shark and Gummy Shark in South Australia is managed by the Commonwealth, and has recently been rationalised (see AFMA, 2002a and AFMA, 2003, and section below on **Issues for Risk and Impact Assessment**).

Snook; no recent data area available for this report, however in recent years (e.g. mid-late 1990s), mid-eastern and south-eastern Spencer Gulf were amongst the top 10 fishing areas in S.A. in terms of quantities taken, with yields in the range of 5t – 10t. per annum at that time.

Other shark species: No recent data are available; however in recent years (e.g. mid-late 1990s), other shark species have been landed in relatively low quantities (e.g. in the range of 3t - 6t per annum from the mid-eastern and south-eastern Spencer Gulf area as a whole)

West Australian Salmon: No data specific to mid-eastern and south-eastern Spencer Gulf are available for this report, however recent stock assessment reports (Jones, 1999; Westlake *et al.*, 2002) showed that the total commercial catch of Australian Salmon from Southern Spencer Gulf was 100.6t in 1998/99 and 133.5t in 2000/2001, with the majority of the catch being taken by hauling nets. Of the 6 aggregated regions in S.A. in which Australian Salmon is taken, Southern Spencer Gulf catches are the second highest, and constitute one of the two main fishing regions for this species in the state. The proportion of the "Southern Spencer Gulf" salmon yield that is taken specifically from mid-eastern and south-eastern Spencer Gulf, is not known for this report, however the region described as "Southern Spencer Gulf" comprises several fishing blocks, and encompasses both sides of the mid and lower gulf;

Giant Cuttlefish: The catch of cuttlefish from the mid-eastern / south-eastern Spencer Gulf area is low compared with that from northern Spencer Gulf, and in 2000, the yield for each fishing area (Block 32 and 33) was in the range of 0.1t to 1t, according to Hall, 2000, Figure 5);

Yellow-fin Whiting: The yields from mid-eastern and south-eastern Spencer Gulf are relatively low by State standards, because the majority of the commercial catch is taken in warmer waters of the northern gulfs. Ferguson (2000) reported that the yellow-fin whiting catch from mid-eastern Spencer Gulf Block 32, (which comprises waters between Warburto Point southwards to Reef Point, and including all waters westward into the gulf, to approximately 137°E), was 5.5t in 1999 and 2.4t in 1998, and that the average yield per annum during the 5 years to 1999, was around 4.2t. The catch of yellow-fin whiting from south-eastern Spencer Gulf Block 33 (which comprises all coastal waters between 34° 30' and 35° S latitude, from approximately Port Victoria south to approximately Gleeson's Landing, and all waters of Spencer Gulf as far west as central Spencer Gulf - approx. 136°40E to 137°E), was 1.7t in 1999 and 1.09t in 1998 (Ferguson, 2000).

Yellow-eye Mullet; No recent figures are available, however during the mid-late 1990s, mid-eastern Spencer Gulf was one of the top 5 fishing areas for this species in S.A., in terms of yield, and south-eastern Spencer Gulf was amongst the top 10 areas.

Other species have been taken commercially in recent years, in smaller quantities, compared with the main species listed above. Examples include *Ocean Leatherjacket*; other *leatherjacket* species; *Trevally*; *Bronze Whaler Shark*; and various *rays* and *skates*. At least 15 other fish and invertebrate species have

been caught commercially in recent years, though in minor quantities, and many of these were not target species.

A previous estimate of the Marine Scalefish and Shark catch (SARDI data, cited by Edyvane, 1999b) from GARFIS Block 32 (**mid-eastern Spencer Gulf**, which comprises waters between **Warburto Point** southwards to **Reef Point**, and including all waters westward into the gulf, to approximately 137°E) was: In 1995/96 a total of 145,970kg (1.40% of State total, representing 42 fishers); In 1996/97 a total of 144,878kg (1.43% of State total, representing 41 fishers). Marine Scalefish and Restricted Marine Scalefish licence holders contributed to these yields. On a State-wide scale, aggregated catch figures for all GARFIS Fishing Blocks in South Australia, between 1995 and 1997, showed that the mid-eastern Spencer Gulf area (Fishing Block 32) was ranked 19th in 1995/96, and 17th in 1996/97, in the list of fish and shark fishing yields from 58 South Australian fishing blocks, at that time. More recently, DEH (2003a, citing SARDI Aquatic Sciences data) reported that the average annual catch in Marine Fishing Area 32 (previously called GARFIS Block 32), over the period 1989 to 1999, was 157.3t. This figure includes fish, sharks, and invertebrates, but excludes Blue Swimmer Crab data from 1997-1999, and excludes the single species fisheries such as prawns, abalone and rock lobster.

During the mid 1990s, the Marine Scalefish and Shark catch (SARDI data, cited by Edyvane, 1999b) from GARFIS Block 33 (**south-eastern Spencer Gulf**, all coastal waters between 34° 30' and 35°S latitude, from approximately Port Victoria south to approximately Gleeson's Landing, and all waters of Spencer Gulf as far west as central Spencer Gulf (approx. 136°40E to 137°E), between the aforementioned latitudinal range) was reported as follows: In 1995/96 a total of 172,073kg (1.65% of State total, from 88 fishers); In 1996/97 a total of 218,560kg (2.16% of State total, representing 74 fishers). Marine Scalefish and Restricted Marine Scalefish licence holders contributed to these yields. On a State-wide scale, aggregated catch figures for all GARFIS Blocks in S.A., between 1995 and 1997, showed that the south-eastern Spencer Gulf area (Fishing Block 33) was ranked 16th in 1995/96, and 13th in 1996/97, in the list of yields from 58 South Australian fishing blocks, at that time. More recently, DEH (2003a, citing SARDI Aquatic Sciences data) reported that the average annual catch in Marine Fishing Area 33 (previously called GARFIS Block 33), over the period 1989 to 1999, was 232t. This figure includes fish, sharks, and invertebrates, but excludes Blue Swimmer Crab data from 1997-1999, and excludes the single species fisheries such as prawns, abalone and rock lobster.

There are boat ramps for commercial and recreational fishing at **Port Victoria**, **Port Rickaby**, **Cockle Beach**; **Port Minlacowie**; south of **Sheriff's Beach (Hardwicke Bay)**, and **Point Turton**. The **Point Turton** jetty is used for unloading salmon and prawn catches from fishing boats (District Council of Yorke Peninsula, 2002). North of the area described in this table, **Wallaroo** is a base for a number of commercial fishing vessels.

There is a depth restriction on netting for Garfish in **Port Victoria Bay** (Aquaculture Group – PISA, 1996).

Abalone

The area described in this table encompasses Abalone Fishing Areas 21 and 22 (and all sub-blocks of those areas), as well as part of 23A, and all of 24A (see maps in Mayfield and Ward, 2002).

Both Greenlip and Blacklip Abalone are taken in the mid-eastern and south-eastern Spencer Gulf region. Greenlip abalone are collected in waters greater than 5m deep in the Spencer Gulf area. The smaller abalone species *Haliotis roei* is found in the area, and although not commercially exploited at present, may be in the future (Aquaculture Group - PISA Fisheries, 1996).

Aquaculture Group - PISA Fisheries (1996) described **Hardwicke Bay** as one of the three main areas in Spencer Gulf where Greenlip Abalone are commercially harvested. Throughout the 1980s to the late 1990's, annual Greenlip Abalone catches from the **Hardwicke Bay** area were highly variable, ranging between less than 5t and approximately 70t (S. Shepherd, pers. comm., 2000). Note that these figures do not include the **Corny Point** area, where both greenlip and Blacklip Abalone are harvested. The annual catch from the Corny Point area cannot be estimated for this assessment, because aggregated figures applicable to that area are available only for the entire toe of Yorke Peninsula. Blacklip catches in the **Hardwicke Bay** area in all years since 1979 have been negligible (i.e. less than 1t per annum) (S. Shepherd, pers. comm., 2000).

According to Mayfield *et al.* (2001):

- ♦ average fishing effort in Area 21 (**Tiparra Reef**) has been around 120 days per year, and there has been no statistically significant increase or decrease in fishing effort in that area over the past 10 years,

to 2001;

- ♦ there has been a statistically significant decrease in fishing effort in Areas 22 and 23, and no observed trend in Area 24, during the past 10 year, to 2001;
- ♦ Area 21 was one of the four fishing areas in the Central Zone classified as “most fished” between 1980-1984, 1988-1992, and 1996-2000, amounting to an average number of fishing days per year of 115.6, 160.4, and 120.4, respectively, during those periods;
- ♦ Area 24 (all sub-blocks) was one of the four fishing areas in the Central Zone classified as “most fished” between 1980-1984 and between 1988-1992, with an average number of fishing days per year of 109.4 and 54, respectively, during those periods. However, only sub-block 24A (**Hardwicke Bay** area, according to maps in Mayfield and Ward, 2002) is relevant to the description of the south-eastern Spencer Gulf region in this table, and the proportion of the aforementioned fishing effort that applies only to sub-block 24A of Area 24, is not known for this report;
- ♦ Area 23 was one of the four fishing areas in the Central Zone classified as “least fished” between 1988-1992, and between 1996-2000, amounting to an average of 16.6 and 6.2 fishing days per year, respectively; and
- ♦ Between 1996 and 2000, Area 21 (**Tiparra Reef**) was one of 4 regions in the Central Zone in which fishing effort, collectively, was highest within the Zone;
- ♦ Catch rates in the sub-blocks covered by Areas 21, 22, 23, and 24 have been, on average, around 60kg – 80kg per hour, during the period 1996 to 2000.

Mayfield *et al.* (2002) reported that:

- ♦ In Area 21 (**Tiparra Reef**), during the periods 1980-1984, 1988-1992, and 1996-2000, the average fishing effort in terms of days fished per year, amounted to 35.7%, 43.2% and 60.8% respectively, of the total effort in the Western Zone (but see also Mayfield *et al.*, 2001, Table 3). Fishing effort in Area 21 was higher during all of these periods than in any other fishing area in the Central Zone.
- ♦ In Area 22 (**Balgowan area** southwards to **Cockle Beach** area), during the periods 1980-1984, 1988-1992, and 1996-2000, the average fishing effort in terms of days fished per year, amounted to 2.4%, 6.3% and 0.77% respectively, of the total effort in the Central Zone. Average fishing effort in Area 22 was the lowest of all areas in the Central Zone, between 1996 – 2000.
- ♦ Average fishing effort in terms of hours fished per year, amounted to 62% in Area 21 (highest in the Central Zone), and 0.88% in Area 22 (second lowest in the Central Zone), as a percentage of total number of hours fished per year in the Central Zone, during the period 1997-2001. In 2001, these figures were 70.6% for Area 21, and 0% for area 22, which was not fished.
- ♦ Between 1997 and 2001, the average catch of greenlip was around 119.66t in Area 21 (= 82.86% of the Central Zone total catch), and around 1.72t for Area 22 (= 1.19% of the Central Zone total catch). In 2001, 146.06t of greenlip were taken from Area 21 (= 96.15% of the total Central Zone catch), and no greenlip were taken commercially in Area 22.
- ♦ Between 1997 and 2001, the average catch of blacklip was around 0.32t in Area 21 (= 0.74% of the Central Zone total catch), and no blacklip were caught commercially in Area 22. In 2001, 1.1t or 2.59% of the total Central Zone blacklip catch was taken from Area 21, and no blacklip were taken from Area 22.

There are no recent figures available that are specific to areas 23A (**Leven’s Beach - Corny Point – Berry Bay to Gleeson’s Landing** area) and 24A (**Hardwicke Bay – Point Turton** area). However, according to SARDI data (cited by Edyvane, 1999b), the collective catch of greenlip from the **Port Victoria to Hardwicke Bay** area (Map Codes 22A; 24A) was previously as follows:

- ♦ in 1994/95, was a total of 34,917kg (24.2% of the total Central Zone catch of greenlip, or 9.22% of the State greenlip catch);
- ♦ in 1996/97 was 7,059kg (4.9% of the total Central Zone catch of greenlip, or 1.89% of the State catch).

For Area 23 as a whole (i.e. from Point Souttar, around the “toes” of Yorke Peninsula, to the Foul Bay region), Mayfield *et al.* (2002) reported that average fishing effort, in terms of days fished per year, amounted to less than 5% of the entire fishing effort for the Central Zone, during the periods 1980-1984, 1988-1992 and 1996-2000. In terms of average number of hours fished per year, Area 23 accounted for less than 1% of the entire fishing effort in the Central Zone, during the period 1997-2001 (Mayfield *et al.*, 2002). Corresponding catch for Area 23 as a whole, amounted to an average of 0.65t of greenlip during the period 1997-2001 (= 0.45% of the Central Zone catch), and 0.08t in 2001 (0.05% of the Central Zone catch). For blacklip catch in Area 23 as a whole, the average was 0.95t during the

period 1997-2001 (=2.23% of the Central Zone catch), and 0.46t in 2001 (1.08% of the Central Zone catch). Recent figures for Area 24 are not provided here, because in addition to Hardwicke Bay, the area encompasses much of the south-eastern Yorke Peninsula (from Foul Bay, around the heel of Yorke Peninsula, up to Port Vincent), and only one sub-block of this area (i.e. 24A) is part of the south-eastern Spencer Gulf region described in this table.

Rock Lobster

Figures specific to the areas between Warburto Point and Corny Point are not available for this report. On a state-wide scale, the region is not considered to be a major fishing area for Rock Lobster, based upon the lack of suitable habitat in most parts of the area, and the small number of fishers operating in the area. Much of the area comprises Rock Lobster Marine Fishing Area 33 (i.e. South-eastern Spencer Gulf, all coastal waters between 34° 30' and 35° S latitude, from approximately **Port Victoria** to approximately **Gleeson's Lading**, and all waters of Spencer Gulf as far west as central Spencer Gulf (approx. 136°40E to 137°E), between the aforementioned latitudinal range). Ward *et al.* (2002, Figures 2.7a to 2.7d) showed that the range in fishing effort in MFA 33 has been less than 10,000 pot lifts per annum from the 1970s to the present, which is considerably lower than the effort in most other MFAs in the northern zone. Other than the low range in effort, no catch or effort figures were provided for that area in a recent stock assessment report (Ward *et al.*, 2002). In 1995/96 three fishers operated in Fishing Block 33 (co-ordinates described above, in section on Commercial Fishing for Scalefish), and two fishers in 1996/97 (SARDI data, cited by Edyvane, 1999b). There is anchorage for Rock Lobster boats at **Point Turton**, **Fish Point** (near Point Turton) and **Dunn Point** (near **Corny Point**).

Prawn Fishing

Prawn trawling does not occur in waters less than 10m. Prawn fishing in Spencer Gulf occurs in waters deeper than 10m, and the waters **north of Corny Point**, and **west of Hardwicke Bay / south-west of Wardang Island** (i.e. fishing regions 6 and 8 – see PIRSA, 2003d) are two of the key fishing areas for prawns in Spencer Gulf. Spencer Gulf as a whole, has the largest production of Western King Prawns in Australia (PIRSA, 2003d).

The fleet exerts high local (or spatial) depletion rates with the estimated mean exploitation rate being 49.9%, which is close to the target limit of 50%. Monitoring indicators and research surveys for the 1999/2000 year showed a good size composition of the prawn catch; "highly satisfactory catch rates" of adult prawns; and a large settlement of post-larval prawns (which results in strong recruitment to grounds the following season) (Carrick and Williams, 2001). Of the total prawn landings for the Spencer Gulf fishery in 1999/00 (1914 tonnes over 61.5 nights trawled, or 21,459 hours), the Wallaroo and the Middle Bank region yielded 1,003.7 tonnes (around 52%) of the annual catch, and the Southern grounds produced around 405 (around 21%) tonnes. Annual catch rate was around 85kg / hr (Carrick and Williams, 2001). In 2001/02, the total Spencer Gulf catch was 2,182t (from 55 days fishing, or 19,8343 hours) (Carrick, 2003).

Some of the most important fishing areas in the southern grounds include Fishing Blocks 84 and 87 (see maps in McDonald, 1998b and Carrick, 2003), and also waters directly **north of Corny Point** (Fishing Block 94) which has reportedly yielded 6 to 10 tonnes per annum in recent years, and has been fished in 4 to 6 of the past 11 years to 2000 (DEH, 2003a, Figure 14). Fishing Block 87, in south-eastern gulf waters northward of Corny Point, has reported yielded 51 to 100 tonnes per annum, and has been fished in almost all of the past 11 years to 2000. In the 2001/02 season, 20t and 50t of prawns were taken in Blocks 84 and 87 respectively, during the period in which these areas were opened (March, 2002) (Carrick, 2003). Catches in 2001/02 from Fishing Block 94 were provided by Carrick (2003), but are not reported here due to way in which catches were aggregated for presentation, which makes the tonnage difficult to discern.

North of Wardang Island, Fishing Block 69 is reported to have yielded 6 to 10 tonnes per annum (but see below, for 2001/02 period), and has been fished in almost all of the past 11 years to 2000 (DEH, 2003a, Figure 14). In Fishing Block 68 (for which **Cape Elizabeth** is the north-eastern boundary, extending into deeper waters west and south-west of that point), 16 to 30 tonnes per annum are reported to be caught, from fishing during almost all of the past 11 years to 2000 (DEH, 2003a, Figure 14). In the 2001/02 season, 87.2t of prawns were taken from Block 69, during the period in which that section of the fishery was open (March, 2002) (Carrick, 2003). Prawns are also taken in small quantities south of Wardang Island (Fishing Block 85). Catches from Fishing Blocks 68 and 85 in 2001/02 were provided by Carrick (2003, Figures 24, 25, 27), but are not reported here due to way in which catches were aggregated for presentation, which makes tonnages difficult to discern.

Prawn fishing does not occur in the near-shore coastal waters south of Wardang Island, to the Hardwicke Bay – Point Turton area. The Moonta Bay / Tiparra Bay area also is not fished for prawns.

Prawn fishers in Spencer Gulf are permitted to take slipper lobster and Southern Calamari as commercial bycatch during prawn trawling operations (MacDonald, 1998b).

Records of bycatch of other species are documented in the section on **Issues for Risk and Impact Assessment**.

Recreational Fishing

McGlennon and Kinloch (1997c) showed that, according to a comparison of recreational and commercial fishing resulting from a recreational boat fishing survey during April 1994 – March 1996, (i) the recreational catch of Snook in mid-eastern Spencer Gulf was more than one half of the total combined catch from commercial and recreational boat fishing, and in south-eastern Spencer Gulf was almost one half of the total combined catch, with larger specimens being caught in the southern gulf area; (ii) the recreational Snapper catch from mid and south-eastern Spencer Gulf was less than one quarter of the combined commercial and recreational boat fishing catch, and considerably smaller than the catch from Northern Spencer Gulf; (iii) the Tommy Ruff (Australian Herring) catch from south-eastern Spencer Gulf was around one eighth of the total combined catch; (iv) the recreational catch of Southern Calamari in mid-eastern Spencer Gulf was less than one quarter of the total (i.e. combined commercial and recreational) boat fishing catch, but amounted to around one third of the total boat fishing catch in south-eastern Spencer Gulf; (v) the recreational catch of Garfish was more than one quarter of the combined commercial and recreational total for boat fishing in south-eastern Spencer Gulf, and (vi) the recreational take of King George Whiting during the survey period was around 30t from mid-eastern Spencer Gulf (representing more than half of the total catch from that part of the Gulf), and around 40t from south-eastern Spencer Gulf (around one third of the total combined catch from commercial and recreational boat fishing).

Within the mid-eastern and south-eastern Spencer Gulf region, there are dense concentrations of recognised fishing “spots” (i.e. GPS fishing marks, in Pescatore and Ellis, 1998, and SA Coast and Marine Atlas data, 2001) and in the **Moonta Bay – Port Hughes** area; the **Wardang Island – Port Victoria** area; and the **Hardwicke Bay – Point Turton** area (see DEH, 2003a, Figure 13).

Popular fishing areas within mid-eastern and south-eastern Spencer Gulf are listed as follows: **Moonta Bay / Port Hughes / Tiparra Light and Reef / Cape Elizabeth** area: Yorke Peninsula tourism materials promote the **Moonta Bay** area for its “excellent fishing”. There is a jetty at **Moonta**, used for recreational fishing. Whiting is a popular target in the bay, and is also fished around **Bird Islands, Tiparra Light** and other localities in the area. The beaches, jetty and boats are used for fishing, and there are several recognised and named fishing “holes” and “grounds” in the area, particularly those between **Moonta Bay** and the **Cape Elizabeth** area, and particularly for fishing King George Whiting. Examples of recognised fishing spots include **Rose Garden; Kemps Beach; Tiparra Reef**; patches and “drift grounds” south of **Cape Elizabeth**; the nearshore area between the ramp and **Cape Elizabeth**. Apart from King George Whiting, other popular species include School Whiting, Blue Swimmer Crabs, Garfish, Tommy Ruff (a popular target at **Port Hughes** and **Moonta Bay** jetties), Snapper, large Snook (e.g. **Cape Elizabeth** area, and the jetties), Red “Mullet” (= Goatfish), Yellow-tail Kingfish, and Southern Calamari (also often caught from the jetties) (Harris, 2002-2003, and other recreational fishing records). Dog sharks and Blue Morwong are also fished in the **Cape Elizabeth / Port Hughes** area, according to recreational fishing reports. **Simms Cove** beach is a recognised fishing area for Mullet and Whiting. Fishing competitions for “state record” sizes of fish and sharks (e.g. ANSA, 1999) report that some of the catches in such competitions have come from the **Cape Elizabeth / Tiparra Reef / Tiparra Light** areas (e.g. bronze whaler shark). There are fishing charter trips from **Port Hughes**, which specialise in catching whiting and Snapper. There is an annual Copper Coast Family Fishing Competition in November, with jetty, boat and shore fishing categories for junior and senior fishers.

Further south, there is beach launching access for boats in the **Balgowan** area, and at **The Gap**.

Recreational fishing at **Port Victoria** is popular from the jetty and from the shore around the rocky headlands (Aquaculture Group – PISA Fisheries, 1996; Net YP, 2000). Tourism promotion materials describe Port Victoria as a place for “great fishing from the jetty, beach, or boat”. There are annual boat and jetty fishing competitions in the **Port Victoria** area, for species such as whiting, Snapper, Snook,

Garfish, Tommy Ruff and Southern Calamari (the latter three species are fished as part of the jetty competition). In the **Port Victoria – Wardang Island** area, Snapper, King George Whiting and Snook are popular target species for boat fishers. Whiting and Snapper are often targeted from the dissected bottom reefs and ledges. Other major species targetted throughout the area include Sand Flathead, Yellow-eye Mullet, Tommy Ruff, West Australian Salmon, Garfish, Blue Swimmer Crab, Trevally, Toothbrush Leatherjacket, and Silver Drummer. The jetty is fished both day and night, particularly for Tommy Ruff, Snook and Calamari, and has been described as “popular for recreational fishers” (District Council of Yorke Peninsula, 2002). Capel (1994) listed the shallow reefs on the southern side of **Wardang Island** as a fishing ground from which “prolific” Snook are taken, along with small and large Snapper, whiting and flathead. The “**Flat Rock**” reefs west of the Goose Island Aquatic Reserve are known as an area for fishing Snapper, large Whiting, Trevally, Sweep, and shark species. East of **Goose Island**, small and medium Whiting are fished from sand patches, and Snook are trolled in the area between the north **Wardang** jetty and Little Goose Island (outside of the Aquatic reserve boundaries). There is a recognised fishing spot at 4m depth near the **Wardang Jetty**, where King George Whiting are targetted over a dissected reef habitat with sand and gravel. The “**Wardang Whiting Hole**” is also popular for fishing large Whiting, small Snapper, various reef fish, Bronze Whaler sharks, Tommy Ruff and Garfish. Whiting are fished from the “holes” in the reef around **Rocky Island**, and from the southern side of the channel off **Rocky Island**, along with Red “Mullet” (Goatfish) and Tommy Ruff, amongst other species. **Beatrice Rock** is also a recognised fishing area. Snook, West Australian Salmon and Tommy Ruff are also taken in this channel between **Port Victoria** and **Wardang Island** (Capel, 1994).

There are more than 15 recognised fishing locations in the shallow waters (10m or less) in the **Port Victoria – Island Point – Wardang Island** area. The *Songvaar* and *Moorara* wrecks in the **Port Victoria** area, are fished for Snapper, whiting, Snook, Garfish and other commercially and recreationally significant fish species. The north side of **Wardang Island** is a recognised fishing spot for whiting. Snapper, large whiting, leatherjackets, sweep are some of the species targetted on the south-western side of **Wardang**. Sweep are common on the reefs around the island. Some of the recognised fishing spots in the area are in very shallow water (e.g. 2m, near the *Moorara* wreck). The waters adjacent to the **Goose Island** Aquatic Reserve are also popular fishing spots. Fishing is prohibited within 200m of the islands making up the Aquatic Reserve (**Goose / Little Goose / White Rocks**), however in the vicinity, species such as Snook, Australian Salmon, King George Whiting, Garfish, Tommy Ruff, Southern Calamari, Sweep, Trevally, leatherjacket species, and Bronze Whaler shark are caught by recreational fishers (Ivanovici, 1984). An annual fishing competition has been held during Easter at **Port Victoria**. Charter boats also operate from the **Port Victoria** area, for fishing species such as King George Whiting and Snapper, and various reef fish and pelagic fish in deeper waters.

Port Rickaby / Barker Rocks: Port Rickaby has been described as a “good fishing area” by regional fishing promotion materials, with a jetty that is “popular for fishing” (SYP Tourism and Promotions Committee, 2002). Whiting and Garfish are popular target species in the Port Rickaby area, close to shore and on the banks. **Barker Rocks** is promoted for rock fishing. Many of the species caught in the **Hardwicke Bay** region (see below) are also found in the Port Rickaby area.

Parsons Beach, Kemps Beach and Bluff Beach: The common species are caught here, such as King George Whiting, Snapper, Sea Garfish, Yellow-eye Mullet, small Australian Salmon (“salmon trout”) and flathead species. Bait digging for worms also occurs (Bryars, 2003). At **Bluff Beach** are boat davits erected in 1925, that are used by some local fishers to hoist their boats out of the water in times of bad weather.

Port Minlacowie: During the mid 20th century, the Port Minlacowie jetty was popular for fishing, both from the jetty, and using the eight boats that were housed on davits at the jetty. The jetty was destroyed during the 1970s, and now people fish from the beach or from boats. The boat ramp is promoted as “first class”, capable of handling larger fishing craft (SYP Tourism and Promotions Committee 2002). Various species are caught on the nearshore reefs, but Snapper is a prime target. Boat fishers catch King George and other whiting species, Southern Calamari, Tommy Ruff, Snook, and other species as described below, for **Hardwicke Bay**.

Hardwicke Bay / Point Turton: In general, fishing from boats, shore and the jetty is popular, with some of the main target species being large King George and School Whiting (often taken by boat fishers on the “drift grounds” and “The Banks” in **Hardwicke Bay**, and also caught in numerous other parts of the area, including **Point Souttar**), large Snook, Southern Calamari, and Tommy Ruff (a popular catch from the **Point Turton** jetty). A summary of the fishing activities in the tidal flat areas of **Hardwicke Bay** includes line fishing, netting, dab netting, “floundering” (fishing for flounder), and bait digging (Bryars,

2003). The jetty at **Point Turton** is promoted by regional tourism materials for the “great fishing” opportunities it provides. Other popular species caught recreationally in the **Point Turton / Point Souttar / Hardwicke Bay** area include Mullet (often caught from the beaches, and also inshore at **Point Souttar** bay, and other fishing spots in the area), Cuttlefish, Garfish (often taken from the **Point Turton** jetty, and also by boat fishing), Snapper (e.g. caught on “**The Banks**”), crabs, Mulloway, Australian Salmon (smaller “salmon trout” are often taken from the **Point Turton** jetty), Sand Flathead, Yellow-eye Mullet, Silver Drummer, leatherjacket species and sharks. Species less often caught by recreational fishers in the **Hardwicke Bay** area include gurnard perch species and wrasse species. The line of reefs close to shore is popular for Snapper, other reef fish, sharks, and Southern Calamari, amongst others. There are at least 9 popular fishing locations within the shallow (10m or less) waters of **Hardwicke Bay** mostly comprising dissected reef and sand areas. There are boat launching areas at both **Hardwicke Bay** and **Point Turton**, and charter fishing trips out from **Point Turton**, and a biennial fishing competition.

Corny Point: The area contains both rocky dissected reefs (including ledges) and seagrass beds. Fishing from boats, beaches and headland reef yields a variety of species. Examples of species fished in the area include King George Whiting, Snapper, Sand Flathead, Yellow-eye Mullet, Australian Salmon, Snapper, Mulloway, Snook, Garfish, Tommy Tuff (Australian Herring), Trevally, leatherjacket species, rock fish species, Silver Drummer and Southern Calamari (McGlennon and Kinloch survey data, cited by Edyvane, 1999b; Harris, 2003). There are recreational fishing competitions held at **Corny Point**.

In general, jetties are popular for fishing in the mid-eastern and south-eastern Spencer Gulf area. There are jetties at **Port Victoria, Point Turton, Port Rickaby, Balgowan, Port Hughes** and two jetties on **Wardang Island** (Aquaculture Group – PISA Fisheries, 1996; Yorke Peninsula Tourist Association, undated). Some of the target catches for these jetties are discussed in sections above, for each town.

There are boat ramps for commercial and recreational fishing throughout the mid-eastern and south-eastern Spencer Gulf area, including **Port Hughes, Port Victoria, Port Rickaby, Cockle Beach**, south of **Sheriffs Beach (Hardwicke Bay), Point Turton** and **Corny Point**. A survey conducted by McGlennon (1996), found that the boat ramps in the area are mainly used by recreational fishers e.g. during the survey period 78% of the use of the **Corny Point** boat ramp was for recreational fishing, 87% at **Hardwicke Bay**, and 95% at **Point Turton**.

North of the area described in this table, fishing charters operate from the **Wallaroo** marina, and visit some of the popular fishing areas south of Wallaroo, as described above.

Diving

The **Wardang Island Maritime Heritage Trail**, managed by DEH, runs between **Port Victoria** and **Wardang Island**, and is considered to have “high recreational value” for divers and snorkellers who wish to observe and explore the shipwrecks (Edyvane, 1995b; Aquaculture Group - PISA Fisheries 1996; Edyvane, 1999b). Divers can follow the history of various wrecks using the plates on the ocean floor and a waterproof guidebook with maps and wreck site plans. There are more than a dozen shipwrecks in the Wardang area, none of which are intact, and 8 of the wrecks are included in the Maritime Heritage Trail (see paragraph above, and section below, on **Protected Shipwrecks**). All wrecks are broken up (some have been blasted by explosives), and are scattered over the area. The Aquanaut’s (undated) guide to SA dive sites, considered the *Songvaar*, *Notre Dame d’Arvor* and *Australian* to be of interest for diving, mostly due to the growth on the wreckage, and DIASA (undated) listed the entire shipwreck trail as being “spectacular wreck diving”.

Apart from the shipwrecks, there are natural reefs in the **Port Victoria** area and southwards (e.g. **Rifle Butts Beach, Barker Rocks, Port Minlacowie**) that are recognised for diving and snorkelling. Diving groups and marine societies visit on occasion.

Other recognised dive spots in the mid-eastern and south-eastern Spencer Gulf area include the **Port Hughes jetty** (see **Part 1** of this table), and reefs in the **Port Hughes / Tiparra Bay** area (Yorke Peninsula Tourism Association map); **Tiparra Reef / Cape Elizabeth** area (and there are dive charter trips in the area); reefs in the **Port Victoria** area; the **Port Victoria** jetty, described as “popular with divers” (District Council of Yorke Peninsula, 2002), and promoted for both day and night diving; **Goose Island** and **White Rocks**; the **Point Turton** jetty (also promoted for night diving) and reefs around **Point Turton** (which has been described as providing “plenty of interest for SCUBA divers and snorkellers” (SYP Tourism and Promotions Committee, 2002); and reefs in the **Hardwicke Bay** area

(including **Port Rickaby** and **Port Minlacowie**), and around **Corny Point**. As well as the Corny Point reefs, the area under the **Corny Point Jetty**, away from the strong currents, is also promoted in diving guides (DIASA, undated; Aquanaut, undated; Brown, undated; Net Yorke Peninsula, 2000).

There is a diving tour charter operating in the waters off **Port Victoria**, and around **Wardang Island**, and north of the area described in this table, diving charters operate from the **Wallaroo** marina, visiting some of the dive spots listed above.

Other Coastal and Marine Recreation / Tourism

In general, tourism is considered to be "a major industry along the coastal area of Spencer Gulf and offshore islands, with the majority of visitors travelling from within South Australia" (Aquaculture Group - PISA Fisheries, 1996). Yorke Peninsula is considered to be a very attractive tourist destination and the number of visitors to the region will continue to grow (Hamill and Associates, 2002). Tourism is largely seasonal, with peak times during school and public holidays, especially during the summer months.

A number of settlements exist along the coast, including **Moonta Bay**, **Port Hughes**, **Port Victoria**, **Port Rickaby**, **Point Turton** and numerous areas where shacks have been developed, such as those at **Cape Elizabeth**, **Balgowan**, **Port Rickaby**, **Brown Point**, **Point Turton to Corny Point**, **Bluff Beach** and **Hardwicke Bay**. Many of the shack settlements are used for seasonal holiday trips to Yorke Peninsula (e.g. for fishing, resting, beachcombing etc). A number of areas on the Yorke Peninsula are also popular destinations for retirement to the coast (Aquaculture Group - PISA Fisheries, 1996; Planning S.A., 1999).

Generally, apart from fishing (see previous section), other coastal and water-based recreational activities of importance in some areas of mid-eastern and south-eastern Spencer Gulf include boating, swimming, diving, snorkelling, water-skiing, coastal walking, beach-combing, photography etc.

Moonta Bay has been described in travel guides as a "popular seaside resort", with a seasonal rise in population due to holiday visitors. Yorke Peninsula tourism materials promote **Moonta Bay** as a family holiday place with "great beaches", and also promote the opportunities for fishing and crabbing (see section above), sailing and other water sports, swimming, beach walking, camping etc. There is a variety of coastal accommodation in the area catering to seaside holidays.

Port Hughes is recognised for recreational fishing, swimming and boating / sailing (SA Regional, undated), and there are sandy beaches in the area that are promoted for beach-walking (e.g. **South Beach**, which runs from **Port Hughes** to **Cape Elizabeth**). The **Cape Elizabeth** area has been described by the local council as having "some of the most beautiful and pristine beaches on Yorke Peninsula" and "a popular beach, not only for many of the locals, but also for visitors to the area". There are boat tours out from **Port Hughes**, with attractions being the **Cape Elizabeth** reefs and wrecks, **Tiparra** reef, the lighthouse and the **Bird Island** sanctuaries. There are 4WD tours operating in the area, visiting such sites as **The Gap** and **Tiparra Rocks**. Charter tours are promoted as a way of seeing the rugged coastline of the peninsula, much of which is not accessible by car (Sightseeing South Australia, 2003).

Balgowan is described as a holiday resort (District Council of Yorke Peninsula, 2002). There are shacks / holiday houses near the shore, and a camping area. Apart from fishing, the area is used for swimming, as is the case with most coastal holiday areas along the mid-eastern and south-eastern Spencer Gulf. A few beach shacks are also located south of **Balgowan**, towards **Reef Point**.

Port Victoria is a popular holiday destination, due to its scenic amenity and recreational fishing, diving and boating opportunities (Yorke Peninsula Tourism Association, undated; Sightseeing South Australia 2003, and other regional tourism materials). There are two caravan parks located along the coast, a jetty and a number of boat ramps (Aquaculture Group - PISA Fisheries, 1996). Tourism promotion material describes **Port Victoria** as "a peaceful seaside town which has the simple pleasures of life - boating, fishing, diving and swimming". The Yorke Peninsula Tourism Association (1989) and Net Yorke Peninsula (2000) also listed swimming (from the beaches and the jetty) as an activity of note in the **Port Victoria** area. There is a marine "eco-tour" charter operating in the **Port Victoria** area, for day trips off the coast and around **Wardang Island**; beach walking at **Fossil Beach**; swimming with sea lions, and viewing fairy penguins at sunset, as they return to burrows on **Wardang Island**. Other activities that are promoted in the **Port Victoria** area include water skiing, wind surfing, walking along the coastal **Geology Trail**, and scenic drives along the coastline. The **Maritime Heritage Trail** and associated maritime history is a significant tourist attraction in the **Port Victoria** area (Aquaculture Group - PISA

Fisheries, 1996). There is a Shipwreck Interpretative Display at the base of the jetty, and a Maritime Museum. There are 4WD tours operating in the area, visiting such sites as the beach and jetty at **Port Victoria**.

In 2002, the Narungga people (Goreta, and the Narungga Nations Aboriginal Corporation) were negotiating with the District Council to develop eco-tourism activities on **Wardang Island** (District Council of Yorke Peninsula, 2002).

There is a coastal settlement at **Port Rickaby**, with shacks, a jetty, and a foreshore caravan park. **Port Rickaby** has been described as “a small holiday spot” (SA Regional, undated), “a quiet holiday destination” (Fairfax Publishing – F2, 2001), and a “popular holiday town” (Sightseeing South Australia 2003). The sandy beach is used for recreation, and has been described by the aforementioned tourism materials as “ideal for families”, with “good swimming and fishing” areas. **Port Rickaby** is also promoted for boating. The **Mullet Bay Walking Trail** at Port Rickaby runs south of the coastal caravan park, for around 900m, to the beaches south of Port Rickaby (Port Rickaby Progress Association, undated), and has been described as a significant asset to the community, used daily by residents and visitors (Hamill and Associates, 2002). The foreshore caravan park, foreshore picnic / seating area, and the recently rebuilt jetty, have been described as major attractions for both residents and visitors (Hamill and Associates, 2002), and the beach is popular with swimmers (SYP Tourism and Promotions Committee, 2002).

South of the Port Rickaby area are holiday spots such as **Parsons Beach**, and **Bluff Beach**, that includes a shack area and a boat ramp. Bluff Beach is promoted as a safe swimming for families area because the small bay is relatively sheltered. The boat davits in the side of the **Bluff** cliff are also promoted as a tourism feature (SYP Tourism and Promotions Committee, 2002). Also south of Port Rickaby is **Barker Rocks**, used for coastal camping and recreation as well as rock fishing (see recreational fishing section above). There is a 5km walking trail at **Barker Rocks** that passes the coastal reserve. **Bluff Beach** is promoted for its “prolific bird life”.

According to the Warooka Development Plan (Planning S.A., 1999), the coastal region, including **Hardwicke Bay**, is one of the district's most attractive features and offers visitors and the local community opportunities to pursue recreational and leisure interests. In general, **Hardwicke Bay** is considered to be a popular spot for campers and anglers (District Council of Yorke Peninsula, 2002), and there are various spots along the coast in the **Hardwicke Bay** area in which these activities regularly take place. There are shacks and beach houses at **Hardwicke Bay**, which is promoted for fishing (see above), swimming at the main beach, and snorkelling along the rocks close to shore. Tourism and housing developments are increasing in this area. The rock swimming hole at the southern end of **Hardwicke Bay** is promoted for swimming, and the bay is also popular for wind surfing and yachting (SYP Tourism and Promotions Committee, 2002).

Point Turton is recognised as one of the three prime retirement and seaside holiday spots on Yorke Peninsula, particularly for the fishing opportunities, and the tranquil nature of the location (Planning S.A., 1999). **Point Turton** is described as “a popular holiday town”, particularly for fishing, diving and boating (Sightseeing South Australia, 2003). The Warooka Development Plan (Planning S.A., 1999), provided some indication of the value of the area for marine-based recreation. “The coastal township of **Point Turton** has experienced firm growth as its attraction for holiday makers and for retirement, has become more pronounced. Pressure for holiday housing has generally been a consistent factor in the Warooka district's development. The existing coastal settlement of **Corny Point** plays a useful role in accommodating holiday housing, despite their limited urban facilities” (Planning S.A., 1999, page 20). Apart from the fishing, Yorke Peninsula tourism promotion materials also list swimming and beach-walking as popular activities in the **Point Turton** area, and the “long white sandy beach” is promoted as a recreation / tourism asset. Due to its sheltered position, Point Turton has been described as “becoming increasingly popular” for boating, windsurfing and sailing (SYP tourism and Promotions Committee, 2002). There are various accommodations in the area catering for seaside holidays (holiday houses, shacks etc), and the foreshore caravan park is situated in the disused flux quarry near the jetty.

The Pines and **Corny Point** were described as “holiday settlements” by Planning S.A.'s Warooka DC Development Plan (1997, 1998, 1999). The Plan emphasised the development of these settlements as “*residential and service centres to accommodate basic needs and facilities for holiday-makers and visitors*”, as well as the local community. **The Pines** and **Couch's Beach** are growing areas for holiday homes. Tourism materials promote **The Pines** for fishing, swimming, beach walking, etc. Also in the area are **Burner's Beach** and **Leven's Beach**, which, apart from fishing, are also promoted for beach picnics, shell collecting, swimming and fishing (SYP Tourism and Promotions Committee,

2002).

There are holiday houses, shacks and camping areas around **Corny Point**, which is seasonally popular for holidays, particularly those involving fishing (see section above on Recreational Fishing). There are also holiday shacks along the dunes in the **Dunn Point** area. The lighthouse reserve at **Corny Point** is open to the public (Lighthouses of Australia Inc., 2002), and there is a coastal lookout with views across the bay. Seaward of the camping area near the Corny Point Lighthouse, the coast has been described as popular for surfing, snorkelling and swimming at nearby beaches (District Council of Yorke Peninsula, 2002), beach picnics, and surf fishing (SYP Tourism and Promotions Committee, 2002). **Corny Point** is also noted for its "excellent and safe holiday beaches" (Fairfax Publishing – F2, 2001).

There are various camping areas along the coast; such as **Tiparra Rocks**, **The Bamboos** and **The Gap** (8km, 12km and 15km north of **Balgowan**, respectively); **Balgowan**; **Wauraltee Beach** south of Port Victoria; **Barker Rocks** south of Port Rickaby, **Burners Beach**, near Point Souttar, and the **Corny Point Lighthouse** area (District Council of Yorke Peninsula, 2002).

Driving on the beach is permitted along various parts of the coast between **Tiparra Bay** and **Hardwicke Bay**, and 4WD clubs have driving and camping trips along the coastal strip (e.g. through the **Port Hughes** area, **Port Victoria**, **Balgowan**, **Port Rickaby** etc). Canoeing / sea kayaking clubs have also held expeditions in the mid-eastern to south-eastern Spencer Gulf area (e.g. **Moonta Bay** to **Port Rickaby**).

There are yacht cruising circuits along the mid-eastern and south-eastern Spencer Gulf, with departure / arrival points at Wallaroo, **Port Victoria**, and **Point Turton** (DEH, 2003a, Figurer 13).

Aboriginal Heritage Values

The following information about the significance of Yorke Peninsula to the Narungga people, unless otherwise specified below, was cited by the District Council of Yorke Peninsula (2002), using references from the Goretta Aboriginal Corporation:

- ♦ The Narungga country extends as far north as Port Broughton and east to the Hummock Ranges. The Narungga nation was made up of four clans, the Kurnara in the north of the peninsula, Winderera in the east, Wari in the west and Dilpa in the south. The Narungga have a strong cultural association with the marine environment of Yorke Peninsula, and maintained large settlements along the coast throughout much of the year, rather than leading a nomadic existence.
- ♦ The eastern coast of Yorke Peninsula has long been an important area for the Narungga, because it has abundant shellfish on the reefs; good fishing and hunting; a wealth of different bush foods; and, importantly, reliable fresh water sources in a series of wells and springs along the coast. For example, the soaks at the **Willows** become the main water supply for the Point Pearce Mission.
- ♦ On the Spencer Gulf side of Yorke Peninsula, some of the main settlements included **Moonta Bay**, **Cape Elizabeth**, **Chinaman's Well**, and **Point Pearce**, amongst others. Throughout the entire Yorke Peninsula, the **Point Pearce** and **Chinaman's Well** area is reported to contain some of the richest records of the Narungga presence. It is at the large camp sites that most of the permanent sources of freshwater were found, and the range of foods was both plentiful and varied. The elderly, the sick and the very young would stay in the camps while others would return each day or so, bringing back various foods they had collected or hunted, wood they had cut or stone they had acquired for tool making. Campfires would be lit, and wurlies of brush wood and mallee would be built. People would walk to a nearby rock hole or soak to collect water, fashion various wooden or stone tools, or repair fishing nets. The seasons probably had some influence on the Narungga movements. During the winter months for instance, when the small swamps and clay pans found throughout the peninsula filled with water, people could travel away from the coast and spend more time inland. At other times of the year, people would gather to exploit the fish 'runs'.
- ♦ Other sites were lived in for only short time periods, presumably when Narungga people were moving from one large camp to another, or where they stopped overnight while collecting food. At the small temporary camps, Narungga people made fires and ate foods such as shells and fish, some of which were also transported to the larger camps for sharing. Remains of the small camps are the most common site type found and occur in many places along the Yorke Peninsula coast. These sites contain stone tools, food remains (particularly shellfish, and also fish bones), old fire places and occasionally burials. Some extend for hundreds of metres and contain thousands of artefacts, whilst others cover a

small area, and contain few artefacts and shells.

- ♦ Stone tools were used for a variety of tasks and are the most common item found in campsites. Hammers, scrapers, chisels, knives and spear tips were all manufactured from stone. Tools were manufactured from various types of stone, including quartz, chert, quartzite, silcrete and flint. Many of these materials can be found as cobbles along beaches while others occur at specific locations around Yorke Peninsula. Others are likely to have come from outside the peninsula and their presence within campsites illustrates trade between the Narungga and their neighbours. Shell remains are the next most common item found within campsites, and Warrener, periwinkle and abalone are often found. These were not only eaten but the shells were also used for scraping animal skins, or made into ornaments and jewellery.
- ♦ Burials have been found at many locations on Yorke Peninsula and in particular within the sand hills that line much of the coast. Usually only the harder bones and teeth remain and become exposed by the action of the wind blowing away the covering sands. People were occasionally buried with some personal items such as a shell necklace or trinket while ochre is also often found and may relate to ceremonies undertaken during the funeral or decoration of the body.
- ♦ Generations of Narungga people lived and travelled throughout the **Point Pearce** area (Bookooyanna) long before the arrival of Europeans, and regularly used **Wardang Island**. The island could be accessed at low tide by wading out to **Green Island** and then swimming across the deep channel. The Narungga people regularly walked and swam across the channel from **Point Pearce** to **Wardang** and other islands in the area. People would sit on the shore and sing songs and wave branches, reputedly to distract the sharks from the people swimming to Wardang. The island's reefs were rich in shellfish and fish, and the nesting birds were used for both eggs and meat. The island has been traditionally important to the Narungga for many purposes, including dwelling, and daily activities such as food gathering.
- ♦ The fish, crustaceans and molluscs of Yorke Peninsula were important food sources for the Narungga, who were very skilled fishers. The Narungga made fishing nets from a local reed, and were expert fishers. A swimmer would sometimes carry a bait fish into deep water and return to shore where others would net the schools of fish that would follow, or a spotter would signal from the cliff tops as to where the schools of fish were. The Narungga also gathered shellfish, which were an important part of their diet, and sometimes collected lobsters and crabs. People would walk out onto the reefs at low tide to collect periwinkles and warrener shells, or swim into deeper water for abalone. The coastal environment provided an important hunting and gathering ground for the Narungga, however conflict with whalers and sealers, and early colonisation and land clearance for agriculture, resulted in the Narungga being progressively dispossessed from most of the areas they previously occupied.
- ♦ When Europeans arrived on Yorke Peninsula, **Wardang Island**, like most of the peninsula, was taken from the Narungga. The first lease was taken out on the island in 1861, but Aboriginal people were still allowed access to the island, to hunt and fish and gather foods. The lease ran until 1877 when it was transferred to the Point Pearce Aboriginal Mission. The Mission was established in 1868, and became a small township within 10 years.

Wardang Island and the land around **Point Pearce**, are leased by the Aboriginal Lands Trust to the Point Pearce Community Council. Permission from the Community is required for landing on Wardang Island. The island has a living settlement, an airstrip and jetties. There is also an outdoor education camp on Wardang Island.

Some of the Narungga's sites are entered on the *Register of Aboriginal Sites and Objects*, and all Aboriginal sites are protected under the *Aboriginal Heritage Act 1988* (NPWSA, 2001a).

Port Victoria – Point Pearce Aboriginal Reserve area is listed as an *Indigenous Place*, on the Australian Heritage Commission's *Register of the National Estate*, in national recognition of the Aboriginal Heritage significance of the area. **Balgowan** is listed as an *Indicative Place* (i.e. pending future heritage assessment), on the *Register of the National Estate*, in terms of its Aboriginal Heritage significance. Other sites listed on the Register of the National Estate include **Warburto Point** Oven Site and the **Moonta Bay** Site (Northern and Yorke Agricultural District INRM Committee Inc. (2002). In addition to these nationally registered sites, there are other sites of Aboriginal Heritage significance along the entire length of mid-eastern and south-eastern Spencer Gulf (see DEH, 2003a, Figure 11).

According to uncited references in Edyvane (1999b), the most important areas of cultural significance include the **Cape Elizabeth / Tiparra Springs** dunes and the dunes north of **Moonta Bay**. Other significant areas of occupation include the dunes between **Port Hughes** and **Cape Elizabeth**, and the dunes south of **Port Victoria**.

Moorara, a composite schooner built 1909, wrecked 1975 in the **Wardang Island** area, had been owned by the Aboriginal Lands Trust / Community Corporation and used to carry water from **Port Victoria** to the aboriginal community on Wardang Island (Stone, undated; Aquanaut, undated).

There is a site of cultural importance to the Narungga Tribe, at **Corny Point** (Hill and Hill, 1975).

The Narungga Tribe have a Native Title claim for sea rights from the shore to 7km seaward off Yorke Peninsula (Tanner, pers. comm. to DEH, 2001), which includes the lower eastern side of Spencer Gulf and associated islands. The Point Pearce Community Council indicated during the mid 1990s, their intention of submitting a Native Title Claim over the waterways adjacent to **Point Pearce** and **Wardang Island** area (Aquaculture Group - PISA Fisheries, 1996). If successful, the waterways would be controlled by the Community Council. This claim has not, to date, been lodged or registered (DEH, 2003a). As at March 2003, there were no applications, decisions or determinations listed in the Commonwealth's National Native Title Tribunal database for Yorke Peninsula (NNTT database, 2003). A voluntary Indigenous Land Use Agreement has been arranged for the claim, by the Narungga people of Yorke Peninsula (DEH, 2003a)

In 2002, there was a proposal for the development of an Aboriginal Cultural Centre in **Moonta** and the establishment of a Coastal Bush Tucker Interpretative Trail between **Moonta Bay** and **Port Hughes** (Copper Coast District Council, 2002).

The Indigenous Land Corporation (ILC) own a 2000ha coastal property at **Tiparra**, for use by the Narungga people, who consider the property to have a number of culturally significant areas within it. The Narungga people manage the land at the Tiparra reserve, which enables the Narungga to access their traditional land and fishing grounds, and provide training and employment opportunities for their people. In 2002, the Narungga Nations Aboriginal Corporation (NNAC), the title holders, were exploring a number of options for the property, including the possibility of having Tiparra, along with the adjoining coastal reserve, declared an *Indigenous Protected Area* (IPA), which would aid the NNAC in protecting the cultural and heritage values of the property, and fulfil its land management responsibilities with the ILC. Multi-agency funding approaches with the ILC, Department of Environment and Heritage S.A and Environment Australia are also being considered (ILC Media Release, April, 2002).

In 2002, the Indigenous Land Corporation (ILC) officially handed back two properties on the Yorke Peninsula to the Narungga people. The **Port Victoria** Fish Farms #1 and #2 were the first purchases on the Yorke Peninsula by the ILC and were be the first in the region to be officially handed back to the Narungga Nations Aboriginal Corporation for Land, who have leased the properties back to family groups within the Narungga community. Narungga family groups in the area will continue to use the land for share farming, and also plan to develop aquaculture enterprises (ILC Media Release, June, 2002).

The titles of **Point Pearce** and **Wardang Island** are currently held in trust for the Narungga by the Aboriginal Lands Trust Lands, and have not, to date (2003) been divested into the Narungga Nation Aboriginal Corporation for Land.

Historic / Protected Shipwrecks

Along the mid-eastern Spencer Gulf coast (**Balgowan / Tiparra / Moonta Bay / Port Hughes / Cape Elizabeth** area), historic shipwrecks include the following (Loney 1993; Stone, undated; S.A. Coast and Marine Atlas, 2001).

- ♦ *San Miquel*: iron barque, built 1864; wrecked at **Tiparra Reef** in 1865 (and has been found and inspected).
- ♦ *Gwydir*: barge, built 1817, wrecked north-west of **Tiparra Light** while under tow to the tug *Eleanor*, in 1900.
- ♦ *Black Diamond*: steamer, built 1864, wrecked 1872, on **Walrus Rock** while steaming from Moonta Bay to Wallaroo. The steamer had previously run ashore on **Wilberta Reef** between Wallaroo and Moonta, then after being re-floated, went aground a second time and was lost.
- ♦ *Dianella*: wooden schooner, built 1872, wrecked 1909 in **Moonta Bay**.
- ♦ *Young Lion*: ketch, built 1874, wrecked on the **Cape Elizabeth Reef** in 1882.
- ♦ *Lillie May*: wooden ketch, wrecked off **Cape Elizabeth** in 1920.

- ♦ *Victor*: schooner, lost on **Balgowan Reef** in 1925.

The small 6 tonne steam launch *Tiparra* appears to be the first of recorded vessels lost off **Wardang Island**. The *Tiparra* foundered whilst under tow, south-west off Wardang Island in 1877 (Loney, 1993, cited by Stone, undated; Aquanaut, undated).

The waters surrounding **Wardang Island** and **Port Victoria** comprise one of the most significant areas in South Australia for maritime heritage (Edyvane, 1999b). There are nine historic protected shipwrecks around **Wardang Island**. Eight of the nine shipwrecks in the area form part of a *Maritime Heritage Trail*. The following wrecks (documented in Loney 1993; Stone, undated; and SA Coast and Marine Atlas, 2001), are protected under the S.A. *Historic Shipwrecks Act 1981*:

- ♦ *Songvaar*, iron ship, built 1884, wrecked 1912;
- ♦ *Moorara*, composite schooner, built 1909, wrecked 1975;
- ♦ *Aargot*, iron barque, built 1882, wrecked 1907;
- ♦ *Notre Dame D'Arvor*, steel barque, built 1902, wrecked 1920;
- ♦ *Investigator*, iron screw steamer, built 1882, wrecked 1918;
- ♦ *Monarch*, wood schooner, built 1871, wrecked 1909;
- ♦ *Australian*, iron screw steamer, built 1879, wrecked 1912;
- ♦ *Macintyre*, iron schooner, built 1877, wrecked 1927;
- ♦ *Maid of Australia*, wood schooner, built 1869, wrecked 1899 (not included in the Heritage Trail because little of the vessel remains intact).

Very little can be seen of the wrecks in the **Wardang Island / Port Victoria** area, even though they are in shallow water, because most have been broken up by the elements, and some also by previous blasting with explosives (Aquanaut, undated).

A number of other historic but unprotected wrecks have been recorded for the **Port Victoria - Island Point** area. These include: *Agnes*, wooden schooner, built 1874, wrecked 1876 but not found; *Patsie*, wood cutter, wrecked 1928 but not found; *Albatross*, wood schooner, built 1874, wrecked 1913, and has been found and inspected by heritage officials.

Further south, historic shipwrecks that are not protected legislatively, include:

- ♦ Off **Port Rickaby**: The *Louise*, wooden schooner built 1869, wrecked 1878.
- ♦ Off **Port Minlacowie**: *Elizabeth Annie*, wooden ketch built 1874, wrecked 1911 after becoming stranded; Unknown cutter, wrecked 1928; Unknown barge, wrecked 1904.
- ♦ Off **Point Turton**: *Yalta*, wooden tug, beached in 1926 after developing a leak.
- ♦ Off **Corny Point**: the ketch *Boieldieu* was wrecked in 1920.

(S.A. Coast and Marine Atlas, 2001; District Council of Yorke Peninsula, 2002).

There are also records of more modern vessels (built 20th century) wrecked in the area described in this table. There are also several historic but unprotected shipwrecks known in the deeper waters off **Corny Point**.

Other Heritage

Moonta Bay / Port Hughes: The heritage of Moonta relates principally to the copper mining, which is not discussed here, because copper mining is not a marine heritage value. The port of Moonta dates back to 1868, and the jetty was built in 1870. The saltwater intake and pumping station at Moonta Bay is listed on the *State Heritage Register*. The Moonta Bay area has historically been an important fishing area, and it is reported that during the 1920s, Moonta Bay had the largest commercial fishing industry in South Australia, with around 370 people engaged in it (FGCSA, 1997).

Balgowan: In 1881 a jetty was erected to enable farmers to ship their grain to Port Adelaide, but it was built in the wrong place, and at low water there was only 1.6 metres covering the reefs off the coast. In 1907 a new jetty was built, and **Balgowan** port shipped away in the vicinity of 200,000 bags of wheat. With the advent of bulk loading at Ardrossan, and better roads with motor transport, small shipping ports such as Balgowan were no longer used (District Council of Yorke Peninsula, 2002).

Port Victoria was a significant shipping area during the 1800s and early 1900s (see *Historic Shipwrecks*).

After the jetty was built in the mid 1870's, sailing vessels called at the port to be loaded with grain. An L-shaped extension was completed in 1883, to provide shelter from south-westerly weather. To save wharf fees, the ships usually anchored about 1 mile offshore, and ketches which carried between 800 and 1000 bags of grain, transported the cargo to the windjammers. Some ships carried 60,000 bags and it took six to eight weeks to load them. They then set out for overseas, usually by way of Cape Horn. In 1932, twenty ships loaded with bags of wheat left Port Victoria for the English Channel; a distance of 15,000 miles. This was the commencement of the "Great Grain Races". In 1933, the *Parma* completed the journey in the fastest time ever recorded (83 days). The last square rigger left Port Victoria in 1949, carrying 56,681 bags of wheat. When the ship sank in 1957, a memorial that commemorates the ships and sailors of the era was erected, near the **Port Victoria** jetty. Port Victoria was the last port in Australia at which a windjammer was loaded with grain, hence its reputation as "the last of the windjammer ports" (Yorke Peninsula Tourism Association, undated; District Council of Yorke Peninsula, 2002). The maritime museum at **Port Victoria** has relics of sailing ship era. The **Port Victoria** jetty, which is over 115 years old, is also considered to be of local heritage significance, both the jetty and the cargo shed are listed on the *State Heritage Register*.

Wardang Island was used for sheep grazing in the 1860s, and much of the natural vegetation was cleared. The high significance of the island to the Narungga Aborigines was, however, recognised during the period in which pastoralists held the lease, and there were no restrictions to Aboriginal access and use (see section above on **Aboriginal Heritage**). The lease was later transferred to the Aboriginal mission at Point Pearce in 1884. From 1910, lime sand was quarried for use in the smelters at Port Pirie. The sand was quarried from cliffs to 20m, firstly using pick and shovel, and in later years, dynamite was used. Large quantities of sand were loaded into horse-drawn trucks and taken to the jetty, from where barges (towed by tugs) carried the loads to Port Pirie. From 1918 onward, the sand in the mobile dunes at the southern end of the island was mined. By 1951, around 900,000 tonnes of sand had been removed from **Wardang Island**, and mining continued until 1968, when the sand source from the mobile dunes was depleted (Robinson *et al.*, 1996).

There are old rock jetties or breakwaters at the southern end of the beach at **Green Island** (Robinson *et al.*, 1996).

South-eastern Spencer Gulf also has an important role in the historic grain trade. Grain ships came to **Hardwicke Bay** and anchored there, and loaded grain by lighter and ketches from **Point Turton**, **Minlacowie** and **Port Rickaby** (Field Geology Club of South Australia, 1997).

Port Rickaby was established as a small shipping port in 1876, and was served by ketches. The jetty was built in 1879, and lengthened three times in the ensuing years, to a total of 820 feet in 1949. (The jetty was shortened again during the 1960's, to save repair costs). Much of the grain from the surrounding farmland was shipped out from Port Rickaby during the late 19th and early to mid 20th centuries. The Port was busy up to the mid 1940s, served by sailing and steam vessels, and was used to transport both cargo and passengers (SYP Tourism and Promotions Committee, 2002). The last windjammer to leave **Port Rickaby** was the *Passat*, in June 1949. The last known ketch to load at Port Rickaby was the *Falie* in 1951 (Port Rickaby Progress Association, undated).

Port Minlacowie: The port thrived during the late 1800s, after a jetty (1200 feet in length) was constructed by local farmers in 1877. In 1908 the jetty was extended to 1700 feet, making Port Minlacowie jetty one of the longest and deepest out-ports on the western coast of Yorke Peninsula. In 1901 a full ketch load of super-phosphate was unloaded from the *Maldon Lewis* for farmers in the district, a first for South Australia. The jetty continued its commercial use, many ketches including the *Falie* and steamers *Broadway* and *Quorna*, which shipped wheat and barley out until 1952. In 1965 the jetty was shortened by 900 feet, and it was completely destroyed in 1971. All that remains to show that there was once a thriving out-port and jetty is a basalt cairn and plaque. The basalt was ballast from an Italian ship, dumped in shallow water from the jetty. The cairn was erected in 1986 when the *Falie* called during the States sesqui-centenary celebrations (District Council of Yorke Peninsula, 2002).

Point Turton jetty was built in 1876 to service the local community, and to ship out local grain and stone. Between 1906 and 1919 about 120,000 tonnes of re-crystallised limestone was quarried in the Point Turton area, and sent to Port Pirie where it was used as a flux in the smelting of metals. After stone quarrying ceased by 1920, the jetty reverted to its original function of serving the port for the Warooka district. Both ketches and steamships were used to ship grain, super-phosphate, heavy freight and local provisions. Grain loading continued into the mid 20th century (e.g. more than 215 000 bags of barley were loaded in 1962) (District Council of Yorke Peninsula, 2002).

It has been recorded that during the 1880s, Chinese immigrants were sending smoked fish from **Point Turton** to markets, and the fish-smoking enterprise may also have been running at **Chinaman Well**, near **Balgowan** (Field Geology Club of South Australia, 1997). West of Point Turton, past **Magazine Bay**, there is a coastal outlet known as "The Drain" which was dug in 1900 by 20 people (using picks and shovels), to drain the inland area. The drain took a year to complete (Net Yorke Peninsula, 2000; SYP Tourism and Promotions Committee, 2002).

Peesy Swamp was previously used in the late 19th century for salt mining. Underground water in the area is almost seven times saltier than seawater. The brine was pumped from below, and evaporated on the surface, until the salt crust was thick enough to scrape off and bag. The swamp is believed to have got its name from one of the first salt workers in the area, Septimus Pizey, who worked the salt pans in the area with Augustus Tocchi, in 1874 (District Council of Yorke Peninsula, 2002).

Corny Point has a lighthouse, built in 1881 to afford protection to the grain ships servicing Port Victoria, Moonta Bay and Wallaroo. The lighthouse is listed on the *Register of the National Estate* (Australian Heritage Commission, undated) and the *State Heritage Register* (DEH, 2003a). The fully laden, southbound windjammers were endangered by south-westerly winds which could bring them in on the Web Rock or onto the reefs and shoals of Berry Bay and Daly Head. Attempts had been made to blast Web Rock but only with moderate success. The site of the lighthouse was not very stable, hence a large concrete base had to be constructed. The tower was built from local limestone quarried from a nearby farm, and two stone cottages (later demolished in 1920) were built for the head keeper and his assistant. The tower experienced two earthquakes, one of which occurred in the first year of operation (Lighthouse Centenary Book Committee, 1982; Lighthouses of Australia Inc., 2000).

Marine Research and Education

Some of the fisheries research work in the **mid-eastern** and **south-eastern Spencer Gulf** area includes catch and effort monitoring of the major commercial fisheries (various fish species, and prawns); monitoring of spawning populations and larval fish stocks (e.g. Fowler and MacGarvey, 1997, for whiting); surveys of prawn biology (e.g. Carrick, 1993), and prawn bycatch studies (e.g. Carrick, 1997, Svane *et al.*, 2000); and research and monitoring of blacklip and Greenlip Abalone stocks (e.g. see Shepherd and Rodda, 2001; Mayfield *et al.*, 2002).

Moonta Bay was one of the sites used in a project (Kumar *et al.*, 1995) to monitor the impact of netting and line fishing on undersized King George whiting.

Examples of ecological studies that have recently been undertaken in Spencer Gulf include a project describing the dynamics of the seagrass system in **southern Spencer Gulf**, the faunal communities within it, and the role of epiphyte grazers (Keuskamp and Svane, 2000), and a project to determine (i) the fate and consequences of by-catch from prawn trawling, and to what extent the discards affect ecosystems, in terms of trophic linkages and food web dynamics; (ii) effects of trawling on resuspension and nutrient regeneration, and (iii) the effects of trawling on the benthic and pelagic assemblages (Svane *et al.*, 2000).

In 2000-2001, a baseline marine survey of an experimental drill site west of **Tiparra Reef** was undertaken, with subsequent assessment of the impacts of the drilling operation on bottom-living communities in the vicinity of the drilling platform (SARDI, 2001).

From **Port Victoria**, there is a geology trail, which has educational value. The trail runs approximately five kilometres along the coast from the jetty to the boat ramp, then to **Rifle Butts Beach** (Aquaculture Group – PISA Fisheries, 1996). There is a detailed guide book of the sites along the trail that record the volcanic geology of the coast in this area, and interpretative brochures are also available, at the foreshore.

In 2001, a maritime archaeological field school for tertiary students, was run during summer at **Port Victoria**. The course included wreck and jetty site inspections, wreck surveys using various recording techniques, corrosion potential measurement tasks, magnetometer searches and some exposure to wreck excavation, underwater still photography, digital video and High Precision Acoustic Survey System (HPASS) technology. Investigated sites include the historic **Port Victoria jetty**, various shipwreck sites (see shipwreck list above) around **Wardang Island**, and the remains of the ketch *Victor*, near **Balgowan** (Flinders University Archaeology web site, 2000).

There is a field station for marine research maintained at **Goose Island** (DENR, 1995, cited by Aquaculture Group - PISA Fisheries, 1996), and this station is also considered important for educational activities (see below). Population monitoring of Australian sea lions is undertaken irregularly in the area.

According to Edyvane (1999b), **Wardang Island** is used extensively for educational purposes by various schools, clubs and institutions, however the extent to which this activity relates to the marine environment was not specified.

Goose Island Conservation Park, including **White Rocks**, has 54 ha of the surrounding marine environment protected as an Aquatic Reserve, and has been used as an education field station by Scotch College. The marine area surrounding the conservation park was proclaimed as an Aquatic Reserve in 1971, following a request from the College (Ivanovici, 1984; Johnson, 1988a). The reserve was proclaimed partly to permit marine biological and ecological education studies in an undisturbed environment.

According to the Warooka Development Plan (Planning S.A., 1999), the **Corny Point** area is classified as being of special geological and/or geomorphological significance, and is considered to have scientific and educational value.

The beach and wave cut platform at **Barker Rocks**, south of **Port Rickaby**, are used by education and school groups (Edyvane, 1999b; Bryars, 2003), due to the "wide variety of intertidal life" (Edyvane, 1999b).

Leven Beach Conservation Park, which abuts the coast in outer **Hardwicke Bay**, is used for environmental and outdoor education classes (DENR, 1995, cited by Aquaculture Group - PISA Fisheries, 1996).

Core samples from **Peesey Swamp** have been used in a project to develop a chronological framework for major climatic and hydrologic changes, using mineralogical and palaeontological analysis, and radiocarbon and thermo-luminescence dating techniques (von der Borch *et al.*, 1993).

A study of the tidal currents and other nearshore processes has been undertaken in the vicinity of **The Pines**, to determine causes and possible solutions to coastal dune erosion in the area (von der Borch *et al.*, 1993).

Wilderness and/or Aesthetic Values

In general, the coastal areas of Yorke Peninsula have been described as "beautiful" and "scenic" (District Council of Yorke Peninsula, 2002).

In the northern part of the area described in this table (e.g. **Moonta Bay / Tiparra Bay, Port Hughes, Tiparra, Cape Elizabeth**), tourism material promote the "unspoilt" coastline, "breathtaking scenery", "beautiful beaches" and "tranquil seaside setting", and the wide variety of bird life (e.g. at Bird Islands) (Sightseeing South Australia, 2003).

Port Hughes has been described as having "one of the most picturesque beaches in the northern area of Yorke Peninsula" (SA Regional, undated). Tourism materials promote the "beautiful sand" and privacy of the beach between Port Hughes and Cape Elizabeth. The Yorke Peninsula Regional Visitor Information Centre also described the Copper Coast area (of which **Moonta** is one part) as "very picturesque". **Cape Elizabeth** beaches have been described by the local council as "some of the most beautiful and pristine beaches on Yorke Peninsula", and the beaches in the **Moonta Bay** area have been described as "beautiful and extensive" by the Yorke Peninsula Regional Visitor Information Centre.

Yorke Peninsula promotion materials state that the **Barker Rocks** Walking Trail offers "great coastal views".

There is a coastal lookout at **Port Rickaby**, and a walking trail to **Mullet Bay**, promoted for views of local cliffs, reefs and "beautiful views back over the Port Rickaby bay" (Port Rickaby Progress Association, undated).

According to the Warooka Development Plan (Planning S.A., 1999), the Warooka Council area contains "a particularly long and scenic coastal region", part of which includes **Hardwicke Bay**, and is described as one of the district's "most attractive features".

Planning S.A. (1999) stated that access to “environmentally fragile” areas around the foot of Yorke Peninsula should be consistent with the need to protect the “natural vegetation and scenic qualities of the coast”, including the **Corny Point** area. Edyvane (1999b) described **Corny Point** as being recognised for “spectacular coastal scenery”. Tourism guides report that the area offers “excellent views over the coast” (Fairfax Publishing – F2, 2001).

Mining

Previously, the S.A. government issued a Petroleum Exploration Licence for Spencer Gulf (Aquaculture Group - PISA Fisheries, 1996), with an expiry date of 2000. The lease site (PEL34) covers 5597km² of the waters of south-central Spencer Gulf, east of the Sir Joseph Banks Group and west of **Wardang Island**. The north-eastern boundary is off **Cape Elizabeth**, and the south-eastern boundary of the tenement is in the **Point Souttar - Corny Point** area.

There are land-based mineral exploration leases close to the coast in the **Moonta – Wallaroo** area; the area between **Cape Elizabeth** and **Point Gawler**, the **Warooka** - eastern **Hardwicke Bay** area, and the foot of Yorke Peninsula, including the northern coast between **Hardwicke Bay** and **Corny Point** (PIRSA map, in S.A. Coast and Marine Atlas data base, 2001).

A mining company has recently been re-logging and re-sampling drill holes in the **Moonta** and **Balgowan** area, and plans further re-surveying of sites in the area to determine potential for minerals production, particularly iron oxide, copper and gold (see Avoca Resources Ltd, 2002).

Towns and Settlements

Moonta and **Moonta Bay**: Population 3,084 (ABS, 2001), or 3,394 including **Port Hughes**. **Moonta Bay** has both permanent and seasonal residents, and has become increasingly popular during the past decade for seaside holidays. There is a seasonal rise in population in the **Moonta / Moonta Bay / Port Hughes** area (up to 10,000, according to an estimate in 2002) due to holiday visitors.

Cape Elizabeth: A small settlement south of Moonta Bay, mainly comprising shacks.

Balgowan is a small settlement mainly used for holidays (District Council of Yorke Peninsula 2002). There are shacks / holiday houses near the shore, and a camping area. There has been some new development along the coast in recent years, for housing.

Port Victoria: Population 333 (ABS, 2001). Previously an important port in the grain trade, and now a small town, with seasonally increasing numbers due to tourism / seaside holidays.

Port Rickaby: A small coastal town of around 61 allotments, the majority of which have houses built upon them (Hamill and Associates, 2002). There is also a 68-site caravan park, and the area has attracted “a significant number of visitors” in recent years (Hamill and Associates, 2002). Tourism materials for Yorke Peninsula report that the population increases to more than 300 during holiday periods. Port Rickaby is a holiday town, with most residents living elsewhere, and using the area only on weekends or during holiday periods (Hamill and Associates, 2002). South of Port Rickaby, there are shack settlements along the coastal strip that includes **Brown Point, Parsons Beach, Bluff Beach, Watsons Beach, and Cockle Beach**.

Port Minlacowie and **Sheriffs Beach**: comprise mainly shack sites, and there are also farm homesteads at Port Minlacowie.

Hardwicke Bay: The town was previously a base for a small number of commercial line fishers (SYP Tourism and Promotions Committee, 2002), but is now also an expanding area for holiday homes and retirement. There are also various shack settlements along the Hardwicke Bay coast.

Point Turton: A small fishing port and holiday town. There are shack sites from **Levens Beach** to **Point Turton**. Beach shacks line the coast between **Point Souttar** and **Point Turton**. The **Point Turton** area is recognised as one of the three prime retirement and seaside holiday spots on Yorke Peninsula (Planning S.A., 1999). The region is also a growing one for new holiday homes / shacks, and there are also caravan parks in the area.

The Pines and **Corny Point** were described as “holiday settlements” by Planning S.A.’s Warooka DC Development Plan (1997, 1998, 1999). The Plan emphasised the development of these settlements as “*residential and service centres to accommodate basic needs and facilities for holiday-makers and visitors*”, as well as the local community. **The Pines** and **Couch’s Beach** are growing areas for holiday homes.

Ports, Harbours and Navigation

There is a harbour at **Point Turton**, declared under the *Harbours and Navigation Act 1993*. The harbour zone commences at **Point Souttar**; then true East to high water mark on the sea coast, then south-westerly and north-westerly following high water mark to the point of commencement (PIRSA, 1996). There are permanent mooring sites for boats in the **Point Turton** area.

Port Victoria was described by PIRSA (1996) as one of the 10 areas in the main circuit for maritime traffic in Spencer Gulf.

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

Aquaculture

There are currently no aquaculture leases within this region, on south-western Yorke Peninsula, and north-western Kangaroo Island (S.A. Coast and Marine Atlas, 2003).

During the early 2000s, there were technical investigations by government and consultants, of the potential of **Marion Bay**, east of the area described in this table, to support finfish and subtidal shellfish aquaculture.

North-Western Kangaroo Island was included as part of PISA’s Cape Torrens Policy Area (Gilliland, 1996). The land-ward boundary of the policy area begins at the north-western coastal boundary of the Ravine Des Casoars Wilderness Protection Area and heads in a general easterly direction to Cape Dutton (see map OC(KI)/1 and Map OC(KI)/4 in Gilliland, 1996). The area is defined as all waters between the mean spring high water mark and the boundaries of the plan, East of a line between 648345E, 6042716N and 646472E, 6048458N and West of a line between 691834E, 6060106N and 693768E, 6054827N. The PISA Policy Area included the following zones: Inner Cape Torrens Zone ICT; Outer Cape Torrens Zone OCT, and Cape Torrens Aquaculture Zone Aq(CT). The Kangaroo Island Aquaculture Management Plan (Gilliland, 1996) provided for the following development:

- ♦ 60 ha of development in the inner Cape Torrens Zone, with the exception of intertidal oyster culture (not permitted);
- ♦ 12ha of development in the Outer Cape Torrens Zone (to 3 nautical miles);
- ♦ 200ha of development in the Cape Torrens Aquaculture Zone.

The Cape Torrens Aquaculture Zone Aq(CT) was defined by PISA (Gilliland, 1996) as the area bounded by the following points (Map OC(KI)/4): 679990E, 6054740N; 679950E, 6052752N; 685801E, 6054636N; 685040E, 6052648N. The zone covers an area of approximately 1000 hectares. However, under the plan, aquaculture would not be considered in the following areas, due to existing values/uses:

- ♦ In the area bounded by the mean spring high water mark and the following points: 666157E, 6048079N; 666169E, 6048748N; 667067E, 6048731N; 667062E, 6048450N (Snug Cove, and Fides wreck site);
- ♦ within one kilometre of the mean spring high water mark between 669761E, 6048846N and 675546E, 6050038N (Western River Wilderness Protection Area);
- ♦ the area enclosed by the mean spring high water mark and a line between 678052E, 6050327N and

678754E, 6050417N (Western River Cove)

- ♦ the area enclosed by the mean spring high water mark and a line passing through 685995E, 6050882N and 687606E, 6051237N (Snelling Beach).
- ♦ All forms of Aquaculture within one kilometre of 693768E, 6054827N (Cape Dutton) (Gilliland, 1996).

Commercial Fishing

Scalefish, Sharks and Invertebrates

South-Western Yorke Peninsula / North-Western Investigator Strait:

Figures specific to western Investigator Strait are currently not available for this report. Commercial fishing boats, as well as a large number of recreational vessels, use the waters around **Innes National Park** all year (Berggy, 1996), and the coastal waters are considered important for both commercial and recreational fishing. Commercial fishers operate from **Pondalowie Bay**, where 10-20 fishing boats are permanently moored (Shepherd and Brook, 2002). There are boat-launching facilities at **Pondalowie Bay**. According to McGlennon (1996), usage of the launching site at **Pondalowie** is approximately 60% recreational fishing and 40% commercial fishing.

No recent figures are available for the **south-western Yorke Peninsula** area, southwards to approximately 35° 30' in **Investigator Strait**, is part of GARFIS Block 40 (from approximately Daly Head in the West, and including waters of Investigator Strait to approximately 35°30'S, across the foot of Yorke Peninsula, northwards into south-western Gulf St Vincent to approximately Giles Point, as far seawards as 138°E). Previously, the Marine Scalefish and Shark catch from GARFIS Block 40 during the mid-1990s, was as follows (SARDI data, cited by Edyvane, 1999b):

- ♦ 1995/96 a total 200, 171kg (1.93% of State total, representing 54 fishers);
- ♦ 1996/97 a total 211,150kg (2.08% of State total, representing 51 fishers).

The proportion of the above yields that relates specifically to the area described in this table is not known for this report

On a State-wide scale, aggregated catch figures for all GARFIS Fishing Blocks in South Australia, between 1995 and 1997, showed that the **southern Yorke Peninsula / northern Investigator Strait** area (Block 40) was ranked 13th in 1995/96 and 14th in 1996/97, in the list of fish and shark yields from 58 South Australian fishing blocks during that period. Note that these figures also include the eastern foot of Yorke Peninsula and much of eastern Investigator Strait.

Regionally, the major commercial fish and shark species that are caught around the foot of **Yorke Peninsula**, and **Investigator Strait** include:

West Australian Salmon (Southern Yorke Peninsula / Investigator Strait has been one of the top 3 fishing blocks in the State in terms of yield, in some recent years – e.g. mid-late 1990s). Area-specific figures are not available, however Jones (1999) reported that the total salmon catch for the Investigator Strait and Kangaroo Island regions combined, was around 350.5 tonnes in 1998/99, with the majority of the catch taken by hauling nets, and that the waters around Kangaroo Island and Investigator Strait continue to be the most important commercial fishing area for this species in South Australia;

Gummy Shark (regionally high tonnages caught in some years, but in terms of annual yield, Southern Yorke Peninsula / Investigator Strait has not been one of the top 10 fishing blocks in the State for Gummy Shark in recent years). Long line and long mesh gill nets operate in waters over 10m in Investigator Strait (G.K. Jones, pers. comm., cited by Edyvane *et al.*, 1996). The fishery has recently been re-regulated by the Commonwealth in an effort to rebuild stocks, ensure fishery sustainability, and protect nursery areas (see section 9.2, and references by AFMA in bibliography);

King George Whiting: no recent figures specific to south-western Yorke Peninsula area available, however although the catches have been amongst the highest of the scalefish caught in this Fishing Block in recent years (in terms of weight), the region is not one of the major fishing areas in the state for King George Whiting – see Fowler and McGarvey, 1997 and 1999, and McGarvey *et al.*, 2000 and 2003 for regional overviews of catch and effort);

Garfish (no recent figures specific to south-western Yorke Peninsula area available, however although the catches have been amongst the highest of the scalefish caught in this Fishing Block in recent years (in

terms of weight), the region is not one of the major fishing areas in the state for Garfish - see Ye, 1999, for regional overview of catch and effort);

Snapper (in some recent years, southern Yorke Peninsula / Investigator Strait has been one of the top 10 fishing blocks in the state in terms of yield); and

School Shark: Long line and long mesh gill nets operate in waters over 10m in Investigator Strait (G.K. Jones, pers. comm., cited by Edyvane *et al.*, 1996). (N.B. the fishery has recently been re-regulated by the Commonwealth, particularly in light of declining School Shark populations in south-eastern Australia (see section 9.2, and references by AFMA in bibliography).

Bronze Whalers and other shark species (e.g. in lesser quantities compared with yield of school and Gummy Sharks, during the mid-late 1990s). Bronze Whalers are caught by long lines and long mesh gill nets in waters over 10m in Investigator Strait.

Other species caught commercially in the Southern Yorke Peninsula region include *Tommy Ruff (Australian Herring)*, *Trevally*, *Snook*, *Southern Calamari*, and *Leatherjacket* species. More than 28 other fish species have been caught commercially in recent years, in minor quantities.

The southern part of the area discussed in this table (i.e. north-western Kangaroo Island) is the south-eastern part of GARFIS Block 39. Recent commercial catch figures specific to this area are not available for this report. Previously, during the mid-1990s, the catch from GARFIS Block 39 (bottom of Spencer Gulf 35° S, southwards to lower western Kangaroo Island 36° S latitude, and spanning between 136° E and 137° E, including all waters in between, with the exclusion of north-western Investigator Strait and the western foot of Yorke Peninsula) was as follows (SARDI data, cited by Edyvane, 1999b):

- ♦ 1995/96 a total of 66,188kg (0.64% of State total, representing 21 fishers);
- ♦ 1996/97 a total of 86,753kg (0.86% of State total, representing 31 fishers).

Note that this figure encompasses a large area between the southern mouth of Spencer Gulf and western Kangaroo Island, and is therefore unlikely to adequately reflect the scalefish and shark fishing yields from north-western Kangaroo Island.

On a Statewide scale, aggregated catch figures for all GARFIS Fishing Blocks in South Australia, between 1995 and 1997, showed that Spencer Gulf mouth to western Kangaroo Island, including islands (i.e. GARFIS Block 39) was 28th in the ranked list of fishing yields from 58 South Australian fishing blocks in 1995/96, and 23rd in 1996/97. However, in some recent years, Fishing Block 39 has been amongst the top 10 fishing blocks in the State, in terms of School Shark and Gummy Shark yields.

South-Western Investigator Strait / North-Western Kangaroo Island:

Regionally, commercial fishing yields in the vicinity of **North-Western Kangaroo Island** have been dominated during the mid-late 1990s (in terms of weight landed) by:

School Shark and *Gummy Shark* (N.B. the fishery has recently been re-regulated by the Commonwealth, particularly in light of declining School Shark populations in south-eastern Australia (see section 9.2, and references by AFMA in bibliography); and

Ocean Leatherjacket. No recent figures specific to the north-western Kangaroo Island area are available for this report, however a State-wide overview is provided in section 9.2.

Purse seining for *West Australian Salmon* is also one of the main scalefish fisheries along northern Kangaroo Island, and occurs from **Cape Borda** to North Cape (Jones, pers. comm., cited by Edyvane, 1999b).

According to commercial catch data from the mid-late 1990s, *King George Whiting*, as well as *Redfish (Red "Snapper")*, *Western Blue Morwong* and *Blue Groper* are also caught commercially in the north-western Kangaroo Island area, in addition to a number of other reef fish species, the latter mainly in minor quantities. (Note that fishing for Western Blue Groper within Investigator Strait is prohibited under the *Fisheries Act 1982*). *Bronze Whaler* sharks are also caught in the area.

Long-lining for *Snapper* occurs along the coast of northern Kangaroo island (Jones, SARDI, pers. comm., 1996, cited by Edyvane, 1999b).

Waters around the mouth of **Western River** are closed to netting (PIRSA, 1999).

Prawn Fishing

Prawns are not fished along south-western Yorke Peninsula or north-western Kangaroo Island (see Figure 1 in Carrick and Williams, 2001). The coast between Daly Head and Corny Point, is the eastern boundary of prawn Fishing Block 93, which extends westward into the middle of the mouth of Spencer Gulf, north of the Gambier Islands. According to a prawn fishing map (DEH, 2003a, Figure 14), Block 93 has been fished in 7 to 9 years of the past 11 years to 1999/2000, and the average catch is around 6 to 10 tonnes per year. Prawn fishing in this block does not occur close to the coast, in waters less than 10m.

Rock Lobster Fishing

South-Western Yorke Peninsula / North-Western Investigator Strait:

At the peak of Rock Lobster fishing, 23 boats were in operation in **Pondalowie Bay**. During the late 1990s, nine lobster boats operated out of Pondalowie Bay, following reduction of licences as part of the management of the northern zone Rock Lobster fishery (SARLAC, 1998). Several Rock Lobster boats still use Pondalowie Bay for mooring, and Rock Lobster fishers live in the area seasonally.

Gleeson's Landing is currently classified as a Rock Lobster Sanctuary zone (all activities permitted except the removal of Rock Lobster).

Fisheries statistics specific to the South-Western Yorke Peninsula / North-Western Investigator Strait area are not available for this report. South-western Yorke Peninsula and north-western Investigator Strait are part of Marine Fishing Area 40, which extends the length of southern Yorke Peninsula, from approximately Daly Head to Giles Point area.

Fishing Block 40 is one of 10 major blocks for Rock Lobster in the Northern Zone (see Ward *et al.*, 2002, Figure 2.5). Since 1986, yield per annum has been over 50t, in all years except 2001. However, yield per annum has been less than 100t in Fishing Block 40, in all years except one, between 1970 and 2001. Effort level has been over 40,000 pot lifts per annum in all years since 1980 (and peaked at more than 80,000 pot lifts in 1991). The yield in 2001 (less than 45t) was the lowest catch per annum that has been recorded during the past two decades, and effort level in 2001 was around 40,000 pot lifts (see Figure 2.5 in Ward *et al.*, 2002).

An indication of the significance of the catch from Fishing Block 40, relative to other fishing blocks in South Australia, was provided by Edyvane (1999b, citing SARDI data): In 1995/96 and 1996/97, the total of 71,795kg and 64,785kg respectively, from Block 40, comprised around 1.4% to 1.3% of State total, representing the catch of 19 fishers at that time. Aggregated catch figures for all fishing blocks in South Australia, between 1995 and 1996, showed that Fishing Block 40 (of which south-western Yorke Peninsula and north-western Investigator Strait form one part - see description above) was the 10th most important commercial lobster fishing area in South Australia during that period, in terms of yield. Note that the figures cited above encompass a larger area across all of southern Yorke Peninsula, and are therefore unlikely to adequately reflect the Rock Lobster fishing yields specific to north-western Kangaroo Island.

South-Western Investigator Strait / North-Western Kangaroo Island:

On North-western Kangaroo Island, **Snug Cove** is used as a safe mooring area for Rock Lobster fishing vessels (Gilliland, 1996).

Fisheries statistics specific to north-western Kangaroo island are not available for this report. South-western Investigator Strait / north-western Kangaroo Island is included in Fishing Block 39, which includes bottom of Spencer Gulf 35° S, southwards to lower western Kangaroo Island 36° S latitude, and spanning between 136° E and 137° E, and all waters in between, with the exclusion of north-western Investigator Strait and the western foot of Yorke Peninsula. Fishing Block 39 includes the Gambier Isles, Neptune Islands, southern part of Thistle Island, western and north-western Kangaroo Island, and all waters in between. Fishing Block 39 is one of the two fishing blocks in the Northern Zone in which catch has consistently been higher than that from other Northern Zone fishing blocks, in almost all years since 1970 (see Ward *et al.* 2002, Figure 2.5). Catches have been higher than around 120t per annum in Fishing Block 39, in at least 25 of the years since 1970, up till the late 1990s, and corresponding effort has been higher than 100,000 pot lifts per annum in almost all of those years. Catch peaked at over 200t per annum in three years (1987, 1991, 1999). During the late 2000 and

2001, both catch and effort decreased - approximate catch in 2001 was around 85 tonnes in Fishing Block 39, for an effort level of around 100,000 pot lifts (according to Figure 2.5 in Ward *et al.* 2002). An indication of the significance of the catch from Fishing Block 39, relative to other fishing blocks in South Australia, was provided by Edyvane (1999b, citing SARDI data): In 1995/96 and 1996/97, the total of 108,867kg and 136,826kg respectively, from Block 39, comprised around 2.1% to 2.76% of State total, representing the catch of between 47 and 51 fishers.

Aggregated catch figures for all fishing blocks in South Australia, between 1995 and 1996, showed that Fishing Block 39 (of which north-western and western Kangaroo Island form one part - see description above) was the 8th most important commercial lobster fishing area in South Australia during that period, in terms of yield. Note that the figures cited above encompass a large area south of the mouth of Spencer Gulf, all island areas south of the mouth, as far south as Maupertuis Bay on lower western Kangaroo Island, and are therefore unlikely to adequately reflect the Rock Lobster fishing yields specific to north-western Kangaroo Island.

When the entire Northern Zone is considered as a whole (i.e. from the Western Australian border, through to Encounter Bay and deeper waters south of Kangaroo Island), the catch for the 2002 season was 594.8 tonnes, being the lowest catch in the Northern Zone since 1979 (Ward *et al.*, 2003).

Bycatch information specific to the toe of Yorke Peninsula and north-western Kangaroo island is not available for this report. However, McGarvey *et al.* (1998) and Prescott (2001) reported that the largest proportion of bycatch in the Northern Zone as a whole, is leatherjackets and octopus. According to the results of a sampling program of bycatch in 1991 and 1992, various wrasse species (Labridae family) together constituted another major component of the bycatch in the Northern Zone e.g. 1127 Labrids caught in pots during the bycatch sampling program in 1991-92 (Table 5 in Prescott, 2001). Octopus are a major predator of Rock Lobster, with losses due to octopus predation equating to approximately 4% of the total number of lobsters landed (in the Northern Zone). According to McGarvey *et al.* (1998), the catches and catch rates of octopus have been sustained over time, and vary from 1 – 2.5 octopuses per 100 pot lifts. Octopus that are caught in the northern zone are sold.

Rock Lobster fishers are also permitted to retain legal sized Giant Crab when caught as by-product, and this species is becoming increasingly valuable, commercially (McGarvey *et al.*, 1998). A small number of Commonwealth-endorsed Rock Lobster fishers also target Giant Crab specifically. Between 1992/93 and 2001/02, total Giant Crab catches (target and byproduct catches combined) have ranged between 7t in 1992/93 and 33t in 1998/99, with a steady decline between 1999 and 2002 due to the introduction of quotas (e.g. 31t in 1999/00; 24t in 2000/01, and 18.5t in 2001/02) (Knight *et al.*, 2003, cited by Sloan, 2003b). The fishery now operates under a quota-based management system with a total allowable commercial catch (TACC) of 13.4 and 8.7 tonnes for the Northern Zone and Southern Zone, respectively (Sloan, 2003b). Giant Crabs are caught from the edge of the continental shelf in the west coast region (McGarvey *et al.*, 1998).

Some Rock Lobster fishers net sharks out of season, and some of these activities require a Commonwealth permit. Licensed Rock Lobster fishers have also had access to fish species, such as West Australian Salmon, Mulloway, and Snapper (Zacharin, 1997, cited by McGarvey *et al.*, 1998).

Predators of Rock Lobster in the Northern zone include New Zealand Fur Seals, Western Blue Groper (minor) and Maori Octopus (McGarvey *et al.* 1998; S. Shepherd, pers. comm., 2004).

Abalone Fishing

Figures specific to the nominated area are not available, but aggregated figures are provided for the area between **Point Souttar to Foul Bay** (which includes to the “toe” of southern Yorke Peninsula, and offshore islands including Althorpe): between 1990 and 1996, recorded annual yield (approximate whole weight) of Greenlip Abalone in the specified area fluctuated between 700kg and 4.5t, and yield of Blacklip Abalone fluctuated between 2.9t and 7.1t (S. Shepherd, pers. comm., 2000). Note that Blacklip Abalone yield was less than 2t from this area in all years between 1979 and 1989, but catches increased significantly during the 1990s.

In the southern part of the area described here, aggregated figures (approximate whole weight) for the **North- Eastern Kangaroo** Island area are provided, part of which includes the southern coastal section of the western Investigator Strait region: between 1990 and 1996, recorded annual yield of Greenlip Abalone fluctuated between 0kg and 4.2t, and yield of Blacklip Abalone fluctuated between 0 kg and 1.3t (S. Shepherd, pers. comm., 2000).

Mayfield and Ward (2002, Figure 8a) showed that greenlip and Blacklip Abalone yields from south-western Yorke Peninsula and associated islands (Fishing Area 23A, B, C, D) have been highly variable since the 1970s, with irregular “peaks” in catch, and long sequences of low catches in the intervening years. Blacklip catches of 2t or less per annum were recorded during the 1980s, and catches increased to 4t – 7t during the early to mid 1990s, followed by a sharp decline to low levels (less than 2t per annum) during the late 1990s. Since 1978, greenlip catches from Fishing Area 23 have been mostly less than 5t per annum, other than 2 years during the mid 1980s, when catches of approximately 15t – 17t per annum were recorded. Both greenlip and blacklip catches from fishing Area 23 were at low levels during the early 2000s. Mayfield and Ward (2002, Tables 4a, 4b, 4c, 4d) reported that the average catch of greenlip from Area 23 during 1997-2001, was 0.65t per annum, representing 0.45% of the Central Zone catch of greenlip. In 2001, the catch of greenlip in Area 23 was very low (0.08t, representing 0.05% of the Central Zone catch). For blacklip, the average catch from Area 23 during 1997-2001, was 0.95t per annum, representing 2% of the Central Zone catch of blacklip, and in 2001, the catch of 0.46t represented 1% of the Central Zone catch of blacklip.

Mayfield *et al.* (2001) reported that (i) south-western Yorke Peninsula and associated islands (i.e. Fishing Area 23A, B, C, and D) is one of the Central Zone regions in which effort has decreased significantly during the past 10 years (to 2001); and (ii) northern Kangaroo Island is the region within the Central Zone in which catch rates have been lowest of all regions within the Central Zone, during the past 5 years to 2000, with average catch rates of 40kg – 60kg per hour.

Recreational Fishing

South-Western Yorke Peninsula / North-Western Investigator Strait:

Recreational fishing (from jetty, beach and rocks) involves both local and seasonal tourists, and is of local social and economic significance, particularly for coastal towns (e.g. **Marion Bay**, **Stenhouse Bay**).

The port and jetty area at **Marion Bay** are used by a number of fishing craft, but the Marion Bay area is not discussed in detail here because it is not part of the region described in this table.

Recreational fishing and tourism promotional materials list the coastal waters of the **Innes National Park** as providing “a wide variety” of fish, with at least seven beach and rock fishing locations where “good catches” of Garfish, Tommy Ruff, King George and Sand Whiting, calamari, Black Bream, mullet, flathead species, and leatherjacket species may be taken. The Australian Tourism Commission (undated) described **Innes National Park** coast as a popular location for recreational fishing, and the DC of Yorke Peninsula (2003) described the area as “excellent” for fishing. A “large number” of recreational vessels, use the waters around **Innes National Park** all year (Berggy, 1996), and the coastal waters are considered important for recreational fishing.

A number of large vessels (e.g. including large fishing boats) pass between **Althorpe Island** and the mainland (Berggy, 1996), however the proportion of these that are recreational vessels is not known for this report. There are boat-launching facilities at **Pondalowie Bay** and **Gleesons Landing**. A survey conducted by McGlennon (1996), concluded that the launching site at **Gleesons Landing** was used entirely by recreational fishers, and at **Pondalowie** approximately 60% of the people who used the facilities were recreational fishers.

In the mid-1990s total annual fishing effort from recreational boats in **lower Yorke Peninsula** exceeded 60,000 boat-hours, about six times the effort of commercial fishers (McGlennon and Kinloch, 1997, cited by Shepherd and Brook, 2002). In the year 2000-1, between 34,000 and 46,000 came to fish (R. Morcom, pers. comm. to S. Shepherd, cited by Shepherd and Brook, 2002). Rock fishers operate from all accessible rocky shores, and probably comprise the major fishing effort close to shore. Spear fishers are less common in the area (Shepherd and Brook, 2002).

Numerous scalefish species (e.g. yellow-eye Mullet, King George Whiting, Sand Flathead, West Australian Salmon, Sweep, Snapper, Garfish, Tommy Ruff, Snook and many others), as well as Southern Calamari, are caught in the area. In general, popular species at a number of surf and rock fishing spots around **Innes National Park** (including those sites listed below) include small West Australian Salmon (known as “Salmon Trout”), King George Whiting, mullet species, Tommy Ruff, Snook, Mulloway, leatherjacket species and Southern Calamari (SA Regional, undated). Edyvane (1999b) listed some of the major scalefish caught in each bay and headland area of south-western Yorke Peninsula, according to SARDI surveys of boat fishing ramps undertaken by McGlennon and Kinloch during the mid 1990s.

Beach and rock fishing occur at a number of locations around **Innes** (e.g. **Stenhouse Bay, Jolly's Beach, Cape Spencer, Brown's Beach, Pondalowie Bay** and others). **Gleesons Landing, Pondalowie Bay, West Cape beach**, and other bays and beaches in the area have been listed amongst the state's most popular spots for salmon fishing, and described as "important salmon locations" (Jones, 2000).

According to recreational fishing records and guides, fishing markers, and tourism promotion materials (e.g. Yorke Peninsula Tourism Association, 1995 and 2001; DC Yorke Peninsula, 2003), examples of popular target species for recreational fishers at various locations are as follows:

- ♦ jetties such as **Stenhouse Bay**, are reported to have "great runs" of fish or squid at various times of the year. Most popular species include: mullet, Snook, Garfish, Snapper, King George Whiting and other whiting, crabs, Mulloway, Tommy Ruffs, calamari, Australian Salmon, flathead, and shark species. **Stenhouse Bay** is a popular area for fishing from shore rocks and the jetty, for Tommy Ruff, mullet, Australian Salmon, whiting, Southern Calamari, Garfish, rock cod, and leatherjacket species. Benthic sharks and rays are also caught.
- ♦ **Jolly's Beach**: Similar to species listed above.
- ♦ **Chinaman's Hat Beach**: Popular for fishing Tommy Ruff and mullet, schools of which are targeted by surf fishers, yielding dozens at a time.
- ♦ **Pondalowie**: Mullet and Australian Salmon fishing close to shore. Boat fishers yield similar species as outlined for locations above, as well as reef such as Snapper, red fish (red Snapper), morwong, rock cod species, and wrasse species.
- ♦ There are various rock fishing locations between **Stenhouse Bay** and **Pondalowie**.
- ♦ **Daly Head**: Australian Salmon, Mulloway, Shark, Mullet, Flathead. **Daly Head** and **West Cape** areas were listed as two of the top 20 shore fishing locations in S.A. for recreational anglers, based upon a survey of long term recreational fishers and fishing experts (Capel, 1994). Beach and rock fishing occur in the area, and major species targeted include: at **Daly Head**: flathead, Australian Salmon, mullet, Mulloway, Tommy Ruff, trevally and Silver Drummer, and at **West Cape**: flathead, mullet, Australian Salmon and sweep.
- ♦ **Salmon Hole**: Surf fishing for Australian Salmon, mullet, and other species.
- ♦ **Brown's Beach**: popular and well known area for surf fishing (especially for the Australian Salmon "run", and mullet, but other species are also taken).
- ♦ **Berry Bay / Formby Bay** area: Surf fishing for salmon, Mulloway, mullet. Flathead and Shark species are also caught in the area.
- ♦ **Althorpe Reef**: Garfish, whiting and reef species.
- ♦ There are several recognised recreational fishing spots for boat fishers, around the **Althorpe Islands** (see list below). There is at least one charter fishing boat that regularly visits the Althorpe group. Tall sailing ship cruises also visit the **Althorpe Islands** irregularly, and recreational fishing is included as part of those cruises. Much of the recreational fishing around the Althorpe Islands (e.g. Smuggler's Cove) is from boats, including charter boats, although there is also a jetty on Althorpe Island. Popular species with boat fishers (including charter boats) in the area include Snapper, whiting, Blue Morwong, red fish ("red Snapper") and Snook. Reef fish (e.g. harlequin fish and other species) are also targeted in the Althorpe area.

Some of the fishing marks recognised by *Fish S.A.* for recreational boat and shore fishers in the area include:

- ♦ Near-shore reef off **Penguin Point** (near Marion Bay); the western side of **Stenhouse Bay**, and **Cape Spencer** (including near-shore reef ledges);
- ♦ **Stenhouse Bay** (e.g. up to 2km from shore);
- ♦ "**Cray Island**" reef between **Cape Spencer** and **Reef Head**;
- ♦ "Bommies" and other reef patches of variable bottom topography, 5 to 7km south-west of **West Cape**;
- ♦ Reefs (including near-shore reef ledges) around **Haystack Island**, particularly the western side;
- ♦ Various reef patches (including "pinnacles" and ledges), up to 4km west of **Seal Island**;
- ♦ Pinnacle reef north of **Althorpe Island**, and reef patches 1.5km north-west of **Little Althorpe Island**;
- ♦ Reef of variable topography (including "bommies") up to 2km south of **Althorpe Island**, and a large depression in reef bottom around 1km south-west of the island;

According to Yorke Peninsula tourism promotion materials and charter boat operator's listings, at least eight charter boats operate off **south-western Yorke Peninsula**. There is also a recreational charter boat operating out of **Foul Bay**, targeting species such as whiting and Snapper in Investigator Strait. Charters visiting the **Pondalowie** and **Daly Head** area catch reef fish species such as Snapper, morwong, red fish ("red Snapper"), rock cod and wrasse. Charter boats out from **Marion Bay** target Snapper, whiting and other species (Fairfax Publishing – F2, 2003). Blue Groper and harlequin fish are also caught by charters operating out of south-western Yorke Peninsula. Charters visiting **Althorpe Island** are discussed above.

Recreation fishing for Rock Lobster occurs in the **South-Western Yorke Peninsula** area, and around the **Althorpe Islands**, using lobster pots, and by diving. According to Tyrer (PISA, 1994), the waters adjacent to **Gleesons Landing** is one of the areas in S.A. where recreational Rock Lobster fishing effort is locally high, and exceeds commercial effort. It is interesting to note that Gleesons Landing is a Rock Lobster Sanctuary, where the taking of Rock Lobsters is totally prohibited at all times. There are no figures available for recreational lobster fishing in the south-western Yorke Peninsula areas, however Ward *et al.* (2002, citing McGlennon, 1999) reported that in the entire northern Zone (which extends from the WA border to Encounter Bay area), recreational catch using lobster pots was approximately 27 tonnes, or 2.6% of the commercial landings during the 1998 season.

Abalone are caught by recreational divers in the **south-western Yorke Peninsula** area (e.g. **Pondalowie** and **The Gap**, and other parts of **Innes**), however figures are not available for this report.

South-Western Investigator Strait / North-Western Kangaroo Island:

The **north-western coast** of **Kangaroo Island** (e.g. **Cape Forbin** to **Cape Dutton** area, including **Snug Cove**, **Western River Cove** and other locations) generally provides exposed conditions that are not conducive to the use of small fishing boats, and recreational fishing depends upon tidal influences and season. There is some fishing from the rocks and near the surf in the **Western River Cove** area. According to Sweeney (1996), the north-western coast of Kangaroo Island receives minimum recreational activity from boats. Inshore catches along the north-western coast (including Western River Cove) include large King George Whiting, sweep species, Silver Drummer, large trevally, Snook, flathead and Australian Salmon. Further offshore, mixed reef fish, red fish ("red Snapper"), small "rigger" Snapper and sharks are commonly caught by those who can access the reefs in the area (Sweeney, 1996). Tourism promotion material (Tour Kangaroo Island web site, Hypernet, 1999) on recreational fishing states that Snapper "abound" all along the north coast, and that large whiting are common. Charter boats also operate in the north-western area, and chartered tall ships visit the area for fishing (e.g. **Western River Cove** area).

Snelling Beach has been described as "one of the top fishing spots on Kangaroo Island" (Channel 9 *Postcards* program media transcript, undated), and is used for surf fishing (e.g. for catching Australian Salmon) and rock fishing (Australian Tourism Net, undated). Mullet and large flathead are also caught at **Snelling Beach**. **Middle River**, near Snelling Beach, is promoted for surf fishing and rock fishing (Tourism Kangaroo Island, 2001).

Sweep and Swallowtail are caught from parts of the **North-Western Kangaroo Island** coast where coastal rock outcrops meet deep water. Rock Lobster are caught recreationally, in some cases using a line with bait and a dab net (Tourism Kangaroo Island, 2001).

Some of the fishing marks recognised by *Fish S.A.* for recreational boat and shore fishers in the area include: a "large rise" around 17km off **Cape Forbin**; "broken bottom" around 15km NNW of **Snug Cove**; "drop-off" / shoal edges around 6km NW of **Western River Cove**, in **Investigator Strait**; ledges / "drop-offs" around 8km N of **Western River Cove**; and reef around 1km seaward of **Cape Dutton**.

Diving and Snorkelling

Dive promotion materials (e.g. Aquanaut, undated) describe Yorke Peninsula as being "extremely popular with South Australian and Victorian divers", and the shipwrecks of the area are considered popular for diving. Divers in the area also take abalone.

Stenhouse Bay, **Cable Hut Bay**, **Chinamans Hat Island**, **Reef Head** and **The Gap**, **Emmes Reef**, **Pondalowie Bay**, **Brown's Beach** amongst other southern and south-western Yorke sites, are recognised for diving and snorkelling, and such sites are listed in one or more of various dive guides to South Australian sites (e.g. DIASA, undated; Christopher, 1998; Aquanaut undated; Dive Oz, 1998-

2003) and tourism promotion materials (e.g. see DC of Yorke Peninsula, 2003). Diving guides promote shore-based diving out from **Chinamans Hat, Cape Spencer, Crystal Bay, Reef Head and West Cape**. Some of these sites are also promoted for underwater photography. In addition to the above, **Penguin Point** was listed in Christopher's (1988) Divers Guide to South Australia.

Pondalowie Bay has been described as "perhaps the most popular of the Yorke Peninsula diving areas", and having "some of the finest diving in the state". Boats for diving are launched at **Pondalowie Bay** and Marion Bay.

The steel barque shipwreck *Hougomont* at **Stenhouse Bay** and the wreck of the steel steamship *Willyama* near **Rhino Head** are also recognised dive sites. The stretch of water between the Yorke Peninsula and Kangaroo Island has been designated the *Investigator Strait Maritime Heritage Trail*, which features twenty-six shipwrecks that date from 1849 to 1982, and this trail is promoted to divers (Dive South Australia, 2004).

Dive charter boats also visit the foot of **Yorke Peninsula**, and associated islands, including the **Althorpe Islands** group.

Marion Bay is popular as an accommodation and launching base for charter boat dive trips to **South-Western Yorke Peninsula** and the **Althorpe Islands**.

Althorpe Island and **Haystack Island** are recognised among the best diving sites in South Australia (DIASA, undated; Christopher, 1988; Aquanaut, undated; Dive Oz, 1998-2003). From late spring to late autumn, there are regular charter boat trips to the Althorpe Islands and "CD's Bommie", leaving from Marion Bay.

The **Stenhouse Bay** jetty is listed in various dive guides (e.g. Christopher, 1988; Aquanaut, undated), due to its abundance and diversity of sponge species, amongst other features.

The Australian Tourism Commission (undated) described **Innes National Park** coast as a popular location for SCUBA diving.

Kangaroo Island has been described as providing "some of the best temperate-water diving in Australia" (Kangaroo Island Visitor Guide, 2003).

There are diving trips in charter boats and tall ships, to **northern** and **north-western Kangaroo Island** sites (e.g. **Pissy Boy Rock, The Arch, The Amphitheatre, Western River Cove, and Snug Cove**, amongst other locations), which are popular with international, national and local divers and marine photographers. **Western River Cove** is also promoted for shore-diving.

Other Recreation / Tourism

South-Western Yorke Peninsula / North-Western Investigator Strait:

The coast around **Innes National Park** is considered to be a very popular outdoor recreation area. The Australian Tourism Commission (undated), the District Council of Yorke Peninsula (2003), the Yorke Peninsula Tourism Association (1995, 2002) and numerous other Yorke Peninsula tourism promotion materials, describe **Innes National Park** coast as a popular location for fishing (see section above), surfing, coastal walking, scenic viewing, beach visits, swimming, camping, coastal bird watching, scenic photography etc.

Innes National Park attracts around 201,000 people per annum (NPWSA, 2001a), of which around 145,000 camp in the area (Morcom, pers. comm. to S. Shepherd, cited by Shepherd and Brook 2002). There are several popular beaches within the park. **Stenhouse Bay** and other beaches around **Innes** (e.g. **Jolleys**) are considered to be an important tourist/visitor destination (recreational fishing, diving, surfing) (Berggy, 1996; Edyvane, 1999b). **Pondalowie Bay** is a popular area for recreational activity, particularly water sports such as surfing, diving and windsurfing. Locals estimate that between 150-200,000 tourists visit **Pondalowie Bay** and adjacent **Innes National Park** each year.

There are many surfing spots in the Innes area, including **Spits, Daly Head, Salmon Hole, Rock Pools, Baby Lizards** (i.e. **Little Lizard Bay**), **Trespassers, Richards, Pondalowie, West Cape, Ethel Wreck / Ethel Beach Chinaman's, Baby Chinaman's, and Rhino Head** (DC of Yorke Peninsula, 2003). **Pondalowie Bay** and **Chinaman's Bay** are known to surfers around Australia for the "excellence of

their waves” (Fairfax Publishing – F2, 2002). **Chinaman’s, Pondalowie Bay** and **West Cape** have been described as “some of S.A.’s most challenging breaks” (DC of Yorke Peninsula, 2003).

Stenhouse Bay is used year round by surfers, and during the 1990s was reported to be a growing township. Yorke Peninsula is considered one of the State’s premier surfing destinations, with the Cutloose Rip Curl Yorke’s Surfing Classic, a “prestigious surfing event”, held at Innes National Park every year on the October long weekend (Dive South Australia, 2004).

The Yorke Peninsula Tourism Association promotes at least six coastal headland and bay walks in the **Innes** area, to promote the coastal scenic views (cliffs, beaches, dunes, salt lakes, lighthouses, ocean views, coastal flora and fauna, southern right whales, dolphins) to State, national and international visitors. **Cape Spencer and Stenhouse Bay** are promoted in tourism materials for coastal walking and seasonal whale-watching (DC of Yorke Peninsula 2003). Other areas in the Innes region that are promoted (by the Yorke Peninsula Tourist Association and the DC of Yorke Peninsula) for coastal walking include **Stenhouse Bay to Jolly’s Beach, Dolphin Beach to Royston Head** (including the **Royston Head coastal trail**), **West Cape Lighthouse, Pondalowie Bay, The Gap to Howling Cave Beach**, and **Cape Spencer**.

There are coastal camping areas within the park (e.g. **Pondalowie, Surfers Camp, Shell Beach, Cable Hut Bay**, and holiday shacks in some areas (e.g. **Stenhouse Bay** and **Pondalowie Bay**).

The wreck of the Norwegian barque **Ethel**, on a beach in the **Reef Head** area, between **Cape Spencer** and **West Cape**, is considered an important tourist attraction in the **Innes National Park**, and can be seen from the road. The skeleton of the ship’s hull remains, and is gradually being eroded/corroded by the sea (Australian Heritage Commission, undated). There is a memorial and interpretative material on the cliff top (Fairfax Publishing – F2, 2003).

There is an annual event celebrating the lobster fishing tradition of **Pondalowie Bay** (“Cray Race Day”).

Formby Bay and **Gleesons Landing** are used for camping and four-wheel driving. Other camping areas outside of Innes include **Berry Bay**, and **Swincer’s Rock** (DC Yorke Peninsula, 2003).

Althorpe Islands are visited by cruising yachts, charter boats, canoeing clubs and tall ships. Short-term holiday accommodation is available on Althorpe Island.

South-Western Investigator Strait / North-Western Kangaroo Island:

Western River Cove and **Snelling Beach** were described by Gilliland (1996) as having “high levels of recreational and tourism usage”.

Tourism materials promote the area for camping / coastal holidays, coastal walking and nature appreciation, coastal photography, swimming, boating and rock and surf fishing (see above for more information on recreational fishing).

There are tours operating that visit the northern Kangaroo Island beaches and bays, including **Western River** and **Snelling Beach**. In the **Western River Cove** area, bush-walking down the creek within the park, to the outlet and the steep surrounding cliffs is promoted as a tourist attraction for walkers and photographers, and the Osprey and White-bellied Sea Eagles in the coastal area are also listed as one of the attractions (Tourism Kangaroo Island, 2001). At nearby **Western River Cove**, the sandy beach area is promoted for swimming, rock fishing and surf fishing (see section above). Coastal walking at **Snelling Beach** is also promoted, for the scenic views of the coast and islands. Swimming, surf fishing and rock fishing are promoted at **Middle River**, near Snelling Beach (Tourism Kangaroo Island, 2001).

Cape Dutton was described by Gilliland (1996) as having “considerable recreational and tourism value”, and “identified as an area suitable for the development of nature retreats and holiday villages”.

Historic/Protected Shipwrecks

There have been at least 40 shipwrecks in the **Innes National Park** area (NPWSA, 2001a).

The following wrecks in the area described in this table, are protected under the *Commonwealth Historic Shipwrecks Act 1976*, but not all have been found to date:

- ♦ *Maldon Lewis*, wooden schooner built 1867, wrecked 1918 near **Stenhouse Bay**.
- ♦ *Willyama*, steel screw steamer built 1897, wrecked 1907 near **Rhino Head** (wreck is relatively intact, and a recognised dive site);
- ♦ *Pioneer*, wooden lugger, wrecked 1886;
- ♦ *Young St George*, built 1856, wrecked 1878 between **Althorpe** and **Haystack Island**;
- ♦ *Experiment*, wooden schooner built 1874, wrecked 1881, at **Althorpe Island**;
- ♦ *Welling*, wooden cutter wrecked 1892 at **Althorpe Island**;
- ♦ *Pareora*, steel screw steamer built 1896, wrecked 1919 at **Althorpe Island**;
- ♦ *Young St George*, wood schooner built 1856, wrecked 1878 at **Althorpe Island**;
- ♦ *Fides*, 3-masted wooden barque, built 1857, occurs at 10m on gravel seabed off **Snug Cove, NW Kangaroo Island**. Declared as Provisional Historic Shipwreck (State Heritage Branch, DEP, undated; S.A. Coast and Marine Atlas, 2001);
- ♦ *Enterprise*, iron ketch, reportedly in deeper waters of **Investigator Strait** (50+m), north of the Snug Cove - Western River Cove area.
- ♦ The *Hougomont*, 4-masted steel barque built 1879. In the 1920s, the Permasite Company purchased the *Hougomont*, and deliberately sunk it at **Stenhouse Bay** during the early 1930s, as a breakwater for the jetty (NPWSA, 2001a). The wreck has been inspected by Heritage officials, and is a recognised dive site.

The following wrecks in the area are protected under the *South Australian Historic Shipwreck Act 1981*, and have been found and inspected by Heritage officials:

- ♦ *Ferret*, a 445t iron screw steamer, built 1871, ran aground on a reef 1920 near **Ethel Beach** (NPWSA, 2001a);
- ♦ *Ethel*, iron barque, built 1876, wrecked 1904 near **Reef Head**; The *Ethel* was a 711t vessel that came aground on a sandy beach south of West Cape during a storm in 1904. The vessel remained largely undamaged. Months later it was bought at auction and an attempt was made to salvage it. However as the *Ethel* was winched into deep water, another storm blew up and the ship was beached again, this time with a broken back (NPWSA, 2001a).
- ♦ *Marion*, iron screw steamer, built 1854, wrecked 1862 near **Chinaman's Hat Island**.

Historic shipwrecks in the **SW Yorke Peninsula** area that are not protected under legislation, include:

- ♦ Another vessel named *Ethel*, wooden schooner built 1882, wrecked 1939;
- ♦ *Ariel*, wooden schooner built 1878, wrecked 1928;
- ♦ *Ismyr*, iron barque built 1868, wrecked 1879.

Historic shipwrecks in the **NW Kangaroo Island** area between **Cape Forbin** and **Cape Dutton** include:

- ♦ *Stormbird*, wooden cutter built 1924, wrecked 1943;
- ♦ *Fides*, wooden barque built 1857, wrecked 1860 near **Snug Cove**, and protected under Commonwealth legislation. A large number of relics have been recovered from the site (see Edyvane, 1999b).

The stretch of water between the Yorke Peninsula and Kangaroo Island has been designated the *Investigator Strait Maritime Heritage Trail*, which features twenty-six shipwrecks that date from 1849 to 1982 (Dive South Australia, 2004).

Other European Heritage Values

The first Europeans in the area would have been sealers who moved along the coasts of South Australia looking for seal colonies (Fairfax Publishing – F2, 2003). For example, **Pondalowie Bay** was used by sealers in the 1830s, who scraped salt from the Salt Lakes nearby for curing seal skins (SARLAC, 1998).

The following information on the history of coastal mining in the area, is mainly from NPWSA (2001a): In 1889, the Australian Gypsum and Whiting Company began mining at Marion Bay, developing the extraction, transport and loading infrastructure for mining gypsum from Marion Lake. This included the first stage of the Marion Bay jetty, a timber rail track (later steel) and eventually the use of two steam

locomotives and seventy small side-tipping trucks. The Marion Lake Geological Site is on the *State Heritage Register*, as a designated place of geological significance (DEH, 2003f). In 1913, the Permasite Company of Melbourne established several mining leases and developed gypsum mining at Inneston Lake. They named **Stenhouse Bay** and built the **Stenhouse Bay jetty**, where fourteen one-ton horse-drawn wagons ran along a wooden tramway from **Inneston Lake**. By the early 1900's a community of approximately 150 people were established at Inneston Lake. In 1927 **Inneston** was officially proclaimed a town, and around 500 people lived there during the most active period of mining (DC of Yorke Peninsula, 2003). During the late 1920s and 1930s the Marion Bay and Inneston gypsum mining operations were consolidated and owned by Waratah Gypsum Pty Ltd. Between 1905 and 1973, 6 million tons of gypsum were mined from Marion, **Inneston** and **Spider Lakes**. Until recently, commercial gypsum mining continued on several lakes excluded from the park. Today, the park features extensive evidence of mining history, including historic sites at Inneston and Stenhouse Bay. Inneston is listed on the *State Heritage Register* under the Provisions of the *Heritage Act 1993*. Part Sections 101, 125 and 131 (the "Inneston Gypsum Complex") were entered on the Register in 1986. Heritage items and relics from the park's mining history are also registered, including the Stenhouse Bay Jetty, provisionally entered in 1988 (NPWSA, 2001a). The **Inneston** Gypsum Mining complex site (comprising lake bed, cottages, stores, stables, residences, ruins of crushing plant, factory, processing areas, tramway and explosives magazine) is on the *State Heritage Register* (DEH, 2003f).

The **Stenhouse Bay jetty** was used for transporting the mining products of the region. Windjammers used to arrive to load minerals bought to the port (Fairfax Publishing – F2, 2003). The Stenhouse Bay Jetty and loading plant (including ruins of gypsum and salt storage bins, the cutting through the cliff, and the conveyor footings) are on the *State Heritage Register* (DEH, 2003f).

The numerous historic shipwrecks in the area have Heritage significance (see section above on **Historic / Protected Shipwrecks**). The wreck of the *Hougomont*, is part of a maritime heritage diving trail along south-western Yorke Peninsula.

East of the area discussed in this table is **Marion Bay**, named after the sailing ship *Marion* which was wrecked on Troubridge Shoal in 1851. Previously, Marion Bay was an important port being used as a major transportation point for the local gypsum industry (Fairfax Publishing – F2, 2003).

The lighthouse and keepers cottages (made of local limestone) on **Althorpe Island** are listed on the *Register of the National Estate*, and these structures, as well as the jetty, railway and access trolley are also listed on the *State Heritage Register*, due to their historic value. The limestone lighthouse was listed as part of the Althorpe Islands Conservation Park in 1991. The lighthouse and jetty are mentioned in this report due to their maritime significance.

Aboriginal Heritage Values

The Warri, a sub group of the Narungga, occupied land now conserved by Innes National Park (Tindale, 1974, cited by NPWSA, 2001a). **Innes National Park** (Pandalawi) has historical cultural significance for the Narungga tribe, as does most of Yorke Peninsula. The south-western end of Yorke Peninsula was an important Aboriginal fishing area. The fish, crustaceans and molluscs of Yorke Peninsula were important food sources for the Narungga, who were very skilled fishers. The Warri and Narungga made and used fishing nets, and also gathered shellfish and lobsters. The coastal environment provided an important hunting and gathering ground for the Warri and Narungga, however conflict with whalers and sealers, and early colonisation and land clearance for agriculture, resulted in the Warri and Narungga being progressively dispossessed. Some of the language and traditional stories have been recorded, but the full extent of Aboriginal heritage at Innes is largely unreported in the public domain (NPWSA, 2001a). The park contains several sites of social and cultural significance, including sites related to the Ngarna creation dreaming, after which many features of the park are named. Other stories include Bulgawan, linked to the creation of coastal formations near **Pondalowie Bay**. Some of these sites are entered on the *Register of Aboriginal Sites and Objects*, and all Aboriginal sites are protected under the *Aboriginal Heritage Act 1988* (NPWSA, 2001a).

A number of natural features on south-western Yorke Peninsula relate to Dreaming stories, such as the small "mud huts" of the Illawari (the "little people") at Marion Bay; "the bones of Badara" lying in the salt lake, and the sound of the evil spirit Wainjira breaking on the rocks at **Point Yorke**.

Brown's Beach is reported to be one of the sites along Yorke Peninsula where the Narungga set up large camps, and these camp areas were utilised for much of the year, for fishing; water collecting; food

gathering; making spears, tools and traps, and other activities (Goreta Aboriginal Corporation references, cited by the District Council of Yorke Peninsula, 2002 and 2003).

In the SW Yorke Peninsula area (e.g. **Marion Bay** and **Point Yorke** area), there is evidence of Narungga camping areas, in the form of rock drawings, and shell middens (DC of Yorke Peninsula, 2002; Fairfax Publishing – F2, 2003). **Marion Bay** is listed as an *Indicative Place* (i.e. pending future heritage assessment), on the *Register of the National Estate*, in terms of its Aboriginal heritage significance.

One of the spiritual symbols of the Narungga was called Wilthulthu, translated as the "great white shark" (DC of Yorke Peninsula, 2003).

Sites of cultural importance to the Narungga also exist at **Corny Point** and **Daly Head** (Hill and Hill, 1975), and other points along the coast.

Burials have been found at many locations on Yorke Peninsula and in particular within the sand hills that line much of the coast. Usually only the harder bones and teeth remain and become exposed by the action of the wind blowing away the covering sands. While many burials have been located in shallow graves, they have also been noted in small caves (DC of Yorke Peninsula, 2002). People were occasionally buried with some personal items such as a shell necklace or trinket while ochre is also often found and may relate to ceremonies undertaken during the funeral or decoration of the body.

To date, no Native Title Claim has been submitted for the area encompassing foot of Yorke Peninsula or north-western Kangaroo Island (according to the National Native Title Tribunal web site, 2003), however, a Narungga Native Title Management Committee has been established (NPWSA, 2001a), and in planning for any development where there has been no determination, or where there has been no clear extinguishment of native title, land managers must consider the possibility that native title may continue to exist (NPWSA, 2001a).

In the *Register of the National Estate* listing of **Western River Conservation Park**, the Australian Heritage Commission (AHC, undated) reported that the area also has indigenous values of National Estate significance. At the time the park was listed, the AHC was consulting with relevant communities about the amount of information to be placed on public record.

Scientific Research and Monitoring / Coastal and Marine Education

Research into the location of King George Whiting spawning times and locations has occurred in the areas of **southern Yorke Peninsula**; northern and **north-western Kangaroo Island** (see Fowler and McGarvey, 1997, 1999). Also, **Western River** and **De Molle River** are sites at which King George Whiting were sampled, for a study on long term changes to reproduction (Cockrum and Jones, 1992).

Rock Lobster and Abalone populations are monitored irregularly along **Southern Yorke Peninsula**.

The near-shore habitat proclaimed as a Rock Lobster Sanctuary at **Gleasons Landing** has previously been used for research into the biology, population dynamics and status of Rock Lobster stocks.

Inneston Lake is used for research into stromatolite formation, and the hyper-saline environments in which they occur (Australian Heritage Commission, undated).

The maritime history of the south-western Yorke Peninsula area has educational significance, and details of the maritime history and shipwrecks are provided in interpretative signage, as well as written materials available at Innes National Park, and as part of a dive trail for shipwreck divers.

The rocky intertidal and shallow subtidal reef platforms (e.g. **Gleasons Landing** to **Daly Head**) have been used for marine education (school biology excursions etc) (Edyvane, 1999b).

Inneston Lake provides is used for education about stromatolite formation, and the hyper-saline environments in which they occur (Australian Heritage Commission, undated).

More recently (2002), Reefwatch has recorded and monitored fish populations in the **South-Western Yorke Peninsula / Innes National Park** area (see Shepherd and Brook, 2002), and reef education classes have also been conducted by Reefwatch in the **Innes** area.

Marine biology trips for high school students are held annually in the **Innes** area, and study sites include a number of the bays and reefs between Marion Bay, **Pondalowie** and **Corny Point**.

Community programs in the area include (i) work supported by Coastcare during the late 1990s, for management and rehabilitation of the access points to **Formby Bay**, and the building of steps to the beach at **Daly Head**, undertaken by the Formby Bay Environmental Action Group (NHT project web site, 1999); and (ii) construction of drift net fencing to help stabilise sand in the coastal dunes at Formby Bay, assisted by Conservation Volunteers South Australia.

Wilderness and Aesthetic Values

Innes National Park is considered to have “spectacular coastal scenery” (Australian Heritage Commission, undated), and is described as “one of the most attractive and spectacular coastal parks in S.A.” (Yorke Peninsula Tourism Association, undated). The area has also been described by the Australian Tourism Commission (undated) in terms of its “seclusion, wilderness and spectacular scenery”. The NPWSA management plan for Innes National Park was developed to “preserve the conservation values and the feeling of remoteness experienced by visitors”. A number of coastal headland and bay wilderness walks are promoted in the Innes National Park area, for their scenic values. Examples include **Dolphin Beach** to **Royston Head**, **West Cape Lighthouse**, **Ethel Beach** (described as “particularly beautiful”, by tourism promotion material), **The Gap** to **Howling Cave Beach**, and **Cape Spencer** (where the coastal views have been described as “a major attraction” (Fairfax Publishing – F2, 2003). The beaches in **Innes** have been described as “striking”, including the “wide, sweeping expanse of **West Cape** to the beautiful protected sandy bays of **Dolphin** and **Shell Beaches**” (DC of Yorke Peninsula, 2003).

The **north-western Kangaroo Island** coastline is largely undeveloped, and generally considered to be of high wilderness value (Gilliland, 1996; Edyvane, 1999b). There is coastal wilderness protection area at **Western River**, proclaimed in 1993. Coastal sections of the park are included for their wilderness value.

Western River outlet and the surrounding cliffs are considered to be of high scenic value (Robinson, National Parks and Wildlife, pers. comm. to S.A. Department of Fisheries 1992) and the aesthetic values of the area’s river, waterfall, river mouth, and coastal cliffs, are promoted in tourism publications, which describe the area as “picturesque”. **Snelling Beach** area is also promoted in tourism materials as a visual attraction (e.g. “spectacular views”), particularly the views of the coast and islands, from Constitution Hill.

Navigation

Western Investigator Strait is heavily used as an approach for ships entering Gulf St Vincent. A number of large vessels (e.g. including large fishing boats) pass between **Althorpe Island** and the mainland (Berggy, 1996).

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

Aquaculture

There are currently no aquaculture developments on south-western, western, or north-western Kangaroo Island. The far north-western, western and south-western parts of Kangaroo Island that coincide with the boundaries of Flinders Chase National Park and the Ravine des Casoars Wilderness Protection Area, are excluded from potential aquaculture development (Gilliland, 1996). Note however that the “excluded” zoning in the description of this area in the South Australian Coast and Marine Atlas (2001), also referred to a Coastal Waters Development Plan Policy that applies in this area, to 3 nautical miles.

The shallow water area of northern Kangaroo island between Harvey’s Return and Cape Torrens is included in PIRSA’s Inner Cape Torrens Aquaculture Management Zone, which includes a section approximately 1km wide for the coast, and 4.75km long, that has been designated for a maximum of

60ha of aquaculture development, excluding intertidal oyster leases. In deeper waters, further seaward than 1km from the coast, the area between Harvey's Return and Cape Torrens was forms the western end of what PIRSA (1996) described as the Outer Cape Torrens Aquaculture Management Zone, which extends to 3 nautical miles from the coast. PIRSA designated the zone for "research and development" aquaculture operations, to a maximum of 12 hectares, with each lease comprising a maximum area of 4ha. However, the potential for aquaculture development in this zone is likely to be low, due to the deep depth of the area, 1km seaward from the coast.

On the south-western coast of Kangaroo Island, waters to 1km seaward in the area between Sanderson Bay and Hanson Bay were described as part of PIRSA's Inner Hanson Bay Aquaculture Management Zone, which was designated for a maximum of 60ha of aquaculture development, excluding intertidal oyster culture. The deeper waters, further seaward than 1km from the coast, between the eastern border of the Flinders Chase National Park and Cape Bouguer, is described as part of PIRSA's Outer Hanson Bay Aquaculture Management Zone, which extends to 3 nautical miles from the coast, and was designated for "research and development" aquaculture operations, to a maximum of 12 hectares, with each lease comprising a maximum area of 4ha. However, the potential for aquaculture development in this zone is likely to be low, due to the deep depths and exposed sea conditions which occur in the area, 1km seaward from the coast.

Commercial Fishing

Scalegfish, Sharks and Invertebrates

No information that is specific to the far north-western, western and south-western Kangaroo Island area is available for this report. However, far north-western and western Kangaroo Island form the south-eastern part of GARFIS Block 39.

Regionally, commercial fishing yields in Fishing Block 39, of which far north-western and western Kangaroo Island for part, have been dominated during the mid-late 1990s (in terms of weight landed) by:

School Shark and Gummy Shark (N.B. the fishery has recently been re-regulated by the Commonwealth, particularly in light of declining School Shark populations in south-eastern Australia (see section 9.2, and references by AFMA in bibliography); and

Ocean Leatherjacket. No recent figures specific to the north-western and western Kangaroo Island area are available for this report, however a State-wide overview is provided in section 9.2.

Purse seine fishing for *West Australian Salmon* is also one of the main scalegfish fisheries along northern Kangaroo Island, and occurs from **Cape Borda** to North Cape (Jones SARDI pers. comm., cited by Edyvane, 1999b).

According to commercial catch data from the mid-late 1990s, *King George Whiting*, as well as *Redfish* (Red "Snapper"), *Blue Morwong* and *Blue Groper* are also caught commercially in the fishing area that includes far north-western and western Kangaroo Island, in addition to a number of other reef fish species, the latter mainly in minor quantities. (Note that fishing for Blue Groper within Investigator Strait is prohibited under the *Fisheries Act 1982*). *Bronze whaler* sharks are also caught in the area.

Long-lining for *Snapper* occurs along the coast of northern Kangaroo island (G.K. Jones, SARDI, pers. comm., 1996, cited by Edyvane, 1999b). Fowler et al. (2003) provided catch and effort statistics for snapper fishing in the Kangaroo Island region.

Previously, during 1995-1997, the catch from GARFIS Block 39 (bottom of Spencer Gulf 35° S, southwards to lower western Kangaroo Island 36° S latitude, and spanning between 136° E and 137° E, including all waters in between, with the exclusion of north-western Investigator Strait and the western foot of Yorke Peninsula) was as follows (SARDI data, cited by Edyvane, 1999b):

- ♦ 1995/96: a total of 66,188kg (0.64% of State total, representing 21 fishers);
- ♦ 1996/97: a total of 86,753kg (0.86% of State total, representing 31 fishers).

Note that this figure encompasses a large area between the southern mouth of Spencer Gulf and western Kangaroo Island, and is therefore unlikely to adequately reflect the scalegfish and shark fishing yields from far north-western and western Kangaroo Island. On a State-wide scale, aggregated catch figures for all GARFIS Fishing Blocks in South Australia, between 1995 and 1996, showed that Spencer

Gulf mouth to western Kangaroo Island, including islands (i.e. GARFIS Block 39) was 28th in the ranked list of fishing yields from 58 South Australian fishing blocks, at that time. However, in some recent years, Fishing Block 39 has been amongst the top 10 fishing blocks in the State, in terms of yields of School Shark and Gummy Shark.

Information that is specific to the south-western coast of Kangaroo Island is not available for this report. The south-western part of area described in this table (from approximately southern **Maupertuis Bay to Cape Bouguer**) is included in the north-eastern part of GARFIS Fishing Block 48, which also extends westwards of the area described here, to 136°E, and southwards to 37°S, in deeper Commonwealth waters. The fishing block thus covers a much larger area (i.e. a degree block) than the southern Kangaroo Island coastal area (to the S.A. waters 5.5km limit), discussed in this table.

In recent years (i.e. mid-late 1990s), State-recorded fisheries yields in Fishing Block 48 were dominated by the following:

- ♦ *School Shark and Gummy Shark*, as well as *Bronze Whaler, Dog Sharks*, and other shark species);
- ♦ *Blue Morwong*;
- ♦ *Ocean Leatherjacket* (caught in State and Commonwealth waters);
- ♦ *Blue-eye Trevalla* (mainly in deeper Commonwealth-managed waters).

Also, a purse seine fishery for *West Australian Salmon* occurs in waters off the south-west coast of Kangaroo Island.

Recent catch statistics are not available for this report. Previously, according to SARDI (cited by Edyvane, 1999b), the catch from GARFIS Block 48 (which includes waters south of Maupertuis Bay = 36° S, southwards into Commonwealth waters, to 37° S latitude, and spanning between 136° E and 137° E, and all waters in between) was as follows, between 1995 and 1997:

- ♦ In 1995/96 a total of 56,668kg (0.54% of State total);
- ♦ In 1996/97 a total of 85,865kg (0.84% of State total).

The proportion of this yield that is specific to south-western Kangaroo Island is not known for this report. The number of scalefish and shark fishers who have fished in Block 48 in recent years, is not known for this report, however during 1995 to 1997, 42 to 44 fishers operated in GARFIS Blocks 48 and 49 combined (which spans most of the southern coast of Kangaroo Island, and deeper Commonwealth-managed waters to 37° S). On a Statewide scale, aggregated catch figures for all GARFIS Fishing Blocks in South Australia, between 1995 and 1996, show that south-western Kangaroo Island area, GARFIS Block 48, extending into deeper Commonwealth waters to 37° S, was 31st in the ranked list of fishing yields from 58 South Australian fishing blocks during that time. However, in recent some years, Fishing Block 48 has been amongst the top 10 fishing blocks in the State, in terms of School Shark and Gummy Shark yields.

Major species in the Commonwealth-managed Gillnet (formerly called Southern Shark) fishery, that operates in deeper southern, western and (to a lesser extent) the north-western waters off Kangaroo Island, include Gummy Shark, School Shark, Hapuku, Blue-eye Trevalla (N.B. a proportion of the yield of Blue-eye Trevalla from southern Kangaroo Island is taken as part of the South Australian Scalefish Fishery - see Knight and Tsolos, 1999; AFMA, 1999), Elephant "Shark", Pink Ling, Saw Sharks, Whiskery Shark, and Warehou species (e.g. Blue Warehou) (AFMA, 1999, 2000a, 2000b; Bureau of Rural Sciences, 1999a, 1999b, 1999c; Larcombe *et al.*, 2002). Regional catch data for South Australia show that the deeper waters south of the south-western coast of Kangaroo Island are a major fishing area in South Australia for School Shark and Gummy Shark (i.e. one of the top 10 regions in the State, in recent years). Larcombe *et al.* (2002) reported that the gillnet fishery operates in relatively shallow continental shelf waters, and that the bulk of the fishing in south-eastern Australia is concentrated in Bass Strait and waters off Kangaroo Island (see Map 17 in Larcombe *et al.*, 2002). Barratt *et al.* (2001, Figure GN1) mapped fishing intensity of the Commonwealth gillnet fishery across southern Australia, on a scale of "very low" to "very high", and fishing intensity within the waters of the Eyre Bioregion, was rated "moderate" in the south-western Kangaroo island area, and "low" in the mid-south Kangaroo Island area, on this nominal scale. School and Gummy Shark catches have recently been re-regulated by the Commonwealth, and are subject to annual quota, as well as various input controls (see AFMA, 2003).

The deeper (Commonwealth-managed) waters of southern Kangaroo Island also form a small part of the Southern Squid Jig Fishery, which encompasses a large area from southern Queensland to the SA / WA border. The main species taken is Arrow Squid, and the fishery is concentrated in south-eastern Australian waters (e.g. Victoria and western Bass Strait) (Lilly, 2001). The current yields from the deeper

Commonwealth waters off the southern Kangaroo Island coast are not available for this report.

Rock Lobster Fishing

No information specific to the north-western and western Kangaroo Island is available for this report.

The area discussed here is part of Fishing Block 39, which includes Gambier Isles, Neptune Islands, southern part of Thistle Island, western and north-western Kangaroo Island, and all waters in between. Fishing Block 39 is one of the two fishing blocks in the Northern Zone in which catch has consistently been higher than that from other Northern Zone fishing blocks, in almost all years since 1970 (see Ward *et al.*, 2002, Figure 2.5). Catches have been higher than around 120t per annum in Fishing Block 39, in at least 25 of the years since 1970, up till the late 1990s, and corresponding effort has been higher than 100,000 potlifts per annum in almost all of those years. Catch peaked at over 200t per annum in three years (1987, 1991, 1999). During the late 2000 and 2001, both catch and effort decreased – approximate catch in 2001 was around 85 tonnes in Fishing Block 39, for an effort level of almost 100,000 potlifts (according to Figure 2.5 in Ward *et al.*, 2002). Note that these figures encompass a large area between southern Spencer Gulf and south-western Kangaroo Island, and therefore do not reflect the Rock Lobster fishing yields specifically from the north-western and western Kangaroo Island area. An indication of the significance of the catch from Fishing Block 39, relative to other fishing blocks in South Australia, was provided by Edyvane (1999b, citing SARDI data): In 1995/96 and 1996/97, the total catch of 108,867kg and 136,826kg respectively, comprised around 2.1% to 2.76% of State total, representing the catch of between 47 and 51 fishers. Aggregated catch figures for all fishing blocks in South Australia, between 1995 and 1997, showed that Fishing Block 39 was the 8th most important commercial lobster fishing area in South Australia at that time, in terms of yield. Note that this figure encompasses a large area south of the mouth of Spencer Gulf, all island areas south of the mouth, as far south as Maupertuis Bay on lower western Kangaroo Island, and is therefore unlikely to adequately reflect the Rock Lobster fishing yields specific to north-western and western Kangaroo Island, which are not known for this report.

No information specific to south-western Kangaroo Island is available for this report. The south-western part of the area discussed here is included in Fishing Block 48, which is one of the 8 main fishing blocks in the Northern Zone fishery, in terms of yield (see Ward *et al.*, 2002, Figure 2.5). Catches from Fishing Block 48 have been more than 50t per annum in each of around 15 years since 1980, and catches of more than 100t per annum were recorded in 1990, 1991, and 1992 (see Ward *et al.* 2002, Figure 2.5). Effort level has been estimated at more than around 40,000 pot lifts per annum in most years since 1980, to 2001 (Ward *et al.* 2002, Figure 2.5). The catch in 2001 was approximately between 50t, from around 45,000 pot lifts (see Ward *et al.*, 2002, Figure 2.5). An indication of the significance of the catch from fishing Block 39, relative to other fishing blocks in South Australia, was provided by Edyvane (1999b, citing SARDI data): between 1995 and 1997, combined catch figures for Fishing Block 48 and Fishing Block 49 (which spans the remainder of southern Kangaroo Island, eastwards of the area discussed here, and includes all waters southwards to 37° S), were 128,941kg in 1995/96 and 118,486kg in 1996/97, which represented the fishing area of between 37 and 35 fishers over that period, and accounted for approximately 2.3 - 2.5% of the state catch of Rock Lobster. Aggregated catch figures for all fishing blocks in South Australia, between 1995 and 1997, showed that Fishing Blocks 48 (of which south-western Kangaroo Island forms one part) and 49 together constituted the 6th most important commercial lobster fishing area in South Australia, in terms of yield (and hence value) at that time. The proportion of that yield that relates specifically to the coastal waters of south-western Kangaroo Island is not known for this report.

When the entire Northern Zone is considered as a whole (i.e. from the Western Australian border, through to Encounter Bay and deeper waters south of Kangaroo Island), the catch for the 2002 season was 594.8 tonnes, being the lowest catch in the Northern Zone since 1979 (Ward *et al.*, 2003).

Bycatch information specific to the northern, north-western and south-western Kangaroo Island area is not available. According to the results of a sampling program of bycatch in 1991 and 1992, various wrasse species (Labridae family) together constituted another major component of the bycatch in the Northern Zone e.g. 1127 Labrids caught in pots during the bycatch sampling program in 1991-92 (Table 5 in Prescott, 2001). Octopus are a major predator of Rock Lobster, with losses due to octopus predation equating to approximately 4% of the total number of lobsters landed (in the Northern Zone). According to McGarvey *et al.* (1998), the catches and catch rates of octopus have been sustained over time, and vary from 1 – 2.5 octopuses per 100 potlifts. Octopus that are caught in the northern zone are sold.

Rock Lobster fishers are also permitted to retain legal sized Giant Crab when caught as by-product, and this species is becoming increasingly valuable, commercially (McGarvey *et al.*, 1998). A small number of Commonwealth-endorsed Rock Lobster fishers also target Giant Crab specifically. Between 1992/93 and 2001/02, total Giant Crab catches (target and byproduct catches combined) have ranged between 7t in 1992/93 and 33t in 1998/99, with a steady decline between 1999 and 2002 due to the introduction of quotas (e.g. 31t in 1999/00; 24t in 2000/01, and 18.5t in 2001/02) (Knight *et al.*, 2003, cited by Sloan, 2003b). The fishery now operates under a quota-based management system with a total allowable commercial catch (TACC) of 13.4 and 8.7 tonnes for the Northern Zone and Southern Zone, respectively (Sloan, 2003b). Giant Crabs are caught from the edge of the continental shelf in the west coast region (McGarvey *et al.*, 1998).

Some Rock Lobster fishers net sharks out of season, and some of these activities require a Commonwealth permit. Licensed Rock Lobster fishers have also had access to fish species, such as West Australian Salmon, Mulloway, and Snapper (Zacharin, 1997, cited by McGarvey *et al.*, 1998).

Predators of Rock Lobster in the Northern zone include New Zealand Fur Seals, Western Blue Groper (minor) and Maori Octopus (McGarvey *et al.* 1998; S. Shepherd, pers. comm., 2004).

Abalone Fishing

Aggregated figures are provided for the period between 1990 and 1996 for parts of the area described in this table (S. Shepherd pers. comm., 2000):

North-east kangaroo Island (from the Dudley Peninsula westwards, as far as Cape Borda, which includes most of northern Kangaroo Island): Recorded annual yield of Greenlip Abalone fluctuated between 0kg and 4.25t whole weight. Yield of Blacklip Abalone fluctuated between 0kg and 1.1t. Note that the proportion of these yields that pertains to the Cape Borda and Harvey's Return areas (far north-western Kangaroo Island) is not known for this assessment;

West Bay to Cape du Couedic: Recorded annual yield of Greenlip Abalone fluctuated between 250kg and an uncharacteristic peak of 13.7t. Note the Greenlip Abalone yields in 16 of the 18 years between 1979 and 1996 were less than 4t. Yield of blacklip fluctuated between 5.4t and 15.4t whole weight;

Hanson Bay area, between Cape du Couedic and approximately Stun'sail Boom River : Recorded annual yield of Greenlip Abalone in the specified area fluctuated between 0kg and 4.4t, although yields in 6 of the 7 years between 1990 and 1996 were around 2t or less. Yield of Blacklip Abalone fluctuated between approximately 0kg and 9.6t, although yields were highly variable between the late 1980s and the mid 1990s, ranging between 0kg and around 18.3t. Note that Shepherd and Rodda (2001) recorded a long term increase (between 1979 and 1998) in the yields of Greenlip Abalone from the Hanson Bay area (Map Code 27A), reporting an 87% increase in yield over that period.

More recent catch figures are not available for this report, however Mayfield *et al.* (2001) reported that (i) there has not been any significant increase in fishing effort during the past decade (to 2000) in the abalone fishing areas of western and northern Kangaroo Island (i.e. 32A, 26A and 26B); (ii) average catch rates along the south-western coast of Kangaroo Island have been in the order of 60kg – 80kg per hour, during the past 5 years to 2000, and yields along the north-western Kangaroo Island coast during that period have been, on average, 40kg – 60kg per hour; and (iii) along the west coast of Kangaroo Island (fishing blocks 26A and 26B), fishing effort exceeded an average of 30 trips per year during 1988 – 1992, but not during 1996-2000 (Mayfield *et al.*, 2001).

Recreational Fishing

The far **north-west coast** of Kangaroo Island generally provides exposed conditions that are not conducive to the use of small fishing boats, and recreational fishing depends upon tidal influences and season.

The entire **northern coast of Kangaroo Island** is promoted for fishing Snapper and large King George Whiting (up to 1.5kg and heavier). Trolling for Snook is also described as popular around the coast (Kangaroo Island Tourism, 2003).

Inshore catches along the **north-western coast** generally include large King George Whiting, Sweep, Silver Drummer, large Trevally, Snook, flathead species, and Australian Salmon. Further offshore, mixed reef fish, Redfish (red Snapper), small “rigger” Snapper and sharks are commonly caught by those who can access the reefs in the area (Sweeney, 1996).

According to tourism promotion materials and recreational fishing records, charter boats target larger (older) King George Whiting on northern Kangaroo Island, but the westward extent of such operations is not known for this report. North-western Kangaroo Island is promoted as a location at which large whiting can be caught by recreational line fishers (see point above).

A number of charter boats visit northern and **north-western Kangaroo Island**, for fishing Snapper, whiting and reef fish species.

Sweep and Swallowtail are caught from parts of the North-Western Kangaroo Island coast where coastal rock outcrops meet deep water. Rock lobster are caught recreationally, in some cases using a line with bait and a dab net (Tourism Kangaroo Island, 2001).

There are few recognised recreational fishing spots offshore from the far north-western coast of Kangaroo Island, due to the exposed conditions, however ledges around 15km offshore from **Harvey’s Return** have geographical coordinates recorded for recreational fishing.

Recreational fishing (by locals and tourists) occurs in the **Hanson Bay** area, and there is a boat ramp located on the beach. The **South West River** enters the bay, and black bream and mullet are fished from the estuary. There are surf fishing beaches near the estuary, where species such as Australian Salmon are caught. The beaches near the mouth of the **South West River** have been promoted as “two of the best fishing spots on Kangaroo Island”, particularly for catching large salmon.

There are beach fishing and rock fishing locations in **Flinders Chase National Park**, particularly the locations where rivers enter the sea. The beaches in such areas are promoted for surf fishing due to their steep pitching shores, and deep holes and gutters close to shore. Salmon and mullet are the prime target species (Kangaroo Island Visitor Guide, 2003)

Recreational surf fishing occurs at **Maupertuis Bay**, although the area is relatively inaccessible. Apart from bay fishing, comparatively little recreational fishing activity along the **western** and **south-west coast** occurs due to dangerous sea conditions (strong winds and gales, high swells, surge, waves and rips). Boats that can access the deeper waters of the south-west coast catch Yellow-tail Kingfish, Southern Bluefin Tuna, and Western Blue Groper (Sweeney, 1996). Recreational fishers troll for Snook around most of the Kangaroo Island coastline (Tour Kangaroo Island web site, Hypernet, 1999).

A summary of fishing activities along the **west coast of Kangaroo Island** includes line fishing, lobster potting, and dive fishing (for lobster and abalone) (Bryars, 2003).

Diving and Snorkelling

Kangaroo Island has been described as providing “some of the best temperate-water diving in Australia” (Kangaroo Island Visitor Guide 2003).

There are diving trips in charter boats and tall ships, to **northern** and **north-western Kangaroo Island** sites, which are popular with international dive tourists and marine photographers. Examples are described for **Location 11: Western Investigator Strait, including “Toe” of Yorke Peninsula and Northern Kangaroo Island**, as most of the sites are east of the Cape Torrens area.

Kangaroo Island tourism materials promote the beach at the mouth of the **South West River** for snorkelling and diving.

The *Kangaroo Island Maritime Heritage Trail* brochure (State Heritage Branch, DEH, 1996) describes the wreck of the **Portland Maru** on north-western Kangaroo Island, at 15m depth off **Cape Torrens**, as “one of the best recreational dives in S.A.”, based upon its historic remains (engine and boilers of the vessels still stand, over 6 metres in height), and the “wide variety of fish, macroalgae, crustaceans, sponges and other marine life” that occur at the site. The *Portland Maru* site is

described as being “alive with marine life”, and having “spectacular visual impact”. Previously, Christopher’s (1988) *Divers Guide to South Australia* also listed the wrecks of the *Loch Vennachar* and *Portland Maru* amongst the best dive sites on Kangaroo Island. The *Portland Maru* was also listed by DIASA’s (undated) guide to the best dive sites in S.A. The *Montebello* is considered to be a “spectacular” dive site, but is relatively inaccessible due to dangerous sea conditions (strong Southern Ocean swell etc). Dive tours of the *Portland Maru* wreck site have been undertaken (Christopher, 1988). A number of dive sites on the north-west coast exist, including the Cape Torrens area, where commercial dive tours operate. Most sites on western and south-western Kangaroo Island are relatively inaccessible due to dangerous sea conditions and lack of road access.

Other Marine and Coastal Recreation / Tourism

The small residential and tourist settlement of **Hanson Bay**, adjacent to the western border of the Cape Bouguer Wilderness Protection area, is considered to have “high levels” of recreational use around the beach area near the settlement, according to Gilliland (1996). The settlement at Hanson Bay contains both local residents and tourists, and Gilliland (1996) stated that development in the area may impact upon the recreational value. The Hanson Bay area is also used for swimming and canoeing (DELM Land Information Division map, 1992), and the colony of fairy penguins is promoted as a tourist attraction.

There are various walking and 4WD tours operating along south-western Kangaroo Island, which include the coastal attractions of **Flinders Chase**, and **Hanson Bay**.

Kangaroo Island tourism materials promote the beach at **South West River** mouth, for swimming.

Kelly Hill Conservation Park (e.g. Remarkable Rocks, and other locations) and **Flinders Chase National Park** have significant tourism values. The main tourism activity in the area that has a marine association is viewing of fur seals and coastal scenery at **Cape du Couedic** (where a boardwalk and viewing platform have been built). The “spectacular and rugged” coastline (Australian Heritage Commission, undated) of the Kelly Hill Conservation Park is popular for coastal walking / scenic viewing, photography etc.

Ecotour companies operate in the western and south-western area of Kangaroo Island, visiting the caves at **Ravine des Casoars**; the coast at **West Bay**; the mouth of the **Breakneck River**; **Kelly Hill Conservation Park** (including the coastal area), **Admirals Arch (Cape du Couedic)**, amongst other coastal locations. Coastal tours are also run to **Northern Kangaroo Island** locations. The cliff tops, rivers and river mouths, and beaches, on northern, western and southern Kangaroo Island, are all popular for wilderness tours / eco-tours.

There are yacht cruises to northern and **north-western Kangaroo Island** locations, for fishing, swimming, beachcombing, viewing Sea Lions and dolphins and sea birds. Apart from fishing and diving (see other sections of this table), **Western River Cove** is promoted as a swimming spot. Collecting shells and beach flotsam and jetsam is another recreational activity (promoted in some tour guides of Kangaroo Island).

The **Cape Borda Lighthouse** is promoted to tourists for its historical value, and daily tours are run of the lighthouse and accompanying maritime museum (NPWSA, 2001b; Travel Downunder, 2003).

Sections of the north-west and south-west coast are also used for shorter coastal walks / hikes (e.g. there are recognised coastal walking / hiking trails at **Sandy Creek**, **Breakneck River**, **Cape du Couedic**, **Admiral’s Arch**, **Weir’s Cove**, **Ravine des Casoars**; and **Harvey’s Return**, which are popular with tourists, as well as a Lighthouse Heritage Walk (Cape du Couedic). The 4km **Ravine des Casoars** (“Valley of the Cassowaries”) track traverses the cliffs and river bed, to the small sandy beach where the river meets the sea. The fairy penguins in the coastal caves at the base of the valley are also a tourist attraction, as is the beach near the caves. The high cliffs and long coastal views of the **Harvey’s Return** to **Cape Forbin** area, are well recognised for their visual appeal to visitors. There is a lookout at **Scott’s Cove**, for scenic viewing, photography etc. (Tourism Kangaroo Island, 2001; Travel Downunder, 2003).

A coastal trekking trail (with camping sites along the way) spans from **Cape du Couedic** in the south, to **Harvey’s Return** on the north-west coast, and includes **Rocky River**, **Maupertuis Bay**, **West Bay**,

Breakneck River, Ravine des Casoars and Cape Borda (NPWSA, undated b). **Maupertuis Bay** is used for swimming and beach walking.

Coastal camping areas include **West Bay, Harvey's Return**, and other locations within and adjacent to **Flinders Chase National Park**.

Aboriginal Heritage Values

There are known Aboriginal archaeological sites along the north-west, western and south-western coast of Kangaroo Island (Robinson and Armstrong, 1992).

The **Cape du Couedic** area is on the *Register of the National Estate* due to its Aboriginal Heritage significance (Australian Heritage Commission, undated). The Cape du Couedic sites included winter sheltering/camping areas for Aborigines who inhabited the area between approximately 7270BP and 5810BP, and well over 1000 "Kartan" artefacts (mostly quartz and quartzite hammer-stones, anvils, choppers, cutters and scrapers) have been found at some sites in the area. Tools were fashioned from coastal rocks and pebbles along the south coast, and Cape du Couedic is considered to have been a site of production and "export" of tools. Aborigines in the Cape du Couedic area also made use of the local coastal fauna (shellfish and sea lions) as food items, remains of which have been recorded at middens in the south-west coast area (Robinson and Armstrong, 1992).

There are no current registered Aboriginal land title claims recorded for the area described here (far north-western, western, and south-western Kangaroo Island (South Australian Coastal and Marine Atlas, 2003, and National Native Title Tribunal web site, 2003).

Historic and Protected Shipwrecks

The following wrecks in the area are protected under the *Commonwealth Historic Shipwrecks Act 1976*:

- ♦ *Portland Maru*, steel, screw steamer built 1919, wrecked west of **Cape Torrens** in 1935. The vessel has been inspected, and is a dive site;
- ♦ *Mermaid*, wooden cutter built 1897, wrecked around 1905;
- ♦ *Atalanta*, cutter wrecked 1860 between **Cape Borda** and **Vennachar Point**;
- ♦ *Loch Vennachar*, 3-masted iron ship built 1875, wrecked 1905 (with the loss of all on board) when it sailed into cliffs 1km north of **West Bay**. The remains are considered to be of marine archaeological value (State Heritage Branch, DEP, undated);
- ♦ *Loch Sloy*, iron barque, built ca. 1877, wrecked 1899 in **Maupertuis Bay**;
- ♦ *Emily Smith*, wood brigantine, built 1849, wrecked 1877 in **Maupertuis Bay**;
- ♦ *Vera*, cutter, wrecked 1915 near **Cape du Couedic**.

A number of other wrecks, some of which are historic but not protected, exist along the west and south-west coasts of Kangaroo Island. Examples include: *Mars* (wood barque, built 1877, wrecked 1885 near northern **Maupertuis Bay**); *Winnie* (wooden cutter, built 1900, wrecked 1942 in **West Bay**); *Jeannette S.* (wooden lugger built 1913, wrecked 1966); and *Amber Star* (cutter built 1916, wrecked 1973).

Within the region, the *Portland Maru*, *Vale*, *Atalanta*, *Loch Vennachar*, *Mars*, *Loch Sloy* and *Emily Smith* are part of the Kangaroo Island Maritime Heritage Trail (State Heritage Branch, 1996). The Heritage Trail was designed as an information source; to promote conservation of the shipwrecks; and to encourage responsible diving activity at accessible shipwreck sites. The wrecks include historic international trading vessels, early passenger steamers, and other historic vessel types. Most of the vessels lie in fairly shallow waters (3 - 20m), and in many cases, parts of the ships and associated artefacts still remain *in situ*.

Other European Heritage Values

European heritage items in the area that have a maritime association include the lighthouses and keepers quarters at both **Cape Borda** and **Cape du Couedic**, which are on the *Register of the National Estate*

and the *State Heritage Register* (DEH, 2003f), due to their historic value. There is a maritime museum at **Cape Borda**. The site of the **Loch Vennachar** wreck (near **West Bay**) is also on the *Register of the National Estate* as a Historic Reserve. The Ravine des Casoars Wilderness Protection Area protects a number of coastal heritage features including **Harvey's Return** and the grave of the unknown sailor (Gilliland, 1996).

The **Cape Borda** lighthouse dates from 1858, and is third oldest lighthouse in South Australia, and the only square stone lighthouse in the State. The lighthouse was manually operated until 1989. In the mid to late 1800's the cannon near the lighthouse was used to signal ships of impending danger, prior to the advent of radio communication. Following restoration in 1999, the cannon is now fired daily during lighthouse tours. Nearby is the old landing site at **Harvey's Return** for the light station stores, which used to be winched up the steep track with the aid of a crane and horses. Remains of this machinery can be found in the area, and the crane pedestal is still located on top of a rock in the cove. Also in the area is an historic cemetery of the Cape Borda lightkeepers (Tourism Kangaroo Island, 2001; Kangaroo Island Visitor Guide, 2003; Travel Downunder, 2003).

The small cove below the camp ground at **Harvey's Return** was first used as a landing site by seal hunters in the early 1800's. This landing site is on the *State Heritage Register* (DEH, 2003f). To the west, **Ravine des Casoars** ("Valley of the Cassowaries") was named by French explorer Nicolas Baudin in 1802, after the Kangaroo island Dwarf Emu, which is now extinct, presumably by the early sealers or whalers hunting the bird for its meat. Harvey's Return (Tourism Kangaroo Island, 2001).

Cape du Couedic lighthouse started operation in 1909. The lighthouse, storeroom and cottages were made from limestone that was quarried from the local cliffs. The remains of a jetty, water tank and storeroom can be seen at **Weir's Cove**, from where building materials and other supplies were hauled by flying fox to the top of the cliffs. The Weir's Cove Jetty, funnelway and store ruins are on the *State Heritage Register* (DEH, 2003g).

Wilderness and/or Aesthetic Values

In 1993, the **Cape Torrens** Conservation Park was proclaimed a **Wilderness Protection Area** due to its undisturbed nature and biological integrity.

De Mole River outlet and the surrounding cliffs have been described as being of "high scenic value", and are considered to be "significantly different" from river outlets on the western and southern coasts of Kangaroo Island (Robinson, National Parks and Wildlife, pers. comm. to South Australian Department of Fisheries, 1992).

The scenic coastal cliffs of the **Cape Torrens** and **Cape Forbin** area are listed as significant features in the *Register of the National Estate* classification of the Cape Torrens area. The cliffs are as high as 263m in some areas, being some of the highest coastal cliffs in S.A. and are described by the Australian Heritage Commission (undated) as a "spectacular coastline". Tourism materials (e.g. Tourism Kangaroo Island, 2001, and others) also promote the scenic aspects of the north-western Kangaroo coastline as a "magnificent vantage point", including the "spectacular" high cliffs, undeveloped "wild" coastline, and the deserted beaches. The **Ravine des Casoars** area is also considered to have high aesthetic value, for its panoramic views of the north-west coast cliffs, the river mouth, and other features.

The coastal section of the **Ravine Des Casoars Wilderness Protection Area** spans from **West Bay** on the western coast, to near **Harvey's Return** on the north-west coast. This area was proclaimed to be wilderness due to the value of its native vegetation, however it also contains coastal features of wilderness and aesthetic value, such as the high cliffs in the area of **Cape Borda**, **Harvey's Return** and **Cape Torrens**. Additionally the park protects coastal habitat for a number of species of conservation concern, including Australian Sea Lions, New Zealand Fur Seals, Australian Fur Seals, White-Bellied Sea Eagles, Little Penguins and Fairy Terns.

The Ravine Des Casoars Wilderness Protection Area forms part of the **Flinders Chase National Park**. According to Gilliland (1996), Flinders Chase is considered one of the most important parks in South Australia because of the wide range of flora, fauna, coastal landforms and historical sites it protects. A number of significant sites of natural heritage are also located in the park including **Remarkable Rocks** and **Admirals Arch** (both well known for their aesthetic value, which is a tourism attraction).

The coastline of the **Kelly Hill Conservation Park** is described as “spectacular and rugged” (AHC, undated) and its wilderness and aesthetic values were some of the key features that resulted in its listing on the *Register of the National Estate*. In 1993 sections of the park were proclaimed as the **Cape Bouguer Wilderness Protection Area**. The proclamation as wilderness was based on the undisturbed and representative nature of the area, and the presence of significant breeding and haul-out sites for Fur Seals and Sea Lions, amongst other wilderness criteria.

Southern Kangaroo Island has been described as potentially “one of the prime wilderness areas on the South Australian coast”, based upon its combination of marine and terrestrial features (Robinson, National Parks and Wildlife Service, pers. comm. to South Australian Department of Fisheries, 1992).

Gilliland (1996) described the **Hanson Bay** area as having “scenic amenity”, and that development may impact upon that value.

Scientific Research and Monitoring

New Zealand Fur Seal and Australian Sea Lion populations are monitored on the **south-west coast of Kangaroo Island**, by National Parks and Wildlife S.A., and by CSIRO. CSIRO conducted a survey in the area in 2001, during which population numbers and pup production were recorded, and the expansion of some colonies was noted (e.g. see Shaughnessy 2001a, 2001b; 2002).

The Sea Mammal Ecology Group at La Trobe University completed in 2003 a long-term study of entangled fur seals and sea lions, including those in **southern Kangaroo Island** waters (see Anon., 2003a).

Geological monuments such as **Harvey's Return** are considered to have value for geological research (unreferenced, in Edyvane, 1999b).

Marine and Coastal Education

The biota of the dive sites on northern Kangaroo Island (particularly the leafy seadragons) have featured in a number of national and international documentaries and magazine articles.

There are educational tours in the area, that discuss Kangaroo Island's maritime history, shipwrecks, and lighthouses. Educational tours of the **Cape Borda Lighthouse** and **Maritime Museum** are conducted daily (Kangaroo Island Visitor Guide, 2003).

Geological monuments such as **Harvey's Return**, **West Bay**, and **Cape du Couedic** are considered to have value for teaching. Seal colonies that have public access such as that at **Cape du Couedic**, also have education value.

Settlements

There is a small coastal settlement at **Hanson Bay**, with seasonal increases in the small population, due to tourism.

Other Uses

Navigation (i.e. shipping and boating traffic) was considered by Gilliland (1996) to be one of the prime existing uses of the deeper waters of north-western (e.g. **Cape Torrens** area) and south-western Kangaroo Island (e.g. **Hanson Bay**).

9.1.14 Southern Eyre (Eyre Bioregion)

Aquaculture

The southern tip of Eyre Peninsula, and the associated bays and offshore islands (i.e. the Cape Carnot Policy Area and Avoid Bay Policy Area), are excluded from aquaculture development (PISA Fisheries - Aquaculture Group, 1997).

Further north, **Coffin Bay** is a significant area for oyster production. Most operations produce Pacific Oysters (*Crassostrea gigas*), but there has been some limited interest in farming native flat oysters (*Ostrea angasi*) (PISA Fisheries – Aquaculture Group, 1997), the latter of which were an historically significant fishery species (mid 1800s). The farming of oysters commenced in **Coffin Bay** in 1969, and a substantial industry for Pacific Oyster farming has developed in Coffin Bay since the late 1980s, following the release of a report on the potential of the area for oyster culture (Grove-Jones, 1986), and the Coffin Bay Waterways Land Tenure Management Plan. By the mid-1990s, following a review of the forementioned Coffin Bay Plan, there were 108ha of area allocated to oyster farming, mainly in Kellidie Bay and Mount Dutton Bay (PISA Fisheries - Aquaculture Group, 1997).

The Lower Eyre Peninsula Aquaculture Management Plan was released in 1997, containing a number of policy areas and management zones, as specified below. In 2003, an Aquaculture Policy document was produced for Lower Eyre Peninsula, but it did not contain any revised zoning for the Coffin Bay area, hence the zones from the previous management plan (PISA Fisheries – Aquaculture Group, 1997) are discussed here.

In **outer Coffin Bay** is the Farm Beach Policy Area, which contains the following zones:

- ♦ *Frenchman Aquaculture Zone*: defined as the waters bounded by the following points; 532320E and 6189520N; 533640E and 6189055N; 534316E and 6188050N; 534480E and 6186130N; 532320E and 6186130N. The zone has a northern boundary of Point Sir Isaac to Frenchman Bluff. Within the zone there was a stated provision for 80ha of aquaculture, excluding intertidal shellfish culture and subtidal finfish cages;
- ♦ the *Coffin Bay Peninsula Zone*: defined as the waters bounded by the following points; 521040E and 6188820N; 526680E and 6182610N; 521240E and 6182610N. Within the zone there was a stated provision for 80ha of culture, excluding intertidal shellfish and subtidal finfish).

South of **Point Longnose**, the waters of **Port Douglas** (as far south as **The Brothers**) have been included in the Port Douglas Policy Area (PISA Fisheries – Aquaculture Group, 1997). Within the Policy Area, the *Port Douglas Zone* includes the waters from mean spring high water mark adjacent to Horse Peninsula, the Coffin Bay National Park, the mouth of Port Douglas and Little Douglas. No aquaculture is permitted within the Port Douglas Zone (PISA Fisheries – Aquaculture Group, 1997). The remainder of the Port Douglas Policy Area was designated mainly for relocation of oysters from existing leases (for fattening / grow-out), and the policy area contains the following zones:

- ♦ *Horse Peninsula Aquaculture Zone*: defined as the waters bounded by the following points; 533000E and 6175100N; 533400E and 6176700N; 534750E and 6177600N; 535600E and 6176050N; 535600E and 6174400N. In 1997, there was provision for leases to be relocated from Dutton Bay Policy Area and/or Kellidie Bay Policy Area, up to a maximum of 15 hectares. As part of the provision, registration of interest for future commercial expansion could be submitted as part of an application in this Zone. (N.B. As indicated below, *Horse Peninsula Aquaculture Zone* has increased in lease number and hectarage since 1997, following the results of R and D trials);
- ♦ *Point Longnose Management Zone*: defined as all waters enclosed by the following points; 529400E and 6178500N; 529400E and 6177500N; 531400E and 6177940N; 531400E and 6178500N. In 1997, there was provision for aquaculture leases (of 10ha maximum per lease) relocated from the Little Douglas Management Zone, and/or Dutton Bay Policy Area and/or Kellidie Bay Policy Area up to a maximum of twenty (20) hectares. In the Point Longnose Zone, it was specified in 1997 that licences would not be issued for aquaculture development if it would result in a total area of more than 110 hectares of development within the combined areas of Port Douglas Policy Area, Coffin Bay Policy Area, Dutton Bay Policy Area and Kellidie Bay Policy Area.
- ♦ *Little Douglas Management Zone*: comprises two sections of Port Douglas, one near the Horse Peninsula, and one towards the centre of the bay. The Zone is defined as all waters enclosed by the

following points: 534750E and 6177600N; 534900E and 6178050N; 535200E and 6177900N; 535200E and 6176780N. The zone also includes all waters bounded by the following points: 533400E and 6176700N; 533000E and 6175100N, 532400E and 6175700N. In 1997, provision was made for leases being relocated from Dutton Bay Policy Area and/or Kellidie Bay Policy Area, up to a maximum of 10 hectares. As with the Point Longnose Zone, licences would not be issued if the proposed lease resulted in more than 110ha of development in total, in the 4 main policy areas of Coffin Bay (see above) .

Within the **Dutton Bay** Policy Area, a total of 64ha of leases were operating during the mid 1990s, most of which were in Mt Dutton Bay itself (PISA Fisheries – Aquaculture Group, 1997). Generally, within the Dutton Bay Policy Area, PISA Fisheries – Aquaculture Group (1997) permitted oyster farming licences to be issued to within 25 meters of the mean spring high water mark within the Lavender Bay, Dutton Bay, Bulldog Point, Dutton Bay North and Salt Creek Aquaculture Zones within the Dutton Bay Policy Area. Licences for oyster farming were permitted to within 100 metres of mean spring high water mark in Lavender Bay and around the three islands at the mouth of Lavender Bay. Licences would be considered for a total of 64 hectares of oyster culture in Dutton Bay Policy Area for the term of this Management Plan. Within the policy area, 1 licence was permitted for a nursery lease to a maximum of 2 hectares. Licences would not be issued to “backfill” vacated sites except for leases returned from the Port Douglas Policy Area. Boating and navigation lanes within the Dutton Bay Policy Area would be excluded from aquaculture development, as would the waters surrounding the Mt Dutton Bay Islands, due to their conservation value (PISA Fisheries – Aquaculture Group, 1997). The Lower Eyre Peninsula Aquaculture Management Plan (1997) designated 6 zones within the Policy Area, as follows:

- ♦ *Dutton Bay Aquaculture Zone*: with provision for a total of 40 hectares of oyster culture, for the term of the Management Plan, plus 1 licence for a nursery lease (to a maximum of 2 hectares) for growing oyster spat.
- ♦ *Lavender Bay Aquaculture Zone*: with provision for a total of 8 hectares of oyster culture, for the term of this Management Plan. Also, further applications for aquaculture development within the Zone would be considered “on merit” if they were a minimum of 100m from the mean spring high water mark and a minimum of 100m from the mean spring high water mark of the islands in Lavender Bay.
- ♦ *Bulldog Point Aquaculture Zone*: with provision for a total of 8 hectares of oyster culture, for the term of the Management Plan. Also, there was provision for a one licence for a nursery lease, to a maximum of 2 hectares. Under the 1997 plan, licences would be considered for a total of 14 hectares of oyster culture in the *Bulldog Point* and *Dutton Bay North Aquaculture Zones* (see below) combined, for the term of the Management Plan.
- ♦ *Dutton Bay North Aquaculture Zone*: with provision for 4 extra hectares of oyster culture, in addition to the ongoing operation of the existing leases (12ha in 1997). There was also provision for relocation of leases within the zone to improve viability. Allowance was made for future development of small nursery leases associated with hatcheries, which must stock oysters less than 25mm size.
- ♦ *Salt Creek Aquaculture Zone*: with provision for a total of 4 hectares of oyster culture, for the term of the Management Plan; and
- ♦ *Mount Dutton Zone*: comprising most of the bay, particularly the eastern side and the northern end, with no permission for aquaculture due to the need to prevent developments from being in close proximity to navigation channels and settlements.

The innermost area within Coffin Bay that has been allocated for aquaculture is the **Kellidie Bay** Policy Area. Oyster leases have been concentrated in the intertidal areas along the northern shore of Kellidie Bay. Land along the shore is privately owned, in some cases by oyster farmers (PISA Fisheries – Aquaculture Group, 1997). During the 1990s there were 40 hectares of leases operating within Kellidie Bay. Within Kellidie Bay, the *Kellidie Bay Aquaculture Zone* is defined as waters to the mean spring high water mark around the north and east sides of Kellidie Bay, and east of a line buffering the mean spring high water mark on the western shore of the bay (a line between 541445E, 6171959N and 543850E, 6169150N. during the mid 1990s, there were 40 hectares of leases operating within this zone. The Lower Eyre Peninsula Aquaculture Management Plan (1997) recognised the possibility of relocating leases to “improve efficiency”, as a result of “viability problems” due to the short season in which the oysters are of marketable condition (considered to be possibly due to poor or limited water movement or limited food availability). Under a previous review of aquaculture in the area (1995), provision was made for a “communal fattening lease” within **Kellidie Bay**, on the sand bank toward the southern end of the bay. The Kellidie Bay fattening lease allowed each grower in the bay to move two hectares from existing leases. Although the lease was considered to be productive, it reportedly failed to significantly extend the

selling season in the bay as “productivity problems appear to be general throughout the whole bay”. The 1997 plan proposed to allow relocation of some of the existing allocation into the Port Douglas Policy Area. The plan did not provide for any “backfilling” of vacated area in Kellidie Bay except by the lessee who previously held the site, and only when relocating back from the Port Douglas Policy Area (PISA Fisheries – Aquaculture Group, 1997). Within Kellidie Bay, the 1997 plan made provision for a total of 40 hectares of oyster culture, but not closer than 25m from the mean spring high water mark, or closer than 250m from the mean spring high water mark adjacent the Kellidie Bay Conservation Park. Licences would not be issued for development within the zone east of a line between the following points; 545370E and 6171060N; 545166E and 6169557N. Licences for oyster farming in Kellidie Bay Aquaculture Zone, would be issued, subject to conditions as follows: (i) part or all of a lease may be added to an existing lease providing final lease area, does not exceed 8 ha, or (ii) a maximum of 2 hectares can be relocated from an existing lease to within a site on the sand bank within Kellidie Bay. This site is bounded by the following points: 543955E and 6170051N; 543079E and 6170051N; 543348E and 6169737N; 543955E and 6169737N; (iii) a single lease will be issued over the communal site which should be lodged by a single entity representing those farmers wishing to relocate into the site. Other than those sections mentioned above. No other part of Kellidie Bay was proposed for aquaculture development, in order to protect the existing navigational, commercial fishing, tourism, recreational, scenic, heritage and conservation values of the Zone (PISA Fisheries – Aquaculture Group, 1997).

In 1997, Hone and Clarke (1997) reported a total of 22 oyster leases in the Coffin Bay system (including a research and development lease), with a combined total area of 116.5ha. The number of leases had tripled by 2004, and during the mid 2000s there were more than 20 operators farming about 122 hectares in the Coffin Bay system (Media report, 2003). According to the Atlas of South Australia (2004) and PIRSA Aquaculture’s Public Register (2004), there are now more than 70 shellfish leases in the Coffin Bay region, comprising more than 20 in Kellidie Bay; about 4 in outer Mt Dutton Bay and 8 in inner western Mt Dutton Bay; at least 17 in western and central Port Douglas Bay; and more than 25 south of Point Longnose.

There is an oyster hatchery in Mt Dutton Bay that supplies spat to oyster farms around South Australia, including those on the far west coast. Oyster spat from Tasmania is also use in Coffin Bay. Some of the young oysters from Coffin Bay are grown out at Franklin Harbour in Spencer Gulf, and then returned to Coffin Bay when they are larger.

In 1999, oyster production in Coffin Bay was about 330,000 dozens, an increase since 1995, when 200,000 dozens were produced (Madigan and Clarke, 2000, Figure 1).

Four aquaculture leases (cultivation sites in deeper water, for caged Greenlip Abalone) have also been approved in outer **Coffin Bay**, near the **Frenchman / Gallipoli Beach** area (Frenchman Management Zone). Three of the leases are classed as “pilot leases”, and the combined area of the leases is about 30 hectares (PIRSA Aquaculture Public Register, 2004).

Commercial Fishing

Scalefish, Sharks and Minor Invertebrates

Figures specific to the area are not available. Regionally, the major commercial fish and shark species that are caught in the southern Eyre Peninsula area, collectively comprising (i) the area from Reef Point, south and eastwards to West Point / Cape Catastrophe area, and (ii) in the Coffin Bay area, including deeper waters west and north of Coffin Bay, include the following:

Ocean Leatherjacket: caught in deeper water, on the southern and south-western side of the tip of **Southern Eyre Peninsula**. Recent catch figures specific to the area are not available for this report. Previously, Grove-Jones and Burnell (1991) provided an indication of the rapid development of the Ocean Leatherjacket fishery in the south-western Eyre Peninsula area. Most of the catches were taken in deeper, Commonwealth-managed waters, however catches from closer to the coast (GARFIS Fishing Block 28) are relevant here. There were no catches of Ocean Leatherjacket in GARFIS Block 28 in 1984/85; 5t were taken the following year; 50t in 1986/87; 25t in 1987/88; 125t in 1988/89 and 25t in 1989/90. During the mid to late 1990s, catches in the order of 20t and 22t per annum were taken from the aforementioned area. It is noted that the majority of the catch in the

southern Eyre region is taken in deeper Commonwealth-managed waters. During the mid to late 1980s, annual catches in two block of the 1° degree fishing blocks in offshore waters were as high as 100t, 200t, and 400t in some years (Grove-Jones and Burnell, 1991). Recent catch figures (from the 2000s) specific to the area are not available for this report, however a statewide overview of the fishery yield is provided in other sections of this report.

Pilchards: are caught across the **bottom of Eyre Peninsula**. There is a small fleet of pilchard boats based in Coffin Bay, and the waters out of Coffin Bay are heavily used by commercial fishers (PISA Fisheries – Aquaculture Group, 1997). In some years, catches in the range low hundreds of tonnes have been taken from the deeper waters **west and north of Coffin Bay** (i.e. near **Point Sir Isaac**). For example, about 2,230t and 770t were taken from the area in 1995/96 and 1996/97 respectively. During the period, much smaller quantities (e.g. several tonnes) were also taken in more southerly waters, off the **southern and south-western tip of Eyre Peninsula**. Recent figures specific to the bottom of Eyre Peninsula are not available, however a comparison of the State-wide totals with those provided above for the Point Sir Isaac area in the mid-late 1990s, shows that substantial proportion of the State-wide catch come from the Southern Eyre region. The reported pilchard catch for *all of South Australia* was as follows, during the past decade: 1991/92:145t; 1992/93:1,230t; 1993/94:2,377t; 1994/95:2,803t; 1995/96:3,708t; 1996/97:3,428t; 1997/98:6,041t; 1998/99:4,465t; 1999/00:3,836t; and 2000/01:7,368t (Knight et al., 2002). The total allowable catch for the 20 pilchard fishers in S.A. has increased annually since the 1990s, and the total quota in recent years has been as follows: 17,750 in 2002, 36,000t in 2003, 40,000t in 2004, and 51,000t in 2005.

Southern Bluefin Tuna are caught in deeper waters off southern Eyre Peninsula, amongst other areas of western South Australia, managed by the Australian Government. The fishery, which is regulated by the Australian Fisheries Management Authority, is not discussed in this report.

Gummy Shark and *School Shark* (and other shark species, such as *Whaler Sharks*). Recent catch figures are not available for this report, however in waters south of the Coffin Bay Peninsula (i.e. **southern tip of Eyre Peninsula**), recorded catches during the mid to late 1990s appeared to be similar for each species on an annual basis: e.g. about 18t and 21t respectively of School Shark and Gummy Shark in 1996/97, and between 4t and 4.5t of each species during the preceding year. In the **Coffin Bay** area, including waters west and north of the bay, between 7t and 9t of Gummy Shark per annum were reported to taken during the mid to late 1990s. Similar catches of School Sharks were recorded during the same period. Smaller quantities of Whaler sharks (less than 1t) were taken off the **southern and south-western tip of Eyre Peninsula** during the mid to late 1990s, but no recent catch figures are available for this report. *Whaler Shark* catches are small compared with yields of School Shark and Gummy Shark. *Saw Sharks* are taken in minor quantities in the deeper waters west of Coffin Bay Peninsula, in the south-eastern Great Australian Bight. Other shark species caught in the south-western Eyre region are not reported to species level, however it is noted that catches of such species are likely to be low (e.g. 1t – 2t per annum have been recorded, during the mid-late 1990s). Note that catch and effort for School Shark and Gummy Shark in South Australia have recently been re-regulated by the Commonwealth, under a new management scheme (see AFMA 2003a, 2003b);

West Australian Salmon: a purse seine net fishery for 2 - 6 year old Australian Salmon operates around the **Avoid Bay** area, between **Pt Whidbey** eastwards to approximately **Shoal Point**, and Salmon are also taken around the **Coffin Bay** area. Recent catch figures are not available, but it is noted that during the mid to late 1990s, catches of approximately 85t and 36t per annum were taken in the fishing area that includes Coffin Bay, and deeper waters north and west of the bay. Further south, off the **southern tip of Eyre Peninsula**, catches during the period were variable (e.g. less than 1t in 1995/96 and 8t in 1996/97).

Sand Crabs: A significant fishery exists in the **Coffin Bay** area, particularly in the inshore waters of **Coffin Bay**, waters adjacent to **Farm Beach**, and the **Coffin Bay Peninsula**. Hoop nets or drop nets are used, and traps are used to a lesser extent. The catches in 1995/96 and 1996/97 were around 51t and 75t respectively; and in 2000/01, around 130t of Sand Crabs were, above a previously estimated maximum constant yield (MCY) of about 95t per annum (Westlake and Jones, 1999). It is noted that Westlake et al. (2002) reported a Constant Average Yield (CAY) of about 100t per annum.

King George Whiting: In the fishing region that includes **Coffin Bay** (i.e. Southern Eyre Peninsula, Coffin Bay, and deeper waters west and north-west of Coffin Bay, up to Sheringa on the west coast), 25.2t of King George Whiting were taken in 2000 and 15.4t in 2001, and almost the entire catch is taken

using handlines (McGarvey et al., 2003). Catches have declined in the area during the past two years to 2002 (McGarvey et al., 2003). It is noted that catches in the low dozens of tonnes were made in **Coffin Bay** (Fishing Block 28, excluding the Sheringa coast north of the bay) during the mid to late 1990s (e.g. 27.6t in 1995/96 and 17t in 1996/97). Over time, peaks and troughs in both catch and effort are evident in Coffin Bay (McGarvey et al., 2003, Figure 4.6).

Scallops: Previously, the Coffin Bay area was significant for Scallop fishing, prior to population crash during the 1990s. The Scallop fishery in **Coffin Bay** was closed for a number of years in the mid to late 1990s (PISA Fisheries – Aquaculture Group, 1997), considered to be caused by a combination of over-fishing (both commercial and recreational), and the effects of ongoing micro-algal blooms in the bay at the time. Prior to the closure there was no bag limit on the commercial catch from Coffin Bay, although a minimum size restriction applied.

Mud Cockles: Previously, Mud Cockles were commercially fished in **Coffin Bay**, however a population crash occurred during the 1990s, considered with high likelihood to be caused by over-fishing (Fowler and Jones, 1997).

Historically (i.e. during the late 19th century), **Coffin Bay** was also an important area for the fishing of Native Oysters, however by 1930, the fishery had collapsed (possibly due to a combination of over-fishing, and dredging of the bay).

Octopus: Caught commercially in **Coffin Bay** (PISA Fisheries - Aquaculture Group, 1997). Recent figures are not available, however it is noted that during the mid to late 1990s, approximately 8t of octopus per annum were taken commercially in the Coffin Bay area (SARDI data).

Garfish: Caught commercially in relatively low quantities. Recent figures are not available, however it is noted that during the mid to late 1990s, approximately 3t - 4t of Garfish per annum were taken commercially in the **Coffin Bay** area, and lower quantities (less than 1t) were taken further south, in the south-western part of **southern Eyre Peninsula** (SARDI data).

Tommy Ruff: Caught commercially in low quantities in **Coffin Bay**. Recent figures are not available, however it is noted that during the mid to late 1990s, examples of annual catches included 300kg, and 2.6t per annum (SARDI data).

Rays and Skates: Recent figures are not available, however it is noted that during the mid to late 1990s, unspecified species of ray and skate (possibly including *Eagle Ray*) were taken in low tonnages (e.g. 1t - 2t per annum in some years) in the Coffin Bay area (SARDI data).

Reef Fish such as various *Wrasse* species, *Southern Blue Morwong* and *Redfish* are taken commercially off the **southern and south-western Eyre Peninsula coast**, but this is not a major part of the scalefish fishery. Recent catch figures are not available, however during the mid-late 1990s, about 1t - 2t per annum of each species were taken. Around a dozen other fish species have been caught commercially off the **southern and south-western tip of Eyre Peninsula** in some recent years (e.g. mid to late 1990s), mostly in minor quantities, in the hundreds of kilos per annum (see part 13 of the **Ecological Values** section for this area, for species examples, such as *Conger Eel*, and *Sweep*).

Other species such as “*Weedy Whiting*”, *Snook*, *Red “Mullet”*, *Conger Eel*, and *Southern Calamari*, have been taken in low quantities in the **Coffin Bay** area (e.g. 1t or less per annum of each species).

Rock Crabs and also taken commercially in the **Coffin Bay** area, in low quantities (e.g. less than 1t per annum).

Unspecified scalefish species (“mixed species”) are also taken off south-western Eyre Peninsula, with recorded catches in the mid-late 1990s of 1t – 2t per annum.

Recent aggregated catch data are not available, however previously, according to SARDI (cited by Edyvane, 1999b), the Marine Scalefish and Shark catch from GARFIS Block 28 (southern Eyre Peninsula, southwards of the Coffin Bay Peninsula, from approximately 34° 30'S south to 35° S, and ranging between 135° E and 136° E) was as follows: In 1995/96 a total of 39,327kg (0.38% of State total, representing 24 fishers); In 1996/97 a total of 78,148 kg (0.77% of State total, representing 21 fishers). Marine Scalefish, Restricted Marine Scalefish, and Northern Zone Rock Lobster licence holders contributed to these yields. Figures for deeper (Commonwealth) waters i.e. fishing Block 38

are not provided, and are not relevant to the area under consideration here. On a State-wide scale, aggregated catch figures for all GARFIS Fishing Blocks in South Australia, between 1995 and 1997, showed that the southern Eyre Peninsula area (Fishing Block 28) was ranked 39th in 1995/96 and 26th in 1996/97, in the list of fish and shark yields from 58 South Australian fishing blocks, at that time. Further north in GARFIS Block 27, which extends from Coffin Bay northwards between 34° 30'S and 34°S, and westwards to 135°E, the Marine Scalefish and Shark catch was reported to be 2,438,888kg in 1995/96, and 923,539kg in 1996/97, with the majority of these large quantities being pilchards.

South of southern Eyre Peninsula, the Commonwealth Gillnet fishery (formerly called the Southern Shark and South East Non-Trawl fisheries - see AFMA, 2001b) operates over a broad area in Commonwealth waters. The fishery is not discussed here, however information on species caught in the fishery is discussed in the sections of this report on **Western, South-western and North-Western Kangaroo Island**, and the **Upper South-East** and **Lower South-East**.

Rock Lobster Fishing (and Bycatch Species)

Fishing Block 28 is one of the two fishing blocks in the Northern Zone in which catch has consistently been higher than that in other northern Zone fishing blocks, in almost all years since 1970 (see Ward *et al.*, 2002, Figure 2.5). Catches have been higher than around 130t in Fishing Block 28, in almost all years since 1980, up till the late 1990s, and corresponding effort has been higher than 110,000 potlifts per annum in most of those years. During the 1980s, 1990s and early 2000s, fishing effort (potlifts per annum) in Block 28 was higher than that exerted in almost all other fishing blocks in the Northern Zone (Ward *et al.*, 2002, Figures 2.7b, 2.7c and 2.7d). Catch peaked at over 200t per annum in two years of the 1990s. During the late 1990's to 2001, both catch and effort decreased – approximate catch in 2001 was around 110 tonnes in Fishing Block 28, for an effort level of around 120,000 potlifts. Catch and effort levels have shown close correspondence in most years of the 1990s, however the figures for 2000 and 2001 show a differential similar to the early 1980s, whereby an increase in total potlifts did not result in a corresponding increase in yield (see Figure 2.5 in Ward *et al.*, 2002). Figure 2.5 in Ward *et al.* (2002) also shows that during the 1970s, the catch curve was above the effort curve (i.e. relatively high yields compared with effort expended) and the situation now shows signs of reversing (i.e. higher effort, and lower proportional yields). An indication of the significance of the catch from fishing Block 28, relative to other fishing blocks in South Australia, was provided by Edyvane (1999, citing SARDI data): In 1995/96, the total of 141,100kg from Block 28 comprised 2.76% of State total, representing the catch of 47 fishers; and in 1996/97, a total of 177,186kg for Block 28 comprised 3.46% of State total, representing the catch of 40 fishers. Aggregated catch figures for all fishing blocks in South Australia, between 1995 and 1996, show that the southern Eyre Peninsula area (Fishing Block 28) was the 5th most important commercial lobster fishing area in South Australia at that time, in terms of yield (and hence value).

Further north in Fishing Block 27 (the southern end of which includes the outer Coffin Bay / Frenchman area), annual catches less than 50t have been recorded in most years since the 1970s, with a peak in catch being recorded in 1989-90. Fishing effort (pot lifts per annum) is considerably lower in Block 27 compared with the area south of the Coffin Bay Peninsula (Block 28), with less than 25,000 potlifts in some years, and less than 50,000 in other years (Ward *et al.*, 2002, Figures 2.7b, 2.7c and 2.7d). In recent years, the majority of lobsters caught in Fishing Block 27 have been taken from relatively shallow waters (less than 30m, with some taken in the depth range 31-60m) (Ward *et al.*, 2002, Figure 2.12).

According to Aquaculture Group - PISA Fisheries (1997), Rock Lobster fishing effort in the area comprising the southern foot of Eyre Peninsula is concentrated around the **Coffin Bay Peninsula**, **Whidbey Isles**, **Rocky Island**, **Greenly Island** and **Cape Carnot**. Lobster boats visit **Perforated Island** in calm weather, to set pots around the cave area in the northern part of the island (Robinson *et al.* 1996). A number of Rock Lobster fishing boats are based in Coffin Bay.

Bycatch information specific to the southern foot of Eyre Peninsula is not available. However, McGarvey *et al.* (1998) and Prescott (2001) recorded that the largest proportion of bycatch in the Northern Zone as a whole is Leatherjackets and Maori Octopus. According to the results of a sampling program of bycatch in 1991 and 1992, various wrasse species (Labridae family) together constituted another major component of the bycatch in the Northern Zone e.g. 1127 Labrids caught in pots during the bycatch sampling program in 1991-92 (Table 5 in Prescott (2001)). Octopus are a major predator of Rock Lobster, with losses due to octopus predation equating to approximately 4%

of the total number of lobsters landed (in the Northern Zone). According to McGarvey *et al.* (1998), the catches and catch rates of octopus have been sustained over time, and vary from 1 – 2.5 octopuses per 100 potlifts. Octopus that are caught in the northern zone are sold.

Rock Lobster fishers are also permitted to retain legal sized Giant Crab when caught as by-product, and this species is becoming increasingly valuable, commercially (McGarvey *et al.*, 1998). A small number of Commonwealth-endorsed Rock Lobster fishers also target Giant Crab specifically. Between 1992/93 and 2001/02, total Giant Crab catches (target and byproduct catches combined) have ranged between 7t in 1992/93 and 33t in 1998/99, with a steady decline between 1999 and 2002 due to the introduction of quotas (e.g. 31t in 1999/00; 24t in 2000/01, and 18.5t in 2001/02) (Knight *et al.*, 2003, cited by Sloan, 2003b). The fishery now operates under a quota-based management system with a total allowable commercial catch (TACC) of 13.4 and 8.7 tonnes for the Northern Zone and Southern Zone, respectively (Sloan, 2003b). Giant Crabs are caught from the edge of the continental shelf in the west coast region (McGarvey *et al.*, 1998).

Some Rock Lobster fishers net sharks out of season, and some of these activities require a Commonwealth permit. Licensed Rock Lobster fishers have also had access to fish species, such as Australian Salmon, Mulloway, and Snapper (Zacharin, 1997, cited by McGarvey *et al.*, 1998).

Predators of Rock Lobster in the Northern zone include New Zealand Fur Seals, Western Blue Groper (minor) and Maori Octopus (McGarvey *et al.* 1998; S. Shepherd, pers. comm., 2004).

Abalone Fishing

According to Aquaculture Group - PISA Fisheries (1997), fishing effort for abalone within the south-western Eyre region is concentrated around **Drummond Point, outer Coffin Bay** and the **Coffin Bay Peninsula, and Whidbey Isles**.

No figures specific to the entire area are available, but aggregated figures for parts of the area described in this table were provided by S. Shepherd (pers. comm., 2000), and are summarised below as the minimum and maximum yields (approximate whole weight) of each species recorded during the period 1990 to 1996:

- ♦ *Frenchmans*: Recorded annual yield of Greenlip Abalone was less than 3t in all years, although higher yields (e.g. 4.5t, 7.9t) were recorded during the early 1980s. Yield of Blacklip Abalone ranged between 1.2t and 4.9t.
- ♦ *Point Sir Isaac to Reef Head*: Recorded annual yield of Greenlip Abalone ranged between 3t and 6t in all years, although yields greater than 20t (up to 47t) were recorded during the early 1980s. Yield of Blacklip Abalone fluctuated between 9t and approximately 29t.
- ♦ *Boardinghouse Bay – Cape Whidbey*: Recorded annual yield of Greenlip Abalone was less than 2t in all years, although yields greater than 4t (and up to 9t) were recorded during the early 1980s. Yield of Blacklip Abalone fluctuated between 500kg and 4.5t.
- ♦ *Misery Bay - Black Rocks*: Recorded annual yield of Greenlip Abalone fluctuated between 6t and 15t, although yields greater than 20t (and up to 58t) were recorded in most years during the late 1970's and early 1980s. Yield of Blacklip Abalone fluctuated between 3t and 14t.
- ♦ *Greenly Island*: (low catches: less than 1t of each species during most years between 1983 and 1993, and no recorded since that time, to 1998).
- ♦ *Whidbey Isles*: Recorded annual yield of Greenlip Abalone fluctuated between 300kg and 2.6t during 1990 - 1996, however it is noted that in 2 years of the 1980s, 20t and 28t of Greenlip were taken. Yield of Blacklip Abalone ranged between 72kg and just over 5t.
- ♦ *Point Avoid*: Recorded annual yield of Greenlip Abalone ranged between 2t and 8t in all years, although yields greater than 20t (and up to 72t, in one year) were recorded in most years during the late 1970's and early 1980s. Yield of Blacklip Abalone fluctuated between 1.4t and 15t.
- ♦ *D'Anville Bay, Liguanea Island*: Recorded annual yield of Greenlip Abalone fluctuated between 1t and 2.8t, although yields from 3t to 7.3t were recorded during the late 1970s and early 1980s. Yield of Blacklip Abalone fluctuated between 500kg and 2.3t.
- ♦ *Fishery Bay and Groper Bay*: Recorded annual yield of Greenlip Abalone fluctuated between 3t and 6.5t, although yields greater than 8t (up to 14t and 18t, in two years) were recorded during the late 1970s and early 1980s. Yield of Blacklip Abalone fluctuated between 1.8t and 4t between 1990 to

1996, although yields greater than 4t were recorded in 9 of the 12 years between 1979 and 1990.

According to Aquaculture Group - PISA Fisheries (1997), the Coffin Bay Peninsula and Whidbey Islands are particularly important locations for abalone fishing on the southern Eyre coast. Blacklip Abalone are taken in waters up to 25m deep, and Greenlip Abalone from waters between 5m and 40m deep.

Recent aggregated figures for the area are not available. Previously, Edyvane (1999b, citing SARDI data) reported that the total catch within the southern Eyre region (Whidbey "biounit"), comprising Abalone Map Codes 13D-F, 14A-F, 15A-B, 16A-C, 17A-B, 18A-B Point Sir Isaac to Cape Catastrophe, including Whidbey Isles and the Avoid Bay Isles, was as follows:

- ♦ 1994/95 a total of 32,064kg of Greenlip Abalone (14.1% of western zone catch, or 8.51% of State catch) and 51,828kg Blacklip Abalone (16.7% of western Zone catch, or 10.49% of State catch);
- ♦ 1995/96 a total of 36,168kg Greenlip Abalone (16% of western zone catch, or 9.66% of State catch) and 38,563kg Blacklip Abalone (13.9% of western Zone catch, or 8.33% of State catch).

Mayfield et al. (2001) reported that: (i) catch per unit effort in all blocks and sub-blocks of south and south-western Eyre Peninsula has been average (i.e. 60kg - 80kg / hour) during the period 1996 – 2000; (ii) fishing effort in the blocks and sub-blocks of south-western Eyre Peninsula (i.e. north, west, and south of the Coffin Bay Peninsula) exceeded more than 75 trips per year during the early 1980s, but decreased during the 1990s and early 2000s; and (iii) in the fishing sub-blocks between Point Avoid and Sleaford Bay, fishing effort for abalone has *decreased* significantly during the past 10 years.

Prawn Fishing

MacDonald (1998) stated that the southern foot of Eyre Peninsula is not a key fishing area in the Spencer Gulf and West Coast prawn fishery, and Figure 14 in DEH (2003) also showed that prawn fishing does not occur along the southern Eyre Peninsula.

Further north, the outer **Coffin Bay** fishing grounds extend from **Drummond Point**, southwards to the **Reef Point** area on the Coffin Bay Peninsula. This fishing area extends as far west as approximately 135°E, and as far south-east as **outer Coffin Bay / Seven Mile Beach** area, in waters deeper than 10m. In 1999/00, 2.4t of prawns were taken from this area, representing only 2.3% of the large total catch (106.1t) from west coast for that year. However, in 2001/ 2002, 71.3t were taken from Coffin Bay (from 1094 fishing hours), and in 2002/ 2003, the Coffin Bay grounds produced 20.4t, from 422.42 hours fishing (Svane and Barnett, 2004). These figures represent the highest production from the 3 fishing areas on the west coast during the 2001/02 and 2002/03 fishing years. It is noted, however, that effort, catch and catch rate were all lower in the west coast fishing regions during the 2002/03 year, compared with the late 1990s / early 2000s, possibly representing oceanically driven cycles of abundance (see Svane and Barnett, 2004).

In addition to prawns, prawn fishers are permitted to retain and sell Slipper Lobster (*Ibacus* sp.), Octopus, Scallops, Southern Calamari, and Arrow Squid / Torpedo Squid (*Nototodarus gouldi*).

Recreational Fishing

Coffin Bay is a significant area for recreational fishing, and has been described as "a haven for fishermen" and "an absolute Mecca" for fishers using small boats, the surf beaches on the ocean side, the jetties in the bays, or the many rock fishing spots throughout the bays (EPTA, 1995; Fairfax Publishing – F2, 2003; Tourism Eyre Peninsula, 2003).

Coffin Bay is popular for fishing King George Whiting, particularly during the colder months, when the "winter whiting" move in to the bay, and fishers target them at "The Ledge", the boat ramp, and the jetty. A study in 1990 (Staniford and Siggins, 1992) showed that Coffin Bay is an important area for fishing from boats and from the shore, and the majority of fishers target King George Whiting (which accounted for more than half the total catch during the survey period of January – June 1990). In addition to whiting, the sheltered waters of **Coffin Bay** are also renowned fishing grounds for trevally, Australian Salmon, Garfish, Tommy Ruff, flathead species and Snapper (EPTA, 1993, 1995; Morelli and de Jong, 1995). Very large Kingfish have also been taken seasonally in **Coffin Bay** (SA Regional News report, 2000, and Eyre Peninsula fishing report, 2003). In **Coffin Bay**, there are charter boat fishing operations for both inshore and offshore waters, one of which specialises in the capture of Snapper and King George Whiting (Postcards Online, undated f; Tourism Eyre Peninsula,

2003). The following species are commonly caught in **Coffin Bay**: King George Whiting, Snapper (in the channel), Tommy Ruff, young Australian Salmon ("Salmon Trout"), mullet, flathead and flounder species, Southern Calamari, Snook (e.g. over the seagrass beds) and Snook (EPTA, 1995, 2000; Tourism Eyre Peninsula, 2003; Eyre Peninsula fishing reports, 2003). There are fishing jetties near **Coffin Bay** township at **Crinolin Point** and **Schnapper Point**, also promoted for recreational fishing (Fairfax Publishing – F2, 2003). The **Coffin Bay Jetty** is promoted as a place for catching flathead and founder species, Garfish, King George Whiting, Snapper, mullet, "Salmon Trout", Tommy Ruff, Trevally, Snook, Southern Calamari, and sharks (Fish Eyre Peninsula web site, 2003). Almost all of these species are also reported to be caught further into Coffin Bay (at **Kellidie Bay**). In **Kellidie Bay**, "Salmon Trout" are often caught at the entrance to the bay. At **Port Douglas** and **Farm Beach**, recreational fishers catch King George Whiting, Tommy Ruff, young Australian Salmon ("Salmon Trout"), Silver Whiting, mullet (including very large specimens), Sweep, flathead species, Southern Calamari, Garfish, Snook, Trevally and sharks. Snapper are also taken at **Farm Beach**. The sheltered waters of **Mt Dutton Bay** are promoted for boat fishing, and the **Mt Dutton Bay Jetty** is promoted for catching flathead, Garfish, King George Whiting, mullet, "Salmon Trout", Southern Calamari and Tommy Ruff (EPTA, 1995; Morelli and de Jong, 1995; Tourism Eyre Peninsula, 2003, and Eyre Peninsula fishing reports). Major species taken in **Mt Dutton Bay** include King George Whiting (e.g. from the rocks), Tommy Ruff, "Salmon Trout", mullet, flathead species, southern Calamari, and Garfish. Whiting, Snapper and Garfish are taken by boat fishers at **The Brothers** islands, and "Salmon Trout" are also taken in that area.

Gummy Sharks, Whaler sharks and other shark species are taken by recreational fishers in the **Coffin Bay Peninsula** area (recreational fishing and sports fishing records, cited in Baker, in press).

Outside and north of Coffin Bay (**Farm Beach**, **Gallipoli Beach**, **Frenchman**, **Mount Greenly Beach**, **Convention Beach** and **Drummond Point**), locations are reported to be "renown for beach and rock fishing" (Tourism Eyre Peninsula, 2003), with examples of popular species including King George Whiting, Trevally, Australian Salmon, Tommy Ruff, Sweep, Silver Drummer, and a number of reef and rock species ("rock cods", wrasses, etc). Species taken at **Frenchman** include King George Whiting, Tommy Ruff, "Salmon Trout", flathead species, Southern Calamari, Sweep, Garfish, Snook and shark species. At **Convention Beach**: Australian Salmon, mullet and flathead species; and at **Coles Point**: Tommy Ruff, Australian Salmon, Sweep, and sharks (Eyre Peninsula fishing reports, 2003; Tourism Eyre Peninsula, 2003). **Farm Beach** is popular for fishing whiting. At **Farm Beach**, old tractors are used by recreational fishers to get their boats over the soft sand and piles of beachcast macroalgae.

Invertebrates taken by recreational fishers in the region include Rock Lobster and Abalone (rocky southern coastline, away from the bays), Sand Crabs (**Coffin Bay**) and Scallops (**Coffin Bay**), and southern Calamari, amongst others. It is noted that a study by Staniford and Siggins (1992) reported that 22% of recreational boat fishers that were surveyed in **Coffin Bay** during January 1990, were targetting scallops, with figures of 10% for February, and 7% for June of that year. Historically, Native Oysters were also collected in the Coffin Bay area, but these populations no longer exist in the large numbers that were observed during the late 19th and early 20th century.

McGlennon and Kinloch (1997c, Figure 8) reported that, according to results from a recreational *boat fishing* survey during the mid 1990s (April 1994 to March 1996), the recreational boat catch of King George Whiting in the **Coffin Bay** area constituted almost one third of the total combined commercial and recreational catch of King George Whiting from the area, at that time. More recent survey figures by SARDI (cited by Anonymous, 2004), showed that recreational handline fishers took the majority of combined commercial and recreational catch of King George Whiting from Coffin Bay in the period 2000/01.

For Garfish, the survey of McGlennon and Kinloch (1997a,b,c) reported that recreational boat fishers took about one third of the combined commercial (net fishing) and recreational catch of Garfish from the **Coffin Bay** area at that time. North of Coffin Bay, the recreational catch of Tommy Ruff was reported to be about one quarter of the combined commercial (net fishing) and recreational catch from the area at that time. Note that these figures do *not include shore-based fishing*, which is significant in Coffin Bay, and therefore the total recreational catch of some of the aforementioned species from Coffin Bay is higher than the proportions given above for boat fishers only.

Little information regarding recreation fishing along the southern Eyre coastline is available for this report, other than that recorded below. **Point Avoid** is described as a "popular recreational fishing area" (DEHAA, 1999). **Point Sir Isaac**, **Mullalong Beach**, **Reef Point Lookout** (on the western foot

of Eyre Peninsula), **Altmona Beach**, **Flat Rock** (between **Point Avoid** and **Avoid Bay**) are also used for surf fishing. **Sensation Beach** (western end of **Avoid Bay**, near **Sudden Jerk Island**) is also described as a popular ocean fishing beach, and **Gunyah Beach** is popular for Australian Salmon fishing (DEHAA, 1999). Several other areas are fished at times, however much of the southern Eyre coast is relatively inaccessible.

The Eyre Peninsula Tourism Association (EPTA) (1995, 2000) listed **Sleaford Bay** and **Fishery Bay** as main spots on lower Eyre Peninsula for surf fishing, particularly when targeting Australian Salmon. **Whaler's Way** was also listed as a "superb" area for rock fishing, particularly **Groper Bay** and **Redbanks**, and the ocean side of **Coffin Bay National Park** (e.g. **Point Avoid**) as a place for catching whiting. A list of species that are targeted and often caught from main fishing spots in the area include at **Sleaford Bay**: Australian Salmon, mullet, flathead, sweep, and sharks; at **Whaler's Way**: sweep and shark; from **Altmona Beach**: Australian Salmon and shark species (EPTA, 1995, 2000).

Altmona Beach was listed amongst the top 20 shore fishing areas in S.A. (Capel, 1994) and is a key place for fishing West Australian Salmon in the surf on southern Eyre Peninsula (EPTA, 1993; Tourism Eyre Peninsula, 2003). Recreational fishers gather cockles from beaches in the area. Surf fishers at **Altmona** catch mainly Australian Salmon, mullet, flathead and trevally. Gamefishing charters operate in the area off south-western Eyre Peninsula, including the waters around islands such as Greenly and Rocky, where Southern Bluefin Tuna, large Samson Fish, large **Yellowtail Kingfish**, and large **Western blue Groper** are targeted (McGlashan, 2004).

Diving

Much of the Southern Eyre Peninsula coast is relatively inaccessible for diving due to exposed conditions, and diving hazards such as great white sharks. However, a number of areas have been promoted, as follows:

Point Sir Isaac and **Reef Point Lookout** have been described as "popular for diving" (DEHAA, 1999). Previously, Point Sir Isaac was listed in Christopher's (1988) Divers Guide to S.A. Divers also visit some of the bays along the south-western foot of Eyre Peninsula (e.g. **Avoid Bay**, and waters around **Sudden Jerk Island**). Various dive guides list **Redbanks** (and other **Whalers Way** sites), "**The Swimming Pool**", **Cape Wiles**, **Liguanea Island**, and **Groper Bay** (Christopher, 1988; DIASA, undated; Aquanaut, undated).

Diving charters also operate in the area. However, most areas along the south-western foot of Eyre are inaccessible, and/or the conditions are too rough for diving.

Coffin Bay is promoted as a base for divers visiting southern Eyre Peninsula divers to stay, and some dive clubs have regular camping holidays in the area. Wrecks in the area are also promoted for diving.

Wyschnja (2000) described **Cape Wiles** as an underwater photographer's "paradise", due to clear shallow water and an abundance of marine life. The lagoon at the base off **Cape Wiles** was described by Aquanaut (undated) as being "an excellent, sheltered dive site", best dived from an inflatable boat.

The southern part of the **Lincoln National Park** coast, including **Whalers Way** and **Wanna** (in the **Sleaford Bay** area) are promoted for diving (Christopher, 1988; DIASA, undated; Aquanaut, undated).

Other Marine Recreation / Tourism

Previously, Christopher (1988) stated that the rugged coastal scenery of the **Lincoln National Park** area is "one of South Australia's top tourist attractions". Aquanaut's (undated) diving guide to S.A. promoted **Whalers Way** as "a popular tourist region", with some features of interest including "*relics from the early whaling industry, magnificent coastal scenery, and abundant wildlife...*". In recent years, the Lincoln National Park, which is renowned for its scenic qualities, has been widely promoted in tourism materials, for recreation such as camping and coastal bushwalking, and visiting the beaches for walking, swimming, and surfing. There are various coastal tours operating throughout **Lincoln National Park**, for coastal walking, viewing coastal scenery, visiting historic sites etc. The **Sleaford Bay** dunes are promoted for sightseeing coastal tours, as are sites in the **Whalers Way** area, including **Cape Wiles**, **Black's Lookout**, **Cape Carnot**, the **Whaleman's Lookout** and **Theakstone's Crevasse**. Much of the coast on the southern side of the Jussieu Peninsula is

inaccessible, however in places there are walking and cycling trails along some parts of the coast. For example, one coastal walking trail across **Sleaford Bay** passes **Sleaford Mere**, **Mary Ellis Wreck Beach**, **Salmon Hole**, **Wiseman's Beach**, **Millers Hole**, and the **Sleaford Bay – Wanna Dunes** area (DEH, 2002). Also on the southern side of Lincoln National Park are driving tracks (e.g. to **Sleaford Mere**, **Wanna** and **Cape Tournefort**) and scenic lookouts (e.g. **Wanna Cove**) along the southern part of the **Jussieu Peninsula**.

The **Cape Wiles / Fishery Bay** has been described as “an ideal surfing or sunbathing retreat” in recent tourism promotion materials about Southern Eyre Peninsula’s coastal and marine environment (e.g. Aquanaut, undated; Wyschnja, 2000).

Driving around the **Coffin Bay Peninsula** is promoted as a recreational pastime. Conventional vehicles have access to places such as **Point Avoid**, **Almonta Beach**, **Golden Island Lookout** and **Yangie Bay**. Four-wheel drive vehicles have access to **Black Springs**, **Gunyah Beach**, **Sensation Beach**, **Point Sir Isaac**, and other places along the **Coffin Bay Peninsula** (DEH, 2000c).

Altona Beach has been described as “one of the country’s finest surfing beaches” (ATN, 2003). **Flat Rock** (between **Point Avoid** and **Avoid Bay**) is also used for surfing (DEHAA, 1999).

Coffin Bay National Park is promoted for activities such as bushwalking, camping and observing the flora and fauna (e.g. DEH, 2000c; Fairfax Publishing - F2, 2003). There are sightseeing / nature observation and camping areas along accessible parts of the southern foot of Eyre / **Coffin Bay National Park**, and 4WD tours along the beaches on the southern side of **Coffin Bay National Park**, such as the **Sleaford Bay** sand dunes, and other coastal locations such as the **Sleaford Mere** (site where living stromatolites exist). There are numerous walking trails through Coffin Bay National Park, with coastal features of interest including the sand dunes, bays, beaches, high cliffs and lookouts over the rugged coastline.

Coffin Bay has been described as “an unspoilt family holiday retreat” and “one of South Australia's prettiest fishing villages” (Tourism Eyre Peninsula, 2003). Coffin bay has also been described as “an attractive and isolated holiday retreat”, and “a typical Australian holiday resort of the unspoilt variety, full of holiday units and relatively cheap accommodation and designed for people who want to spend a holiday fishing, sailing, skindiving, bushwalking or enjoying themselves on the beach” (Fairfax Publishing – F2, 2003). The calm waters of bays are reported to have become “enormously popular” in recent years. In addition to recreational fishing (see above), some of the other coastal and marine activities in the **Coffin Bay** area include coastal camping, bushwalking and foreshore walks, beachwalking / “beachcombing”, and general sightseeing (in the bays and channels; also from the lookouts, and on the ocean side, towards the islands), boating (e.g. dinghies can be hired, and there is considerable recreational boating activity within **Mt Dutton Bay**, particularly during the tourist season), sailing, swimming (N.B. there is an enclosed seawater swimming pool with pontoons), water skiing (e.g. **Kellidie Bay**), wind-surfing, and charter boat tours (e.g. for fishing, and also for oyster farm visits). There are also kayaking (canoeing) tours in parts of **Coffin Bay** and **Mt Dutton Bay**, for viewing coastal scenery, interacting with dolphins etc. Some of the facilities that cater for coastal holidays include boat launching ramps (floodlit at night), two jetties, bridges and boardwalks around some of the bays, foreshore caravan park and other beachside accommodation, yacht club, and hiring of small motorised boats, charter boats, yachts and paddle boats.

Coastal scenic walks within the **Coffin Bay** area include the beaches; the **Yangie** Lookout (which provides views over Yangie Bay); **Yangie Island** walk (a trail that leads to a close up view of Yangie Island from the adjoining beach); **Yangie Bay to Long Beach** Walking Trail (a walk between the vegetated dunes, that come out on the expansive **Long Beach**; **Black Springs** Well (which follows the coast around the headland overlooking sheltered **Port Douglas**; **Black Rocks** (a walking trail to the rugged coastline of **Avoid Bay** with views overlooking Lake Damascus along the way) (DEH, 2000c).

According to PISA Fisheries – Aquaculture Group (1997), in outer Coffin Bay, areas of recreational and tourism significance include **Seven Mile Beach**, **Farm Beach**, **Gallipoli Beach**, **Frenchman Bluff**, and **Morgans Landing**. Apart from fishing, the areas are used for beachwalking, sightseeing, swimming and camping. The old tractors the recreational fishers use to pull their boats into the water at **Farm Beach** are promoted as a sight for tourists (Fairfax Publishing – F2, 2003).

Within the Whidbey Wilderness Area, coastal walks include the **Sudden Jerk** Lookout (overlooking the rugged coastline out to **Sudden Jerk Island**; **Boarding House Bay** (the rugged coastline of cliffs,

beaches and off shore reefs can be seen at the end of a trail that goes through coastal heath, samphire flats and mallee woodlands) (DEH, 2000c).

The oyster farming in **Coffin Bay** is a tourist attraction, with boat trips to some lease sites and associated facilities. **Coffin Bay** is also part of Eyre Peninsula's *Seafood and Aquaculture Trail*, with the 8km Coffin Bay Oyster Walk being promoted in tourism materials. Also promoted is the retail outlet of one of the oyster farms, where tourists buy fresh oysters, prawns and lobsters as well as a variety of local fish (Fairfax Publishing – F2, 2003).

Kellidie Bay Conservation Park has been described as a "popular tourist attraction" (Australian Heritage Commission, undated; PISA Fisheries Aquaculture Group, 1997).

Historic/Protected Shipwrecks

- ♦ *Mary Ellis*, wooden ketch, built 1868 (Stone, undated), wrecked in the shallows of **Sleaford Bay** in 1907, is protected under Commonwealth legislation, and has been found and inspected.
- ♦ *Amelia*, a wooden cutter built 1858, wrecked 1883, purportedly near **Avoid Bay** Conservation Park (but not found). Protected under Commonwealth *Historic Shipwrecks Act 1976*.
- ♦ An unknown wooden vessel, wrecked 1849, in the centre of **Avoid Bay** (approx. 40m deep), but not found. Protected under Commonwealth *Historic Shipwrecks Act 1976*.
- ♦ *Vulcan's Canvas Boat*, a cutter built in 1845 and wrecked in the same year, off **Point Sir Isaac**, is protected under Commonwealth legislation, but has not been found.
- ♦ *Mary Ann*, a cutter wrecked in **Coffin Bay** area, 1843

Other European Heritage

Sealing and whaling activities were undertaken during the 1800s, and both industries ceased when seal and whale numbers become depleted. Whale bones, relics from this early industry, are reported to still be visible along the Coffin Bay Peninsula at **Point Sir Isaac** and **Phantom Cove** (Morelli and de Jong, 1995).

There are remains of whaling operations in the **Sleaford Bay / Fishery Bay** area (Staniforth, 1998; Staniforth and Richards, 2000). It is assumed that the Sleaford Bay whaling station was established by 1837, and operated until the early 1840s, producing oil and whale bone (Kostoglou and McCarthy, 1991, cited by Staniforth and Richards, 2000). Building foundations and storage sites have been found, and evidence of the processing facilities (e.g. tryworks platform, hoop iron, and other artefacts) (Bradbury *et al.*, 1997, cited by Staniforth and Richards, 2000).

Price Island has an abandoned lighthouse. A windlass and stone shed foundations still exist on the cliff top at the northern end of the island, and a sling jetty is sited on rocks at the water's edge, below the windlass (Robinson *et al.*, 1996).

There is a cast iron lighthouse on the south island of the **Four Hummocks**. Originally, when built in 1914, the light was gas powered, and cylinders for that purpose were hauled on an annual basis, 320m up the steep side of the island, by "flying fox". The power of the light was increased in 1940, and more permanent means of servicing it were built (e.g. crane, landing area with rungs secured to the rock, and a permanent aerial ropeway to the summit), however the light remained one of the most hazardous in the S.A. to service during the 20th century (Robinson *et al.*, 1996).

Mt Dutton Bay Jetty (reportedly 207m long) and the historic Woolshed (built in the late 1800s) are listed on the *South Australian Heritage Register*, and also listed as an Indicative Place on the *Register of the National Estate* (Australian Heritage Commission, undated). The Mt Dutton Bay Jetty was a major 'land-sea link' for the Eyre Peninsula region in the 19th century. The Woolshed provided space for provisions coming into the area by ketch, and for the wool and grain that left via the Mt Dutton Bay Jetty, between 1880 and 1945 (Wade, 2002). At one time, 20,000 sheep per year were shorn in the area, and about 100,000 sheep fleeces were stored in the nearby Woolshed, awaiting ketches from the Mt Dutton Bay Jetty, for overseas markets. The Woolshed is now a museum with displays relating to the history of shearing, farming and fishing in the area (Fairfax Publishing – F2, 2003, and

other Eyre Peninsula tourism materials, 2003).

Coffin Bay was originally called Oyster Town. During the 19th century, Native Oysters were taken from the bay. It was noted in 1849 that the first large quantities of oysters were taken to Port Lincoln, from where they were shipped to Adelaide (Wade, 2002). The fishers and their families lived on the foreshore in the little settlement of Oyster Town. The fishery collapsed by the 1930s (Postcards Online, undated f), likely due to a combination of over-fishing, and dredging of the bay by the sailing cutters.

Rabbit Island and **Goat Island** in **Coffin Bay** were mined for guano in the late 19th century. **The Brothers** islands were also mined during this period and again during the 1930s (Morelli and de Jong, 1995; Robinson et al., 1996).

Aboriginal Heritage and Native Title

The Coffin Bay Peninsula is listed on the *Register of the National Estate*, in recognition of its Aboriginal Heritage significance. There are a number of significant, relatively intact sites in **Coffin Bay** (e.g. **Horse Peninsula**) and along the **Coffin Bay Peninsula**, such as burial sites, camping grounds and associated middens and other materials, stone implements, and stone-wall fish traps. The area is considered to contain a rich and diverse Aboriginal cultural record, of great importance to the local Aboriginal community (Australian Heritage Commission, undated; Martin, 1988, and A. Nicholson, pers. comm., cited by Edyvane and Nias, undated; Morelli and de Jong, 1995).

The Barnjarla Claim for Native Title on Eyre Peninsula was lodged in 1996 with the National Native Title Tribunal (NNTT). The claim, which covers eastern Eyre Peninsula and the Gawler and Flinders Ranges, also includes the Lincoln National Park area, and the coast, waters and islands of south-western Spencer Gulf / south-eastern Eyre Peninsula. Following amendments in late 1999 and early 2000, the claim was accepted by the Federal Court for registration, pursuant to s190A of the *Native Title Act 1993* (National Native Title Tribunal web site, 2003).

In 1997, a land title claim for the south-western end of Eyre Peninsula, from the Coffin Bay National Park area to Elliston, was lodged on behalf of the Nauo People, and included the coast and coastal waters of south-western Eyre Peninsula. In 2000, the claim was accepted by NNTT for registration, pursuant to s.190A of the *Native Title Act 1993* (NNTT, 2000). The Nauo people's descendants use the area for camping, travelling, hunting, fishing, protecting sites and wildlife, conducting ceremonies, and trading artefacts (NNTT, 2000).

Artefacts recovered during archaeological surveys of former whaling in the **Sleaford Bay / Fishery Bay** area have included bone and charcoal and stone tools (Staniforth and Richards, 2000). The authors reported that these artefacts suggest former Aboriginal occupation in the area.

Marine Research and Education

The population numbers and pup production of Sea Lions and Fur Seals on the islands off **south-western** and **southern Eyre Peninsula** are monitored (e.g. Shaughnessy et al., 1997; Shaughnessy, 2002).

The cool water upwelling of southern Eyre Peninsula, and its consequent influence on biological productivity in the region, has been of continuing interest to oceanographers, fisheries biologists and other scientists (see for example Wenju *et al.*, 1990; Jones *et al.*, undated; Griffin *et al.*, 1997; Ward and McLeay, 1998; Ward *et al.*, 1998; Ward *et al.*, 2000).

Pilchard egg surveys are regularly undertaken in the southern Eyre Peninsula area (e.g. see Ward *et al.*, 2000).

Coffin Bay has been the site for studies on King George Whiting, including biological research (Jones, 1980; Jones et al., 1990) and fisheries research (e.g. Jones, 1983, 1987; Staniford and Siggins, 1992; Kumar et al., 1995). Fisheries research on other species (such as West Australian Salmon, Tommy Ruff, Garfish, Sand Crabs) has also been undertaken in **Coffin Bay** (e.g. Jones, 1983; Westlake and Jones, 1999). Some recent fishery stock assessment reports have also included information specific to Coffin Bay (e.g. see McGarvey et al., 2003, for King George Whiting).

In Coffin Bay, **The Brothers** is reported to be a significant archaeological site, since the discovery of fossil bones of six species, including an extinct kangaroo, giant flightless bird and a pinniped related to sea lions and fur seals, which date from the late Pleistocene period (c. 20,000 years ago) (Morelli and de Jong, 1995; Robinson et al., 1996).

Sleaford Bay is one of several sites in South Australia where the archaeology of whaling has been researched (e.g. see Staniforth, 1998; Staniforth and Richards, 2000). 'The Archaeology of Whaling in South Australia' project at Flinders University is part of a larger project in which the archaeology of whaling is being researched in both Australia and New Zealand. The study has involved the survey and archaeological investigation of whaling vessels throughout Australia (the maritime archaeology of whaling) and the survey and excavation of selected whaling station sites in South Australia. Sleaford Bay is one of the sites where remains of the whaling industry has been found.

Abalone populations are tagged and monitored along parts of **southern Eyre Peninsula** (e.g. see Shepherd et al., 1999; Rodda et al., 2000).

Wilderness and Aesthetic Values

The wilderness value of the southern Eyre Peninsula coast is reflected in the recommendation during the late 1990s for protection of the coastal area (**Coffin Bay National Park**) under the *Wilderness Protection Act 1992* (DEHAA, 1999). In an assessment of the wilderness quality of southern Eyre Peninsula by Lessie (1981), which has been incorporated into the National Wilderness Inventory, a large part of the park near **Point Whidbey** was ranked as being some of the highest wilderness quality in the State, and the highest quality on Eyre Peninsula, due to its low biophysical disturbance, amongst other assessed criteria (DEHAA, 1999). More recently (2003), **Point Whidbey** was declared a Wilderness Zone, under the *National Parks and Wildlife Act 1972*.

The coast of the **Coffin Bay National Park** has been described in tourism promotion materials, as "attractive", "isolated", containing "beautiful, unspoilt coastal wilderness", and being "spectacularly beautiful" (e.g. Wilkins, 1999; Fairfax Publishing, 2001; ATN, 2003). Some of the scenic features are described above, in the section on **Other Recreation / Tourism**.

Point Avoid and **Yangie Bay**, two of the few parts of the Coffin Bay Peninsula that are accessible by conventional vehicles, are promoted for their scenic appeal. The views of the rugged, isolated beaches on the western shoreline of Coffin Bay National Park, and the "dramatic view" across Coffin Bay from the Yangie Bay Lookout, have been described as "truly breathtaking". The spectacular, large sand dunes of the peninsula (some are over 100 metres high) are also promoted (Fairfax Publishing – F2, 2003).

Coffin Bay has been described as "*an area of outstanding beautythere are no other comparable systems of bays and inlets in so compact a form anywhere on the coast. Coffin Bay is a maritime wilderness area*" (Australian Heritage Commission, undated). The Australian Tourism Network (2003) described Coffin Bay as being "*situated on one of Australia's most beautiful estuaries, Coffin Bay offers a scenic smorgasbord of unspoilt inlets, bays and vast waterways*". In a recommendation for listing **Coffin Bay** on the Register of the National Estate, the Australian Heritage Commission (undated) described the wilderness and aesthetic values of the **Coffin Bay** area as follows: "The number of national and conservation parks already designated in the area lie along the coasts and so depend on the integrity of the waterways for a great deal of their own integrity. The waterways unite with the parks into a whole which cannot be separated into smaller units. It is an area of outstanding beauty only because of the system of bays and channels. The waterways must be preserved to preserve the natural condition of the remainder. Each landform can be viewed across stretches of water both from land and from sea; there are views across the Bays to peninsulas of native vegetation and to more bays beyond them, with abrupt and isolated hills and/or ranges in the distance inland. The miles of unspoilt waterways are the heart of the area, the untouched coasts provide their wild appeal" (Australian Heritage Commission, undated). Tourism associations also promote the picturesque nature of the area, including the "unparalleled scenic view of vast expanses of meandering waterways with bays, channels and inlets.." (Tourism Eyre Peninsula, 2003). Examples of very scenic locations include **Almonta Beach** and rugged **Avoid Bay** on the ocean side, and tranquil **Yangie Bay**, within Coffin Bay (Tourism Eyre Peninsula, 2003). Other scenic features are described above, in the section on **Other Recreation / Tourism**.

Kellidie Bay Conservation Park has been described as “a very picturesque area” (Australian Heritage Commission, undated).

Fishery Bay has been described as “picturesque”, with “a beautiful stretch of white sand and clean, cool water” (Aquanaut, undated).

The **Whidbey Islands**, listed on the *Register of the National Estate*, are considered by Australian Heritage Commission (undated) to be of “high scenic value”.

Register of the National Estate listing for the **Avoid Bay Islands**, considered that the close proximity of the islands to the shore gives them “enhanced aesthetic importance” (Australian Heritage Commission, undated).

The *Register of the National Estate* listing for **Rocky Island (South)** described the island as “picturesque” (Australian Heritage Commission, undated).

Lincoln National Park is recognised for its wilderness value, as it is one of the few areas in South Australia that contains relatively undisturbed coastal mallee habitat (G. Ogle, verbal submission to Environment, Resources and Development Committee, 2001). The coastline of the park is also relatively undisturbed, and undeveloped. The wilderness quality of the area is reflected in the recent designation of the Memory Cove Wilderness Area in the south-eastern section of the park (discussed in section 9.1.5), and such wilderness value also applies to the rest of the park, including the southern and south-western sections.

The southern coast of **Lincoln National Park** (e.g. **Sleaford Bay**) is described by tourism promotion materials as “spectacular”, and “breath-taking” (Tourism Eyre Peninsula, 2003). The entire coast is renowned for its wilderness quality and scenic assets (vegetated cliffs, rocky coves, beaches, islands). Examples of scenic spots include **Cape Carnot**, and also **Wanna Cove**, **Cape Tournefort**, and other places in **Sleaford Bay**. For example, the scenery at **Cape Carnot** has been described as “magnificent”, and **Sleaford Bay** is reported to have “fantastic beaches” (Australian Explorer, 2003).

Towns and Settlements

Coffin Bay: has a permanent population of about 450, which swells to between 2,000 and 3,000 people, during the holiday periods (Fairfax Publishing – F2, 2003; Tourism Eyre Peninsula, 2003).

Within inner Coffin Bay, areas of the peninsula on the western shore of the bay around **Shelley Beach** contain dwellings which are accessed from **Kellidie Bay** (PISA Fisheries - Aquaculture Group, 1997). Dwellings exist at **Mt Dutton Bay East** and **West**, and there are also dwellings at the small settlement of **Little Douglas** (PISA Fisheries - Aquaculture Group, 1997).

Within the Coffin Bay region, holiday housing has increased, and also new residential sub-divisions have been developed, in the **Coffin Bay** area (including **Kellidie Bay** and **Mount Dutton Bay**) during the past decade. Examples of residential sub-divisions in Coffin Bay include Holly Rise and Sophie Crescent.

Farm Beach is a small settlement with a caravan park and shacks (Fairfax Publishing – F2, 2003).

Ports, Harbours and Navigation

Coffin Bay is designated under the *Harbours And Navigation Regulations 1994*, as follows: The subjacent land underlying, and the adjacent land extending from, the waters, rivers, creeks and inlets to high water mark of **Coffin Bay**, **Port Douglas**, **Mount Dutton Bay** and **Kellidie Bay**, contained within a line drawn from **Point Sir Isaac** to a hill known as “**Frenchman Lookout**” in the Hundred of Warrow. There is a boating channel in the **Point Longnose** area (which separates outer Coffin Bay from **Port Douglas**); a number of channels into the southern and northern sections of **Mt Dutton Bay**, and a boating channel into **Kellidie Bay**.

Lavender Bay, at the southern end of **Mt Dutton Bay**, is particularly used for boat access to **Horse Peninsula** and as a safe haven for boats under certain weather conditions (PISA Fisheries – Aquaculture Group, 1997).

9.1.15 The 'Heel' of Yorke Peninsula (Gulf St Vincent Bioregion)

Aquaculture

The eastern part of the area described in this table, i.e. between **Point Gilbert / Port Moorowie** and **Troubridge Point**, was included as the western edge of PISA's Foul Bay / Port Moorowie Management Zone (part of the Lower Yorke Peninsula Policy Area), in which a maximum of 40ha of aquaculture would be permitted, according to the 1996 Gulf St Vincent Aquaculture Management Plan (Berggy, 1996).

PISA (see Berggy, 1996) also approved aquaculture development within a Gulf St Vincent West Policy area. Within this area, much of the coastal area (to two nautical miles seaward) has been designated as the Inshore Yorke Peninsula Management Zone, from north of **Edithburgh**, up to Muloowurtie Point on the western side of Gulf St Vincent. Within the Inshore Zone, a maximum of 100ha of aquaculture development was zoned by PISA. Berggy (1996) stated that **Coobowie Bay** has long been regarded as "an opportune site" for shellfish cultivation, and oyster trials were first conducted during the 1960s. **Stansbury** has been the site of oyster growing trials for "many years" (Berggy, 1996), sometimes with limited success, but there has been continuing interest in the area for oyster cultivation, both for trials and commercial cultivation.

An additional 60ha maximum development was approved by PISA for the **Coobowie Bay** Zone (which includes **Salt Creek Bay**), and 80ha for the Stansbury Zone. Development must be sited 1km from residential developments onshore in the **Coobowie** Zone, and 1.4km from the coast in the part of the Stansbury Zone that occurs 1km north of the Stansbury jetty. Waters two nautical miles seaward of the Inshore Zone have been classified in the Gulf St Vincent Aquaculture Management Plan as part of the Yorke Peninsula Offshore Management Zone, with provision for a maximum of 100 ha of aquaculture development, including sea cage farming (in waters deeper than 14m) and long line shellfish culture (in waters deeper than 10m) (Berggy, 1996).

According to the South Australian Coast and Marine Atlas (2003) and PIRSA Aquaculture's Public Register (August, 2003), the following aquaculture leases have been approved since 1996:

- ◆ **Salt Creek Bay**: 5 aquaculture leases (all licensed for growing Pacific Oysters);
- ◆ South-east of **Giles Point**: 1 aquaculture lease (Pacific Oysters);
- ◆ Between **Giles Point** and **Port Giles**: 1 aquaculture lease (Blue Mussels);
- ◆ North and east of **Oyster Point** (i.e. **Oyster Bay** and **Stansbury** area), 14 aquaculture leases (for Pacific Oyster).

During the early 2000s, there were technical investigations by government and consultants, of the potential of the area between **Edithburgh** and **Port Giles**, to support finfish and subtidal shellfish aquaculture. In 2003, there were 4 development applications in the offshore area.

Commercial Fishing

Scalefish, Sharks and Minor Invertebrates

Regionally, the major commercial fish and shark species that are caught around **the foot of Yorke Peninsula**, and **Investigator Strait**, northwards into south-western Gulf St Vincent to approximately Giles Point, include:

- ◆ **West Australian Salmon**: are caught by nets in the area. Jones (1999, Table 1) reported that the **Investigator Strait** area and Kangaroo Island combined, produce the largest catches of Australian Salmon. Southern Yorke Peninsula has been one of the top 3 areas of the State in terms of Australian Salmon yield in some recent years (e.g. mid-late 1990s);
- ◆ **Gummy Shark**: Recent figures are not available for this report. The fishery has recently been re-

regulated by the Commonwealth (see section on **Issues for Risk and Impact Assessment**);

- ♦ *King George Whiting*: no recent figures are available, however McGarvey *et al.* (2000) showed that the hand line catch for the entire Gulf St Vincent region in 1999 was below the long term average of around 30t per annum (i.e. records between 1977 and 1999) and that hand line effort has continued to decrease since the mid 1990s; that gill net catch in 1999 was slightly above the long term average of around 15t per annum; and that haul net catch has consistently fluctuated over the period between 1977 to 1999, but was slightly more than the long term average of around 30t in 1999;
- ♦ *Garfish*: no recent catch data specific to the area are available for this report;
- ♦ *Snapper*: no recent figures are available, however Fowler reported in 2002 that hand line catches in the Southern Gulf St Vincent region were as follows: 1997/98: 8.7t; 1998/99: 10.7t; 1999/00: 14.3t, and 2000/01: 13.2t.; and that long line catches between that 4-year period have ranged between around 2.5 and 3.9t (Fowler, 2002); and
- ♦ *School Shark*: No recent figures are available for this report. The fishery has recently been re-regulated by the Commonwealth (see section on **Issues for Risk and Impact Assessment**);
- ♦ *Tommy Ruff (Australian Herring)*: no recent figures specific to the area are available, however Westlake *et al.* (2002) reported that for Gulf St Vincent and Kangaroo island combined, the target commercial catch of Tommy Ruff in 2000/01 was 13.5t, and the non-target catch was 62.9t.

Other commercial species caught in the region include *Trevally*, *Snook*, *Southern Calamari*, and *Leatherjacket* species. More than 28 other fish species have been caught commercially in recent years, in minor quantities. Apart from Gummy Sharks and School Sharks, *Bronze Whalers* and other shark species are caught commercially in the Southern Yorke area, in lesser quantities than Gummy and School Sharks.

Catch and effort data specific to the “**heel**” of **Yorke Peninsula** and **eastern Investigator Strait**, are not available for this report, however the area forms the eastern part of GARFIS Block 40. Previously, according to SARDI (cited by Edyvane, 1999b), the Marine Scalefish and Shark catch from GARFIS Block 40 (from approximately Daly Head in the West, and including waters of Investigator Strait to approximately 35°30'S, across the foot of Yorke Peninsula, northwards into south-western Gulf St Vincent (GSV) to approximately Giles Point, as far seawards as 138°E) was as follows:

- ♦ 1995/96 a total of 200, 171kg (1.93% of State total, representing 54 fishers); and
- ♦ 1996/97 a total of 211,150kg (2.08% of State total, representing 51 fishers).

Marine Scalefish and Restricted Marine Scalefish licence holders contributed to these yields. The proportion of the above yields that relates specifically to the area described in this table is not known for this report.

Further north, from **Port Giles** to approximately Rogues Point, major commercial fish and invertebrate species that are caught include:

- ♦ *Garfish* (a major fish species caught commercially in the area, in terms of yield);
- ♦ *King George Whiting* (although not a major area for commercial fishing of this species, in some recent years, such as the mid-late 1990s, the area has been amongst the top 20 in terms of yields from approximately 36 fishing blocks in which King George Whiting is commercially caught);
- ♦ *Southern Calamari*; and
- ♦ *Blue Swimmer Crab* (mainly in the northern part of the area, and amongst 7 regions in S.A. in which blue crabs are caught by commercial scalefish fishers, in addition to licensed crab pot fishers).

Around 14 other fish species have been caught commercially in recent years, including Tommy Ruff, Australian Salmon, Snook, yellow-eye mullet, Snapper, and sharks (e.g. bronze whaler and other species), although shark fishing is minor in this region compared with some other areas.

Catch and effort data specific to the area from **Port Giles to Stansbury** are not available for this report, however the area forms part of GARFIS Block 34. Previously, according to SARDI (cited by Edyvane, 1999b), the Marine Scalefish and Shark catch from GARFIS Block 34 (from approximately Giles Point, northwards to approximately Rogues Point, as far seawards as 138°E) was as follows:

- ♦ In 1995/96 a total of 113, 884kg (1.09% of State total, representing 37 fishers);
- ♦ In 1996/97 a total of 75,173kg (1.74% of State total, representing 30 fishers).

Marine Scalefish and Restricted Marine Scalefish licence holders contributed to these yields. The proportion of the above yields that relates specifically to the area discussed in this table is not known, for this report.

On a State-wide scale, aggregated catch figures for all GARFIS Fishing Blocks in South Australia, between 1995 and 1997, show that the southern Yorke Peninsula / northern Investigator Strait area (Block 40) was ranked 13th in 1995/96, and 14th in 1996/97, in the list of fishing yields from 58 South Australian fishing blocks during that period. During the same period GARFIS Block 34 was ranked 22nd in 1995/96, and 27th in 1996/97.

More specific to the area discussed in this table, Jones (pers. comm. 1996, cited by Edyvane, Paxinos and Clarke 1996) provided a list of the major species caught commercially in the region that includes the “**Heel**” of Yorke Peninsula, which include:

- ♦ *Snapper*: fished using hand line and long line, mainly around **Troubridge Island**, in waters deeper than 20m;
- ♦ *Yellow-Eyed Mullet*: mainly caught in shallow waters (to 5m) in the **Edithburgh** area, using gill and haul nets;
- ♦ *King George Whiting*: caught around **Edithburgh**, using haul and gill net, and from **Stansbury** northwards, using haul and gill nets and handlines, in waters to around 10m;
- ♦ *Tommy Ruff*: caught around **Edithburgh**, **Stansbury** and northwards, mainly using gill nets and haul net, in shallow waters (to 5m);
- ♦ *Australian Salmon*: caught by seine and haul netting at **Troubridge Point**, **Troubridge Hill** (out of the Reserve), and in the **Stansbury** area and northwards, using haul nets and gill nets, in shallow waters (to 5m);
- ♦ *Snook*: caught around **Edithburgh** by trolling in waters over 20m depth, and in the **Stansbury** area and northwards, using haul and gill nets, seaward to 5m;
- ♦ *Leatherjackets*: a bycatch of King George Whiting fishery (e.g. around **Edithburgh**), and also caught using haul and gill nets in the **Stansbury** and **Port Giles** areas;
- ♦ *Sharks*: caught mainly in deeper waters along the lower Yorke coast, using long mesh gill nets, in waters over 20m. Gummy shark is often caught near **Stansbury** and **Port Giles**;
- ♦ *Garfish*: caught along the whole western Gulf St Vincent coastline, in shallow waters (to 5m), using hauling nets and dab nets. Also caught in the **Edithburgh** area, using hoop nets, to approximately 10m depth;
- ♦ *Southern Calamari*: caught around **Edithburgh**, using squid jigs and hauling nets. Also caught from **Stansbury** northwards along the coast, to 8m - 9m depth;
- ♦ *Yellow-fin Whiting*: caught from **Stansbury** northwards, using hauling and gill nets, in shallow waters (to 5m);
- ♦ *Sand crabs* are caught south of Port Vincent, according to Berggy (1996).

McGlennon and Kinloch (1997c) showed, in a comparison of recreational and commercial fishing resulting from a recreational boat fishing survey during April 1994 – March 1996, that, during the survey period:

- ♦ the commercial catch of Southern Calamari from south-western Gulf St Vincent (i.e. north of the “heel” of Yorke Peninsula) was more than three quarters of the combined yield from commercial and recreational boat fishing for Calamari in that area
- ♦ the commercial catch of Tommy Ruff (Australian Herring) from south-western GSV accounted for around three quarters of the total yield from commercial and recreational boat fishing for Tommy Ruff in the area, at that time;
- ♦ the commercial net catch of Garfish from south-western GSV (i.e. north of the “heel” of Yorke Peninsula) accounted for more than three quarters of the total yield from commercial and recreational boat fishing for Garfish in that area, at that time; and (iv) approximately half of the total yield of King George Whiting from the eastern Investigator Strait area (south of the “heel” of Yorke Peninsula) was taken by commercial line and net fishers using boats at that time.

McGlennon (1996) reported that during the mid 1990s, the multi-lane concrete boat ramp at **Edithburgh**, was used around 6% of the time for commercial fishing.

Netting Closures in the Scalefish Fishery

Edithburgh: All waters south west of a line from **Sultana Point** to a point on the mainland adjacent to

the roadway between sections 185 and 205 Hd Melville. In addition to this total closure, nets are prohibited in waters exceeding 5 metres in depth contained within a line from **Sultana Point** to **Marion Reef** buoy, then to **Troubridge Island** lighthouse and then to a point adjacent to **Giles Point** (PIRSA, 1999).

Coobowie: Waters within a line from the **Salt Swamp Creek** causeway to the end of the old **Coobowie** jetty structure and then to **Hickies Point** (PIRSA, 1999).

Rock Lobster Fishing

The area discussed in this table is part of GARFIS fishing Block 40, which extends from approximately **Daly Head to Giles Point** area. Within that area, figures specific to the heel of Yorke Peninsula are not currently available, but the following information is provided:

- ◆ Previously, the yield from the entire GARFIS Block 40 (encompassing the fishing area of 19 fishers during 1995 - 1997) was 71,795kg in 1995/96 and 64,785kg in 1996/97, representing 1.4 and 1.3 % of the State catch of Rock Lobster during those years (Edyvane, 1999b, citing SARDI data). Aggregated catch figures for all fishing blocks in South Australia, in 1995-1996, showed that Fishing Block 40 (see above) was the *10th most important commercial Rock Lobster fishing area in South Australia* at that time, in terms of yield (and hence value), but the proportion of the yield from the entire southern Yorke Peninsula that pertains only to the “heel” of the peninsula, is not known for this report.
- ◆ Ward *et al.* (2002) showed that the yield from Fishing Block 40 was above 50t in all years between 1988 and 2000 (and over 100t in 3 of those years, during the early 1990s), but that catch in 2001 was below 50t. Effort in 2001 amounted to around 40, 000 pot lifts, in Fishing Block 40 (see Ward *et al.*, 2002, Figure 2.5).

In the northern part of the area discussed here (i.e. part of Fishing Block 34), Rock Lobster fishing is not significant due to lack of suitable reef habitat.

When the entire Northern Zone is considered as a whole (i.e. from the Western Australian border, through to Encounter Bay and deeper waters south of Kangaroo Island), the catch for the 2002 season was 594.8 tonnes, being the lowest catch in the Northern Zone since 1979 (Ward *et al.*, 2003).

Bycatch information specific to the heel of Yorke Peninsula is not available for this report. Predators of Rock Lobster in the Northern zone include New Zealand Fur Seals, Western Blue Groper (minor) and Maori Octopus (McGarvey *et al.* 1998; S. Shepherd, pers. comm., 2004). McGarvey *et al.* (1998) and Prescott (2001) reported that the largest proportion of bycatch in the Northern Zone as a whole, is Leatherjackets and Maori Octopus. According to the results of a sampling program of bycatch in 1991 and 1992, various wrasse species (Labridae family) together constituted another major component of the bycatch in the Northern Zone. For example, 1127 Labrids were caught in pots during the bycatch sampling program in 1991-92 (Table 5 in Prescott, 2001). Octopus are a major predator of Rock Lobster, with losses due to octopus predation equating to approximately 4% of the total number of lobsters landed (in the Northern Zone). According to McGarvey *et al.* (1998), the catches and catch rates of octopus have been sustained over time, and vary from 1 – 2.5 octopuses per 100 potlifts. Octopus that are caught in the northern zone are sold.

Rock Lobster fishers are also permitted to retain legal sized Giant Crab when caught as by-product, and this species is becoming increasingly valuable, commercially (McGarvey *et al.*, 1998). A small number of Commonwealth-endorsed Rock Lobster fishers also target Giant Crab specifically. Between 1992/93 and 2001/02, total Giant Crab catches (target and byproduct catches combined) have ranged between 7t in 1992/93 and 33t in 1998/99, with a steady decline between 1999 and 2002 due to the introduction of quotas (e.g. 31t in 1999/00; 24t in 2000/01, and 18.5t in 2001/02) (Knight *et al.*, 2003, cited by Sloan, 2003b). The fishery now operates under a quota-based management system with a total allowable commercial catch (TACC) of 13.4 and 8.7 tonnes for the Northern Zone and Southern Zone, respectively (Sloan, 2003b). Giant Crabs are caught from the edge of the continental shelf in the west coast region (McGarvey *et al.*, 1998).

Some Rock Lobster fishers net sharks out of season, and some of these activities require a Commonwealth permit. Licensed Rock Lobster fishers have also had access to fish species, such as Australian Salmon, Mulloway, and Snapper (Zacharin, 1997, cited by McGarvey *et al.*, 1998).

Prawn Fishing

According to Jones (1996, pers. comm., cited by Edyvane *et al.*, 1996), prawns are caught commercially all along the **western GSV** coastline, from **Troubridge Hill** to just below Ardrossan, in waters to 20m - 30m.

The waters from **Point Yorke** eastwards of **Waterloo Bay** form part of the GSV Prawn Fishery grounds. Prawn fishing reportedly does not occur in waters shallower than the 10m bathymetric contour (although Blocks 120 and 121 have waters around that depth, and were trawled in 1978, according to maps in report by Morgan, 1995). Between **Point Yorke** and **Troubridge Hill**, Blocks 111, 112, 113, 114, 117, 118 have been trawled intermittently since 1968 (Morgan, 1995). Between **Troubridge Hill** and **Giles Point**, some blocks (i.e. blocks, or parts thereof, of the following: 23, 27, 26, 25, 39, 24, 40, and 111), in relatively shallow water (i.e. to approximately the 15m contour, according to the S.A. Coast and Marine Atlas, 2001), have been trawled regularly between 1968 and 1994 (Morgan, 1995).

Figures specific to the area discussed in this table are not available, however the total catches of Western King Prawns from Gulf St Vincent in 2000/01 and 2001/02 were reported to be 384t and 322t respectively (SARDI Aquatic Sciences statistics, 2003). Svane (2003) reported that in 2002/03, the total prawn catch from all areas of GSV combined, was 231.9t, being 29% smaller than the previous year's catch, and 42% smaller than the 1999/2000 catch. Fishing effort (3791 trawl hours, over 53 nights) was higher in 2002/03 than in the previous two seasons, but the catch was lower. The catch in the 2002/03 year was almost as low as that taken in 1991, when the fishery was closed. The catch rate in 2002/03 was 61.2kg per hour, the lowest since the fishery was re-opened in 1994. Fishery independent surveys in the 2002/03 season showed that the abundance of new recruits was low (Svane, 2003). This contrasts sharply with the reported state of the fishery a few years previously. For example, Boxshall and Williams (2000) reported that (i) the total catch for the 1999/2000 GSV prawn season (i.e. from all areas of the GSV fishery combined) was 400.24 tonnes, the highest catch recorded since the 1983/84 season; (ii) catch rates for the season (99.03 kg / boat hr) were the highest recorded in the history of the fishery; and (iii) the total level of fishing effort (4042 boat hrs) increased over that seen in the previous (1998/99) season, but remained within limits set for the fishery. Boxshall and Williams (2000) considered the performance of the fishery in 1999/00 to be consistent with a fishery that had rebuilt to previous levels; that the recovery was likely to have been assisted by strong recruitment over the past two seasons prior to assessment, and that recruitment levels are variable, and it was unlikely they would be sustained at high levels on a consistent basis. However, as reported by Svane (2003), the strong recruitment apparently did not persist, based on the low catch for that season, as well as data for 2002/03 which showed mainly large adult prawns in the catch; a widely dispersed fleet (reflecting low prawn abundance); the lowest catch rates recorded in a 10-year period of fishery-independent surveys, and few recruits (young prawns) in the surveyed areas. Spatial and temporal restrictions to catch and effort were recommended, to prevent continued declines in prawn biomass (Svane, 2003).

Abalone Fishing

Aggregated figures are available for the area East of **Foul Bay** to **Sultana Point** (i.e. Map Codes 24E, 24F, part of which is included in the "heel" area). Between 1990 and 1996, recorded annual yield (approximate whole weight) of both Greenlip and Blacklip Abalone in the region was negligible (S. Shepherd, SARDI, pers. comm., 2000). *Perkinsus* infection has severely affected stocks in the area throughout the late 1980s to 1990s. Prior to 1984, reported annual Greenlip Abalone catch ranged between approximately 6.5t and 34t (whole weight) from the eastern side of Foul Bay to Sultana Point area (S. Shepherd, SARDI, pers. comm., 2000). Note that Blacklip abalone catch in this area has historically been negligible, even prior to the *Perkinsus* outbreak.

Aggregated figures are available for the area from **Ardrossan** southwards to **Sultana Point** (i.e. Map Codes 22B, 24B, 24C, 24D, part of which is included in the "heel" area). Between 1990 and 1996, recorded annual yield of Greenlip Abalone was less than 1t (whole weight), and yield of Blacklip Abalone was approximately 190kg (recorded in only one year of the period from 1990 to 1996) (S. Shepherd, SARDI, pers. comm., 2000). Annual Blacklip Abalone yields in the area have been negligible in most years since 1979. Greenlip abalone yields have been historically highly variable, but regionally significant in some years (e.g. around 46t in 1979, and 54t in 1980). As occurred in the

Foul Bay to Sultana Point area, *Perkinsus* infection has severely affected stocks in the area throughout the late 1980s to 1990s, resulting in negligible yields.

According to Jones (pers. comm. 1996, cited by Edyvane *et al.*, 1996), commercial diving for Greenlip abalone in the “heel” of Yorke Peninsula area now occurs mainly from **Black Point to Troubridge Hill**. The extent to which the reefs have recovered from the *Perkinsus* infection and the viability of commercial harvesting is not known for this report.

According to Mayfield *et al.* (2001), the “heel” of Yorke Peninsula is one of the fishing areas in the Central Zone in which abalone fishing effort has exceeded an average of 30 trips per year, between 1980-1984 and 1988-1992, but not between 1996-2000.

Recreational Fishing

Berggy (1996) described the recreational fishing catch from the southern Yorke Peninsula area as being “very large”, and in some cases exceeding the commercial catch. Recreational fishing in the southern Yorke Peninsula area is economically, regionally important particularly for the coastal resort towns. Bryars (2003) summarised the fishing activities in the “**Heel or Yorke Peninsula**” area as including line fishing, netting, dab netting, spear fishing, and dive fishing (for molluscs and crustaceans).

Generally, recreational fishing (from boat, jetty and shore) for scalefish is a popular activity around **Edithburgh, Tapley Shoals** and around **Troubridge Island**, and **Coobowie**.

Main species targeted by boat anglers around south-western Gulf St Vincent include Garfish, King George Whiting, Tommy Ruff, Southern Calamari, and Blue Swimmer Crab. Recreational fishers also catch Australian Salmon, Snook, Red Mullet, leatherjacket species, Trevally, Mulloway, Silver Drummer, Striped Trumpeter, and Greenlip Abalone (McGlennon and Kinloch survey, cited by Edyvane *et al.*, 1996). In the southern part of the peninsula, surf rod fishing occurs at **Troubridge Point**, and recreational fishers target Australian Salmon, sweep and Snapper from rocks around the “heel” of Yorke Peninsula.

McGlennon and Kinloch (1997c) showed that, according to a comparison of recreational and commercial fishing resulting from a recreational fishing survey during the mid 1990s, (i) the recreational catch of Southern Calamari from **south-western GSV** (i.e. north of the “heel” of Yorke Peninsula) was less than a quarter of the yield from commercial jigging and netting for calamari in that area, at that time; (ii) the recreational catch of Tommy Ruff (Australian Herring) from south-western Gulf St Vincent was around a quarter of the yield from commercial netting for Tommy Ruff, at that time; (iii) the recreational catch of Garfish from south-western Gulf St Vincent (i.e. north of the “heel” of Yorke Peninsula) was less than one fifth of the yield from commercial netting (including “dab-nets and other nets) for Garfish in that area, at that time; and (iv) almost half of the total yield of King George Whiting from the eastern Investigator Strait area (south of the “heel” of Yorke Peninsula) was taken by recreational fishers at that time.

North of **Edithburgh**, a SARDI survey of boat angling catches during the early-mid 1990s, recorded the following percentage breakdown: Garfish 27%; King George Whiting 26%; Tommy Ruff 15%; Southern Calamari 9%; Blue Swimmer Crab 7%; Snook 2%; Leatherjacket 1%; Red “Mullet” 0.9%; Trumpeter 0.7%, and Australian Salmon 0.4% (McGlennon and Kinloch survey data, cited by Edyvane *et al.*, 1996). Other fish caught by anglers in the area include flathead species, Trevally, Mulloway, Snook and Silver Drummer.

Troubridge Point is listed as one of the top 20 shore fishing locations in S.A. for recreational anglers, based upon survey of long term recreational fishers and fishing experts (Capel, 1994). Beach and rock fishing occur in the area, and major species targeted include flathead, mullet, Australian Salmon, Snapper, Mulloway, Snook, sweep, Tommy Ruff and Silver Drummer. The shallow waters around Troubridge are popular for recreational fishing. Mullet, Whiting species, and Tommy Ruff are the main species caught on sandflats at incoming tide (NPWS, 1995). “The Paddocks” area, east of Edithburgh is also listed amongst the best fishing spots in S.A. (Capel, 1994). Some of the main species of interest being whiting, both large and small Snapper and Red “Mullet”.

According to regional tourism and fishing promotion materials, there are at least two fishing charter boats operating out of **Edithburgh** (including charter trips to **Troubridge Island**), targeting some of the

species described above (e.g. King George Whiting, Snapper, and other species).

The significance of beaches and inshore waters in the **Coobowie/Salt Creek Bay** areas for recreational fishing (and other recreational and seasonal tourism activities) was reflected in PIRSA's (1996) decision to approve aquaculture developments only if they were proposed 1km or more seaward of the beaches and inshore waters.

Yorke Peninsula tourism promotion materials state that the jetties at **Wool Bay** and **Edithburgh** have "great runs of fish or squid" at various times of the year, and that the most popular species taken from Yorke Peninsula jetties include Mullet, Snook, Garfish, Snapper, crabs, Mulloway, Tommy Ruff, King George Whiting and other whiting species, Southern Calamari, West Australian Salmon, flathead species, and shark species.

Other recreational fishing information specific to the area includes the following (McGlennon and Kinloch survey data, cited by Edyvane, 1996b; Sweeney, 1997; FishInternet Australia, 2000; Yorke Peninsula Tourism Association, 2000, 2001). This is an incomplete list, but indicative of some of the major species caught:

- ♦ **Edithburgh, Tapley Shoal and Troubridge Island:** Southern Calamari, Tommy Ruff and Cuttlefish are caught from the jetty at **Edithburgh**, and from rocks in the area. Edithburgh jetty is a popular fishing spot, and attracts a large number of anglers during holiday periods. Fish which are regularly caught from the jetty in summer include: Tommy Ruff, Southern Calamari, mackerel, Garfish; in winter and spring mainly Tommy Tuff and Southern Calamari ("considerable numbers"); in autumn and winter larger King George Whiting (usually well over 30cm), caught by casting north, further out into the sand holes. Calamari and Whiting are also taken from the rocks north of the jetty (Sweeney, 1997). Boat fishers in **Edithburgh** and **Troubridge** area catch King George Whiting (including large fish to 55cm), Garfish, Leatherjackets, Tommy Ruff and Snapper, amongst other species. In addition to these species, Sand Flathead, Yellow-eye Mullet, and Trevally are also targeted in the area. Snapper are a main target at **North Shoals reef** (24m) near **Edithburgh**.
- ♦ There are recreational boat fishing markers for **Tapley Shoal**, where Snapper is a major target species.
- ♦ **Marion Reef:** boat fishing in shallow water, with Snapper, Sweep, Snook, and shark species being prime targets. There are recreational fishing markers for fishing near the Marion light. Snapper and Whiting species are targetted at the Drop-off. ("Newton's Ground").
- ♦ **Troubridge Point:** Recreational surf and rock fishing competitions occur in the area, where Mullet, Tommy Ruff, Australian Salmon, Sweep, Silver Drummer, Flathead and Leatherjackets are caught, amongst other species. Eagle Rays are sometime targetted from the shore in the area. There is a 5m ledge in the area where Snapper, Trevally, and Whiting are targetted.
- ♦ Angling clubs hold fishing competitions in the **Edithburgh, Coobowie** and **Port Giles** areas, where competitors fish from boats, rocks and jetties for Whiting, Tommy Ruff, Snapper, Australian Salmon, Sweep, Silver Drummer, Snook and other species.
- ♦ **Port Giles:** Southern calamari and Tommy Ruff are often caught from the jetty. Other jetty species include King George Whiting, Snapper, Snook, Garfish, Trevally, and Silver Drummer.
- ♦ **Wool Bay:** Many of the species listed for Port Giles are caught in the Wool Bay area. Tommy Ruff are often caught from the shore and jetty.
- ♦ **Stansbury:** King George Whiting, Tommy Ruff, Trumpeter, Snapper, Leatherjacket species, Trevally, Snook, Flathead, Garfish, Silver Drummer, Southern Calamari, and Mulloway, amongst other species, are caught mainly from the jetty and shore in this area. Some of these species are taken by fishers in boats (including large quantities of Garfish during periods when the species is "running" in the area). Crab fishing is also popular for recreational fishers and visitors. There is a jetty, used for fishing, and an all-weather boat ramp in the area.

Some of the recognised fishing marks (Pescatore and Ellis, 1998; Fish SA, 2000) for recreational boat fishers in the area include:

- ♦ reef east of Troubridge Hill Aquatic Reserve;
- ♦ the rocky outcrop beside a 5m ledge at Troubridge Point, at 6m – 14m depth;
- ♦ reef (including the "drop-off") in the Marion Reef area;
- ♦ the navigation marker, a buoy, and a pole, all on sand bottom in Sultana Passage.

- ♦ North Shoals reef near Edithburgh (24m).
- ♦ at least 14 locations (mainly reef patches and ledges and depressions between sand shoals) east and north-east of Troubridge Island;
- ♦ dissected reef, and the artificial reef (tyres) south of Port Giles;
- ♦ sites in shallow seagrass beds and sand off Wool Bay and Stansbury, including the “Stansbury Hump”.

Recreation fishing for Rock Lobster also occurs in the **Southern Yorke Peninsula** area, such as **Port Moorowie** (e.g. see Tyrer’s 1994 Management Plan from PIRSA, and marine tourism promotion materials for Yorke Peninsula). Recreational fishers also target Greenlip Abalone in the area (Jones, pers. comm. 1996, cited by Edyvane *et al.*, 1996). There are no figures available for recreational lobster fishing in the southern Yorke Peninsula area, however Ward *et al.* (2002, citing McGlennon, 1999) reported that in the entire northern Zone (which extends from the WA border to Encounter Bay area), recreational catch using lobster pots was approximately 27 tonnes, or 2.6% of the commercial landings during the 1998 season.

There are jetties used for recreational fishing at **Edithburgh, Wool Bay, Stansbury, and Port Giles**. Almost 92% and 89% of the use of multi-lane concrete boat ramp launching facilities was for recreational fishing at **Stansbury** and **Edithburgh** respectively, according to a 1996 survey (McGlennon, 1996). There is also a small boat ramp at **Port Moorowie**, mainly used by recreational fishing boats.

Diving and Snorkelling

Numerous sites within the area described in this table are significant for recreational diving. Dive promotion materials describe Yorke Peninsula as being “extremely popular with South Australian and Victorian divers”. **Troubridge Point, Troubridge Hill, Troubridge Island**, the sponge beds between **Edithburgh** and Troubridge Island, **Edithburgh Jetty**, wreck sites such as the **Clan Ranald** (and the reefs and outcrops surrounding the wreck), and other sites in the area described in this table, are amongst the popular dive sites in the region. These locations are listed in various diving guides, such as DIASA (undated), Christopher (1988), Aquanaut (undated) and Dive Oz (1998-2003), and sites in the area have been described as “superb” and “spectacular” diving. In addition to these sites, two wrecks on **Marion Reef** are listed in Christopher’s (1988) Divers’ Guide to S.A., and the wreck of the **Iron King** near Troubridge Island is also listed by DIASA. **Clan Ranald** has been described as one of the best wreck dives on the S.A. coast (State Heritage Branch, DEP undated), and recognised in diving guides as the most popular wreck diving spot on Yorke Peninsula. Berggy (PIRSA, 1996) stated that the waters around **Troubridge Island** are considered to be very dangerous for diving.

The wrecks around **Troubridge Island**, and along the coast between the island and the mainland, have been promoted for diving (Dive South Australia, 2004).

There are dive charter trips that operate out of **Edithburgh**. Within the town itself, the **Edithburgh jetty** has been described as one of the “most interesting jetties” for diving in South Australia (Christopher, 1988), and one of the “best” jetty dives in S.A. (DIASA, undated). Numerous dive clubs (and thousands of divers) have regularly used these sites (particularly **Edithburgh**) for training and recreation, for decades. Apart from diver training, the **Edithburgh** jetty is also a popular location for underwater photography. The jetties at **Stansbury** and **Port Giles** are also recognised for recreational diving.

Recreation and seasonal tourism (associated with marine activities, of which diving is also significant in this area) is a major economic contributor to the **Coobowie** area.

There is a tidally exposed reef at **Port Moorowie** that is has been described by tourism promotion material as being “very interesting for snorkelling”.

There is an artificial reef at **Coobowie** which is promoted to divers, and listed in DIASA’s guide to the best diving sites in S.A.. There is also an artificial reef at 15m depth, at **Giles Point** (tyre modules).

The jetty at **Port Giles** is also considered to be of value for diving, due to the invertebrate growth on the pylons, and other features (see **Part 1** of this table).

Other Recreation / Tourism

Berggy (1996) described **Edithburgh** and **Stansbury** as “high use” areas for tourism and recreation.

Planning SA's (1997) *Yorke town Development Plan* described **Stansbury** as a “major tourist and holiday resort” and the objectives of development in the area included the requirement to retain the town as a service centre and holiday / tourist resort, and provide for increased tourist facilities in the foreshore area.

Yorke Peninsula tourism promotion materials describe **Stansbury** as a popular place for fishing (see section above on **Recreational Fishing**), particularly during the summer holiday season, with the bay being a “hive of activity”, during the summer months, with fishers, wind surfers and water-skiers. Other activities include diving (see section above), swimming, walking along the jetty and the coastal area. There is a coastal walking trail, which runs 2.7km from the Foreshore Caravan Park to the cemetery.

Planning S.A. (1997) described one of the primary functions of **Coobowie** as being a “small holiday resort”. Similarly, **Edithburgh** was described as being a “small holiday resort” and “tourism and recreation resort”, apart from its role as a service centre. Edithburgh jetty is a popular place for fishing, and is close to a number of other popular jetties. Edithburgh is considered to be a popular place for anglers to stay and use as a base, providing an important source of revenue to the local economy (Yorke Peninsula Tourism Association, 2000). Some of the development proposals for Edithburgh listed in the Yorke town Development Plan, centre on developing facilities for coastal tourism (associated with the foreshore, jetties etc). **Wool Bay** was described in the development plan as a “holiday town” and “holiday home settlement”, and the development principles include the need to preserve the “seaside character” of the area. **Port Morowio** was described by Planning S.A. (1997) as a “small recreation and holiday house settlement” with “seaside character”.

Berggy (1996) described the **Coobowie / Salt Creek Bay** area as supporting a “number of uses”, being partly surrounded by both permanent and seasonally occupied (holiday) housing. The population has increased during the past decade due to immigration by retirees. Seasonal tourism (and the associated activities of fishing, boating and diving etc.) is considered to be a major economic contributor to the **Coobowie** area (Berggy, 1996). The significance of beaches and inshore waters in the area for recreation/tourism activities was reflected in PIRSA's (1996) decision to approve aquaculture developments only if they were proposed 1km or more seaward of the beaches and inshore waters. Both **Coobowie** and **Port Giles** were listed by Berggy (1996) as being comprised mainly of holiday and retirement shacks.

Troubridge Point – Port Moorowio: Considered by Australian Heritage Commission to be “interesting, popular with tourists and clearly part of the National Estate”. **Port Moorowio** is used for coastal holidays/weekend trips to shacks in the area.

The **Troubridge** region is a popular anchorage for cruising yachts, and a popular swimming site (NPWS, 1995). The waters around **Troubridge Island Conservation Park** provide opportunities for water based recreational activities (Troubridge Island Conservation Park Management Plan, 1993). There are guided eco-tours running to **Troubridge Island**, and the lighthouse cottages are used year round for short holidays, involving swimming, fishing, snorkelling, beach walking and bird watching.

According to tourism promotion materials for Yorke Peninsula, swimming in sheltered bays and coves occurs in most coastal towns in the Southern Yorke area.

Tours of oyster farms in the **Edithburgh – Coobowie** area are available.

Historic / Protected Shipwrecks

The area is significant in terms of historic shipwrecks. There are at least 35 wrecks around Troubridge Island alone, including a number of the oldest shipwrecks in South Australia (Dive South Australia, 2004). A number of the shipwrecks around Troubridge Island are exposed at low tide, and can be accessed on foot (NPWS, 1995).

Shipwrecks in the area that are protected under the S.A. *Historic Shipwrecks Act 1981* include:

- ♦ *Success*, iron ketch built 1883, wrecked 1917, west of **Troubridge Hill**, but not found.
- ♦ *Sultana*, wooden barque built 1837, wrecked 1849 at **Sultana Point**. Several barges and a 15m cutter were salvaged from this wreck (Robinson *et al.*, 1996).
- ♦ *Marion*, 3-masted wooden ship, built 1850, wrecked 1851 at **Marion Reef**. Located on shallow limestone reef in 4m of water, approximately 9km south-east of Edithburgh. Part of the hull, and many artefacts and fittings remain (State Heritage Branch, DEP, undated).
- ♦ *Sir Wilfred Lawson*, wooden ketch built 1878 and wrecked 1908 off **Point Gilbert**, but not found.
- ♦ *Iron King*, 3-masted iron ship, built 1867, wrecked 1873. Located in waters 6m deep, approximately 9km south-east of **Edithburgh** (near the *Marion*). Many parts of the ship remain, including plating, frames, fittings, machinery, and part of the hull, as well as cargo and other artefacts (State Heritage Branch, DEP, undated).

Shipwrecks protected under *Commonwealth Historic Shipwrecks Act 1976*:

- ♦ *Clan Ranald*, a 3600 tonne single-screw turret deck steamer built 1900, wrecked 1909, west of **Troubridge Hill**. Located in 25m of water, approximately 700m from shore. Although the hull has now collapsed into a heap of rubble about 1m high (S. Shepherd, pers. comm., 2004), the site is considered to contain significant archaeological data on turret deck steamers (State Heritage Branch, DEP, undated), and some fittings and machinery occurred at the site. The anchor is located on the cliffs above the wreck, as a monument. The *Clan Ranald* is listed on the *Register of the National Estate* due to its European Heritage value.

Other historic shipwrecks in the **Troubridge Island** area include:

- ♦ *Dart*, brig wrecked 1838;
- ♦ *Parsee*, barque wrecked 1838;
- ♦ Unknown ship wrecked in 1839, between the *Dart* and *Parsee* (Robinson *et al.*, 1996).

Other European Heritage Values

Apart from historic shipwrecks (see above), the **Edithburgh** and **Wool Bay** jetties are listed as being of Heritage Significance (see Planning S.A., 1997). The **Wool Bay jetty** is on the *State Heritage Register*.

The lighthouse on **Troubridge Island** is the only example of a cast iron lighthouse in South Australia, and is the second oldest remaining lighthouse in South Australia. Both the lighthouse and keepers' cottages are considered to be an important part of the State's maritime heritage, and are listed on both the *State Heritage Register*, and the *Register of the National Estate* (Troubridge Island Conservation Park Management Plan, 1993; Australian Heritage Places Inventory, undated; DEH, 2003f).

The **Troubridge Hill Lighthouse** and **Clan Ranald Shipwreck** are both on the *Register of the National Estate* (Australian Heritage Places Inventory, undated). According to the Australian Heritage Commission, the *Clan Ranald* demonstrated the principal characteristics of the class of turret deck steamer (N.B. presumably prior to the collapse of the hull), and had the potential to provide archaeological information on such matters as construction, materials, fittings, rations for seamen, working conditions on board and other research topics. Furthermore, the number of death that occurred is considered to increase the significance of the wreck.

Aboriginal Heritage Values

Two of the Aboriginal heritage sites on Yorke Peninsula have been radiocarbon dated. The first, a site at **Troubridge Hill**, was found to be over 500 years old. The second is a campfire at **Port Moorowie**. This was found to be about 900 years old. It is possible however that some sites are be much older than this, possible several thousand years old or more (District Council of Yorke Peninsula, 2002).

The Narungga Tribe have a Native Title claim for sea rights from the shore to 7km seaward off Yorke Peninsula (Tanner, pers. comm. to DEH, 2001). The seaward extent of the claim over the heel of Yorke Peninsula is not known for this report. As at March 2003, there were no applications, decisions or determinations listed in the Commonwealth's National Native Title Tribunal database for Yorke Peninsula (NNTT database, 2003). A voluntary Indigenous Land Use Agreement has been arranged for the Yorke Peninsula claim, by the Narungga people (DEH, 2003a).

Wilderness / Aesthetic Values

Australian Heritage Commission (undated) considered **Troubridge Point** and **Port Moorowie** area to be "spectacular", due to rugged cliffs, with the scenic attraction "enhanced by deep sea swells breaking at cliff base".

Tourism promotion materials for Yorke Peninsula describe **Oyster Bay** (where **Stansbury** is situated) as picturesque. The coastal walking track at **Stansbury** is described as providing "some good views along the coastline", and across the gulf.

Planning SA's *Yorke Development Plan* (1997) mapped the entire coastal area between **Sultana Point** and **Waterloo Bay** (west of Port Moorowie) as being "an area of coastal landscape significance".

Planning SA's *Yorke Development Plan* (1997) considered that the cliffs north and south of **Stansbury** were "natural features" of the area, and should be conserved (i.e. development not permitted), and that the **Port Moorowie** coast has "unique qualities" (presumably associated with the dunes in the area).

Marine Research, and Marine Education

The **Salt Creek Bay** and **Coobowie** area is considered to be an important site for marine biological education, and scientific research into marine ecological patterns and processes. Much research into patch dynamics (recruitment, predation, competition) has been undertaken in the area, including nationally and internationally recognised work by A. Butler and colleagues, which has advanced the knowledge of marine ecological process theory. The University of Adelaide has a marine research and tertiary education station at **Coobowie**, from which much research has been undertaken on the intertidal and subtidal communities in the area, by local, interstate and international researchers, as well as regular courses in marine biology, carried out by Adelaide, Melbourne and Monash Universities (Edyvane, 1996b; Berggy, 1996).

Studies by Shepherd and Sprigg (1976) in the **south-western Gulf St Vincent** area have provided important and pioneering knowledge of benthic habitats in the area. More recently, work by Tanner (2005) has been undertaken on the habitat effects of prawn trawling in **southern Gulf St Vincent / Investigator Strait**.

University of Adelaide has regularly used in the intertidal reefs between **Black Hill** and **Troubridge Point** for both teaching and research (Edyvane, 1996b).

Edithburgh jetty and surrounding areas have been the site of numerous marine biological and ecological studies (e.g. see Butler, 1982; Rowlings, 1994; Stevenson, 1996), particularly those associated with sessile invertebrate patch dynamics.

Previously, when the *Clan Ranald* wreck was declared as a reserve, the money from salvage operations was paid to the South Australian Museum Underwater Research Group, and used to establish an underwater photographic prize, an event that lasted for almost 20 years (S. Shepherd, pers. comm., 2004).

In the southern Yorke Peninsula area there is reported to be regular catch and effort monitoring of fish stocks (according to Edyvane, 1999b); abalone (e.g. see Mayfield *et al.*, 2001), and research and monitoring of larval fish and abalone populations.

Sea bird populations are monitored on **Troubridge Island** (Robinson *et al.*, 1996). Also, research on the Little Penguin colony was being undertaken in the early 2000s. (S. shepherd, pers. comm., 2004,

citing a project by A. Weibkin)

Studies of reef fish composition, abundance and distribution are also undertaken along Southern Yorke Peninsula (e.g. see Shepherd and Brook, 2002).

Ports, Harbours and Navigation

There is a shipping lane opposite **Port Giles** (Berggy, 1996). **Port Giles** is considered to be a major port, with gazetted limits under the *Marine and Harbours Act 1993* (Berggy, 1996). Ships bound for **Port Giles** enter the gulf from both Investigator Strait and Backstairs Passage, but travel in deeper waters, more than 3 nautical miles from shore. (Berggy, 1996). **Edithburgh**, although not a gazetted port, is considered to have a "reasonable volume" of local marine traffic, and can be "very busy" during holiday periods in terms of marine traffic (Berggy, 1996). The waters around **Troubridge Island** were considered by Berggy (1996) to be "very dangerous" for navigation. **Port Giles** is the deepest sea port in South Australia, and is a major grain-handling terminal (Berggy, 1996). In 2002, 36 international ships berthed at **Port Giles** (Flinder Ports website, 2003).

Klein Point is defined under the *Harbours and Navigation Regulations 1994*, as follows: the subjacent land underlying, and the adjacent land extending from, the waters, rivers, creeks and inlets to high water mark within one nautical mile seaward of any part of the Klein Point Jetty.

Mining

Current leases are not known for this report. A petroleum exploration licence was issued by government in 1990 for a large area of Gulf St Vincent, including the "heel" of Yorke Peninsula, but that licence expired in 1995.

Towns and Small Settlements

Edithburgh (population approx. 429, according to ABS statistics, 2001) and **Stansbury** (population approx. 531) are two of the four major towns on the western side of Gulf St Vincent.

Other settlements comprise mainly holiday and retirement shacks (e.g. **Sultana Point**, **Coobowie** and **Port Giles**, the latter of which is also a major grain-handling port - see above) (Berggy, 1996).

9.1.16 Upper Gulf St Vincent (Gulf St Vincent Bioregion)

Aquaculture

During the early 2000s, there was no aquaculture development in the far northern Gulf St Vincent area, nor in north-eastern Gulf St Vincent. Similarly, on the western side, there was no aquaculture development north of Ardrossan at that time. The closest lease sites to the area described in this table are south of Ardrossan, in the Muloowurtie Point area (4 leases, comprising 2 Pacific Oyster and 2 native oyster leases) (S.A. Coast and Marine Atlas, 2003).

During the 1990s, PISA (now PIRSA) provided for aquaculture development in waters less than 10m deep, as part of the Upper Gulf St Vincent Policy Area (see Berggy, 1996). The boundaries of the Policy Area were defined in Berggy (1996). PISA's designated zone within the northern part of this Policy Area was:

Upper Gulf North Management Zone which includes all waters within the Policy Area North of an East-West line commencing at GR237645E, 6171120N, and proceeding to the coast. Within this zone, PISA provided for a maximum of 40ha of algal aquaculture.

Upper Gulf Management Zone which extends along the south-west boundary of the Policy Area,

commencing at (25371E, 6155731N), then generally north-east to (255905E, 6157710N), thence south-west to (258472E, 6155230N), thence south west to (256386E, 6153143N), thence generally north-west to the point of origin. Within this zone, PISA provided for a maximum of 40ha of mixed types of aquaculture, which included Blue Mussel, but not the cultivation of Pacific Oysters (Berggy, 1996).

In waters deeper than 10m, seaward of the St Kilda area, PISA (see Berggy, 1996) designated the following area for aquaculture development:

Central Gulf Management Zone which is directly adjacent to the seaward boundary of the Upper Gulf Management Zone, and comprises all waters bounded by co-ordinates commencing at (251505E, 6153652N), thence north-east to (253721E, 6155731N), thence generally south-east to (259283E, 6150365N), thence generally south-west to (257019E, 6148260N), thence to the point of origin. Within the *Central Gulf Management Zone*, PISA provided for a maximum of 100 hectares of aquaculture development, particularly bivalve culture (Berggy 1996).

Seven leases, principally for bivalve culture, were approved between 1996 and 1997, within what PISA (see Berggy, 1996) classified as the *Central Gulf* and *Upper Gulf* Management Zones. According to S.A. Coast and Marine Atlas, this area occurs in waters deeper than 10m, seaward of the St Kilda area. These were originally experimental aquaculture leases and are no longer operating.

Commercial Scalefish, Sharks and Invertebrates

Far Northern Gulf St Vincent

Far Northern Gulf St Vincent is of State significance in terms of annual yields of a number of commercial fish and invertebrate species, as outlined below. Regionally, the main fish species caught commercially in the upper Gulf St Vincent area (i.e. north of the Light River) are:

Blue Swimmer Crab: Since the 1990s, there have been 8 or fewer crab pot fishers licensed across South Australia, under the Scheme of Management (Gulf Waters Experimental Crab Fishery) Regulations 1988. In 2002/03, 3 of the 8 crab pot fishers operated in Gulf St Vincent, and there has been a slight increase in the number in recent years, compared with the early 1990s (Svane and Hooper, 2004, Figure 6). Additionally, a number of Marine Scalefish Fishery (MSF) licence holders fish for Blue Swimmer Crabs. In South Australia, between 1996/97 and 2003/04, the number of MSF licence holders endorsed to catch Blue Swimmer Crabs steadily declined, from about 29 down to 14 (Svane and Hooper, 2004, Figure 6), and 13 of those MSF fishers operated in Gulf St Vincent in the 2002/03 year. Since 1996/97, there has been an annual total allowable commercial catch (TACC) for the pot sector and MSF sector combined. The initial TACC in 1996/97 was 520t. In 2002/03, the TACC for the entire fishery (pot and MSF sectors, in both Spencer Gulf and Gulf St Vincent) was 626.8t, similar to the two previous years (Svane and Hooper, 2004), but 106t larger than the TACC in 1997/97. For the entire fishery, about 89% of the TACC was taken in 2002/03 (representing an increase in catch of about 4% from the previous year), and the majority of which was taken by the crab pot sector. At a State-wide scale, effort in the crab pot sector increased from 152,315 pot lifts per annum in 2001/02 to 196,646 potlifts in 2002/03 (a 29% increase). In 2002/03, the crab pot sector took almost all of its allocated quota (i.e. nearly 94% of the 2002/03 crab pot sector quota of 549.6t), representing the highest pot sector catches since the implementation of the TACC in 1996/97 (Svane and Hooper, 2004). Boxshall *et al.* (2000) reported that, according to a provisional assessment, the total catch in the Gulf St Vincent pot fishery to the end of February 2000 was approximately 20% higher than at the same time for the 1998/99 season, and that the increase in catch was reflected in a higher catch rate. Catch and effort figures for the pot sector were not provided. During that period, the total catch in the GSV Marine Scalefish fishery was reportedly 18.7 tonnes, from 174 boat days, with an average catch rate of 107.2 kg/boat day (Boxshall *et al.*, 2000). The CPUE for the 1999/2000 season, in the Marine Scalefish sector, was the highest to date, with the previous (1998/99) season's catch rate being slightly less, at 98.3 kg/boat day (Boxshall *et al.*, 2000). The Marine Scalefish Fishery portion of the total commercial catch of Blue Swimmer Crabs from Gulf St Vincent was considerably less during the late 1990s and early 2000s, compared with that sector's catch during the early 1990s. For example, the Marine Scalefish sector catch of blue crabs in GSV during 1992/1993 was approximately 76 tonnes (Baker and Kumar, 1994). The highest proportion of this Marine Scalefish sector tonnage was yielded using hoop nets. Other gears within the Marine Scalefish Fishery that are used to catch blue crabs include haul nets (crabs caught mainly as bycatch, but forming a significant proportion of the total MSF catch in some years - e.g.

during the early 1990s), gill nets, dab nets, crab rakes and drop nets (Baker and Kumar, 1994). Of the areas (approximately eight) of the State in which Blue Swimmer Crabs are regularly caught as part of the marine scalefish fishery, the upper GSV area has regularly been amongst the top two areas in terms of yield. For confidentiality reasons, no data specific to the pot sector or the scalefishery sector in Gulf St Vincent were provided in a recent fishery assessment report (Svane and Hooper, 2004).

Garfish: The Far Northern GSV area is important for net fishing of Garfish (Berggy, PIRSA 1996), which is the principal catch in terms of weight, and in some recent years (e.g. mid-late 1990s), has been the most important Garfish fishing area in South Australia. The importance of the upper GSV area for commercial Garfish netting was expressed recently in the 2000 Senate Inquiry into Gulf St Vincent (Parliament of South Australia, 2000). Recent catch and effort figures for the area are not available for this report.

Southern Calamari: Far Northern Gulf St Vincent is one of the two most productive areas in the State, in terms of annual yield. Triantafillos and Fowler (2000, Figure 5) showed that the commercial catch of Southern Calamari from North Western Gulf St Vincent (GARFIS Blocks 34 and 35) was more than 60t per annum in all years between 1993 and 1999. A large proportion of the Southern Calamari catch from this area is taken by hauling nets (Triantafillos and Fowler, 2000). Between 1993 and 1999, the hauling net catch from the area was over 50t per annum (with a record for that decade of more than 75t in 1998). Catches by commercial jig fishers in the area were mostly under 6t per annum during the 1980s, but increased during the 1990s, to a record catch of 27t in 1997. The jig sector catch in 1999 was 19t. Both hauling net and jig fishing effort in the area decreased during the late 1990s relative to the mid 1990s (see Triantafillos and Fowler, 2000, Figure 4e). More recent figures are not available for this report.

Tommy Ruff: Far Northern Gulf St Vincent has, in some recent years (e.g. mid-late 1990s) been amongst the top five areas of approximately 25 areas in the State in terms of annual commercial yield of Tommy Ruff. Recent figures specific to the area are not available for this report.

Snook: In terms of annual yield of Snook, Far Northern Gulf St Vincent has, in some recent years (e.g. mid-late 1990s), been ranked first and second in a list of approximately 15 areas in the State in which Snook are fished. Recent catch and effort figures specific to Far Northern GSV are not available for this report.

King George Whiting: In some years (e.g. mid-late 1990s) the area has been amongst the top 10 fishing blocks of approximately 36 - 40 blocks in the State, in which King George Whiting are fished. Fowler and McGarvey (1999) and McGarvey *et al.* (2000 and 2003) presented the catch and effort statistics for Gulf St Vincent as a whole, however recent catch and effort data specific to the Far Northern GSV area are not available for this report. McGarvey *et al.* (2003) reported that (i) haul nets, hand lines and gill nets have all contributed substantially to the King George Whiting catch in Gulf St Vincent; (ii) the haul net catch was quite variable between 1984 and 2001; and in 2002, dropped to the lowest recorded level for Gulf St Vincent; (iii) hand line catches were highest from the early to mid 1990s, but have dropped substantially since 1995, and the hand line catches between 2000 and 2002 were the lowest on record for the region; (iv) hand line effort has decreased systematically since 1995, except for a marginal increase in 2002, and CPUE has increased consistently since 1984; (v) the gill net catches during 2000-2002 were the lowest for a decade. McGarvey *et al.* (2000) reported that, for GSV as a whole, there has been an increase in *non-targeted* catch and effort since the 1980s.

Yellow-Fin Whiting: An average of 78% of the total annual catch of yellow-fin whiting in Gulf St Vincent, is recorded from Marine Scalefishing Area 35 (i.e. upper GSV, north of Long Spit) (Ferguson, 2000). In terms of annual yield, Far Northern Gulf St Vincent has, in recent years, been amongst the top two or three areas of approximately seven areas in the State, in which Yellow-fin Whiting are caught.

Yellow-eye Mullet: In terms of annual yield, Far Northern GSV has in some recent years (e.g. mid-late 1990s) been amongst the top two of approximately 15 areas in the State, in which yellow-eye mullet are caught. Recent catch and effort figures specific to Far Northern GSV are not available for this report.

Snapper: Far Northern GSV has in some recent years (e.g. mid – late 1990s) been amongst the top 10 blocks of the State in terms of Snapper yield; nevertheless, during that period annual yields from upper Gulf St Vincent were two orders of magnitude lower than those from the most significant

Snapper fishing areas in S.A., in terms of quantity taken by commercial fishers. Recent figures specific to far northern GSV are not available for this report, however Fowler (2002) and Fowler et al. (2003) reported that in 2000/2001 and 2001/2002 respectively, the total Snapper catch for Northern Gulf St Vincent (NGSV - which includes fishing blocks 34, 35 and 36), was 8.1t and 7t for hand lines; 5.4t and 13.4t for long-lines, and 0.4t from other gear types in 2000/2001. The collective catch from NSGV in 2000/2001 was around 14t, or 2.6% of the State-wide Snapper catch by commercial fishers. As shown in the figures above, the long-line catch increased substantially over a 12 month period. The long-line catch has increased from a low of 3.4t in 1999/2000 to 13.4t in 2001/2002, and corresponding long-line effort has also increased considerably during that period (Fowler et al., 2003). During the past two decades (1983 to 2001), the commercial Snapper catch from Northern GSV was less than 10% of the State catch, in all of those years (Fowler, 2002, Table 3.2). The long-line catch has been variable over the years in Northern GSV, and the effort using long-lines decreased during the 1990s, but increased again during the early-mid 2000s. By 2001, the number of fishers targeting Snapper using *hand lines* in Northern GSV had halved since 1983-84, and the average annual effort had decreased substantially. This was thought to reflect a substantial reduction in biomass available to the fishers (Fowler, 2002). However, the increased total catches and CPUE during the 2001/2002 are thought to indicate a “slow recovery of the fishery” in this region (Fowler, et al., 2003).

Other species caught in the Marine Scalefish Fishery in Far Northern GSV include species of leatherjacket; *Australian Salmon*; *Mud Cockle*; *Razor Fish*; and *Striped Trumpeter* (not targeted), and more than a dozen other fish species are caught commercially in the area, in minor quantities. A small proportion of the overall state catch of mud cockles is taken from GARFIS Blocks 34 and 35, and the mud cockle harvest from this area in 2000/2001 was 1.495t, representing an effort level of 16 fisher days, (Fowler and Eglinton, 2002), substantially lower than the catch and effort of mud cockle species in the Barker Inlet – Port River system (see below).

Bronze Whaler Shark, *Gummy Shark* and other shark species are also caught commercially in the far northern Gulf St Vincent region. On a State-wide scale, far northern GSV is not a major shark fishing area for School Shark and Gummy Shark, however in some years the annual tonnage of bronze whalers is higher than that taken in most other fishing blocks in S.A. in which the species is caught commercially.

Recent aggregated catch statistics are not available for this area, for this report. Previously, according to SARDI data, cited by Edyvane (1999b), the Marine Scalefish Fishery catch from GARFIS Block 35 (far northern Gulf St Vincent, north of Long Spit) was as follows:

- ♦ In 1995/96 a total of 533,498kg (5.13% of State total);
- ♦ In 1996/97 a total of 402,551 kg (3.97% of State total).

On a Statewide scale, aggregated catch figures for all GARFIS Fishing Blocks in South Australia, showed that in both 1995/96 and 1996/97, the northern Gulf St Vincent area (Fishing Block 35) was 5th in the ranked list of fishing yields from 58 South Australian fishing blocks.

There are concrete boat ramps at **Ardrossan** and **Port Wakefield**. A survey during the mid 1990s showed that use of the boat ramp for commercial fishing at these locations was around 8% at **Ardrossan** and around 64.5% at **Port Wakefield** (McGlennon, 1996), indicating that Port Wakefield is significant as a commercial fishing area. Commercial boats are berthed at the wharf on the **River Wakefield** (Morelli and de Jong, 1995). (See section on **Recreational Fishing**, for additional boat ramp locations).

North-Central and North-Eastern Gulf St Vincent

The majority of scalefish fishing in this area occurs with nets (G.K. Jones, pers. comm., cited by Paxinos and Clarke, 1996). Net fishing occurs in the area in waters 5m or less (apart from netting closure areas - see **Notes on Current Level of Protection and Management**). The main species targeted by net fishers are Yellow-eye Mullet, King George Whiting, Garfish, Yellow-fin whiting, Australian Salmon, Trevally, Southern Calamari and Leatherjacket species (the latter of which are caught but not usually targeted). Trolling for Australian Salmon and yellow-fin whiting (to 10m) is considered to be one of the major commercial scalefish fisheries in the Outer Harbour area (G.K. Jones, pers. comm., 1996, cited by Paxinos and Clarke, 1996).

Regionally, some of the main fish species caught commercially in the northern and mid-northern Gulf St Vincent area (from the Light River area southwards to approximately Glenelg) are: Blue Swimmer Crab, Mud Cockle, King George Whiting, Southern Calamari, Tommy Ruff, Garfish, yellow-eye

mullet, Snook, Australian Salmon, blue mackerel, tube worm, mussel, Yellow-fin Whiting, blood worm, Snapper. More than a dozen other fish species are caught in minor quantities. Bronze Whaler shark, Gummy Shark and other shark and ray species are also caught commercially in this area. A summary of main species caught in the area includes:

Blue Swimming Crab are caught north of Outer Harbour, from inshore to 10m - 15m depth, using crab pots, hoop nets and other gear. For details, see previous section on **Far Northern Gulf St Vincent**.

Garfish are caught inshore to 5m depth in summer, and further offshore in winter, from Port Parham to Outer Harbour. Although the area is important for net fishing of Garfish (Berggy, 1996), and in some recent years (e.g. mid-late 1990s) was amongst the top 10 areas of the State in terms of annual yields of Garfish, yields from the area at that time were an order of magnitude lower than those from the upper Gulf St Vincent area (i.e. north of the Light River). Recent catch and effort figures for the area are not available for this report.

Gummy Sharks are caught south of Port Parham, using long lines and large mesh gill nets, between a depth of 5m and 10m. The northern Gulf St Vincent area is not a major area for shark fishing on a Statewide scale.

King George Whiting is caught in the upper and mid Gulf St Vincent area. In some recent years (e.g. mid-late 1990s), the northern Gulf St Vincent region has been one of approximately 20 fishing blocks in the State in which more than 10 tonnes of whiting were caught per annum. Recent catch and effort figures specific to the area are not available for this report. Fowler and McGarvey (1999) and McGarvey *et al.* (2000 and 2003) presented the catch and effort statistics and trends for Gulf St Vincent as a whole (as cited above, in section on Commercial Fishing in Far Northern Gulf St Vincent).

Snook: In some recent years (e.g. mid-late 1990s), northern Gulf St Vincent has been amongst the top 10 of approximately 15 areas in the State in which the species is taken commercially. No recent catch and effort data are available for this area, for this report.

Australian Salmon are caught in the northern Gulf St Vincent area (e.g. south of Port Parham). The salmon caught in upper GSV waters are mainly smaller fish ("salmon trout") that have recruited to the fishery from the shallow nursery areas of northern and north-eastern GSV. Catch and effort figures specific to northern Gulf St Vincent are not available for this report, however the approximate catch for the entire GSV region was around 35.8t in 1996/97; 30.2t in 1998/99; and 14.8t in 2000/01, the majority of which was taken by hauling nets (Dimmlich and Jones, 1997; Jones, 1999; Westlake *et al.*, 2002). Long term data between 1983/84 and 1998/99 (see Jones 1999, Figure 6c) showed that yields from the entire GSV region were generally under 40t per annum in most years during those two decades, except for a markedly larger catch during 1991/92 (around 120 tonnes), with the catch returning to the approximate 40t level again within 3 years of that peak.

Southern Calamari is caught North of Outer Harbour to Port Parham, using haul nets. No recent figures specific to GARFIS Block 36 are available for this report, however Triantafillos and Fowler (2000) showed that the commercial catch from South Central Gulf St Vincent (which includes GARFIS Block 36, but also Blocks 43 and 44), the most productive area in S.A. for calamari, more than 100t was landed in 1999, from the combined jig and hauling net sectors. Catches in this region are high during spring and summer of each year. During the 1990s, the catch from jig fishing ranged between around 40t and 90+t, with catches of over 70t per annum being recorded between 1994 and 1999. The hauling net catch fluctuated throughout the 1990s, but was 20t or more per annum for 5 years of that decade. The hauling net effort on Southern Calamari, in terms of boat days, is low compared with the jig fishing effort for the South Central Gulf St Vincent area. Between 1993 and 1999, the jig fishing effort fluctuated between approximately 1800 and 2100 boat days per annum (see Triantafillos and Fowler, 2000, Figure 4g). More recent figures are not available for this report, nor are catch and effort figures specific to GARFIS Block 36.

Yellow-eye Mullet: In some recent years (e.g. mid-late 1990s), north-central and north-eastern Gulf St Vincent has been amongst the top 5 of approximately 15 areas in the State in terms of annual yield of yellow-eye mullet caught commercially. Recent catch and effort figures specific to the area are not available for this report.

Australian Herring (Tommy Ruff): In terms of annual yield, northern Gulf St Vincent has, in recent years (e.g. mid-late 1990s) been amongst the top 10 of approximately 25 fishing areas in the State in

which Tommy Ruff are caught. Recent figures specific to northern Gulf St Vincent are not available for this report. Jones and Dimmlich (1997) reported that most Australian herring are taken by hauling net; that the fishery comprises both targeted and non-targeted components; and that the species has traditionally been opportunistically caught, depending upon market price. This makes interpretation of catch and effort data difficult, however during the 1990s, there was a declining trend in the catch from GSV as a whole, compared with the 1980s (see Jones and Dimmlich, 1997). Westlake *et al.* (2002) provided figures for targeted and non-targeted catch of Australian herring in the combined area of GSV and Kangaroo Island.

Mud Cockles are gathered in the Port River and Outer Harbour areas, in the intertidal zone. In recent years mid-upper Gulf St Vincent has been an important area in the State for collecting mud cockles, with annual yields in the dozens of tonnes. In 2000 / 2001, the catch from the northern metropolitan Adelaide fishery (GARFIS Block 36) was around 133.1 tonnes, 4.1t lower than the previous year, but still representing the bulk (84.6%) of the State catch (Fowler and Eglinton, 2002). The 2000 / 2001 harvest was estimated to be less than 4% of the estimated population. The fishery has grown in recent years, and may continue to grow, in response to increased demand.

Tube Worms are caught commercially at the Bolivar outfall, with fishers using spades and/or garden forks to dig up the worms in the muddy intertidal reaches at low tide (Westlake *et al.*, 2002). Yields tend to be higher in summer than winter, and the Bolivar area has been an important commercial fishing area for tube worms in South Australia, with annual yields in the tonnes, in recent years. Since 1983/84, the annual commercial harvest from the area has varied between 8 and 16 tonnes, with a slight (but reportedly not significant) declining trend over that period (Westlake *et al.*, 2002). Annual effort has varied between 1983 and 2001, ranging between 980 fisher days and 1300 fisher days, with no apparent trend (Westlake *et al.*, 2002).

Blood Worms are caught seasonally in the area, particularly in the surface waters of the outer reaches of Barker Inlet, during periods when blood worms “swarm” on the full moon during winter months (Westlake *et al.*, 2002). The worms are located near the mangrove tidal creeks using hand-held spot-lights, and caught using fine mesh dab nets. The inter-annual variability in harvest is considered to be greater for the blood worm fishery compared with the tube worm fishery, and has ranged between 0.2t and 1.7t per annum since 1983/84, with the highest harvests recorded to date during the mid to late 1990s. Effort has fluctuated between 200 and 1700 target fisher days during that period. The combined targeted and non-targeted harvest in 2000/2001 was around 1.1t, from an effort level of over 1000 fisher days (see Westlake *et al.*, 2002).

Recent aggregated catch figures specific to the area are not available for this report. Previously, according to SARDI data (cited by Edyvane, 1999b), the Marine Scalefish Fishery catch from GARFIS Block 36 (GSV, from the Light River area southwards to approximately Glenelg, and gulfwards to approximately 138°E) was:

- ♦ In 1995/96: a total of 298,601kg (2.87% of State total);
- ♦ In 1996/97: a total of 290,343kg (2.86% of State total).

On a Statewide scale, aggregated catch figures for all GARFIS Fishing Blocks in South Australia, showed that in 1995/96 and 1996/97, Fishing Block 36 was 9th in the ranked list of fishing yields from 58 South Australian fishing blocks.

There are commercially used concrete boat ramps at **St Kilda** and **Outer Harbour**. At these locations, use of each boat ramp for commercial fishing boat launching is around 5% at St Kilda, and around 6% at Outer Harbour (McGlennon, 1996). There are permanent coastal mooring facilities for commercial craft at **St Kilda**, **Garden Island**, **North Arm** and **Port Adelaide**.

There is a sunken barge 1 nautical mile south of the *Zanoni* wreck, which was provided for fishers as an alternative artificial reef site to the *Zanoni*, at which commercial fishing is not permitted within 550m of the wreck (Heritage South Australia, 2000).

Prawn Fishing

Prawn fishing does not occur in the upper part of Gulf St Vincent. The prawn fishery operates south of a line between Ardrossan and Port Prime, in waters deeper than 10m (DENR, 1997; Zacharin, 1997). Part of prawn fishing blocks 1, 5, 6, 16, 17, 32 and 33 of the Gulf St Vincent prawn fishing zone include waters less than 10m. According to maps in report by Morgan (1995), all of these blocks were fished between 1968 and 1990, except in 1968, 1969 and 1987. The prawn fishery in Gulf St

Vincent is was closed in 1991, and re-opened in 1994, and the waters deeper than 10m are being regularly fished again. Figures specific to the area discussed in this table are not available, however the total catches of Western King Prawns from Gulf St Vincent in 2000/01 and 2001/02 were reported to be 384t and 322t respectively (SARDI Aquatic Sciences statistics, 2003). Svane (2003) reported that in 2002/03, the total prawn catch from all areas of GSV combined, was 231.9t, being 29% smaller than the previous year's catch, and 42% smaller than the 1999/2000 catch. Fishing effort (3791 trawl hours, over 53 nights) was higher in 2002/03 than in the previous two seasons, but the catch was lower. The catch in the 2002/03 year was almost as low as that taken in 1991, when the fishery was closed. The catch rate in 2002/03 was 61.2kg per hour, the lowest since the fishery was re-opened in 1994. Fishery independent surveys in the 2002/03 season showed that the abundance of new recruits was low (Svane, 2003). This contrasts sharply with the reported state of the fishery a few years previously. For example, Boxshall and Williams (2000) reported that (i) the total catch for the 1999/2000 GSV prawn season (i.e. from all areas of the GSV fishery combined) was 400.24 tonnes, the highest catch recorded since the 1983/84 season; (ii) catch rates for the season (99.03 kg / boat hr) were the highest recorded in the history of the fishery; and (iii) the total level of fishing effort (4042 boat hrs) increased over that seen in the previous (1998/99) season, but remained within limits set for the fishery. Boxshall and Williams (2000) considered the performance of the fishery in 1999/00 to be consistent with a fishery that had rebuilt to previous levels; that the recovery was likely to have been assisted by strong recruitment over the past two seasons prior to assessment, and that recruitment levels are variable, and it was unlikely they would be sustained at high levels on a consistent basis. However, as reported by Svane (2003), the strong recruitment apparently did not persist, based on the low catch for that season, as well as data for 2002/03 which showed mainly large adult prawns in the catch; a widely dispersed fleet (reflecting low prawn abundance); the lowest catch rates recorded in a 10-year period of fishery-independent surveys, and few recruits (young prawns) in the surveyed areas. Spatial and temporal restrictions to catch and effort were recommended, to prevent continued declines in prawn biomass (Svane, 2003).

Recreational Fishing

A summary of fishing activities in the north-eastern Gulf St Vincent area includes line fishing (from shore and boats), hoop netting, dab netting, crab trapping and raking, "floundering", bait digging, and dive fishing (Bryars, 2003).

Recreational catch and fishing effort in Gulf St Vincent are high for a number of species, such as King George Whiting, Yellow-eye and Jumper Mullet, Southern Calamari, and Blue Swimmer Crabs.

For example, according to a boat fishing survey during April 1994 – March 1996 (see McGlennon and Kinloch, 1997a and 1997c):

- ♦ Almost three quarters of the total metropolitan waters catch of King George Whiting was taken by recreational fishers, and the majority of these whiting taken the metro fishing region would have emigrated to the fishery from northern GSV nursery areas. In far northern GSV, the recreational catch of whiting during the survey period was around one eighth of the total catch (i.e. the majority of the total catch of King George Whiting during the survey period was taken by commercial net fishers).
- ♦ The recreational boat catch of Garfish in northern GSV is small (i.e. around one eighth of the total catch compared with the catch from commercial netting).
- ♦ In the northern GSV and metropolitan GSV area combined, the catch of Southern Calamari was more than one third of the total combined catch (McGlennon and Kinloch, 1997c, Figure 15).
- ♦ The recreational catch of Blue Swimmer Crabs amounted to 33% of the total combined recreational and commercial catch in GSV (McGlennon and Kinloch, 1997c, Figure 18), with the majority of the catch taken in northern, north-eastern and north-western GSV waters, where the species is abundant.

Note that the survey discussed above did not include jetty fishing, which is significant in some areas (e.g. **Ardrossan, Price, Port Wakefield**). Specific and recent catch and effort figures for all recreational fishing in the upper Gulf St Vincent area are not available for this report.

Blue Swimmer Crab is a particularly significant species for recreational fishers in far north-eastern and north-western Gulf St Vincent, as discussed below. According to Boxshall *et al.* (2000) there has been no regular estimate of the recreational share of the blue swimmer crab harvest (during the past

decades). However, a recreational boat fishing survey undertaken by SARDI (McGlennon and Kinloch, 1997a) estimated that, of a total harvest of over 161.2 tonnes per year by recreational boat fishers, 115.8 tonnes were taken in Gulf St Vincent. The recreational share of the total catch (commercial plus recreational) was reported to be around 33% for Gulf St Vincent, 11% for Spencer Gulf, and around 20% overall. This estimate did not include the recreational shore-based fishery, which is considered to be significant (Boxshall *et al.*, 2000). Specific data for Gulf St Vincent, from the more recent National Recreational and Indigenous Fishing Survey (Henry and Lyle, 2003), are not available, however the survey reported a total State-wide recreational catch of 389.8t of Blue Swimmer Crabs during the period May 2000 to April 2001, about 32% of which was released after capture (due to the crabs being under legal size, or due to catches being over the legal bag limit) (Anonymous, 2003d, cited by Svane and Hooper, 2004).

North-Western and Northern Side

A causeway leads from **Price** to the western bank of **Wills Creek**, which provides access to a small jetty, boat ramp and boat moorings. The **Price** area is used as a thoroughfare to fishing grounds. The site is popular for recreational fishing and boating (Morelli and de Jong, 1995). **Port Wakefield** has been described as a recreational fishing town (Wilkins, 1999; South Australian Tourism Commission, 2000), and **Bald Hill**, in the Port Wakefield area, has been described as a popular fishing spot (South Australian Tourism Commission, 2000). King George Whiting, yellow-fin whiting, black bream, Sand Flathead, yellow-eye mullet, Australian Salmon, Snapper, Mulloway, Snook, Garfish, blue swimmer crab, Tommy Ruff and Southern Calamari are the main species yielded by boat and jetty fishers in the waters around **Price** and **Port Wakefield** (McGlennon and Kinloch, 1997a; Harris, 2002 and 2003, and other recreational fishing reports).

Species commonly targetted in the **Port Gawler** area include Yellow-eye Mullet, Black Bream, King George Whiting and Southern Calamari (Fish Internet Australia, 2000)

Port Clinton / Clinton Conservation Park area is stated to be “used extensively for recreation by the local community, and by tourists visiting the nearby towns”. The seagrass and sand beds in the area are popular locations for fishing scalefish, Blue Swimmer Crabs and molluscs (Morelli and de Jong, 1995).

The area North and East of **Ardrossan** (including **Tiddy Widdy** area, and waters to the middle of the upper gulf), contains numerous patches of nearshore seagrass, and deeper sand, sandy mud, and shelly patch reefs that are popular areas for recreational boat fishing. At least nine popular recreational fishing marks exist in this area, with sandy bottom areas in particular being promoted for whiting fishing (FishSA, 2000; Fishnet, 2002). The artificial reef (sunken barge) off **Ardrossan** is also used for recreational fishing, and aggregates reef fish such as Snapper, whiting and Snook. Another barge in the **Ardrossan** area is also reported as fishing area for Snapper, Mulloway, Tommy Ruff (Australian herring), Australian Salmon, cuttlefish and crabs (Fishnet, 2002; Harris, 2002 and 2003).

Major species targeted in the **Ardrossan - Tiddy Widdy** area include blue crabs (particularly during spring and summer), King George Whiting, Sand Flathead, Sand Whiting, Yellow-eye Mullet, West Australian Salmon, Snapper (both large Snapper and small “rigger” Snapper), Mulloway (e.g. on the **Barge** reef, and also close inshore), Snook, Trevally, Garfish, Tommy Ruff, and Southern Calamari (the latter three species often caught from the jetty (McGlennon and Kinloch, 1997a; Harris 2002 and 2003, and other recreational fishing reports). **Tiddy Widdy** has been described as “a popular crabbing resort” (DC of Yorke Peninsula, 2002).

There are jetties at **Port Wakefield** and **Price**. There are concrete boat ramps at **Port Wakefield**, **Price** and **Ardrossan**. At these locations, a survey during the mid 1990s showed that use of each boat ramp for recreational fishing was around 80% at **Ardrossan**, 93% at Price, and 35% at Port Wakefield (McGlennon, 1996). Boats are also launched off trailers towed out over the intertidal zone by 4WD vehicles and tractors (Berggy, 1996). Recreational boats are berthed at the wharf on the **River Wakefield** (Morelli and de Jong, 1995).

North-Eastern Side

Much of the area is popular for catching blue swimmer crabs (e.g. **Port Parham**, **Middle Beach**, **Port Gawler**, **St Kilda**, and other locations). **Port Gawler** and its surrounds are used intensely for fishing

and crabbing (Morelli and de Jong, 1995), with the area described as “very important for recreational crab fishers” (Berggy, 1996).

Between **Parham** and **Barker Inlet**, there are numerous (e.g. more than 35) recognised recreational fishing markers in waters less than 10m, mostly in seagrass, and also including sand patches and muddy sediments, and patches of shelly reef (the latter particularly in the **Outer Harbour** area).

Barker Inlet - St Kilda is a popular area for recreational fishing, particularly crabbing in the **St Kilda** area and coastal areas to the North and South, and bait collecting (Morelli and de Jong 1995; Berggy, 1996). Major fish species that are targeted by boat and shore fishers in the **St Kilda to Port Adelaide** area include King George Whiting, yellow-fin whiting, blue swimmer crab, black Bream, Sand Flathead, yellow-eye Mullet, Snapper, Mulloway, Garfish, Snook, Tommy Ruff, Australian Salmon and Southern Calamari. The main species of recreational value are considered to be blue swimming crabs, King George Whiting, Tommy Ruff, and Garfish (McGlennon, 1992, cited by Paxinos and Clarke, 1996).

Angling from boats is common around **Garden Island, St Kilda** and **Outer Harbour** (McGlennon 1992, cited by Paxinos and Clarke, 1996; McGlennon and Kinloch, 1997a; GotOne Australian Fishing Reports, 2001). Blue swimmer crab is one of the major recreational species targeted in the area. Other species caught include King George Whiting, yellow-eye mullet, Tommy Ruff, Garfish, Snook, yellow-fin whiting, Leatherjacket species, Red “Mullet”, trumpeter, Australian Salmon, Southern Calamari and sand crab.

Worm species such as tube worms and beach / seaweed worms are harvested by recreational fishers in the **Port Adelaide – Barker Inlet** area. At the time of the first commercial fishery stock assessment (Westlake *et al.* 2002), the quantity of worms harvested by recreational bait-diggers in the area was not known.

Three locations off **Outer Harbour** were listed amongst the top 50 recreational boat fishing locations in South Australia (Capel, 1994), particularly for Snapper, whiting, Tommy Ruff, Mulloway, salmon, Tommy Ruff, Garfish, rays, sharks and blue crabs.

There are permanent coastal mooring facilities for recreational craft at **St Kilda, Garden Island, North Arm, and Port Adelaide**. There are concrete boat ramps at **St Kilda, Garden Island** and **Outer Harbour**. A survey during the 1990s, showed that use of each boat ramp for recreational fishing boat launching was around 91% at **St Kilda**; 91% at **Garden Island**, and nearly 84% at **Outer Harbour** (McGlennon, 1996).

Although there is a 550m Protected Zone around the *Zanoni* wreck site in which no fishing is permitted, the area has been described as “very popular for fishing” (Environment Australia 2001). When the Protected Zone was implemented during the early 1980s, many anglers and divers protested the new restrictions, as the *Zanoni* had become an abundant artificial reef and a popular fishing location. As a result the Department of Fisheries decided to establish a new artificial reef nearby, and acquired an obsolete Department of Marine and Harbours barge for the purpose. On 11 April 1984, No 5 dumb hopper barge (known as “the *Zanoni* barge” or “the *Ardrossan* barge”) was deliberately scuttled approximately one nautical mile south of the *Zanoni* wreck site (DEH, 2003b).

In addition to the main boat ramps listed above in the section on **Commercial Fishing**, there are also boat launching facilities used by recreational fishers at **Tiddy Widdy, Price** (launching into the creek), **Port Clinton, Port Gawler, Port Parham** and **Middle Beach** (Fish SA, 2003).

Diving

Popular dive sites, listed by DIASA (undated); Christopher (1998); Aquanaut (undated); Anonymous (undated); Adelaide SCUBA (undated) and regional tourism promotion materials (e.g. Fairfax Publishing – F2, 2000) include the following (N.B. Features of interest to divers at these sites are listed under **Popular Dive Sites**, in the **Ecological Attributes** table for this area, and above, under **Historic / Protected Shipwrecks**:

- ♦ **Ardrossan** jetties (the fishing jetty and the grain-loading jetty);
- ♦ The artificial reef (sunken barge) near **Ardrossan**.

- ♦ *Zanoni*, a protected shipwreck in approximately 18m of water (Heritage S.A., 2000), around 20km west-south-west of Parham. The *Zanoni* is declared a Historic Shipwreck protected under the *Historic Shipwrecks Act 1981*. A 550 metre radius Protected Zone has been declared around the site due to its high significance and fragile remains. It is illegal to enter the Protected Zone without first obtaining a permit issued by DEH's Heritage SA. A boat mooring buoy has been installed at the site for the safety of divers and so the wreck will not suffer anchor damage (Arnott, DEH, cited by Adelaide SCUBA, undated). The *Zanoni* has been described as a "popular SCUBA diving destination" (Fairfax Publishing – F2, 2000) and "very popular for diving" (Environment Australia, 2001a). There is a *Zanoni* Dive Club, based at Ardrossan (AIMA, 1997).

Other Coastal and Marine Recreation / Tourism

Ardrossan has been described as an "interesting port" and "popular holiday destination" (Wilkins, 1999; Fairfax Publishing – F2, 2002); a "major seaside town" on Yorke Peninsula, and "an attractive coastal town" (Frog and Toad Australian Tourism Guide, 2003). In addition to fishing and crabbing (see section above on **Recreational Fishing**), other popular activities include swimming, beach walking, and admiring the scenic views. There is a various forms of coastal accommodation in the town to cater for holiday-makers.

There is a walking trail in the **Ardrossan - Tiddy Widdy** area. The trail, of 3km, goes along the front of Ardrossan cliff tops to Tiddy Widdy Beach (District Council of Yorke Peninsula, 2002).

Apart from fishing and crabbing (see section above), the beach and nearshore waters of **Tiddy Widdy** and **Mac's Beach** (north of Tiddy Widdy) have social value for beach recreation and boating. Other activities in the **Tiddy Widdy** area include sand-boarding. The District Council of Yorke Peninsula (2002) reported that there are "a great many holiday homes erected at **Tiddy Widdy** beach".

The concrete boat ramps at **Price** and **Ardrossan** are also used for other marine leisure activities in addition to fishing. According to a survey during the mid 1990s (McGlennon 1996), use of each of these boat ramps for other recreational activities (which included pleasure boats, diving, water skis, and/or jet skis, or any other activity not involving fishing) is around 12% at **Ardrossan** and 7% at **Price**. Morelli and de Jong (1995) also listed **Price** as an area used for recreation boating.

Apart from fishing for scalefish, crabs and molluscs (see previous section), the **Price / Port Clinton / Clinton Conservation Park** area is used for boating, picnicking, camping and coastal bird watching (Morelli and de Jong, 1995; Yorke Peninsula Country Times, 2002). **Port Clinton** has been described as a "small seaside village with good fishing"; "a popular destination" for holidaymakers from Adelaide (Fairfax Publishing – F2, 2002), and "a popular beach resort and holiday home centre for many from Adelaide who enjoy the wide sandy beaches" (Yorke Peninsula Country Times, 2002). Features in the area include "an attractive sandy beach" for swimming and relaxing; "ideal" waters for fishing and crabbing; and extensive mud flats, for watching local and migratory birds (particularly in the **Clinton Conservation Park**) and exploring marine life at low tide. There is a foreshore caravan park and other accommodations to cater for visitors (Fairfax Publishing – F2, 2002; Yorke Peninsula Country Times, 2002). **Price**, 7 km south of Port Clinton is described as a "tiny coastal township" which is popular for crabbing. There is a coastal caravan park at Price for visitors (Fairfax Publishing – F2, 2002; Yorke Peninsula Country Times, 2002).

At **Middle Beach**, the Samphire Discovery Trail has a recreational function in addition to its educational role in raising community awareness about the importance of samphire and salt bush in the structure and function of the coastal area (see section below on **Marine Education**). There are also camp sites and launching facilities in the area (e.g. between **Middle Beach** and **Port Parham**). Although fishing and crabbing are the most popular activities in the area, other recreational activities include canoeing and boating, swimming and walking along the foreshores (DC Mallala Foreshore Advisory Committee and EcoConnect, 2002). The local community has been involved with a number of projects to improve the facilities / amenities for visitors to the area (see DC Mallala Foreshore Advisory Committee and EcoConnect, 2002).

The **Light River** is described as being of "increasing popularity for visits and recreation" (Thomas, verbal submission to Senate Inquiry into Gulf St Vincent, February 2000).

There is a community project plan (by a tourism and trade association and a planning group in the Two

Wells are) for the **Port Gawler Conservation Park** and **wharf site**. The plan is aiming to develop an interpretive centre, public access improvements, and revegetation (DC Mallala Foreshore Advisory Committee and EcoConnect, 2002).

The **St Kilda** Mangrove Trail and Interpretive Centre has high recreation value, in addition to its significant role in public education about the functioning of mangrove systems (see section below on **Marine Education**).

Dolphin watching in the area has become an increasingly popular eco-tourism / recreational activity during the past decade. The **Outer Harbour - Barker Inlet - Port River** area is one of few in the world in which wild dolphins occur close to a city, and interact with humans (Bossley, pers. comm., cited by City of Port Adelaide – Enfield 2003). The existence of a large number of bottlenose dolphins close to a relatively accessible, major centre of human population, is a distinctive feature of the area in terms of eco-tourism. A Dolphin Interpretive Trail was developed in 2003, along the banks of the Port River – Barker Inlet system to enable visitors to appreciate and observe the dolphins in a non-intrusive manner, and assist in their protection (see section below on **Marine Education**). The promotion of the area as a Dolphin Sanctuary (Government of South Australia, 2002; DEH, 2003c) is also likely to increase the tourism value of the Port River – Barker Inlet system.

Barker Inlet - St Kilda: Apart from fishing (see section above), popular recreational activities include boating, power boat racing, canoeing, water skiing and bird watching. The area is regularly visited by overseas ornithologists and has become a bird observation area of interstate and international renown (Morelli and de Jong, 1995).

Historic / Protected Shipwrecks

No protected wrecks known for the far northern Gulf St Vincent area, between Port Price and Sandy Point. There is an historic shipwreck in the area, that is not protected under legislation (*Sarah*, wood yawl, built 1874, wrecked 1879).

South of Sandy Point, some of the more significant wrecks and wreck remains include:

- ♦ *Grecian*, 3-masted wooden barque, built 1841, wrecked 1850 at **Outer Harbour**. Located in waters 5m deep, south of the harbour entrance. Fittings, hull timbers, part of the cargo remain at the site. Protected under the *SA Historic Shipwrecks Act 1981* (Mate, 1983; State Heritage Branch, DEP, undated).
- ♦ *Santiago*, 3-masted iron barque, built 1856, abandoned 1945 in the shallow water of **North Arm**, south of Garden Island. The *Santiago* is listed on the *Register of the National Estate* due to its historic significance. The vessel is mainly intact, exposed above water level. The *Santiago* is considered to have “great archaeological and educational value”, being one of the oldest intact hulls of its type in Australia (State Heritage Branch, DEP, undated). The *Santiago* is reportedly significant as the oldest iron vessel in the world. Since it was scuttled it has suffered gradual, but irreversible, corrosive deterioration (Kentish, 1995).
- ♦ *Norma*, steel barque, built 1893, wrecked 1907 in approximately 10m of water off the **LeFevre Peninsula** (south-west of Outer Harbour). Note that the ship was destroyed for navigational safety reasons, and is now scattered over a wide area (DIASA, undated).
- ♦ *Zanoni*, 3-masted composite barque, built 1865, wrecked in 1867, and not located until 17 April 1983, almost 100 years later. The *Zanoni* shipwreck is the most intact nineteenth century merchant sailing vessel in South Australian waters (DEH, 2003b), and has been declared an Historic Wreck under the *Historic Shipwrecks Act 1981*. The *Zanoni* is considered to be a “very significant” wreck site in South Australia, because the barque has had minimal disturbance from swell and surge, the timbers are still intact, and the teredo worm has not damaged the hull. The *Zanoni* is virtually complete with all fittings, equipment and artefacts, and represents a typical square-rigger trading ship of the period (State Heritage Branch, DEP, undated). The site of the wreck was designated in 1983 as a Historic Shipwreck site (see section on **Legislated Conservation Measures**).

The **Garden Island** “ships' graveyard” is one area amongst a larger ships' graveyard in the Port Adelaide region, that contains the remains of over 40 located abandoned ships. As well as containing many historically significant ships, the ships' graveyard at Garden Island represents one of the largest assortments of accessible vessel remains in the world. Ships were abandoned on the

banks of Garden Island from 1906 to 1945 (Richards, 1999). The collection includes large and small sailing, steam and motor vessels, barges, pontoons and dredges. Many ended their working days in Port Adelaide as storage hulks or lighters. One vessel was used as a footbridge, another a floating grain mill, and another a crayfish depot. Most of these obsolete vessels were beached and broken up at various sites around Port Adelaide - some were completely salvaged but others were only partially scrapped, with remains still *in situ* (DEH, 2003b).

Other sites that form part of the “graveyard” are located at **Jervois Basin, Mutton Cove, Broad Creek and Angas Inlet**. The vessel remains in these areas represent more than a century of maritime activity and constitute the largest and most diverse shipwreck site in Australia which is accessible to non-divers (DEH, 2003b).

In addition to the vessel remains protected under legislation, more than 60 other shipwrecks of various types and constructions (lost between mid 1800s to mid 1900s) also occur in the region. Many of these have historic significance, but are not formally protected under State or Commonwealth legislation, and not all have been found.

Other European Heritage Values

Ardrossan: The town became the first port in South Australia with bulk handling wheat facilities. The port developed rapidly during the late 1800s due to the opening of agricultural land on Yorke Peninsula. The town jetty was built in 1877 and used a simple tramway system to load vessels. In 1877 the jetty was nearly 150 metres long, and in later years it was extended a number of times (to reach 400m long), to cater for the larger steam ships (FRR, 2003). As late as the 1930s, Ardrossan was served by a twice-weekly steamer from Port Adelaide (FRR, 2003). In 1952 the wheat silos were built, making Ardrossan the largest grain receiving centre in Australia at the time. On the jetty are the old wheat trolleys which were used to take wheat to the end of the jetty, to be loaded onto ships (Fairfax Publishing – F2, 2002).

Early records contain many references to the natural well in the beach sand at **Tiddy Widdy**. The well was a reliable source of good water for the early settlers on this part of Yorke Peninsula. Farmers came as far as 48 kilometres, travelling by horse and dray, to obtain the water, and at times they had to climb down into the well and fill the bucket with a tin pannikin before hoisting it to the top and tipping it into their container. It sometimes took all night. They then had to convey the water home (District Council of Yorke Peninsula, 2002).

Price has a causeway, which extends from the township through the mangrove swamps to a tidal inlet, is about 1600 metres long. It connects to the 78.6 metre long wharf, where the ketches from Port Adelaide moored when they brought provisions for the township. In the early days the ketches back-loaded with the mallee roots for the fires of people in Adelaide. Farmers at times sold the stumps for 5/6d a dray load, and pioneers recalled seeing up to 12 ketches waiting to load. Harvesting of salt at Price commenced in 1917, when the Gulf Salt Company took out the first lease (DC of Yorke Peninsula, 2002).

Port Clinton, established in 1863 to supply the mining towns of Moonta and Kadina, was the first port on Yorke Peninsula (Morelli and de Jong, 1995). At that time, Port Clinton was the shipping centre of farmers in the area, and many of the miners for Moonta and Wallaroo were also landed by ketch after their journey from Port Adelaide. After the completion of the railway from Adelaide to Wallaroo in 1878, the jetty at Port Clinton fell into disuse and disrepair (DC of Yorke Peninsula, 2002).

Port Wakefield, established in 1849, was one of the first ports in South Australia, and has been described as “historically important” (Fairfax Publishing – F2, 2002). Port Wakefield, previously names Port Henry, was dredged and then used for loading residual copper ore from Burra, for smelting at the Swansea smelter by the Patent Copper Company (Wilkins, 1999). Within six months of operation, an estimated 7000 tonnes of copper had passed through the port (Fairfax Publishing – F2, 2002). Port Wakefield was considered to be an important, busy and prosperous port during the 1850s. Flat-bottomed sailing barges loaded and unloaded larger ships anchored in deeper water, and transported copper ore and refined copper to Port Adelaide. In 1851, a jetty was built west of the new town for discharging coal from Newcastle (NSW), to be used mainly at the Burra Smelter. During the latter part of that century, it became more economical to ship ore from Gawler by rail, however Port Wakefield was still used to ship wool and grain from the hinterland, into the 1900s (Wilkins, 1999; South Australian Tourism Commission, 2000; Fairfax Publishing – F2, 2002). In

1909, 300,000 bags of wheat were exported through the port. At the port there is a memorial with an anchor on top of it, in memory of the sailing ketches that traded between 1850 and 1930. A monument located beside the lagoon at **Port Wakefield**, commemorates Captain Matthew Flinders' landing at the head of the gulf on March 30th 1802, the day he named Gulf St Vincent and Yorke Peninsula. Flinders found that the water was so shallow, he had to row about 12 km and walk another kilometre through the mudflats and mangroves before he reached the true shoreline (Fairfax Publishing – F2, 2002).

There are significant heritage values in **Port Adelaide**, a major port and site of marine-related activity since the mid 1800s. Port Adelaide was one of South Australia's earliest settlements and represents South Australia's first State Heritage area (Flinders Ports, 2003). The site of Port Adelaide was officially proclaimed a harbour on 6 January 1837 when Harbour Master Captain Thomas Lipson took up residence on the shore of the Port Creek (FRR, 2003). Although the colony's surveyor, William Light believed it would make a good harbour, he was not prepared to make it the site for the capital for South Australia. Passengers and goods were landed unsatisfactorily, and it soon became known as Port Misery. Port Misery officially became Port Adelaide on 23 May 1837 but it was not until 1839 that a new site was agreed upon, and McLaren Wharf was built. Added to this were a crane to unload ships of up to five hundred tons, a storehouse, and a road across the swamp which surrounded it. All were completed during late 1840. Buoys were laid down to mark the channel, but it was still difficult for ships at that time to find the harbour, which was masked by mangroves (FRR, 2003).

In 1838 **Port Adelaide** held its first regatta to commemorate South Australia's first anniversary. The early colony at Port Adelaide suffered from water shortages; sewage problems, and periodic water flooding over a large part of the town. After completion of port facilities and a proper road, Port Adelaide grew quickly and within only a short time became the lifeline to the capital and its hinterland. It was proclaimed a corporate town in 1855 when it handled about three hundred ships per annum and its population numbered about 1,500 people. By the year 1900, more than a thousand ships called in at the port wharves every year. Until the 1940s, Port Adelaide was the main entry and exit point for people and goods into and out of South Australia (FRR, 2003).

Industries have operated at Port Adelaide since the mid 1800s. During the early period of copper mining, Port Adelaide provided the increased profitability for the mines by building smelters in 1848. Here the English and Australian Copper Company reduced the copper ore, from mines as far away as Blinman, and improved the value of the exported minerals. The smelting operation continued into the twentieth century. In 1856, South Australia's second railway line, but the first to use steam locomotives, was completed between the Port and the city. Much of all this early progress was destroyed during the 'Great Fire of Port Adelaide' on 12 November 1857. However, neither the Great Fire nor the floods of 1865 stopped progress at the Port. In 1876 the South Australian Stevedoring and Dumping Company was formed and in 1886 the Maritime Labor Council was established. South Australia's first power station began operating in 1889, in Port Adelaide, and within a few years it also supplied the capital and its suburbs with electricity (FRR, 2003).

Shipwrecks (described in the previous section) are an important part of the European heritage of the Port Adelaide area. The Statement of Heritage Significance (*Register of the National Estate* listing) is as follows: "The *Santiago* is a link with the days of sail. Australia continued to be connected to the outside world by sail far longer than most other countries, indeed sail traffic is still well remembered by inhabitants of Australian port cities. As an island nation maritime history and technology are particularly important to Australia (Criterion A.4). Despite their recent importance to Australia, ordinary cargo carrying sailing craft are not common, those which have survived are susceptible to deterioration (Criterion B.2). The *Santiago* can provide information on early iron hulled ship construction and that of associated equipment. It is also valuable in demonstrating the importance of sail in the relatively recent history of Australia (Criterion C.2). In addition to being a rare surviving example of an early iron hulled clipper (prior to being barque rigged to cut labour costs) it is a reminder of the importance of sail to Australia (Criterion D.2). Iron hulled craft were an important development for Australian maritime trade by creating a swift and efficient link between Australia and foreign ports (Criterion F.1). The hull is still intact and some fittings and equipment lie in situ (Andrews, 1976, cited by Australian Heritage Commission, undated).

According to PPK *et al.* (1992), significant items of European culture also include the explosive magazine dump, as well as the jetty and tramline constructed to Broad Creek from the Magazines and St Kilda – North Arm embankment.

Aboriginal Heritage Values

Sites north and south of **Ardrossan** have cultural heritage significance for the aborigines of Yorke Peninsula. The natural freshwater wells in the beach sand at **Tiddy Widdy** (located between **Ardrossan** and **Mangrove Point**), and **James Well** were the two main freshwater wells on the east coast of Yorke Peninsula, and an important source of fresh water for the Narungga. **Tiddy Widdy** was one of a number of major camping settlements for the Narungga on Yorke Peninsula (DC of Yorke Peninsula, 2002). **Tiddy Widdy Beach** was a significant burial site, and also contained middens, and stone implements. Hill and Hill (1975) stated that many skeletons were exposed in the mid 20th century by erosion. The burial site has been disturbed, and the campsites have been "looted". Significant locations, and artefacts from those areas, are listed in the State register of Aboriginal Heritage sites, managed by DOSAA.

The Narungga Tribe have a Native Title claim for sea rights from the shore to 7km seaward off Yorke Peninsula (Tanner, pers. comm. to DEH, 2001). As at March 2003, there were no applications, decisions or determinations listed in the Commonwealth's National Native Title Tribunal database for Yorke Peninsula (NNTT database, 2003). A voluntary Indigenous Land Use Agreement has been arranged for the Yorke Peninsula claim, by the Narungga people (DEH, 2003a).

The **Greenfields** Archaeological and Burial Site is located on the floodplain of **Dry Creek** adjacent to the salt fields and was traditionally used as a regular camping area by the Kaurna people. Previous excavations have uncovered stone artefacts, food remains (i.e. animal skeletal material) and burial sites (Morelli and de Jong, 1995).

The Port Adelaide River region is reported to be home to the Pelican and Dolphin Dreaming of the Kaurna people (Kirner, 2000).

The Kaurna Peoples Native Title claim (lodged in 2000 and accepted for registration in 2001), includes the upper and north-eastern coastal area of Gulf St Vincent, as part of a total land claim area covering 8160 square km (National Native Title Tribunal 2003). The boundaries of the Kaurna Peoples claim include metropolitan Adelaide, extending north to Broughton, south to Cape Jervis, and approximately 800 metres into coastal waters of Gulf St Vincent from Cape Jervis to **Port Wakefield**. Within this boundary, less than 10 per cent of the area is estimated to be actually covered by the claim (Media release 2001, cited by NNTT, 2002). Native title may apply to vacant Crown land, state forests, national parks, public reserves, beaches and foreshores, land held by Government agencies, and any other public or Crown lands subject to existing laws (Media release 2000, cited by NNTT, 2002).

Marine Research

The **Port Clinton / Clinton Conservation Park** area is reported to be of "great value" for research, especially in the fields of botany, sedimentology, marine zoology and ornithology (Morelli and de Jong, 1995).

The **Port Adelaide - Barker Inlet** area has high scientific research value. During the past two decades, examples have included:

- ♦ Monitoring of coastal land movement and sea level rise (e.g. work by the National Tidal Facility at Flinders University);
- ♦ Hydrodynamics / water circulation studies (e.g. Steedman Limited, 1984; Petrushevics, 1986; Provis, 1987; South Australian Department of Fisheries, 1989; PPK *et al.*, 1992; Oceanique Perspectives, 1995);
- ♦ Modelling studies of the wind and tide driven currents, applied to the dispersion of prawn larvae, and also oil spills (Department of applied Mathematics, Adelaide University, cited by Harbison 1997);
- ♦ both short-term and long-term monitoring studies of the population dynamics and/or ecology of various fish species (Connolly, 1994a, 1994b, 1994c; Connolly *et al.*, 1997; Connolly, 1999; Jones *et al.*, 1996, Dimmlich and Jones, 1997; Jones and Jackson, 1998; Ferguson, 1999 and 2000);
- ♦ long-term studies of bottlenose dolphin population behaviour, and monitoring of bottlenose dolphin distribution and population dynamics (conducted principally by M. Bossley, of the Australian Dolphin

Research Foundation);

- ♦ monitoring of mangrove distribution, ecology, health, and spatio-temporal dynamics (e.g. Burton 1982a and 1982b; Connolly, 1986; Edyvane, 1991; Bayard, 1992; Fairhead, 1995).
- ♦ production of GIS maps for all supratidal, intertidal and shallow subtidal habitats in the northern GSV area (DEH Saltmarsh Mapping program);
- ♦ studies on the Penrice salt fields; including mapping of the ecological units; studies on the ecology of the salt ponds and samphires; and studies of the flora and fauna, including vulnerable species (Delta Environmental, cited by DC Mallala Foreshore advisory Committee and EcoConnect, 2002);
- ♦ pollution monitoring and modelling studies of nutrients, red tides, heavy metals, industrial chemicals, sediments, etc); pollution ecology; amongst other studies (e.g. Hodgson, 1959; Thomas *et al.*, 1986; Harbison, 1986a and 1986b; SEA and Harbison, 1989; Cannon, 1990 and 1991);
- ♦ studies of the bio-accumulation of metals in marine mammals in Barker Inlet, by the South Australian Museum (cited by Harbison, 1997);
- ♦ studies on the introduction of exotic organisms in ballast water, by the biological Sciences department of Flinders University (cited by Harbison, 1997); and
- ♦ studies of the distribution and species composition of saltmarsh vegetation in northern Gulf St Vincent, undertaken by DEH (cited by Harbison, 1997).

Some examples of more recent research in the northern Gulf St Vincent area include the following:

- ♦ a tagging study of blue crabs, with sampling being undertaken in the **Tiddy Widdy** beach / **Ardrossan** area (e.g. see Boxshall *et al.*, 2000, and Anonymous, 2003);
- ♦ a study of the seagrass ecology in the **Port River – Barker Inlet** system, including collection of fish and invertebrates in seagrass, mangroves and unvegetated habitats (Adelaide University);
- ♦ a biological study of mud cockle species in the **Port River - Barker Inlet** system (see Fowler and Eglinton, 2002, and references therein);
- ♦ a pelican tagging project at **Pelican Island (Outer Harbour)**, undertaken by Adelaide Zoo (Dalgetty, 2003).
- ♦ a study of the influence of introduced European green shore crab on habitat selection by juvenile blue swimmer crabs (see SARDI, 2001d).
- ♦ a study of the effect of effluent discharge from **Bolivar** on marine macrofauna in Gulf St Vincent (see SARDI, 2001d).

Organisations that have regularly conducted research in this area include the former Department of Fisheries; SARDI Aquatic Sciences; Adelaide and Flinders Universities; various branches of Department for Environment and Heritage (including the Environment Protection Authority, and the former National Parks and Wildlife branch); various public utility corporations (e.g. the former ETSA and EWS public utility departments); Australian Dolphin Research Foundation; and a number of private consultants (e.g. Kinhill; PPK; P. Petrusевич; P. Harbison, and many others). Examples are listed in management plans produced during the past two decades, for both Gulf St Vincent and Port River / Barker Inlet. The large number of reports and studies that were produced for the MFP (Multi-Function Polis) project during the early 1990s also describe the value of this location for research and monitoring.

Previously, the benthic surveys of Shepherd and Sprigg (1976) provided important and pioneering knowledge of the habitats in the **northern Gulf St Vincent** area.

In **northern Gulf St Vincent**, there is also regular catch and effort monitoring by government, of several major commercial fisheries in the region, and periodic research and monitoring of larval and juvenile fish and crustacean stocks. Examples from recent years include Ferguson, 1999 and 2000 (Yellowfin Whiting); Dimmlich and Jones, 1997 (Tommy Ruff and West Australian Salmon); Fowler and Eglinton, 2002 (Mud Cockles); Westlake *et al.*, 2002 (commercial worm species); Triantafillos and Fowler, 2000 (Southern Calamari), amongst others. Other studies have included impact of netting and line fishing on undersized King George whiting (Kumar *et al.*, 1995), for which Port Wakefield was one of the sampling sites. Settlement of post-larval prawns in northern Gulf St Vincent was monitored during the late 1980s through to the mid 1990s (Kangas and Jackson, 1997). Research into the status of Blue Swimmer Crab populations has been periodically undertaken in northern GSV. One recent example is the surveys undertaken in 2002 and 2003 on the spatial abundance

and size composition of adult and juvenile blue crabs (to determine a pre-recruit index) (Svane and Hooper, 2004).

In the early 2000s, the Adelaide Coastal Waters Study (ACWS) was undertaken, involving scientists from various research institutions including CSIRO, SARDI, Flinders University, and Adelaide University. The project was funded by SA Water, the SA Environment Protection Authority, Transport SA, the SA Coast Protection Board, three metropolitan Catchment Water Management Boards (Patawalonga, Torrens and Onkaparinga), Mobil and TXU, with additional support from the SA Conservation Council, the Local Government Association and the South Australian Fishing Industry Council. The study area stretches from Port Gawler to Sellicks Beach, and 20 kilometres out to sea. The overall objective of the study is to understand and develop tools to enable sustainable management of Adelaide's coastal waters, by identifying causes of ecosystem modifications, and the actions required to halt and reverse degradation. The ACWS focuses on seagrass loss, seafloor instability and water quality degradation. Identified themes include nutrients, pollutants, ecotoxicology, salinity, seagrass dynamics and ecology, algal blooms, water quality, environmental health of recreational water, coastal processes, marine habitats and stormwater management. Research tasks include quantifying diffuse and point source terrestrial inputs entering Adelaide's coastal waters; assessing the effects of inputs to the Adelaide coastal waters on seagrass ecosystems and key biota; remote sensing and interpretation of marine and coastal features including historical and present seagrass coverage, and development of an environmental information system; study of the coastal sediment budget; water circulation studies in the Adelaide coastal and Gulf St Vincent waters; and an environmental monitoring program. Key outcomes of the ACWS include recommending options for management actions, and developing a program to assess effectiveness of management actions (including monitoring programs) (SARDI, 2001; Onkaparinga Catchment Water Management Board, 2002; CSIRO, 2002).

Marine Education

Port Clinton / Clinton Conservation Park area is considered to be of "great value" for education, especially in the fields of botany, sedimentology, marine zoology and ornithology (Morelli and de Jong, 1995).

At **Middle Beach**, there is a Samphire Discovery Trail. The educational boardwalk and interpretative signage at Middle Beach is designed to raise community awareness about the importance of samphire and salt bush, and the role of this vegetation in the structure and function of the coastal area. The trail follows, in part, a chenier ridge, ending at a salt-water tidal creek, where an interpretive platform provides information about the area and its ecology. Educational material and information brochures are available.

In 2000, Coastcare funding was provided for the development of a Community Coastal Conservation and Recreation Action Plan, for the **Samphire Coast** area. The project was co-ordinated by the District Council of Mallala, and involved local community groups, staff and students from Adelaide University's Mawson Centre for Environmental studies, and many volunteers. There was a major educational component to this project; involving meetings; seminars and workshops; field days; field surveys and projects; and production of mail-outs, survey forms, feedback sheets and other written materials. The project aimed to educate the public about the ecological importance of the "Samphire Coast" (i.e. including the area within the Council District - **Middle Beach to Port Parham**, but also extending south to **Barker Inlet** and north to the Experimental Proof Range); the opportunities to protect, enhance, and restore the coastal habitats; and to promote environmentally-sensitive recreational, commercial and industrial opportunities.

The **Light River**, which has recently been proclaimed as a Conservation Park, is described as being of "increasing popularity for learning experiences" (Thomas, verbal submission to Senate Inquiry into Gulf St Vincent, February 2000).

The **Zanoni** wreck site is considered to have a role in marine education for SCUBA divers, and marine archaeological research and education (Heritage South Australia, 2000).

The **St Kilda** Mangrove Boardwalk and associated Interpretive Centre are considered to be exceptional educational facilities, and are listed as a major feature of the Barker Inlet area in a description of the national importance of the **St Kilda - Barker Inlet** Wetland area (Morelli and de Jong 1996). The St Kilda boardwalk (1.7 km through mangroves) is considered to be one of the few in the world where

people are able to come into close contact with a natural mangrove ecosystem. The facility also has significant recreation value, as well as its education role.

Long term research by the Australian Dolphin Research Foundation into dolphin population behaviour and population dynamics in the **Port River – Barker Inlet** system and surrounding coast, has had an important role in public education about the biology and behaviour of this species.

Northern Gulf St Vincent has been identified as one of five priority sites in Australia that have been selected as part of a Shorebird Conservation Project, funded by the Natural Heritage Trust, and co-ordinated by WWF - Australia (WWF). Priority project sites were selected using criteria such as site importance to shorebird populations, threats to shorebirds and their habitat and the potential to mitigate these threats, current levels of management, and opportunities for community involvement. WWF is working closely with community groups, other non-government organisations and government agencies, as part of a suite of projects that aim to conserve important shorebird habitat throughout Australia. Groups involved include Birds Australia, The Australasian Wader Studies Group, Wetlands International — Oceania, The Marine and Coastal Community Network, Wetland Care Australia, Conservation Volunteers Australia and State-based Conservation Councils. A range of activities has been proposed, or are underway, including community education and awareness programs (signage, brochures, workshops), assistance with management planning (surveys, workshops), management of recreational activities (walkways, fencing) and exploring opportunities for conservation on private land (Handley, 2003).

A Dolphin Interpretive Trail was developed in 2003, along the banks of the **Port River – Barker Inlet** system. The trail includes directional signs pointing to viewing locations, and signage about the Port River dolphins, at appropriate locations. A brochure providing extensive information about the dolphins and the environment has also been produced. The trail was developed by the Australian Dolphin Research Foundation, in conjunction with the Port Adelaide Enfield Council and Flinders University eco-tourism students (City of Port Adelaide – Enfield Media Release, 2003). The project, which was supported by Coastcare, has an education function as well as tourism value, and helps to raise awareness about the Port River dolphin population, their biology, ecology and behaviour, and the threats they face.

There are eco-tourism trips held in conjunction with dolphin research in the Port River – Barker Inlet system (Postcards Online, undated d).

North Haven Schools has developed a teaching package for students, about the **Port River** dolphins, and their biology, ecology and conservation (see Lynch, 2001).

Wilderness / Aesthetic Values

There is a constructed coastal lookout south of **Ardrossan**, described as offering “brilliant scenic views” in all directions (District Council of Yorke Peninsula, 2002), and “great views across Gulf St Vincent (Fairfax Publishing - F2, 2002).

The **far northern and north-eastern Gulf St Vincent** coast is largely undeveloped, and is considered to have aesthetic qualities as a major saltmarsh and mangrove estuarine area with tidal creeks, and associated bird habitat (e.g. see DC Mallala Foreshore Advisory Committee and EcoConnect, 2002).

Although the **Port Adelaide-Barker Inlet** system is located in a polluted industrial area, the aesthetic qualities of the mangrove-lined tidal creeks and other estuarine habitats are appreciated by many visitors.

Shipping and Boating Facilities

The **Port River – Outer Harbour** area has major commercial value for international and national shipping / cargo carrying, and the Outer Harbour and Port Adelaide (Inner Harbour) are major ports for these ships. together, the Inner and Outer Harbours support over 20 wharves, including the CSX World Terminals container port (Flinders Ports, 2003). In 1995-1996, 794 vessels called at Port Adelaide, carrying 2.258 million tonnes of imports, and 2.625 million tonnes of exports (Harbison, 1997). In 2002, 1043 international ships visited Port Adelaide (Flinders Ports website, 2003). During 2002/2003, 7.94 million tonnes of cargo was moved through the Port of Adelaide with 4.57 million tonnes imported / exported to overseas markets. Significant growth in container trade has been

experienced in recent years with Port Adelaide accounting for the handling of 96% of all container cargoes shipped out of the State. Primary Export destinations include the Middle East, North Asia and South East Asia. Primary Import origins include the US, North Asia and South East Asia (Flinders Ports, 2003).

There is also a considerable volume of shipping traffic on the western side of GSV, with many large ships anchoring offshore at **Port Giles** and **Ardrossan** (Senate Inquiry into Gulf St Vincent, 2000).

Permanent coastal mooring facilities for smaller commercial and recreational craft occur at **St Kilda**, **Garden Island**, **North Arm** and **Port Adelaide**.

Mining

There is a dolomite mine in the **Ardrossan** area, opened in the mid-1970s. Both dolomite and limestone of Cambrian age are worked at the quarry (Field Geology Club of South Australia, 1997). Dolomite is used as a flux in the steel making process. It is also used in the local area for concreting, road making and fertilising (Fairfax Publishing – F2, 2002). During the late 1990s, the annual production of dolomite from the Ardrossan quarry was 1 Mt per annum, from a reserve of around 20 Mt (PIRSA, 1999g).

There are salt mining leases and associated salt fields at **Price** and **Dry Creek**. Cheetham Salt at **Price** has around 200,00 tonnes of salt in stockpile, and harvested 40,000 tonnes more salt than expected in the 2003 season (ABC Rural, 2003). Salt production from sea water evaporation started in 1919 at Port Price. At **Dry Creek**, the salt mining enterprise was established in the 1930s, at a basin that forms a 35 km strip of low-lying land. Around 10,000 ha of coastal lands in the area are owned or leased by Penrice, and 4000ha are currently used for salt production (DC Mallala Foreshore Advisory Committee and EcoConnect, 2002). The evaporative and crystallising basins, covering 4000ha, produce an average of 750,000 tonnes per year of salt (Penrice, 2000). Salt crystallises from October to March, and harvesting is usually carried out in the following 90 days before the first winter rains. Sea water is pumped into the basins at two points (**Middle Beach** and **Chapman's Creek**) and over a period of two years moves south through a series of terraced concentrating ponds. As the water concentrates, material such as iron and calcium sulphate crystallises, leaving a high density water which is pumped into eight salt crystallising ponds covering 370 ha. After undesirable magnesium and other salts are separated, the sodium chloride salt is crystallised out in a layer up to 150 mm deep on the floor of the ponds. The residual brine, or "bitterns", is rich in magnesium chloride and other salts, and most of this is returned to the sea via the nearby Barker Inlet; some is further processed for sale as a dust suppressant on open-surface roads (Penrice, 2000). Mechanical harvesters, mobile conveyors and staff, scrape the salt from the ponds and place it in stacks alongside the crystallisers. Each harvester can collect up to 1200 tonnes per hour of salt, and the harvest team averages 8000 tonnes per day to peak season. Much of the salt is used in the production of soda. Soda ash has been produced at **Osborne**, since the plant's establishment in 1940. It is the final phase of a three-stage process that involves the production of crushed marble and salt used as raw feed. Throughout the year, the stacks of salt are continuously redissolved. Groundwater, taken from on-site bores and supplemented by town water, is sprayed on the stacks 24 hours a day. This percolates through the salt to form a saturated brine, which is collected in drains and pumped 10 km overland and under the **Port River** to the **Osborne** plant. Approximately 5000 kilo-litres of brine reaches the plant every day, the equivalent of a semi-trailer load of salt arriving every 15 minutes (Penrice, 2000). To produce soda ash at the **Osborne** plant, Penrice employs the Solvay method. A mixture of coke, and marble from Angaston, is burnt in vertical shaft kilns to form carbon dioxide and quicklime. The carbon dioxide is added to a solution of ammonia and purified brine from Dry Creek to form a magma of crude sodium bicarbonate. Using steam from the Osborne Cogeneration Plant the sodium bicarbonate is decomposed to sodium carbonate in rotary dryers, producing a 'light ash'. Water is added to form new crystals of sodium carbonate monohydrate, which are dried to form 'dense soda ash' with a bulk density twice that of 'light ash'. Once processed, bulk soda ash is transported around Australia and overseas by road, rail and sea. Other product is dispatched in 20-25 kg bags or in large 'semi-bulk' bags of up to 1200 kg capacity. The 48,000 t of sodium bicarbonate produced at the plant each year is used in a range of products, including stock feed, pharmaceuticals, bleaching of powders, biscuit and cake mixers and baking powder (Penrice, 2000).

The chenier beach ridges in the north-eastern GSV coastal area providing a significant source of shell grit, which is mined by a number of leases in the area (DC Mallala Foreshore Advisory Committee,

2002).

Towns and Settlements

There are small coastal settlements at **Clinton, Price** and **Port Arthur**. The populations of these settlements increase seasonally during holiday periods, particularly due to crabbing and fishing.

Ardrossan is the major eastern port of Yorke Peninsula servicing the mining and grain industries, with a substantial jetty and bulk grain loading facility (Wilkins, 1999). Wheat and dolomite are major exports from the area (Fairfax Publishing – F2, 2002). Ardrossan has a population of around 1083 (ABS statistic, 2001) with a large and temporary increase in population during the holiday months.

Tiddy Widdy is a small coastal settlement of less than 200 residents, swelling to more than 500 during holiday periods (Yorke Peninsula Country Times, 2003). The town has been a popular place for both retirement and seasonal holidays, and the amount of holiday housing on the foreshore has increased in recent years.

Port Wakefield has a population of around 500 (ABS statistic, 2001; S.A. Regional, undated; Yorke Peninsula Country Times, 2002).

On the eastern side of northern GSV, there are small coastal settlements and access points at **Port Parham, Webb Beach, Thompson's Beach, Port Prime, Light River Beach, Middle Beach, Port Gawler** and **St Kilda**. There is vehicular access to the coast in most of these areas (Berggy, 1996). Around 10,000 ha of the land in the north-eastern GSV region is owned or leased by Penrice, of which 4000ha is currently used as salt fields, and 6000ha (in the vicinity of the Light River Delta), is not under production.

Port Adelaide was one of South Australia's earliest settlements, and continues to be the main service point for shipping in the State. In recent years there has been a significant increase in export activity with "booms" in the shipment of grains, wine, motor vehicles and automotive components, ores and concentrates (Flinders Ports, 2003). Port Adelaide – Barker Inlet area is a major industrial centre, with hundreds of industries, some of which as discussed in the section on **Issues for Risk and Impact Assessment**. Power generation occurs at **Torrens Island, Osborne** and **Pelican Point**. In 2000, there were around 54,100 people living in the Coast and Port section of the Port Adelaide – Enfield Council District (City of Onkaparinga, 2002, citing ABS statistic).

Other Coastal and/or Marine Related Information

Between **Port Clinton** and **Port Price** there are large deposits of brown coal. In 1923 drilling tests revealed an estimated 32 million tonnes lying at a depth of 89 metres in a 6.4 metre seam. Since then further investigation has revealed that the deposit extends under the waters of St. Vincent Gulf (DC of Yorke Peninsula, 2002).

Waters south of **Port Wakefield** to **Sandy Point** are part of the Army restricted and danger areas R259E, R259D and R259A, part of the proof and experimental establishment. The Proof Range, established in the 1920s, is on the southern side Port Wakefield. The large expanse of sand exposed at low tide is used for the Army's testing program (South Australian Tourism Commission, 2000).

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

***Bay of Shoals - Nepean Bay - Western Cove;
American River - Eastern Cove - Dudley Peninsula***

Aquaculture

Some of the main objectives of PISA's (Gilliland, 1996) Kangaroo Island Aquaculture Management Plan were:

- ♦ to provide for the development of shellfish culture, particularly oyster and Blue Mussel culture in near-shore areas by allocating zones considered suitable at that time for development;
- ♦ to also encourage smaller research and development leases to develop, including establishment in areas additional to those zoned for commercial development (i.e. "unallocated areas");
- ♦ to encourage some developments in near-shore (e.g. intertidal) areas, to provide for the aquaculture interests of local landholders;
- ♦ to encourage limited areas of "concentrated" (Gilliland, 1996) development in deeper (outer bay) waters, as well as providing for research and development sites in deeper waters that are additional to the zoned areas, with potential for commercial development following review of the plan.

From **North Cape**, to the waters **south of Busby Islet Conservation Park** (i.e. including much of the **Bay of Shoals**), PISA (see Gilliland, 1996) classified the **Bay of Shoals** Aquaculture Zone as being suitable for aquaculture development (both Research and Development, and commercial, subject to EIA). The zone has been defined the area bounded by the mean spring high water mark and the following points (see Map OC(KI)/2 in Gilliland, 1996): 738424E, 6061086N; 738836E, 6061057N; 743475E, 6053894N; 732633E, 6054184N.

Despite unsuccessful trials during the 1980s, PISA (Gilliland, 1996) considered that the area had potential for aquaculture; for example, as an oyster fattening site, useful during winter, for oysters produced in other parts of Nepean Bay. PISA provided for up to 30ha of Research and Development (R and D) sites for oyster culture, subject to a number of conditions regarding cultured species and locations of leases. The sites were subject to approval as commercial ventures following environmental impact assessment during the R and D period.

Three shellfish leases were approved in 1997 for the northern **Bay of Shoals**, according to S.A. Coast and Marine Atlas (2001), however in 2003, no leases were operating in the area (S.A. Coast and Marine Atlas, 2003; PIRSA Aquaculture map, June 2003).

The waters between the spring high water mark and the following points with the exception of the navigation exclusion zone (see below) were designated by PISA (see Gilliland, 1996) as the **Nepean Bay** Aquaculture Zone (see Map OC(KI)/2 in Gilliland, 1996): 738572E, 6066630N; 738424E, 6061086N; 738836E, 6061057N; 743475E, 6053894N; 747221E, 6041844N; 751365E, 6042932N; 753885E, 6044530N; 762679E, 6043348N; 762844E, 6048932N. Within the zone, PIRSA provided for a maximum of 250 ha of aquaculture, including 200ha of longline shellfish culture. The navigation exclusion zone within the Nepean Bay Aquaculture Zone is defined as waters bounded by the following points: 743475E, 6053894N; 750608E, 6057975N; 757999E, 6052518N; 745262E, 6041844N.

Nepean Bay has been of continuing interest in the development of the oyster and Blue Mussel aquaculture industries on north-eastern Kangaroo Island, and areas for both intertidal oyster culture and open water aquaculture have been identified in Nepean Bay (e.g. see Gilliland, 1996; and PIRSA Aquaculture Public Register, 2003). Since the mid 1990s, the Nepean Bay area has been the centre for interest in aquaculture development on Kangaroo Island, following unsuccessful trials in oyster production in the **Bay of Shoals** (mid 1980s) and trials of limited success in **American River** (1969, and mid 1980s). Research and development trials were undertaken during the 1990s and the area is now used for commercial production of shellfish. Interest has also been expressed in Rock Lobster culture in the region.

Nepean Bay: PISA (see Gilliland, 1996) considered that the Nepean Bay area has potential for future development of aquaculture *in excess of the allocation provided for in the Kangaroo Island Aquaculture Management Plan* (1996), and that an expansion of the area available for aquaculture may be considered in the five-year review of the plan. As at 2001, there were 200 hectares available for approved aquaculture development in the **Nepean Bay** Aquaculture Zone (PIRSA web site, 2001).

During the 1990s, industry indicated that the **Nepean Bay** area had high potential for aquaculture, and PISA (see Gilliland, 1996) provided for a total of 70ha of intertidal oyster culture in the area. Since 1990, at least 10 oyster leases have been approved east of **Nepean Bay Conservation Park** (SA Coast and Marine Atlas 2001) and in 2003, 7 leases for Pacific Oyster and 1 lease for Native Oyster were operating in the **Nepean Bay** area, west of **Point Morrison** (S.A. Coast and Marine Atlas, 2003; PIRSA Aquaculture Public

Register, August, 2003). PISA (Gilliland 1996) provided for aquaculture developments to be placed 300m or greater distance away from the **Nepean Bay Conservation Park**, following discussion with the park ranger at Nepean Bay.

PISA (see Gilliland, 1996) designated an aquaculture zone east of Nepean Bay Conservation Park, in recognition of the existing leases at the time (20ha in 1996) and future potential. The **Western Cove Aquaculture Zone**, east of Nepean Bay Conservation Park, was defined as the area bounded by the mean spring high water mark and the following points (see Map OC(KI)/2 in Gilliland, 1996): 738637E, 6042163N; 738769E, 6042604N; 744032E, 6041969N; 744018E, 6041470N.

The waters forming a block between **Ballast Head, Point Morrison** and **Kangaroo Head** were classified by PISA (see Gilliland, 1996) as the **Eastern Cove Aquaculture Zone**, for shellfish farming, subject to EIA if the potential lease is to be positioned over seagrass (N.B. Reef occurs in much of the eastern part of this area). The Eastern Cove zone was specified for the deeper waters in the northern section of Eastern Cove, defined as the area bounded by the mean spring high water mark and the following points (see Map OC(KI)/2 in Gilliland, 1996): 762679E, 6043348N; 753885E, 6044530N; 751365E, 6042932N; 761757E, 6042556N; 753093E, 6038787N.

PISA provided for a maximum of 200ha of longline shellfish culture in the zone, subject to height constraints and consideration of seagrass beds deemed to be significant by the Director of Fisheries. PIRSA also considered that the area had potential for future development of aquaculture in excess of the allocation provided for in the 1996 plan (Gilliland, 1996). PIRSA considered an expansion of the area available for aquaculture, following the five yearly review of the plan.

Four shellfish aquaculture leases were approved in 1996 for the area between **Point Morrison** and **Ballast Head**, in **Eastern Cove** (S.A. Coast and Marine Atlas, 2001), however no leases were operating north of Ballast Head in 2003 (PIRSA Aquaculture Map, June, 2003).

PISA (Gilliland, 1996) designated an aquaculture zone **south of Ballast Head: the American River Aquaculture Zone**. The **American River Aquaculture Zone** was specified for the intertidal area between the American River township and Ballast Head, and defined as the area enclosed by the mean spring high water mark and the following points (see Map OC(KI)/2 in Gilliland, 1996): 752626E, 6038539N; 752818E, 6038224N; 751991E, 6037401N; 751599E, 6037711N.

PISA provided for a maximum of 30ha of intertidal oyster culture, comprising research and development leases which had provision to become permanent commercial leases following an assessment of the suitability of the product for human consumption (given the pollution sources in the area). Between 1996 and 2001, five shellfish leases were approved south of **Ballast Head** (western side of **Eastern Cove**, north of **American River**), and in 2003, 3 leases were operating south of **Ballast Head** area (PIRSA Aquaculture map, June 2003), comprising one lease each for Greenlip Abalone, Blacklip Abalone, and Pacific Oysters (S.A. Coast and Marine Atlas, 2003).

According to PISA's Kangaroo Island Aquaculture Management Plan (1996), aquaculture development has been prohibited in the area from Kangaroo Head to Cape Willoughby, with an exception of 200ha block within the **Penneshaw Aquaculture Zone** (between Penneshaw proper and Cuttlefish Bay), in which longline shellfish culture would be considered. The Penneshaw Aquaculture Zone Aq(P) is defined as the area bounded by the mean spring high water mark and the following points (see Map OC(KI)/10 in Gilliland 1996): 768396E, 6042912N; 772608E, 6041361N; 769663E, 6044032N; 773540E, 6042621N. This permitted block may have been based upon an application, rather than site suitability assessment procedures. A previous (mid 1990s) fin-fish farming application in the north-eastern Kangaroo Island area was rejected by government.

There are Scallop farming trials underway on (northern) Kangaroo Island (SA Country Hour media report, June 2000).

Interest has been expressed in fin-fish aquaculture in the northern waters of Kangaroo Island, but no leases have been approved to date.

Commercial Fishing

Scalefish, Sharks and Invertebrates

Regionally, the major commercial fish and shark species that are caught in the north-eastern Kangaroo Island area include the following. Much of the information pertains to the Bays region (e.g. **Bay of Shoals, Western Cove, Nepean Bay, American River, Eastern Cove**). Fisheries information that is specific to eastern **Dudley Peninsula** is not available for this assessment, however, some broader regional information is provided, as specified below:

King George Whiting: Hand line fishing for King George Whiting occurs around **American River, Nepean Bay** (including both **Western and Eastern Coves**) and the **Bay of Shoals**, and there is, to a lesser extent, net fishing for whiting in some of these areas (those not subject to netting closure). During the mid 1990s, the north-east Kangaroo Island bays area was ranked 3rd in S.A. in terms of annual yield of King George Whiting per fishing block, with per annum yields of 30t - 35t in some years. McGarvey et al. (2000 and 2003) provided catch and effort statistics for Gulf St Vincent as a whole.

Garfish: Dab netting for Garfish occurs in the north-eastern Kangaroo Island bays, such as **Western and Eastern Coves** (G.K. Jones, pers. comm. cited by Edyvane, 1999b). During the mid 1990s, the north-east Kangaroo Island bays area was amongst the top 10 regions in S.A. in terms of annual yield of Garfish, with per annum yields of more than 15t to 20+t in some years. Information specific to the Dudley Peninsula is not available. The eastern Dudley Peninsula is part of a large fishing area that includes Backstairs Passage and Southern Fleurieu, but Garfish yields are comparatively low in the Dudley Peninsula area.

Australian Salmon: The inshore salmon fishery for 1+ aged salmon occurs in the bays and shoals of north-eastern Kangaroo Island (G.K. Jones, pers. comm., cited by Edyvane, 1999b). Statewide significance of the north-eastern Kangaroo Island area as a salmon fishing area is variable, in line with the periodic abundance of the resource, which depends upon annual recruitment strength. For example, in 1996/97, the Australian Salmon yield for the fishing area that encompasses north-eastern KI bays area was more than 100 tonnes, however in some other years during the 1990s, tonnages from that area were much smaller (e.g. less than 10 tonnes). The north-east KI area is amongst the top 10 fishing area for Australian Salmon in S.A.. Further east, the Southern Fleurieu - Backstairs Passage region also records fluctuating yields (depending upon recruitment strength), and in some years during the 1990s, was amongst the top 5 fishing areas for salmon in S.A. (e.g. nearly 25t in 1995/96), however the proportion of yield that pertains only to the North-East KI / Dudley Peninsula area is not known for this report. Recent figures are available for the aggregated catch from **Gulf St Vincent and Kangaroo Island** combined: 1990/91: 115.75t; 1991/92: 435.7t; 1992/93: 337.7t; 1993/94: 308.1t; 1994/95: 596.5t; 1995/96: 315.6t; 1996/97: 299.1t; 1997/98: 333.1t; 1998/99: 380.6t; 1999/00: 210t; 2000/01: 377.2t. (Knight et al., 2002). The proportion of this yield taken from the north-east KI area is not available for this report.

Southern Calamari: During the 1990s, annual yields of more than 5 tonnes were taken from the north-east KI Bay region in some years, although the area is not regularly amongst the top 10 in S.A., in terms of calamari yields. Further east, the South-Central GSV – Southern Fleurieu - Backstairs region is a significant fishing area for calamari (see section below on south-eastern GSV), however the proportion of yield from that region that pertains only to the Dudley Peninsula is not known for this report, but is considered to be low compared with the Southern Fleurieu area. Recent aggregated figures for "**Kangaroo Island**" (= fishing blocks 41 and 42, which include the north-eastern KI bays, waters seaward of the western side of the Dudley Peninsula, and northern KI waters to 137°E longitude) show that the total yield from this area (haul-net and jig catches combined) ranged between approx. 7t and 11t over the period 1994 - 1999 (see Figures 4f and 5 in Triantafillos, 2000).

Gummy Shark: Recent figures are not available for this report. Gummy shark catches in South Australian waters are controlled by Commonwealth quota, and the fishery has recently been re-regulated in light of the *fully-fished* status of Gummy Shark in southern Australian states (see AFMA 2000d, 2003a, 2003b). The fishery for this species is managed by the Commonwealth. Within state waters, more than 10 tonnes per annum were taken from the North-East Kangaroo Island Bays region in some years during the 1990s. Of the 50 fishing areas in S.A. in which Gummy Sharks are caught, more than 10 tonnes per annum of Gummy Shark were taken during the mid to late 1990s from each of approximately 20 to 25 of those areas, and the North-East KI bays area was amongst those areas.

Snook: Trolling for Snook occurs in the Backstairs Passage region, in waters to around 20m (G.K. Jones, pers. comm., 1996, cited by Edyvane et al., 1996), but the yield from the Kangaroo Island side of the Passage is not available for this report. Low tonnages per annum were recorded from the Southern Fleurieu / Backstairs Passage / Dudley Peninsula fishing region during the mid to late 1990s, but it is of lesser significance compared with other regions of the State, in terms of annual Snook yields.

Various Ray species: Variable yields in the aggregated Southern Fleurieu / Backstairs Passage / Dudley

Peninsula region. Recent figures are not available for this report. During the mid to late 1990s, yields ranged from several tonnes to nearly 10 tonnes, and in recent years that aggregated region was one of the top two fishing areas in S.A. in terms of annual yields. The proportion of the yield that is specific to the Dudley Peninsula area is not available for this report. Tonnages taken from the north-eastern Kangaroo Island bays are lower (e.g. less than 3t per annum during the mid to late 1990s).

Other species for which small tonnages are taken in the area, include *Yellow-Eye Mullet*, *Tommy Ruff* and *Sand Crab*. In addition to those species listed above, more than 18 other species (mainly fish, but also including sharks and minor invertebrates) are commercially caught in and around the North Eastern Bays area, in small quantities.

The majority of fin-fish taken in the north-eastern Kangaroo Island region are caught in the **Nepean Bay** area, and Gilliland (1996) stated that "significant amounts" of fish are taken with both nets and lines in this region, though several areas in Nepean Bay are currently closed to netting. On Kangaroo Island major netting areas include the **Bay of Shoals** and the western section of **Western Cove**. Gilliland (1996) considered **Bay of Shoals** to be of major importance to the net fishing industry. Line fishing is reported to be concentrated near **The Spit** (which can be navigated over at high tide), **Western Cove**, and **Eastern Cove** (Gilliland, 1996). **Busby** and **Beatrice Islets** (**Bay of Shoals** area) are used for commercial fishing and cockle harvesting, particularly on the spit (Morelli and de Jong, 1995). **Kingscote** and **Penneshaw** are ports of landing for marine scale fish.

The north-eastern Kangaroo Island bays area is part of GARFIS Fishing Block 42. Recent fisheries statistics for the area are not available for this report. Previously, according to SARDI (cited by Edyvane, 1999b), the marine scalefish catch from Fishing Block 42 (eastwards of North Cape, including all the North-eastern Kangaroo Island bays - Western Cove, Bay of Shoals, Eastern Cove – Nepean Bay - American River, eastwards to approximately Penneshaw, and all waters northwards to approximately 35°35'S) was:

- In 1995/96 a total of 84,372kg (0.81% of State total, representing 33 fishers);
- In 1996/97 a total of 221,191 kg (2.18% of State total, representing 32 fishers).

On a Statewide scale, aggregated catch figures for all GARFIS Fishing Blocks in South Australia show that between 1995-1996, the catch of marine scalefish, sharks and minor invertebrates from Fishing Block 42 was 25th in the ranked list of fishing yields from 58 South Australian fishing blocks. In 1996-1997, the catch of marine scalefish, sharks and minor invertebrates from Fishing Block 42 was 12th in the ranked list of fishing yields from 58 South Australian fishing blocks.

No information specific to the Dudley Peninsula is available for this report. According to SARDI (cited by Edyvane, 1999b), the marine scalefish catch from Fishing Block 44 (i.e. eastern side of Dudley Peninsula, from approximately the Hog Bay / Penneshaw region 138°E, eastwards into Backstairs Passage, and south of Dudley Peninsula to approx. 36°S, eastwards to approximately 138°30'E, and northwards of Backstairs Passage, to include Southern Fleurieu Peninsula as far north as approximately Aldinga) was:

In 1995/96 a total of 171,288kg (1.65% of State total, representing 47 fishers);

In 1996/97 a total of 129,167 kg (1.27% of State total, representing 37 fishers).

On a Statewide scale, aggregated catch figures for all GARFIS Fishing Blocks in South Australia show that between 1995-1997, the catch from the marine scalefish fishery (which includes sharks and minor invertebrates as well as scalefish) from Fishing Block 44 was 17th in 1995/96, and 20th in 1996/97, in the ranked list of fishing yields from 58 South Australian fishing blocks.

Abalone Fishing

Aggregated figures are provided for the area from **False Cape to Cape Coutts** (Map Codes 31A, 31B and 31C), which includes the area from **Cape Willoughby** northwards into **Antechamber Bay** and **Cape Coutts**. Between 1990 and 1996, recorded annual yield (approximate whole weight) of Greenlip Abalone in the False Cape to Cape Coutts area fluctuated between 0.5t and almost 7.8t whole weight, and yield of Blacklip Abalone fluctuated between 0.8t and 4.1t (S. Shepherd, SARDI, pers. comm., 2000).

No figures specific to the area north of Cape Coutts are available, including figures for the Kangaroo Head area. However, aggregated figures for the **North Eastern KI** area that are incorporated into Map Codes 32A, 32B, 32C are provided, because Map Code 32C includes the north-eastern reef area of KI (**Kangaroo Head**, **Ironstone Point** etc). Between 1990 and 1996, recorded annual yield (approximate whole weight) of Greenlip Abalone in the North East KI area fluctuated between 0kg and 4.2t, and yield of Blacklip Abalone fluctuated between 0 kg and 1t (S. Shepherd, SARDI pers comm., 2000). Abalone catch in the north-east Kangaroo island area is low, on a Statewide basis. However, Gilliland (1996) considered that sections of the waters between Kangaroo Head and Cape Willoughby (i.e. Penneshaw Aquaculture

Policy Area) were significant to the abalone fishing industry, and that “Blacklip Abalone are taken in waters up to 5 meters deep around the entire island with the exception of Nepean Bay”.

Rock Lobster Fishing

No information specific to the **North-eastern Kangaroo Island bays** is available for this report, even aggregated figures for Fishing Block 42, due to the small number of fishers fishing in the area (reported to be four fishers in 1995/96 and three fishers in 1996/97, according to Edyvane, 1999b). Catch figures listed for the north-eastern KI bays area in SARDI Report 39 (Edyvane, 1999b) relate to Block 44 (Southern Fleurieu and eastern and southern sides of Dudley Peninsula), not to Block 42. Kingscote and Penneshaw are ports of landing for Southern Rock Lobster. During the mid 1990s, more than half (14 of 24) of the Rock Lobster boats that use the northern Kangaroo Island area as Port of Landing, operated from Kingscote, and only one operated from American River (Edyvane, 1999b).

Both Fishing Blocks (Marine Fishing Areas = MFAs) 42 and 44 records minor yields compared with those from the top 10 fishing areas in the Northern Zone (see Ward *et al.*, 2002). For example, Ward *et al.* (2002) reported that although there has been an increase in the proportion of the catch taken from the third most heavily fished groups of MFAs since the early 1980s (i.e. MFAs 6, 9, 12, 13, 24, 25, 35, 37, **42** and **44**), and thus these MFAs have increased in significance, only about 3% of the total annual catch is taken from these areas. In terms of fishing effort, the number of pot lifts in MFAs 42 and 44 is between 0 and 10,000 per annum for each area, which is low compared with the fishing effort from the key fishing areas in the Northern Zone (see Ward *et al.*, 2002, Figure 2.7a, 2.7b, 2.7c, 2.7d).

Gilliland (1996) considered that sections of the waters between **Kangaroo Head** and **Cape Willoughby** (i.e. Penneshaw Aquaculture Policy Area) were significant to the Rock Lobster industry (but see above, for Statewide comparison), yet also stated that lobster fishing is limited west of **Snapper Point** (which would include the area between **Kangaroo Head** and **Snapper Point**). In the north-eastern Kangaroo island area, there is limited Rock Lobster fishing also in deeper waters (e.g. out of **Nepean Bay**, in **Investigator Strait** area) in suitable habitat, and within 3 NM of the coast.

No information specific to the Dudley Peninsula is available for this report. Previously, according to SARDI (cited by Edyvane, 1999b), the Rock Lobster catch from Fishing Block 44 (i.e. eastern side of Dudley Peninsula, from approximately the Penneshaw region 138°E, eastwards into Backstairs Passage, and south of Dudley Peninsula to approx. 36°S, eastwards to approximately 138°30'E, and northwards of Backstairs Passage, to include Southern Fleurieu Peninsula as far north as approximately Aldinga) was as follows: In 1995/96 a total of 7,036kg (0.14% of State total, representing 8 fishers); in 1996/97 a total of 5,390 kg (0.11% of State total, representing 6 fishers).

Aggregated catch figures for all fishing blocks in South Australia for which Rock Lobster data are available, between 1995 and 1996, showed that Fishing Block 44 was 21st in the ranked list of commercial Rock Lobster fishing areas in South Australia, in terms of yield (and hence value) during that period, and that catches in the top fishing areas of the State were two orders of magnitude higher than those yielded from the north-eastern KI / Backstairs Passage / Southern Fleurieu region. The specific significance of this figure to the Dudley Peninsula is not known for this report, because Fishing Block 44 includes other areas (as described above).

Prawn Fishing

Prawns are not fished in the north-east Kangaroo Island bays, because the waters are shallow and contain nursery areas (i.e. therefore closed areas).

Specific information on prawn fishing yields in parts of the north-west Kangaroo island area is not available for this report.

A designated prawn fishing block (Block 78) occurs near the coast at the Kangaroo Head to Penneshaw region, but, according to Morgan (1995) this block was not fished in any year between 1968 and 1994. Other blocks in the area, in which waters deeper than 10m occur, include part of Block 85 (east of Marsden Point), and Blocks 79 and 84 (outer Nepean Bay). Between 1968 and 1994, the area comprising the aforementioned blocks was trawled during 20 of the 27 years, although not all blocks were trawled in any one year (Morgan, 1995). The deeper water blocks at the northern Backstairs Passage / Eastern Investigator Strait area seaward of Nepean Bay include blocks 77, 80, 83 and 86, some of which have been regularly fished during that time period (e.g. Block 80).

Figures specific to the area discussed in this table are not available, however the total catches of Western King Prawns from Gulf St Vincent in 2000/01 and 2001/02 were reported to be 384t and 322t respectively (SARDI Aquatic Sciences statistics, 2003). Svane (2003) reported that in 2002/03, the total prawn catch from all areas of GSV combined, was 231.9t, being 29% smaller than the previous year's catch, and 42% smaller than the 1999/2000 catch. Fishing effort (3791 trawl hours, over 53 nights) was higher in 2002/03 than in the previous two seasons, but the catch was lower. The catch in the 2002/03 year was almost as low as that taken in 1991, when the fishery was closed. The catch rate in 2002/03 was 61.2kg per hour, the lowest since the fishery was re-opened in 1994. Fishery independent surveys in the 2002/03 season showed that the abundance of new recruits was low (Svane, 2003). This contrasts sharply with the reported state of the fishery a few years previously. For example, Boxshall and Williams (2000) reported that (i) the total catch for the 1999/2000 GSV prawn season (i.e. from all areas of the GSV fishery combined) was 400.24 tonnes, the highest catch recorded since the 1983/84 season; (ii) catch rates for the season (99.03 kg / boat hr) were the highest recorded in the history of the fishery; and (iii) the total level of fishing effort (4042 boat hrs) increased over that seen in the previous (1998/99) season, but remained within limits set for the fishery. Boxshall and Williams (2000) considered the performance of the fishery in 1999/00 to be consistent with a fishery that had rebuilt to previous levels; that the recovery was likely to have been assisted by strong recruitment over the past two seasons prior to assessment, and that recruitment levels are variable, and it was unlikely they would be sustained at high levels on a consistent basis. However, as reported by Svane (2003), the strong recruitment apparently did not persist, based on the low catch for that season, as well as data for 2002/03 which showed mainly large adult prawns in the catch; a widely dispersed fleet (reflecting low prawn abundance); the lowest catch rates recorded in a 10-year period of fishery-independent surveys, and few recruits (young prawns) in the surveyed areas. Spatial and temporal restrictions to catch and effort were recommended, to prevent continued declines in prawn biomass (Svane, 2003).

Recreational Fishing

North-east Kangaroo Island (general): Promoted as a location providing a variety of fishing opportunities in both sheltered inner bays and rivers, and more exposed waters of the open bays, headlands and cliff-lines. Bream fishing in the estuarine areas of the north-east is considered to be the best in the State (Sweeney, 1996a). Anglers can fish in all weather conditions, due to the very sheltered nature of the coves and rivers of the north-eastern side.

A summary of fishing activities in the **Eastern Cove** and **Western Cove** areas includes line fishing from shore and boat, netting, dab netting, hoop netting, lobster potting, spearfishing and dive-fishing (e.g. for molluscs) (Bryars, 2003).

Bay of Shoals / Kingscote: popular area for boat fishers catching King George Whiting. Tommy Ruff and Razorfish, and most of the species described below for Kingscote jetty, are also caught by boat fishers in the area. Cockles and Scallops are also taken by recreational fishers.

Kingscote jetty: Described by Sweeney (1996a) as "one of the most productive jetties in the State" for recreational fishing, and "an excellent jetty" for the abundance and variety of recreationally significant species. The jetty is renowned for King George Whiting fishing. Some of the major species caught are King George Whiting (including large 40+cm fish), Snook, Tommy Ruff (abundant), Garfish, Southern Calamari and trevally, and fish from the area are recognised for their large size. Barracouta, kingfish, various ray species, and small bronze whaler sharks are also caught in the **Kingscote** area. Fishing from boats also occurs in the **Kingscote** area, for a similar mix of species to those listed above.

King George Whiting, Australian Salmon and other common species in the area are also targeted on charter boat fishing trips (including fishing cruises on sailing boats) out from **Kingscote**, which fish in the **Bay of Shoals** and **Nepean Bay**, and other bay and headland areas along north-eastern Kangaroo Island. Fishing for large King George Whiting is promoted in the area. There are boat ramps at **Brownlow Beach** (south of **Kingscote**) and a boat launching facility at **Nepean Bay** (Gilliland 1996).

Off Cape Rouge: Dissected patch reefs (described as "lumps" and "broken bottom") between 10m and 15m depth, east of **Cape Rouge**, are recognised recreational fishing marks (*Fish SA* 2000). Main targeted species include those described for **Nepean Bay**.

Cygnets River mouth: Black bream is a popular target. Boat fishers target King George Whiting, Australian

Salmon, flathead, Garfish in **Nepean Bay**. Leatherjackets are also caught although not usually targeted (Kangaroo Island Tourism Guide, 2001, and other regional fishing promotion materials).

The jetty at **Ballast Head (Eastern Cove)** is used for fishing, targeting a similar mix of species outlined below for American River and Penneshaw. Charter boats also operate out of the **American River / Eastern Cove**, with King George Whiting as one of the main species targeted.

American River: Has been a popular recreational fishing area for more than a century, for both locals and tourists. Renowned as a fishing area for catching King George Whiting (especially by hand-lining) and Garfish, particularly in the channels. American River is popular with small boat owners, for holiday fishing (Sweeney, 1996a). Boat fishers target King George Whiting, Garfish, Snook, Australian Salmon, Tommy Ruff, Yellow-eye Mullet, Trevally and Southern Calamari. Fishers also wade in the shallows and cast in the sand patches for whiting, Garfish and other species. flathead species and Sand Crabs are also regularly caught in American River. "Rock cod" species are also caught, less commonly, and some recreational fishers also collect bivalve molluscs (e.g. Scallops) from the area. There is a jetty, wharf and boat ramp at **American River**, a boat ramp at **American Beach**, and various mooring areas.

There are charter cruises for fishing (Postcards Online, undated; FishInternet Australia Guides and Charters, 2001; Australian Waters website, undated), departing from **American River**, described as "very popular" (Postcards Online, undated).

Charter boat fishing has become an increasingly popular activity in the area over the past decade, and charters operate out from **Kingscote**, **American River**, and **Penneshaw**.

Tourism promotions advertise charters to the north coast of Kangaroo Island that target more than 20 species, including Snapper, Samson Fish, Harlequin Fish, King George Whiting, Redfish ("Nannygai"), Blue Morwong, flathead species, Western Blue Groper, Trevally, King Fish, Bluefin and Albacore Tuna, School Shark, Gummy Shark, and Whiskery Shark, amongst others.

The bays of the north-east Kangaroo Island are used by boat and jetty fishers. At **Penneshaw**, the main species caught are King George Whiting, Sand Flathead, yellow-eye mullet, Australian Salmon, Snapper, Snook, sweep, and Garfish, Tommy Ruff, Southern Calamari, trevally and leatherjacket species. Charter boat operators also use the area.

Antechamber Bay is listed as one of the top 20 recreational boat fishing locations in S.A. (Capel 1994), with the major targeted species including Snook (by trolling), salmon, whiting, flathead and rockfish species (e.g. gurnard perch species and "scorpion-cod").

Penneshaw jetty: Tommy Ruff, Garfish, trevally and Southern Calamari commonly caught from the jetty. Weedy whiting also caught (not a targeted species).

A summary of recreational fish caught in the area, according to a government survey during the mid 1990s (McGlennon and Kinloch, SARDI recreational fishing survey data, cited by Edyvane, 1999b), includes the following major species caught around **Kingscote**, **American River** and **Penneshaw**: King George Whiting, Black Bream (Kingscote), Yellow-eye Mullet, Sand Flathead (American River and Penneshaw), Australian Salmon, Tommy Ruff, Snook (Kingscote and Penneshaw), Garfish, Southern Calamari, Trevally (Kingscote and Penneshaw), leatherjacket species (Kingscote and Penneshaw), Sweep (Penneshaw).

Christmas Cove (e.g. rock fishing): Commonly targeted are Australian Salmon, flathead, trevally, Snook, mullet, ray species. There is also some shore-based fishing at **Hog Bay** (which also has a jetty) and **Antechamber Bay** (surf fishing). A mooring area and boat ramp is located in **Christmas Cove**. Tommy Ruff, trevally, Snook, King George Whiting and Australian Salmon are caught from the **Hog Bay** jetty (FishInternet, 2000; KI-AMCS, 2000; Kangaroo Island Visitor Guide, 2001).

There are charter boat tours in the **Dudley Peninsula** area. For example, charter boat tours operate out of **Cape Willoughby**, targeting such species as Australian Salmon, sweep, King George Whiting and other species in the **north-eastern Kangaroo Island** area (FishInternet Australia, 2000; Australian Waters website, undated)

Chapman River: Main species caught are Black Bream and Yellow-eye Mullet, with small fish being caught near the mouth into **Antechamber Bay**, and larger adult fish being caught up the river. Australian Salmon and flathead species are also caught in the area. **Chapman River mouth** is recognised as a "good fishing" area (Wilkins, 1999; Kangaroo Island Visitor Guide, 2001, and other regional fishing promotion materials).

There is an artificial reef off **Kingscote** (450 tyre modules), used for fishing (Edyvane 1999). Branden *et al.* (1994) stated that fishers had reported “excellent catches” of sought after recreational species within a few years of the artificial reef installation.

Some of the other recognised recreational fishing marks in the area include reef patches at around 10m, in the area between **Eastern Cove to Kangaroo Head**, and near-shore reef in the are between **Cape Willoughby** and **Pink Bay**. Note that the depths of GIS fishing marks specified according to position of interpolated depth contours in S.A. Coast and Marine Atlas, 2001, which may not be accurate.

There is a small recreational fishery for Rock Lobster out of Cape Jervis, into the Backstairs Passage area, extending from the Pages Islands in the east to the waters between Cape Jervis and **Penneshaw** to the west. Fishing is restricted to dodge tides, and a small number of fishers operate in the area. Fewer lobsters are caught in this area compared with more popular locations, but the lobsters tend to be larger (Tyrer, 1994).

Diving

Both local and visiting divers, including international tourists (e.g. through commercial diving charter), use this region, and the **Dudley Peninsula** area has become increasingly recognised during the past several years, due to the abundance of large sessile invertebrates and variety of fish species in the near-shore area, as well as the presence of leafy seadragons. The area is now promoted by Tourism South Australia as one of South Australia’s special dive locations.

Some of the popular dive spots on the north-east coast occur around **Kangaroo Head, Penneshaw, Hog Bay, Ironstone Hill, Cuttlefish Bay, Snapper Point, and Cape Coutts** areas. Diving sites in the area include reefs below the cliffs all along the north-east coast, deeper reefs of the north-east coast, and Penneshaw jetty. Previously, the **Penneshaw Jetty** was listed in Christopher’s (1988) Divers Guide to South Australia. The **Penneshaw** and **Kangaroo Head** area is used for dive training, and the **Penneshaw jetty** has been described as a “very popular local spot for training novice divers, night diving and underwater photography” (Edyvane, 1999b).

Recreational diving is also reported at the reef areas between **Redbanks** and **Point Morrison**, in the south-eastern part of **Western Cove** (Bryars, 2003).

Other Marine Tourism / Recreation

Tourism, particularly that associated with conservation areas, is a major industry on Kangaroo Island (Gilliland, 1996). Coastal and marine based tourism is part of the overall tourism appeal. Apart from fishing and diving, Gilliland (1996) listed boating / yachting etc, swimming and the scenic qualities of the coast as marine activities contributing to the tourism appeal of Kangaroo Island.

Marine tourism on Kangaroo Island is likely to further develop as part of an overall tourism strategy that has been planned for Kangaroo Island. Reports on the future prospects for Kangaroo Island tourism include the Kangaroo Island Tourism Policy (Kangaroo Island Tourism Policy Working Group 1991), the Kangaroo Island Sustainable Tourism Development Strategy (Kangaroo Island Development Board, 1995), and the development of a Tourism Optimisation Management Model (TOMM) (Manidis Roberts Consultants, 1997; Twyford, 2000; Twyford *et al.*, 2001). TOMM has been developed jointly by community, government, and industry. The aim of these strategies and models is to market Kangaroo Island as a major nature based tourism destination at international, national and State levels.

Kingscote and **American River** provide accommodation for many of the tourists visiting the island. **Brownlow, Nepean Bay, American Beach, Island Beach, and Sapphire town** also provide accommodation for locals and tourists (Gilliland, 1996).

Bay of Shoals / Kingscote / Western Cove / Nepean Bay: Used for boating, and its historical locations (e.g. **Beatrice Point / Reeves Point**) also have tourism significance (Edyvane, 1999b). There are boat mooring areas in various parts of Nepean Bay (Bryars, 2003). Daily feeding of Pelicans on the foreshore at **Kingscote** is a recognised tourism feature (Wilkins, 1999), and there are Penguin watching tours run nightly at **Kingscote** by NPWSA. Also used for swimming (e.g. in the tidal pool at **Kingscote**). **Brownlow Beach** (south of **Kingscote**) reportedly supports “a high level of recreational use”, and is used by both

locals and visitors (Gilliland, 1996).

The **Eastern Cove - American River** area has high recreational value for local residents, seasonal holiday residents and tourists, with many developments in the region (hotels, motels, shacks, residential housing) to support the recreational activity in the area. The area is used for a variety of boating activities (in addition to fishing - see above). Also a coastal camping area.

American River and Eastern Cove: The American River area has been used for holidays and recreation for more than a century, and there are numerous facilities catering for coastal holidays and associated activities. **American River** is one of the island's three major population centres, particularly during holiday seasons, and population numbers in American River significantly increase due to seasonal tourism. American River is described by tourism promotion materials as one of South Australia's "oldest resorts" (Australian Tourism Net, 2001) and as a "thriving" area for tourism (Channel 9 media transcript).

American Beach, Island Beach and Sapphire town are also locally important for seasonal recreation and tourism. Due to the high recreational value for local residents, seasonal holiday residents and tourists, the **Eastern Cove - American River** area has many developments in the region (hotels, motels, shacks, residential housing) to support the recreational activity in the area. For example, there are numerous holiday houses, guest houses, motels, shacks and other accommodation for locals and tourists in areas such as American River, American Beach, Island Beach, and Sapphire town.

Apart from fishing, other tourism and recreation activities include boating, sailing, canoeing, beach-walking, swimming (e.g. at **Brown's Beach** and **American Beach**), coastal bush-walking, bird watching, and watching the daily feeding of pelicans (described in tourism promotion material as "a major tourist drawcard", the activity now attracts tour buses full of pelican-watchers). **American Beach, Island Beach** and **Brown Beach** reportedly support "high levels of recreational use", and are used by both locals and visitors (Gilliland, 1996). There is also a coastal camping area, as well as a coastal "nature trail" that goes to the coastal cliffs and shoreline of the American River area, and bird watching tours.

There are charter boats and yachts for cruising, and small boats are also hired from lodges and motels in the area. Yachts often use the area between **Point Morrison** and **Ballast Head** (Gilliland, 1996).

Pelican Lagoon is recognised as a bird sanctuary with tourism value (for sightseeing, bird watching etc).

Penneshaw: Vehicular and passenger ferries arrive and depart daily. Two thirds of the 160,000 annual visitors to Kangaroo Island embark and disembark at **Penneshaw**, according to the KI-AMCS (uncited reference, 2000). There is a variety of tourist accommodation in the town. The beach area near **Penneshaw** is reported to have a high level of recreational use (Gilliland, 1996). The evening "parade" of Little Penguins returning to shore along the **Penneshaw** foreshore is recognised as a tourism feature (Wilkins, 1999). NPWSA runs guided tours, and there is a Penguin Interpretative Centre at Penneshaw. The area is also used for boating activities (in addition to fishing - see above), coastal walks (e.g. for the scenic views, and to visit historical sites such as the 1802 memorial, and geological sites such as the Permian glacial scour marks at Christmas Cove), and is a coastal camping area. **Hog Bay** has a swimming beach, and the foreshore area is promoted for holiday activities (Australian Tourism Net, 2000; Tourism Kangaroo Island, 2001, and other regional tourism promotion materials).

Chapman River Mouth and Antechamber Bay: Recognised recreational uses include swimming at the river mouth, canoeing, boating, camping, coastal walking in the Antechamber Bay area, including the coastal tracks through the scrubland, sand dunes, around the lagoons, and the long beach (Wilkins, 1999, and other tourism promotion materials). There is a camping ground, and camping tours (which attract international tourists), are run in the area. The Chapman river and Antechamber Bay are promoted as a family holiday destination, with safe places for children to swim, and to learn how to fish. Gilliland (1996) stated that the beach at Antechamber Bay has "a high recreational use and tourist value". There are tours at the **Cape Willoughby** lighthouse, and other recreational / tourism features in the area include **Windmill Beach** and **Devil's Kitchen** (rock formation on the exposed coastline).

There are sailing cruises to north-eastern Kangaroo Island bays and headland areas, departing from **Kingscote**. Activities include beach visits, swimming and wildlife appreciation (cetaceans, dolphins, sea birds etc).

Aboriginal Heritage Values

North-eastern Kangaroo Island features in the Ngurrindgeri people's Dreaming myth of the travels of the

Ancestral Being.

Although most known Aboriginal Heritage sites on north-eastern Kangaroo Island exist inland, there are a number of coastal locations, such as those at **Kingscote**, **Point Morrison**, **American River**, **Pelican Lagoon**, **Penneshaw** and the **Cuttlefish Bay** area. Robinson and Armstrong (1992) reported that some of the stone artefacts (such as quartz, quartzite and chert tools, including flakes and cores), were derived from beach deposits on shorelines around the island. For example, chert, which is not common on the island, was taken from Kingscote and worked into small cutting tools. A dunal camp site at **American Lagoon**, which was found to be eroding away during the 1940's, contained quartz flakes, hearthstones, hammerstones, choppers and other stone implements, and the remains of foods eaten at the site, which included 8 species of local molluscs (Cooper and Condon, 1947, cited by Robinson and Armstrong, 1992).

There is an Aboriginal Heritage site, listed in the *Register of the National Estate*, at **Kingscote**, and the coastal land in this area (**Beatrice Point / Reeves Point**) has been proclaimed an Historic Reserve under the Aboriginal and Historic Reserves Act 1975 (Edyvane, 1999b).

Contact between Aboriginal inhabitants and Europeans occurred with the commencement of whaling and sealing at the turn of the 19th century. Aboriginal women taken from Tasmania and from areas of the South Australian mainland featured prominently in the early development of these industries at Kangaroo Island. Reliance on the skills and cultural knowledge of these women continued long after official settlement in 1836. Descendants of these women form part of the contemporary Ngurrindgeri community (Australian Heritage Commission, 2000).

Historic/ Protected Shipwrecks

- ♦ *Robert Burns*, schooner built 1857, wrecked 1908 on sand spit at **Nepean Bay**. Remains protected under Commonwealth Historic Shipwrecks Act 1976. Positioned in shallow water (less than 4m), but most of the remains are submerged under sand, eroded, or have been removed (State Heritage Branch, DEP, undated).
- ♦ *Fannie M*, lost in 1885 off the **Bay of Shoals**, and protected under Commonwealth legislation (Gilliland, 1996; Edyvane 1999b).

Backstairs Passage is renowned for being a treacherous stretch of water due to its strong tidal currents and high velocity winds. The Pages Islands (two islands and a reef), the Scraper (sand bar) and Yalata Shoal (reef) provide further hazards, and therefore there are many shipwrecks in the area. A number of shipwrecks protected under the Commonwealth *Historic Shipwrecks Act 1976* occur in the area, but not all of the following have been found to date. These include the following (State Heritage Branch, DEP, undated; McKinnon, 1993; S.A. Coast and Marine Atlas, 2001; DEH, 2003h).

- ♦ *Treasure Trove*, cutter wrecked 1884 at **Kingscote**.
- ♦ *Golden Hope*, wooden cutter, wrecked 1894, west of **Point Morrison**.
- ♦ *Breeze*, wooden cutter, wrecked 1863, in **American River**.
- ♦ *Goulburn*, iron vessel, wrecked 1856, at **Penneshaw**.
- ♦ *William*, cutter wrecked 1847, at **Hog Bay**. The *William* was built locally on Kangaroo Island, and is one of S.A.'s oldest shipwrecks.
- ♦ *Daring*, wooden ketch wrecked 1885 east of **Hog Bay**.
- ♦ *Albert*, 2-masted wooden schooner, built 1863, wrecked 1875, whilst moored near **Antechamber Bay / Cape Coutts**.
- ♦ *Venture*, wooden cutter, wrecked 1858 near **Snapper Point**.
- ♦ *Eva*, wooden sloop, built 1876, wrecked 1903, in **Antechamber Bay**, during a journey to Beachport.
- ♦ *Kona*, 4-masted American wooden schooner, built 1901, wrecked 1917 during low tide at the **Scraper Shoal**, near **Cape St Albans**.
- ♦ *Mindaro*, wood schooner built 1901, wrecked 1920, off Cape St Albans, in **Backstairs Passage**.

Other shipwrecks in the area include the following (McKinnon, 1993; DEH, 2003a):

- ♦ *Mary*, wooden ketch, built 1876, wrecked 1951, in **Antechamber Bay**.
- ♦ *May*, single-masted vessel, rebuilt 1905, wrecked in 1951 at **Cape Willoughby**.
- ♦ *Midge*, one-masted cutter, built 1840, wrecked 1853, on rocks near **Cape Willoughby**.
- ♦ *Wanderer*, a fishing cutter, disappeared in **Backstairs Passage** in 1907, whilst heading for Cape Willoughby.
- ♦ *Minnie Simms*, cutter, built 1899, wrecked 1933 whilst anchored at **Cape Willoughby**.
- ♦ *Grelka*, motor cruiser, built 1910, wrecked 1955 in **Backstairs Passage**, en route to a game fishing expedition to the Pages Islands.

- ♦ *Corona Astron*, fishing cutter, built 1928, wrecked 1976, north-east of **Cape St Albans**.

Other European Heritage Values

Just north of Kingscote, **Beatrice Point (Reeves Point)** is the site of South Australia's first official settlement, in 1836 (State Heritage Branch, undated). The Kingscote Pioneer Memorial commemorates South Australia's first settlers who arrived at Reeves Point in 1836, aboard the *Duke of York*. A colony was established to partake in farming and whaling. A jetty (the remains of which can be seen at low tide) was constructed in 1838. Stone from a quarry at Kingscote was used as ballast for ships, and for road building. Boat-building and cooperage industries were also planned for the area. However, living conditions were harsh, soils were poor quality, freshwater was lacking, and therefore the site was abandoned as a major settlement area by 1839 (State Heritage Branch, undated; Edwards, 1987, cited by Edyvane 1999b; Wilkins, 1999).

Other historically significant areas include **Western Cove**, **Eastern Cove**, **Penneshaw**, and the coast from **Penneshaw to Cape Willoughby** (uncited references, in Edyvane, 1999b). Cape Willoughby is considered to have a "rich maritime history", because it formed the gateway to Gulf St Vincent for the early shipping trade, prior to the advent of efficient land transport, and thus has been an integral component in the development of Kangaroo Island (DEH, 2003h). The Sturt Light **Cape Willoughby**, dated 1852, was the first lighthouse built in South Australia. The tower is 27 metres high; made of local limestone; and sits on a cliff 73 metres above the sea (Wilkins, 1999). The Cape Willoughby Light Station, which includes the lighthouse and cottages, in the recently proclaimed Cape Willoughby Conservation Park, has been included on the *State Heritage Register* (DEH, 2003f).

Captain Matthew Flinders landed near **Christmas Cove** in 1802. A granite boulder on the beach ("**The Monument**") bears a plaque commemorating the event. The granite boulders were deposited by glaciers, and glacial striation marks can be seen on the rock faces at the northern end of the beach (Tourism Kangaroo Island, 2001). For over 150 years Christmas Cove has been used as a shelter for small boats. It was once a landing place for coastal ketches, which brought goods in and took out produce from Kangaroo Island (Wilkins, 1999). **Frenchman's Rock at Penneshaw Beach** commemorates the French explorer Baudin's anchorage in the area in 1803. The crew who came ashore carved an inscription in the rock. A replica now exists at the site. The Maritime and Folk Museum at **Penneshaw** houses items that explain the district's history of nautical relics, with remains salvaged from shipwrecks. The **Penneshaw** jetty was built in 1902, and has recently been restored.

American River was named after a group of American sealers who arrived on a brig and built and launched a schooner (the *Independence*) there in 1803 - 1804. The Americans caught thousands of seals during the winter of their visiting period, and their success and promotion of the island encouraged the arrival of up to 500 sealers and whalers to exploit the islands marine fauna during the following few years. American River was previously called Pelican Lagoon in 1802, named by Captain Flinders. American River is also an historic area for fishing and trading. The first lobster pots in South Australia were reportedly thrown from the fishing boat "Stella" a century ago, and the coastal ketches regularly called into American River with imports and exports until the 1970's (Postcards Online, undated).

American River is one of the oldest known areas in South Australia. There are numerous maritime heritage items within the township, on the coast and within the **Pelican Lagoon Conservation Park**. The lagoon itself is considered to be of State heritage due to its variety of historical associations relating to initial contact and primary industries (Morelli and de Jong, 1995).

American River's **Muston Wharf** was once used as a shipping area for thousands of tonnes per annum of salt, loaded onto coastal ketches round the turn of the twentieth century. All that remains of the 14km railway to the salt lake are concrete and wooden piles, projecting into the narrow channel that leads to Pelican Lagoon. At American River, there are ruins of the fish canning factory that ran for a few years in the late 1800's (Postcards Online, undated).

A summary of heritage items in the **American River** area includes the Anchor Memorial on the foreshore; a cairn on the site where the *Independence* was constructed; the Muston jetty ruins on the western shoreline; and the Matthew Flinders cairn on the south-western corner of American Lagoon. There are several other European heritage sites within the Pelican Lagoon Conservation Park. Pelican Lagoon is considered to be of State Heritage significance due to its variety of historical associations (Edwards, 1987, cited by Edyvane, 1999b; and Kangaroo Island tourism promotion materials).

The S.A. government (2001) has identified **Frenchman's Rock** and **American River** as potential Marine Heritage "icons".

Scientific Research / Monitoring and Marine Education

In 2004, a Coast and Marine Biodiversity Monitoring Program was set up by the Kangaroo Island Natural Resources Board. Aspects of the program include documentation and mapping of the island's marine habitats and biota, and monitoring of areas that are subject to impacts and disturbances.

There have been collaborative government and community based monitoring projects since the mid 1990s, studying the effects of seagrass loss in the **Nepean Bay** area (e.g. see Edyvane, 1997; Gray, 2000).

In recent years there has been a collaborative government and community-based program for monitoring reef health in the North-eastern Kangaroo Island area (e.g. **Dudley Peninsula / Hog Bay** region) (e.g. see KI-AMCS, 2000).

There is community and school involvement with the Coastcare **Hog Bay** Monitoring Project (for monitoring of impacts on reefs, and sand movement in the area) (KI-AMCS, 2000). The Hog Bay program also includes a facts and resources register, which includes Heritage information as well and marine scientific information (McKelvey, 1997).

North-eastern Kangaroo Island was surveyed in 2002 to determine the distribution and relative abundance of Western Blue Groper and other reef fish species (see Shepherd *et al.*, 2002).

There is a long term penguin population monitoring project on Kangaroo Island (commenced 1980), and the colonies in the **Penneshaw** area (and other parts of north-eastern Kangaroo Island) are part of that program.

There is a marine research site at **Pelican Lagoon**. Previously, the majority of studies in the area have been on terrestrial flora and fauna, and therefore will not be discussed in this assessment. More recently, the Centre has been associated with marine habitat studies (for example, as part of a recent Coastcare project monitoring the seagrass ecosystem at Pelican Lagoon, and documenting long term changes in the seagrass beds since the 1940s - e.g. see McKelvey, 1997 and Pelican Lagoon Research Centre promotion materials).

Edyvane (1999b) listed the geological monuments at **Alex Point** to **Snapper Lookout**, **Old Government Quarry** (Kingscote) and **Kingscote Foreshore** as having scientific and/or teaching values.

Pelican Lagoon / American River area has been the site of marine biological and ecological investigations since the 1940s, particularly studies in macroalgal taxonomy and ecology, undertaken by a phycologist of international renown (see Womersley, 1950, 1956; Womersley and Edmonds, 1958, 1979).

Fisheries researchers also sample scalefish populations in the north-east Kangaroo Island area. For example, **Redbanks** and **Kingscote Beach** are two of the sites at which King George Whiting were sampled, for a study on long term changes to reproduction (Cockrum and Jones, 1992).

Wilderness / Aesthetic Values

Pelican Lagoon / American River: Described by tourism promotion material as a "beautiful inlet". Quite water environment with islets, many birds and coastal vegetation down to the sea, is considered to have aesthetic appeal, as well as value for those seeking tranquil environments. **Mount Thisby**, near Pelican Lagoon, provides views of both the quiet water Pelican Lagoon / American River area to the north, and the exposed Southern Ocean at Pennington Bay to the south.

The **American River** system has been long recognised by locals, holiday-makers/tourists, fishers and conservationists for its scenic amenity and wildlife, features that are regularly mentioned in tourism promotion literature, and also in government reports.

Kangaroo Island is widely promoted locally, nationally and internationally as an "unspoilt wilderness area", and **American River** is one of the towns in which people who come to appreciate the wilderness values of Kangaroo island, can stay, and also appreciate the local surroundings. American River, its "beautiful blue waters", and the surrounding coastal areas, are also promoted by the tourist industry and its operators, as

a place where people can escape “the hustle and bustle of crowds”, and appreciate the local wildlife, such as pelicans and abundant other bird life, the local mammals, and the local flora.

Chapman River mouth and Antechamber Bay: The beach area is recognised for its scenic appeal and views (Wilkins, 1999). **Antechamber Bay** has been described by tourism promotion materials as being an area of “startling splendour”, with attractive views from above the bay, of the long beach, with the mainland in the distance.

Penneshaw: The area has scenic amenity (Gilliland, 1996) and is described in tourism promotion material as “an attractive town” with “spectacular views across Backstairs Passage”. **Hog Bay** has been described as “peaceful and picturesque” by tourism promotion materials.

Brownlow Beach (south of **Kingscote**), **American Beach**, **Island Beach** and **Brown Beach** also have “scenic amenity” (Gilliland, 1996).

Scenic areas, according to Edyvane (1999b) include **Western Cove**, **Kingscote**, **Eastern Cove**, and the coastal area from **Penneshaw** to **Cape Willoughby**. Edyvane (1999b) also listed the geological monuments at **Cape Willoughby**, **Christmas Cove (Penneshaw)**, and **Kingscote Foreshore** as having aesthetic value.

Tourism promotion materials describe the coastal area north of **Antechamber Bay** as having “wonderful views” (e.g. of the long beach in the Bay, and of the mainland across Backstairs Passage) and **Cape Willoughby** as having “spectacular views”.

Towns and Settlements

Kingscote: base population approximately 1,693 (ABS figure, 2001), with around 3,300 in the district, which includes the smaller towns and holiday settlements. The wharf at **Kingscote** is the major centre for moving freight to and from Kangaroo Island. A new service for transporting grain by barge has recently commenced (SA Country Hour media report, April, 2001).

American River: has a resident base population around 250. Although the resident population of American River is small, the area is one of the island’s three major population centres, particularly during holiday seasons, and population numbers in American River significantly increase due to seasonal tourism. **American Beach**, **Island Beach** and **Sapphire town** are also locally important for seasonal recreation and tourism .

Penneshaw: base population around 300, according to Australian Tourism Net (2001) and other Kangaroo Island tourism promotion materials from the early 2000s. Population numbers in **Penneshaw** significantly increase seasonally due to tourism. There is a newly commissioned desalination plant that provides water supplies to **Penneshaw**.

There are several smaller coastal settlements including **Brownlow**, **Nepean Bay**, **American Beach**, **Island Beach** and **Sapphire town**.

Ports, Harbours and Navigation

American River is defined under the *Harbours and Navigation Regulations 1994*, as follows: *the subjacent land underlying, and the adjacent land extending from, the waters, rivers, creeks, and inlets to high water mark of American River and Eastern Cove bounded as follows: on the north by a line running north- west from the American River Entrance Beacon to intersect with high water mark on the western side of Eastern Cove then generally south-west along high water mark to its intersection with a straight line drawn from the south-west corner of Section 8, Hundred of Haines to the most northerly point of Section 178, Hundred of Dudley; then south-easterly along the line to its intersection with high water mark; then generally easterly and northerly along high water mark on the eastern side of American River to Strawbridge Point, then easterly along high water mark to its intersection with a line running south-west from the Entrance Beacon, then along this line to the point of commencement.*

Kangaroo Island relies upon safe marine navigation for transport of people and goods, as well as for the fishing industry, recreation, and elements of the tourism industry (Gilliland, 1996). There are navigation channels

on north-eastern Kangaroo Island (e.g. **Kingscote**, **Penneshaw**), associated with the navigation route for boats and ships through Backstairs Passage, which provides access to the mainland. **Penneshaw** is the main site for moving passengers and vehicles to and from Kangaroo Island.

Gilliland (1996) considered that some sections of **Nepean Bay** have a high level of marine traffic (e.g. commercial and recreational fishers, tourists, shipping, yachts), and have significant navigational value for vessels travelling to or from **Kingscote**, including fishing vessels, and a ferry service.

There is significant marine infrastructure, including jetties, boat ramps and mooring areas, in the **Kingscote** and **American River** areas (Gilliland, 1996).

Southern Fleurieu – Backstairs Passage – Pages Islands

Aquaculture

Previously, PISA's GSV / Fleurieu Management Plan (Berggy, 1996) provided for aquaculture development in the area, including 30ha in the West Fleurieu Management Zone and 60ha in the Rapid Bay area.

To date (2004), no leases have been approved, although applications were received (and rejected) by government during the 1990s.

Commercial Fishing

Scalefish, Sharks and Minor Invertebrates

General Information: Shark fishing (using longlines and long mesh gill nets) is one of the main fisheries in the **Backstairs Passage / Pages Islands** region. School, gummy and bronze whaler shark are the main species targeted, particularly on the western side of **Backstairs Passage** (i.e. eastern side of Kangaroo Island), however although the shark fishery is important within the region, there are at least 10 other fishing areas in South Australia in which yields have been higher than those from the Backstairs area in recent years (e.g. mid to late 1990s, although recent figures are not available for this report). Trolling for Snook and Australian Salmon occurs in **Backstairs Passage**, in waters to 20m. Hand-lining and long-lining for Snapper also occurs in the southern Fleurieu / Backstairs Passage area, in waters deeper than 10m and up to 50m (see figures below). Commercial fishing for Southern Calamari also occurs in Backstairs Passage, and is particularly active in the Cape Jervis region, which is a major fishing area for both Southern Calamari (G.K. Jones pers. comm., 1996, cited by Edyvane *et al.*, 1996 and Edyvane, 1999b). Ray species are also caught in the **Backstairs Passage** region, but recent figures are not available for this report. The broader fishing region in which Backstairs Passage is situated (i.e. including North-eastern Kangaroo island and Southern Fleurieu Peninsula) is one of the major fishing area sin S.A. for ray species (see Commercial Fishing notes for Southern Fleurieu).

Regionally, the major commercial fish and shark species that are caught in the broad area that includes south-eastern Gulf St Vincent (from approximately Aldinga southwards into Backstairs Passage, and as far west into lower Gulf St Vincent as 138°E), north-eastern Kangaroo Island (from approximately Hog Bay eastwards into Backstairs Passage) and Backstairs Passage area (as far east as approximately Parsons Beach 138°30'E and as far south as 36°S), include the following, with information about annual yields referring to tonnages recorded during the mid 1990s:

Southern Calamari: mainly jig fishing over seagrass beds, in waters to 15m (Jones, SARDI, pers. comm. 1996, cited by Edyvane *et al.*, 1996), particularly jig fishing in south-eastern Gulf St Vincent (GSV) to Cape Jervis area, with annual yields from the south-eastern GSV area in the dozens of tonnes during the mid to late 1990s. During the mid to late 1990s, the Southern Fleurieu / Backstairs Passage region was one of the top two fishing areas in S.A. in terms of annual yields of Southern Calamari (and the highest yields in S.A. are recorded from the area in some years). Recent figures specific to the south-eastern Gulf St Vincent / Cape Jervis area are not available for this report, however the aggregated catch for "South Central Gulf St Vincent" (fishing blocks 36, 43 and 44, which includes all metropolitan and southern Fleurieu waters south to

36°S latitude, with a western boundary of 138°E longitude), has been more than 80 to 90 tonnes per annum between 1993 and 1999, with yields greater than 115t in one of those years (see Figure 5 in Triantafillos, 2000).

Garfish: In the southern Fleurieu area, dab netting for Garfish occurs in waters to around 15m deep, especially the Cape Jervis area (Jones, SARDI, pers. comm. 1996, cited by Edyvane *et al.*, 1996). During the mid to late 1990s, annual yields were between approximately 10t and 30+ tonnes per annum. During the past decade, the fishing block that includes the Southern Fleurieu, has been amongst the top 5 to 10 fishing areas in S.A., in terms of annual yields of Garfish. Recent figures specific to the south-eastern GSV area are not available for this report.

Australian Salmon: Beach seine netting for Australian Salmon occurs around the southern Fleurieu region, such as Cape Jervis, and trolling occurs in the Backstairs Passage region to around 20m (Jones, SARDI, pers. comm. 1996, cited by Edyvane *et al.*, 1996). During the mid to late 1990s, yields from the area were in the tonnes to low dozens of tonnes, and the fishing block that includes the southern Fleurieu has been in the top 5 to 10 regions in S.A. in terms of annual yields. Recent figures specific to the south-eastern GSV area are not available for this report.

Gummy Shark: Recent figures are not available for this report. Gummy Shark catches in South Australian waters are controlled by Commonwealth quota, and the fishery has recently been re-regulated in light of the *fully-fished* status of Gummy Shark (see AFMA, 2000d, 2003a, 2003b). During the mid to late 1990s, around 20t - 30t per annum of Gummy Shark were taken from the fishing area that includes Southern Fleurieu, Backstairs Passage, eastern end of Dudley Peninsula and Pages Islands. However when compared with the yields from other blocks in the state in which School Sharks and Gummy Sharks are fished, the region was not amongst the top 10 fishing areas.

Bronze Whaler: Recent figures are not available for this report, however during the mid to late 1990s, yields ranged from less than 1 tonne to more than 5 tonnes per annum. The region that includes Southern Fleurieu / Backstairs Passage has been one of the top fishing areas in S.A. in terms of annual yields, in some recent years.

various Ray species: Recent figures are not available for this report, however during the mid to late 1990s, yields ranged from several tonnes to nearly 10 tonnes, and the aggregated Southern Fleurieu / Backstairs Passage / Dudley Peninsula region has been one of the top two fishing areas in S.A. in terms of annual yields.

Snapper: Handline and long-line line fishing for Snapper occurs in the southern Fleurieu (e.g. Cape Jervis, and Deep Creek areas) and Backstairs Passage area, mainly deeper than 10m and fished to 50m depth (Jones, SARDI, pers. comm. 1996, cited by Edyvane *et al.*, 1996). Yields of several tonnes to less than 10 tonnes per annum were recorded in the southern Fleurieu / Backstairs Passage region during the mid to late 1990s, and the fishing block that includes Southern Fleurieu / Backstairs Passage region was one of the top 10 fishing areas in S.A. in terms of annual yields, in those years. Recent figures specific to the Southern Fleurieu / Backstairs Passage area are not available for this report, however a recent stock assessment report (Fowler, 2002) showed that the total targetted catch from hand-lines and long-lines combined in "Southern Gulf St Vincent" (fishing blocks unspecified, but for which the Southern Fleurieu / Backstairs Passage is one part) has been as follows: 1990/91: 33.2t; 1991/92: 22.7t; 1992/93: 19.2t; 1993/94: 17.4t; 1994/95: 7.4t; 1995/96: 10.1t; 1996/97: 11t; 1997/98: 11.8t; 1998/99: 13.2t; 1999/00: 17.5t; 2000/01: 17.1t (see Fowler 2002, Table 3.6). In contrast, McGlennon and Jones (1999) and Fowler *et al.* (2003) reported the total catches for "Southern Gulf St Vincent" as follows: 1990/91: 42.4t; 1991/92: 35.6t; 1992/93: 28.4t; 1993/94: 23.3t; 1994/95: 10.9t; 1995/96: 13.6t; 1996/97: 22t; 1997/98: 20.9t; 1998/99: 18.2t; 1999/00: 22.1t; 2000/01: 21.7t, and 2001/02: 27t (see McGlennon and Jones, 1999, Table 1; Fowler *et al.*, 2003). Regardless of the discrepancy between the figures cited in various stock assessment reports, it is evident that the catches in southern Gulf St Vincent are increasing again, following low catches during the mid-1990s. Since that time, there has been a consistent, systematic increase in the handline catch, up to the present (Fowler *et al.*, 2003).

Yellow-eye Mullet: Beach seine netting for mullet occurs around the southern Fleurieu area, such as Cape Jervis (Jones, SARDI, pers. comm., 1996, cited by Edyvane *et al.*, 1996). Recent figures are not available for this report, however low tonnages (i.e. less than 5t) per annum were recorded during the mid to late 1990s, however this equated to the fishing block that includes the Southern Fleurieu / Backstairs Passage region being one of the top 5 fishing areas for mullet in S.A. when compared with the yields from other parts of SA during that period.

King George Whiting: In the southern Fleurieu area, mostly handline fishing occurs, in inshore areas to 10m

deep, such as Deep Creek (Jones, SARDI, pers. comm. 1996, cited by Edyvane *et al.*, 1996). During the mid to late 1990s, low tonnages per annum were recorded in the fishing block that includes the Southern Fleurieu / Backstairs Passage / Dudley Peninsula area, and it is noted that, at that time, the region was not one of the top 10 fishing areas in S.A. for King George Whiting, in terms of annual catch.

Snook: Trolling for Snook occurs in the Backstairs Passage region, in waters to around 20m (Jones, SARDI pers. comm., 1996, cited by Edyvane *et al.*, 1996). During the mid to late 1990s, low tonnages per annum were recorded in the fishing block that includes the Southern Fleurieu / Backstairs Passage / Dudley Peninsula area, and the region was not one of the top 10 fishing areas in S.A. when compared with other fishing areas in the state in which Snook are fished.

Mulloway: During the mid to late 1990s, low tonnages per annum were recorded in the fishing block that includes the Southern Fleurieu / Backstairs Passage / Dudley Peninsula area, and the region was in the top 5 to 10 fishing areas in S.A. for Mulloway fishing, when compared with other fishing areas in the state.

For King George Whiting, Snook and Mulloway, catch figures that are specific to the Southern Fleurieu / Backstairs Passage area are not available for this report. Apart from the above, other species caught in the area in minor commercial quantities include Redfish ("red Snapper"), Western Blue Groper, various Wrasse species, Sweep, Trevally, Ocean Leatherjacket, Boarfish, Jackass Morwong, Blue Morwong, Blue Mackerel, and Swallowtail. Shark species caught in minor quantities include Saw Shark and Whiskery Shark.

GARFIS Block 44 encompasses (i) south-eastern Gulf St Vincent, from approximately Aldinga southwards into Backstairs Passage, and as far west into lower Gulf St Vincent as 138°E; (ii) north-eastern Kangaroo Island (from approximately Penneshaw / Hog Bay eastwards into Backstairs Passage) and (iii) Backstairs Passage area (as far east as approximately Parsons Beach 138° 30'E and as far south as 36°S). Recent aggregated catch figures for the area are not available for this area, for this report. Previously, according to SARDI statistics (cited by Edyvane, 1999b), the Marine Scalefish Fishery catch from GARFIS Block 44 was as follows, during the mid 1990s:

- ♦ In 1995/96 a total of 171,288kg (1.65% of State total, representing 47 fishers);
- ♦ In 1996/97 a total of 129,167kg (1.27% of State total, representing 37 fishers).

The proportion of this catch that is specific to the Southern Fleurieu area is not available for this report. On a Statewide scale, aggregated catch figures for all GARFIS Fishing Blocks in South Australia show that between 1995-1997, the catch from the marine scalefish fishery (which includes sharks and minor invertebrates as well as scalefish) from Fishing Block 44 was 17th in 1995/96, and 20th in 1996/97, in the ranked list of fishing yields from 58 South Australian fishing blocks.

Prawn Fishing

Prawns are not fished in the waters less than 10m, along the Southern Fleurieu.

Prawn fishing Blocks 65, 75, 74, 73, 72, 71, and 76 occur near the coast along the **Southern Fleurieu**, between **Aldinga** and **Cape Jervis**. According to Morgan (1995), Block 73 (**Yankalilla Bay**) is irregularly fished (e.g. fished for six of the years between 1968 and 1994), as is Block 76 (**Cape Jervis**, fished for 5 of the years between 1968 and 1994).

Seaward of the coastal blocks, deeper water blocks along the **Southern Fleurieu** coast to **Cape Jervis** include Blocks 66, 67, 68, 69, 70, and 81. Between 1968 and 1994, some of the blocks in the region were trawled in most years (although all blocks were not trawled in any single year), and in four of the 27 years, none of these blocks were trawled (Morgan, 1995).

According to Edyvane (1996b and 1999b), Western King Prawn is the major single species fishery off the area of coast between Marino Rocks and **Rapid Head**, and boats trawl within a few kilometres of the shore.

Marina St Vincent reportedly provides berths for 20 prawn trawlers (Environment Australia, 2001).

Figures specific to the area discussed in this table are not available, however the total catches of Western King Prawns from Gulf St Vincent in 2000/01 and 2001/02 were reported to be 384t and 322t respectively (SARDI Aquatic Sciences statistics, 2003). Svane (2003) reported that in 2002/03, the total prawn catch from all areas of GSV combined, was 231.9t, being 29% smaller than the previous year's catch, and 42% smaller than the 1999/2000 catch. Fishing effort (3791 trawl hours, over 53 nights) was higher in 2002/03 than in the previous two seasons, but the catch was lower. The catch in the 2002/03 year was almost as low as that taken in 1991, when the fishery was closed. The catch rate in 2002/03 was 61.2kg per hour, the lowest since

the fishery was re-opened in 1994. Fishery independent surveys in the 2002/03 season showed that the abundance of new recruits was low (Svane, 2003). This contrasts sharply with the reported state of the fishery a few years previously. For example, Boxshall and Williams (2000) reported that (i) the total catch for the 1999/2000 GSV prawn season (i.e. from all areas of the GSV fishery combined) was 400.24 tonnes, the highest catch recorded since the 1983/84 season; (ii) catch rates for the season (99.03 kg / boat hr) were the highest recorded in the history of the fishery; and (iii) the total level of fishing effort (4042 boat hrs) increased over that seen in the previous (1998/99) season, but remained within limits set for the fishery. Boxshall and Williams (2000) considered the performance of the fishery in 1999/00 to be consistent with a fishery that had rebuilt to previous levels; that the recovery was likely to have been assisted by strong recruitment over the past two seasons prior to assessment, and that recruitment levels are variable, and it was unlikely they would be sustained at high levels on a consistent basis. However, as reported by Svane (2003), the strong recruitment apparently did not persist, based on the low catch for that season, as well as data for 2002/03 which showed mainly large adult prawns in the catch; a widely dispersed fleet (reflecting low prawn abundance); the lowest catch rates recorded in a 10-year period of fishery-independent surveys, and few recruits (young prawns) in the surveyed areas. Spatial and temporal restrictions to catch and effort were recommended, to prevent continued declines in prawn biomass (Svane, 2003).

Rock Lobster Fishing

The Southern Fleurieu – Backstairs Passage and Pages Island area forms part of Marine Fishing Block (Marine Fishing Area = MFA) 44. This fishing area records minor yields compared with those from the top 10 fishing areas in the Northern Zone (see Ward *et al.*, 2002). For example, Ward *et al.* (2002) reported that although there has been an increase in the proportion of the catch taken from the third most heavily fished groups of MFAs since the early 1980s (i.e. MFAs 6, 9, 12, 13, 24, 25, 35, 37, 42 and **44**), and thus these MFAs have increased in significance, only about 3% of the total annual catch is taken from these areas. In terms of fishing effort, the number of pot lifts in MFA 44 is between 0 and 10,000 per annum, which is low compared with the fishing effort from the key fishing areas in the Northern Zone (see Ward *et al.*, 2002, Figure 2.7a, 2.7b, 2.7c, 2.7d).

Previously, according to SARDI data (cited by Edyvane, 1999b), the Rock Lobster catch from Fishing Block 44 (i.e. eastern side of Dudley Peninsula on Kangaroo Island, from approximately the Penneshaw/Hog Bay region 138°E, eastwards into Backstairs Passage, and south of Dudley Peninsula to approx. 36°S, eastwards to approximately 138°30'E, and northwards of Backstairs Passage, to include Southern Fleurieu Peninsula as far north as approximately Aldinga) was: in 1995/96 a total of 7,036kg (0.14% of State total, representing 8 fishers); in 1996/97 a total of 5,390 kg (0.11% of State total, representing 6 fishers).

Aggregated catch figures for all fishing blocks in South Australia for which Rock Lobster data are available, between 1995 and 1996, showed that Fishing Block 44 (described above) was 21st in the ranked list of commercial lobster fishing areas in South Australia, in terms of yield (and hence value) during that period, and that catches in the top fishing areas of the State were two orders of magnitude higher than those yielded from the aggregated North-eastern KI / Backstairs Passage / Southern Fleurieu region. The specific significance of this figure to only the Southern Fleurieu or Backstairs / Pages Islands area is not known for this report, because Fishing Block 44 includes other areas (as described above in preceding paragraph).

Abalone Fishing

No figures specific to the **Deep Creek to Newland Head** area or **Backstairs Passage** and **Pages Islands** are available, but aggregated figures for the **Cape Jervis to Encounter Bay** area (Map Codes 25A, 25B, 25C and 25D) are provided. Between 1990 and 1996, recorded annual yield (approximate whole weight) of Greenlip Abalone in the Cape Jervis to Encounter Bay area fluctuated between 0kg and 1.2t, and yield of Blacklip Abalone fluctuated between 0kg and 5.1t (S. Shepherd, pers comm., 2000).

Note that the low levels of Greenlip Abalone catch throughout the late 1990s (approximately 1t or less per annum) in the aggregated area from **Cape Jervis to Encounter Bay** are considerably lower than yields between 1979 to 1989, during which time yields per annum of 5t to about 13t were recorded in 9 of those years (S. Shepherd, pers comm., 2000).

Recreational Fishing

According to a government survey during the early 1990s, the main recreational fisheries (i.e. equal to or greater than 10% of the total catch) in the southern metropolitan area (including the **Southern Fleurieu**) are recorded to be King George Whiting, Tommy Ruff, Southern Calamari and leatherjacket. Australian Salmon,

blue mackerel, wrasse species, sweep, Mulloway (e.g. by surf fishing in the **Maslins - Aldinga** area) and Snook are also taken by recreational fishers in the Southern Fleurieu area. In the **Aldinga** and **Sellicks Beach** areas, beach and boat fishing occurs for at least 13 scalefish species (King George Whiting, Sand Flathead, Australian Salmon, Snapper, Snook, Sea Garfish, Tommy Ruff, Yellow-eye Mullet, Black Bream and Mulloway and Yellow-fin whiting (**Sellicks Beach**) leatherjackets, Silver Drummer) and Southern Calamari (McGlennon and Kinloch, SARDI recreational fishing survey data, cited by Edyvane, 1999b). A summary of the fishing activities in the **Southern Fleurieu** area includes line fishing from boats and shore, spear-fishing, and dive-fishing (e.g. for molluscs) (Bryars, 2003).

Wirrina - Normanville - Lady Bay - Carrickalinga area: There is a jetty at **Normanville**. Some of the main species targeted by boat and jetty fishers in the area include King George Whiting, Snapper, Garfish (sometimes in large schools in the area), Tommy Ruff, Australian Salmon, Southern Calamari and Snook. Target species for rock fishers include Snapper, Mulloway, Black Bream and Australian Salmon (e.g. caught from rocks in the area, and the **Wirrina** breakwater). Other species (some non-targeted) caught in the area include Red "Mullet" (Blue-spotted Goatfish), leatherjacket species (plentiful), gurnard perch species and "rock cod" (e.g. from reef near cliffs, and other near-shore reef areas). According to summary data from a recreational fishing survey by McGlennon and Kinloch (SARDI data, cited by Edyvane, 1996b), the main species targeted in the **Normanville** and **Carrickalinga** area by boat, beach and rock fishers, include King George Whiting, Sand Flathead, yellow-eye mullet, Australian Salmon, Snapper, Snook, Garfish, Tommy Ruff, Toothbrush Leatherjacket, Silver Drummer and Southern Calamari. **Carrickalinga** is also used for recreational crabbing.

There are several fishing boat charter operators in the **Wirrina** area (including "deep sea" fishing charters), and small boat hire for fishing (Yankalilla Tourism Association, 2001, and Marina St Vincent tourism promotion materials).

Rapid Bay - Second Valley area: **Rapid Bay** is listed as one of the top 20 shore fishing locations in S.A. for recreational anglers, based upon survey of long term recreational fishers and fishing experts (Capel, 1994). Rock, beach and boat angling occur in the area. **Second Valley** has been described by tourism promotion materials as "a popular rock and jetty fishing spot". The main species targeted from **Rapid Bay** jetty and **Second Valley** jetty include Southern Calamari, Sea Garfish, Tommy Ruff, Trevally, Australian Salmon, whiting species, Mullet, Snook, and Yellow-tail Kingfish. Flathead, Leatherjacket species, weedy whiting species, Red "Mullet" (Blue-spotted Goatfish), Long-finned Pike, cuttlefish, and Gummy Sharks and other small sharks are also reportedly caught from the Rapid Bay jetty and surrounds. The beach and eastern headland at **Rapid Bay** are also used for fishing. According to recreational fishers' records during the past few years (e.g. see FishInternet, 2001), examples of species taken by rock fishers at **Second Valley** include whiting species, Snapper, Southern Calamari, leatherjackets, "rock cod" (i.e. species of gurnard perch and/or scorpion-cod) and Red "Mullet". According to Edyvane (1999b) **Five Mile Reef** is also a popular place for fishers. According to summary data from a recreational fishing survey by McGlennon and Kinloch (SARDI, cited by Edyvane, 1996b), the main species targeted in the (**Second Valley** area by boat, jetty and rock fishers include King George Whiting, Sand Flathead, Yellow-eye Mullet, Australian Salmon, Snapper, Snook, Sea Garfish, Tommy Ruff, toothbrush leatherjacket, Silver Drummer and Southern Calamari. The main species targeted in the **Rapid Bay** area by jetty and boat fishers include King George Whiting, Sand Flathead, Yellow-eye Mullet, Australian Salmon, Snook, Garfish, Yellow-tail Kingfish, Tommy Ruff, Trevally, Toothbrush Leatherjacket, Silver Drummer and Southern Calamari.

Cape Jervis / Morgan's Beach / Fishery Beach / Backstairs Passage area is used for boat, jetty & rock fishing. According to summary data from a recreational fishing survey by McGlennon and Kinloch (SARDI data, cited by Edyvane, 1996b), the main species targeted in the **Cape Jervis** area by jetty, boat and rock fishers include King George Whiting, Australian Salmon, Snapper, Snook, Garfish, Southern Bluefin Tuna, Tommy Ruff, Toothbrush Leatherjacket, Silver Drummer and Southern Calamari. The waters of **Cape Jervis** are particularly popular for recreational fishers during the summer "Snapper run" (Capel, 1994). Recreational fishers of Snapper fish close to the coast, and also in deeper **Passage** waters towards Kangaroo Island.

There are several charter fishing boat tours operating from **Cape Jervis** (Yankalilla Tourism Association, 2001), visiting **Southern Fleurieu**, **Backstairs Passage** and **Kangaroo Island** waters.

There are recreational angling competitions held in the southern Fleurieu area (e.g. fishing spots at **Rapid Bay**, **Cape Jervis**, and Waitpinga and Parsons) with target species such as Australian Salmon, Tommy Ruff, wrasse species, and other fish in the area. There is an annual Fleurieu Fishing Festival, involving areas between **Carrickalinga** to **Rapid Bay** (Yankalilla Tourism Association, 2001; FishInternet, 2001).

There is a small recreational fishery for Rock Lobster out of **Cape Jervis**, into the Backstairs Passage area,

extending from the Pages Islands in the east to the waters between Cape Jervis and Penneshaw to the west. Fishing is restricted to dodge tides, and a small number of fishers operate in the area. Fewer lobsters are caught in this area compared with more popular locations, but the lobsters tend to be larger (Tyrer, 1994).

Deep Creek is used for recreational fishing (e.g. mouth of **Blowhole Creek / Blowhole Beach** and **Boat Harbour Beach**) (NPWS, undated). Some of the species targeted by coastal rock fishers at **Deep Creek** include Tommy Ruff, sweep, “rock cod” (species of gurnard perch and/or scorpion-cod), and leatherjacket species. Brown Trout and Rainbow Trout are caught in the creeks.

Species commonly targeted and caught by surf / beach and rock fishers in the **Waitpinga** and **Parsons** areas include Australian Salmon (sometimes in large quantities, and including larger fish 2.5 – 3kg), Tommy Ruff, Yellow-eye Mullet, Tailor, Sand Flathead, Sweep (particularly near patch reef areas close to shore), Black Bream, and Mulloway, the latter of which are fished mainly in summer (NPSW, undated; Capel, 1994; FishInternet, 2001). The area was considered by Capel (1994, cited by Baker and Edyvane, 1996) to be in the top 20 shore-fishing spots in South Australia, based upon survey of long term recreational fishers and fishing experts. The area is considered popular for surf fishing for some of the forementioned species, which aggregate in the natural “gullies” off the beach, to feed and shelter (NPWS, undated). Recreational diving for Greenlip and Blacklip Abalone also occurs in the **Waitpinga - Parsons** area.

There are recreational angling competitions held in the southern Fleurieu area (including fishing spots at Rapid Bay, Cape Jervis, and **Waitpinga** and **Parsons**) with target species such as Australian Salmon, Tommy Ruff, wrasse species, and other fish in the area (FishInternet, 2000; Yankalilla Tourism, 2001 and regional recreational fishing promotion materials).

Deeper reefs (more than 30m) south-east of **Newland Head** are recognised recreational fishing marks (Note that depth of GIS fishing marks specified according to position of interpolated depth contours in S.A. Coast and Marine Atlas, 2001, which may not be accurate).

Some of the recognised recreational fishing marks in the area include shallow (less than 10m) sandy areas and reef patches in the **Snapper Point** area and southwards towards **Aldinga Bay**; reef ledges/“drop-offs” in the **Carrickalinga Head / Haycock Point** area; ledge and patch reefs / rubble reef (“broken bottom”) in waters around 15m - 25m off **Lady Bay**; reef at around 15m off **Porpoise Head - Tunkalilla**, and reef at around 40m off **Cape Jervis**. (Note that depths of GIS fishing marks are specified according to position of interpolated depth contours in S.A. Coast and Marine Atlas, 2001, which may not be accurate).

There are boat launching facilities at **Wirrina**, **Rapid Bay**, **Normanville Beach**, **Second Valley** (which also has a natural harbour for boats), and **Cape Jervis**.

Backstairs Passage / Pages Island Area: For this report, there is little recreational fishing information available for the Backstairs Passage and Pages Islands. Much of the area is relatively inaccessible to recreational fishers due to its distance from land, as well as strong currents and other adverse sea conditions.

The waters south-west of the **Pages Islands** are a recognised recreational fishing mark.

Recreational fishing boats operate mainly at the edges, such as **Cape Jervis** on the Fleurieu, and **Dudley Peninsula** on Kangaroo Island. The main recreational species taken in those areas are documented in other sections of this report.

Snapper, Australian Salmon, shark species, and Snook are some of the main species taken in the **Backstairs Passage** waters. Other species include reef fish (e.g. Wrasse species, Leatherjackets) and pelagic fish such as Southern Bluefin Tuna.

There are several charter fishing boat tours operating from **Cape Jervis**, visiting **Backstairs Passage** and other waters in the region (Yankalilla Tourism, 2001).

There is a small recreational fishery for Rock Lobster out of Cape Jervis, into the **Backstairs Passage** area, extending from the **Pages Islands** in the east to the waters between Cape Jervis and Penneshaw to the west. Fishing is restricted to dodge tides, and a small number of fishers operate in the area. Fewer lobsters are caught in this area compared with more popular locations, but the lobsters tend to be larger (Tyrer, 1994).

Diving

Willunga: *Star of Greece* iron shipwreck, 200m from shore, is used for diving and snorkelling (State Heritage Branch, DEP, 1987).

Aldinga: The marine reserve has been a popular diving and snorkelling area for several decades (see Ottway *et al.*, 1980), and was declared an Aquatic Reserve in 1971 in recognition of its value for SCUBA diving, following a nomination during the late 1960s. The “drop-off” 1.2km from shore is particularly valued by divers. The Aldinga “drop off” and Aldinga “pinnacles” are listed by DIASA as being amongst the best dive sites in South Australia. **Aldinga** has also been promoted in recent dive guides (Dive South Australia, 2004). Reef to 6m off **Snapper Point** (i.e. **Aldinga** platform reef) is described by Christopher (1988) as a good dive site for divers without boats.

The navy ship *Hobart* was sunk off **Wirrina** in 2002, as a new artificial reef. The site is expected to become significant for recreation and tourism diving (and as additional reef substrate for invertebrates and site-attached fish) during the 2000s. The majority of the ship remains fully intact, so divers can explore the engine rooms, mess decks, smoke stacks, missile launchers, gun turrets and bridge area (Dive South Australia web site, 2004). The South Australian Tourism Commission predicted that after several years operation, there might be around 16,000 dive visitors to the wreck site, with around 50% being international tourists.

Carrickalinga, Wirrina, Lady Bay and Yankalilla Bay, Rapid Bay, and reefs and benthic caves in the **Rapid Head** area are recognised diving locations. **Carrickalinga Beach** and **Myponga Beach** are also promoted for snorkelling (e.g. Yankalilla Tourism Association 2001). “Bommie” reefs (e.g. **Lassiters Reef**), **Five Mile Reef**, and other reefs in the **Second Valley** area (e.g. 5m to 15m) are popular diving locations. Christopher’s (1988) Divers Guide to S.A. reported that the “most interesting” dive area, includes several caves located on the southern side of the fishing boat winches at **Second Valley**, and the reef 200m north of the jetty. **Lassiters Reef, Second Valley jetty, Rapid Head, and Rapid Bay Jetty** are listed in dive promotion materials such as DIASA’s guide to best dive spots in S.A. (undated); Dive South Australia (web site and brochure, 2004) and Christopher’s (1988) Divers Guide to South Australia. **Second Valley** has been a popular dive training site for many years. Some of the aforementioned sites also have a dive tourism function for visitors to the Southern Fleurieu.

The **Rapid Bay** jetty, in particular, is recognised amongst the diving community (both locally, and more recently by national and international dive tourists) as being a readily accessible site with abundant fish of several species, and a site at which leafy seadragons are very frequently seen. Rapid Bay jetty has been described as “one of the most spectacular (jetty dive sites) in South Australia” (Christopher, 1988) and one of the “best jetty dives in Australia” (Lipson, cited by DIASA, undated). The area is heavily promoted in dive tourism materials. Dive trips to **Rapid Bay** (and especially to view the seadragons at the jetty) are run by both metropolitan and regional dive centres.

Previously, Christopher (1988) described **Cape Jervis** as “interesting shore or boat diving”, particularly sites east of the boat ramp, towards **Fishery Beach**. An iron barge, also used as a dive site, is located in 6m of water, approximately 800m south of the **Cape Jervis** jetty, 100m from shore (Christopher, 1988). Nearshore reefs along the southern Fleurieu coast between Cape Jervis and Newland Head (e.g. **Blowhole Creek; Deep Creek**) are also recognised for diving (DIASA, undated; Yankalilla Tourism Association, 2001; Dive South Australia brochure and web site, 2004). **Deep Creek** was listed by DIASA (undated) as one of S.A. best diving locations.

Backstairs Passage / Pages Island Area: Charter boat operations occur in this area (for cage viewing of great white sharks), although at present no licenses have been issued (Twyford, NPWS, pers. comm., 2000). Charter boat operators in the southern Fleurieu area offer dive charters to the **Pages Islands**.

Other Tourism / Recreation

The near-shore area of **Aldinga Reef** has recreational significance for walking / beach-combing, viewing rock pool biota etc.

Southern Fleurieu (general): Apart from fishing and diving (recreational, and as part of the dive tourism industry), the region is significant for coastal recreational activities such as beachwalking, swimming, canoeing, yachting and other small boating, windsurfing, and jet ski-ing (in some areas).

There is coastal holiday housing along much of the southern Fleurieu, particularly in the **Rapid Bay / Lady Bay / Normanville / Carrickalinga** area.

Catamarans, sea kayaks, power boats and jet skis can be hired in the **Southern Fleurieu** area.

A summary of some of the main marine recreation uses, other than diving and fishing, according to Edyvane (1996b), Yankalilla Tourism Association (2001), and various Southern Fleurieu tourism promotion materials, include:

- ♦ **Aldinga Bay (Aldinga Beach, Silver Sands, Sellicks)**: swimming, surfing, windsurfing, boating, beach walking / coastal sightseeing, camping, seaside holidays.
- ♦ **Myponga Beach**: boating; swimming, seaside holiday housing, hang-gliding.
- ♦ **Wirrina**: Coastal resort with 210 berth marina, scenic cruise and yachting charters, small boat hire, marine tours (whale and dolphin watching and other “eco-tours”, fish feeding, evening cruises). Marina St Vincent provides berths for 500 recreational vessels, and caters for 5000 recreational trailer boats per year (Environment Australia, 2001).
- ♦ **Normanville / Carrickalinga / Lady Bay**: Boating / yachting (including boats for hire in the area), swimming at the beaches, sea kayaking, walking / coastal sight-seeing at beach, dune and headland areas; intertidal reef pool exploration; camping. Seasonally popular for seaside holidays, with various holiday accommodation types in the region. **Carrickalinga** has been described as “a very popular holiday retreat” (Yankalilla Tourism Association, 2001).
- ♦ **Rapid Bay**: camping, boating, swimming, sea kayaking.
- ♦ **Second Valley**: boating, camping, swimming beach / cove, coastal sightseeing (e.g. coastal geological features), hang-gliding.
- ♦ **Cape Jervis**: boating, ferry departures for Kangaroo Island, swimming, cliff walking, and beachwalking at **Morgan’s Beach**.
- ♦ The **Deep Creek** area is used for coastal walking, whale-watching and sightseeing. Coastal features promoted for recreation in the **Deep Creek** area include walking from the conservation park to the cove at the mouth of **Deep Creek**, and visiting **Blowhole Beach** and **Boat Harbour Beach**. There are also coastal walking trails with ocean views, within the conservation park (NPWS, undated). **Tunk Head** is also used for coastal sightseeing and coastal hang-gliding.
- ♦ **Waitpinga / Parsons / Newland Head area**: According to the Australian Heritage Commission (1976), the “naturalness and beauty of aspect of the area make it much sought after for recreation and enjoyment”. Apart from surf fishing (see section above), the Newland Head Conservation Park is promoted for beachwalking / beachcombing, viewing from the lookouts, camping, picnics, and visiting the lagoon at the mouth of **Waitpinga Creek** (NPWS, undated). **Waitpinga** is also used for windsurfing.

Historic / Protected Shipwrecks

North of **Aldinga** (i.e. **Willunga**), the *Star of Greece*, an iron ship wrecked in 1888, is situated 200m from shore, and is protected under State legislation. *Star of Greece* is considered to have been one of S.A.’s worst shipping disasters. Iron floors, frames, hull plating, part of the masts, and scattered artefacts are of historical significance (State Heritage Branch, DEP, 1987).

The schooner *Emma*, wrecked 1840, has been found in **Aldinga Bay**, but is not protected (S.A. Coast and Marine Atlas, 2001).

In the **Cape Jervis** area, wrecks protected under Commonwealth legislation include the cutter *Wanderer*, wrecked around 6km east-south-east of Fishery Beach, in **Backstairs Passage**, but has not been found, (according to S.A. Coast and Marine Atlas, 2001); the *Thistle*, wooden schooner, wrecked 1866 (not found); and *Hopper Barge No. 3*, iron vessel wrecked 1880, which has been found and inspected by Heritage officials; and the *Vanquish*, wooden schooner, wrecked 1864 north of **Cape Jervis**, but not found.

There are historic shipwreck sites in the following areas, but the vessels have not been found, and therefore are not protected by legislation. These include the following, with the dates referring to the year the vessels were wrecked:

Near **Aldinga Aquatic Reserve** northern boundary

- ♦ *Grenada*, and *Trader*, both wooden schooners, both wrecked 1856;

- ♦ *Agenora*, wooden schooner, 1863;
- ♦ *Ida*, brig, 1857, and
- ♦ *Mary*, wooden cutter, 1859.

Between **Snapper Point** and **Myponga (Aldinga Bay area)**

- ♦ *Henry and Mary*: wooden cutter, 1861;
- ♦ *Dart*: cutter, 1882;
- ♦ *Lady Fergusson*, cutter, 1870;
- ♦ *Oriana*, screw steamer, 1885.

Yankalilla Bay and Lady Bay area

- ♦ *Guldax*, wooden barque, 1887;
- ♦ *O.G.*, wooden cutter, 1854;
- ♦ *Industry*, wooden ketch, 1854;
- ♦ *William*, wooden cutter, 1838.

Rapid Bay / Rapid Head area

- ♦ *Good Intent*, wooden cutter, 1856;
- ♦ *Eclair*, wooden schooner, 1875;
- ♦ *Polly*, wooden cutter, 1894.

North of **Cape Jervis**:

- ♦ *Ellen*, iron screw steamer, 1908; and
- ♦ *Sans Pareille*, brigantine, 1855.

Backstairs Passage / Pages Island Area: A number of wrecks protected under Commonwealth legislation but not found to date, occur on the north-eastern Kangaroo Island side of Backstairs Passage, between Cape St Albans and Hog Bay. These are detailed in the section on **Historic / Protected Shipwrecks** for the north-eastern Kangaroo Island area (see above).

Tunkalilla: The motor vessel *Victoria* was wrecked in 1934 (Berggy, 1996; Philippou, 2001). Although not historic, the vessel has been of interest to marine archaeologists due to a salvage camp being set up in 1934-1935, from which artefacts have been recovered, and some of the ship's artefacts are still buried in sand at the camp site, in the coastal area adjacent to the wreck (Philippou, 2001).

Other European Heritage

Aldinga was a coastal port for the surrounding farm communities during the 1860s.

Rapid Bay: Beachside monument, a memorial to Colonel Light, who carved his initial in rock at Rapid Bay upon arriving in the new colony (Yankalilla Tourism Association, 2001).

Cape Jervis was named by Matthew Flinders in 1802, and supported a whaling industry, which was established during the 1840's, continuing until 1855 (Edyvane, 1996b).

The **Cape Jervis** lighthouse was established in 1871 (Edyvane, 1996b).

In the **Cape Jervis – Fishery Beach** area, a whaling station began operations in 1841, when shipping records show that whale oil from the **Cape Jervis** whaling station was delivered to Port Adelaide aboard a cutter. The cutter was later wrecked 80 kilometres south of the Murray Mouth. After a succession of "poor seasons", with few whales caught, the whaling station ceased operation in about 1855 (Staniforth and Richards, 2000). **Fishery Bay** was later used as a port to ship silver and lead from the Talisker Mine (Staniforth and Richards, 2000).

Aboriginal Heritage Values

Aldinga: Contains a coastal site of Aboriginal heritage significance, listed on the Register of the National Estate. Also, the Register's indicative listing of the Aldinga Scrub (mainly for terrestrial ecological reasons) contains sites of Aboriginal heritage significance, because the Aldinga Scrub and its environs are reported to have been a major focus of Aboriginal occupation in the Adelaide region. Stone tools and campsites suggest occupation for at least 20,000 years by Aboriginal people (including the Kartan period). The campsites are well preserved, and are rare in the Adelaide region (Campbell, 1989, cited by Australian Heritage

Commission, 1994).

The Kaurna people lived in the Fleurieu region and regularly migrated to the coast to fish and collect. Artefacts and in some instances, human remains, have been found at various locations along the coast, especially **Sellicks Beach, Aldinga**, Onkaparinga and Hallett Cove (Edyvane, 1996b). A register of important sites is kept by the South Australian government.

Normanville Dunes: The Australian Heritage Commission (undated) determined that the area has indigenous values of National Estate significance. At the time of the nomination (early 1980s), the Commission was consulting with relevant Indigenous communities about the amount of information to be placed on public record.

There is an Aboriginal Heritage site listed in the *Register of the National Estate*, at **Second Valley**. At **Cape Jervis**, Aboriginal sites include large pebble and block Kartan tools, indicating some of the earliest Aboriginal occupation on the Fleurieu Peninsula (Ross, 1984, cited by Baker and Edyvane, 1996).

The S.A. Government (in 2001) identified **The Pages** as a potential Indigenous Culture “icon”, in recognition of the role of the Pages in the Ngurrindgeri people’s Dreaming myth of the journey of the Ancestral Being Ngurunderi and his two wives.

Kaurna Peoples in the southern area of the State have a Native title application in the area, with boundaries that include metropolitan Adelaide and extend north to Broughton, south to **Cape Jervis**, and approximately 800 metres into coastal waters of Gulf St Vincent from Cape Jervis to Port Wakefield. Within this boundary, less than 10 per cent of the area is estimated to be actually covered by the claim. The application was (in 2001) at a stage in the assessment process whereby public notices were issued, inviting interest holders to register to participate in mediation, through the Federal Court, with a view to reaching voluntary agreements that respected all parties right and interests (National Native Title Tribunal, 2001). The Kaurna Peoples' native title claim was first lodged with the Federal Court on 25 October 2000 and was amended in August 2001 after further discussions with the Kaurna community and neighbouring indigenous groups (National Native Title Tribunal, 2001). The Kaurna Peoples' application may apply mainly to areas of government interests, a small number of lease-holders, some commercial fishers and a number of irrigation licensees (National Native Title Tribunal, 2001).

The Ngurrindgeri Native Title Claim for the Encounter Bay and Coorong region, lodged in 1998 and registered in 2000, comprises 10,353 square km, and includes a sea claim to approximately 3km seaward (according to map in S.A. Coast and Marine Atlas, 2001). The western boundary was specified as north of **Cape Jervis** and the southern boundary approximately 13km south of the southern end of Coorong National Park.

The headland between **Waitpinga Beach** and **Parsons Beach** lies within an Aboriginal site on the Register of the National Estate. Aboriginal sites at **Waitpinga Beach** cover approximately 20ha, and are on the Register of the National Estate (Bilney, 1981, cited by Baker and Edyvane, 1996). The sites comprise three blowouts in the dunes near Waitpinga Creek, which were used as campsites, and contain tools of the old Kartan tradition, characterised by large cores, hammer stones and flaked pebbles. Other relics at the site include hearths and shell middens. Kartan mainland sites such as Waitpinga are considered rare on the Fleurieu Peninsula, because most sites are believed to have been covered by advancing seas (Ross, 1984, cited by Baker and Edyvane, 1996).

Marine Research and Education

The benthic surveys of Shepherd and Sprigg (1976) across **southern Fleurieu Peninsula** have provided important and pioneering information on the habitats of the area.

The coastal cliffs and intertidal platforms of the mid to **Lower Fleurieu** have significance as field sites for both research and education in coastal geology, palaeontology, geomorphology, coastal dynamics and coastal environmental impacts. For example, details of the geological significance of the Maslins - Aldinga area are discussed below.

Maslin Bay – Aldinga Bay Geological Site: According to the Australian Heritage Commission (undated), the fossiliferous sediments have yielded scientific information that is significant for understanding the geology and palaeontology of the Tertiary period. The area is the designated type section for Tertiary rocks in the St Vincent Basin, and is also considered an important reference area for secondary and tertiary teaching in geology. Since 1878 the area has been subject to scientific studies which have been reported in at least

twenty-one papers in scientific journals. Professor Ralph Tate, who held the Inaugural Chair in Natural Science at the University of Adelaide from 1874 until his death in 1901, carried out important early investigations of the Tertiary sequence in Maslin and Aldinga Bays. Between 1876 and 1896 he described a large number of invertebrate fossil species from the area and the first full account of these Tertiary cliff sections was given by Tate, in Tate and Dennart (1896). The work of M A Reynolds in the area formed the basis for modern Tertiary biostratigraphy in South Australia because he developed faunal zones based on foraminifera. The value of the area to regional geological research has resulted in regular visits by geology students from both secondary schools and universities. The area “will continue to be important for scientific research relevant to the Tertiary period” (Australian Heritage Commission, undated).

Aldinga Reef has been used for marine biological education, particularly the near-shore areas, where students can learn about the biology of rock pool biota. Ottway *et al.* (1980) described the area as being “extensively used by class groups, snorkellers and SCUBA divers”.

Aldinga Reef and the reefs of the Southern Fleurieu (e.g. **Rapid Bay, Second Valley**) are some of the monitoring sites included in the community-based Reefwatch Monitoring project.

The headland between **Waitpinga Beach** and **Parsons Beach**, a steeply dipping outcrop of Kanmantoo group sediments, has geological value, and is therefore used for research and teaching. Behind **Waitpinga Beach**, there is a platform across consolidated dunes, evidence of a 6m higher shoreline. **Newland Head** has well preserved cliff top parabolic dunes (Baker and Edyvane, 1996).

The **Cape Jervis** jetty has been used by researchers from the University of Adelaide for research into the ecology of marine plant communities. Reefs at **Cape Jervis** and other **Southern Fleurieu** sites have also been the subject of long term monitoring of abalone populations (see Shepherd *et al.*, 2001).

Marine archeological studies have been undertaken in the **Cape Jervis – Fishery Beach** area. Various artefacts associated with slate huts used by whalers in the 1850s, have been excavated (Staniforth and Richards, 2000).

Tunkalilla Creek - Tunkalilla Beach area: Some geological interest, due to the presence of isolated “seacliffs” and raised benches, as evidence of Pleistocene higher sea levels (3m – 10m) and occur behind the present beach and behind the mouths of First Creek and Tunkalilla Creek (Australian Heritage Commission, undated). There has also been work carried out in the area by marine archaeologists and associated students (i.e. at the *Victoria* wreck site - see Philippou, 2001).

The globally significant Australian Sea Lion population at the **Pages Islands** is regularly monitored (e.g. Rowley, 2001; Shaughnessy, 2002). Seabird numbers are also monitored, on an irregular basis, on the **Pages Islands**.

Tanner (2005) has undertaken research on the effects of prawn trawling on Hammer Oyster populations in **south-eastern Gulf St Vincent**

Wilderness and/or Aesthetic Values

The following areas (excluding the aesthetic values of **Lady Bay** and **Second Valley**) have aesthetic values that contributed in some way to their inclusion on the Register of the National Estate, although the aesthetics are almost always a minor reason for inclusion compared with specific physical, ecological, biological or other features.

- ♦ **Maslin Bay - Aldinga Bay** Geological Site: The shore rock outcrop is about 5km long and forms “an aesthetically pleasing area frequented by various social groups” (Australian Heritage Commission, undated). The beach is described in tourism promotion materials as “attractive” and “beautiful”.
- ♦ **Lady Bay**: Described as a “scenic point” (Edyvane, 1996b).
- ♦ **Carrickalinga Head**: Described by the Australian Heritage Commission (undated) as “spectacular scenery of the southern gulf coastline”.
- ♦ **Normanville - Carrickalinga** area: Marine environment has been described as “relatively unspoilt” (Edyvane 1996), and described by tourism promotion materials as “an attractive seaside village”.
- ♦ **Second Valley**: Described by Edyvane (1996b) as “a particularly spectacular scenic area” and by tourism promotion materials as having “spectacular cliff scenery”.

Deep Creek: The Conservation Park's scenic value (due to steep coastal topography) is considered to be enhanced by views across Backstairs Passage to Kangaroo Island, and these features form part of the Statement of Significance for the area's inclusion in the *Register of the National Estate*. The area has been described as "rugged" and "spectacular", with "breathtaking views" (NPWS, undated).

Cape Jervis: Described by tourism promotion material (e.g. Yankalilla Tourism Association, 2001) as having "some of the best sea views to be found in South Australia".

Tunkalilla Creek – Tunkalilla Beach area is described as being of "scenic interest" (Australian Heritage Commission, undated).

Waitpinga / Parsons / Newland Head area: According to the Australian Heritage Commission (1976), the "naturalness and beauty of aspect of the area make it much sought after for recreation and enjoyment".

Towns and Settlements

Population figures from Australian Bureau of Statistics (2001 census):

- ♦ **Aldinga Beach:** 5,539
- ♦ **Normanville:** 693
- ♦ **Yankalilla:** 440
- ♦ **Carrickalinga:** 318.
- ♦ **Cape Jervis:** Regional population of approximately 800, according to recent tourism promotion materials. Cape Jervis is the mainland service point for Kangaroo Island, handling motor vehicles, passengers and freight.
- ♦ There are several other small coastal centres with smaller base populations during the mid 1990s, including **Myponga, Lady Bay, Second Valley, and Rapid Bay**. These areas are predominantly used as holiday areas and consist primarily of beach houses and shacks. Population numbers increase during holiday seasons, particularly during summer. Population increases may be anticipated during the 2000s, due to new housing developments in some areas (e.g. **Lady Bay**).

Other Information

Backstairs Passage is a major shipping route, particularly for vessels heading to and from Adelaide (Gilliland, 1996).

A submarine cable runs through **Backstairs Passage**, between Cuttlefish Bay (Kangaroo Island) and Fishery Beach (Cape Jervis), and supplied power to Kangaroo island.

Encounter Bay to Murray Mouth

Commercial Fishing

Scalefish, Sharks and Invertebrates

Historically, the **Encounter Bay** area was considered to be very productive in Snapper and Rock Lobster, and mullet was commonly caught in the shallows (Hodge, 1932, cited by Baker and Edyvane, 1996).

Commercial fishing in the **Murray Mouth** area is undertaken by Marine Scalefish Fishery fishers, and also by fishers who hold permits for the Lakes and Coorong fishery.

Regionally, the major commercial fish and shark species that are caught by the Marine Scalefish and Lakes and Coorong Fisheries in the **Encounter Bay** to the **Murray Mouth** area, and in deeper waters south of the Bay and Mouth include the following, with information about annual yields referring to tonnages recorded during the mid 1990s.

Goolwa Cockle: The Murray Mouth area (part of Block 45) is on the border of the major Goolwa cockle fishing area in the Coorong region (i.e. Fishing Block 46, in which several hundred tonnes of Goolwa Cockle were yielded per annum by the Scalefish Fishery fishers during some recent years, mainly from Coorong beach areas not included in this assessment). In the Coorong ocean beaches area (Kingston to Middleton), there is a significant commercial and recreational fishery for the Goolwa Cockle. There has been a rapid expansion of the fishery since the late 1980s, with the total commercial catch peaking in 2000/2001 at 1241t (Lakes and Coorong and Marine Scalefish fishery components), from an effort level of 3539 fisher days (Murray-Jones and Johnson, 2003). Catches in the last four years to 2001 have been substantially higher than previously (Murray-Jones and Johnson, 2003). In the 2000/01 year there were 15 Lakes and Coorong commercial licensees and 7 Marine Scale licensees active in the fishery. A total of 130 cockle fishing devices are endorsed in the Lakes and Coorong component of the fishery, however since only 45 devices are currently reported to be used, there is significant latent effort in that sector of the fishery,. (Murray-Jones and Johnson, 2003). There is also latent effort in the Marine Scalefish sector (currently being addressed in changes to regulations), which has operators with gear endorsements who can take cockles commercially, and those without endorsements, who can take cockles for bait (Murray-Jones and Johnson, 2003). Commercial cockle-gathering operations in the Coorong area (including the Murray Mouth) provides a major source of cockles for commercial and recreational bait in south east Australia, and a food item as well (Morelli and de Jong, 1995).

Mulloway: Mulloway are taken in the Coorong lagoons and adjacent ocean beaches. Mulloway is an important fishery in the Murray Mouth area, but figures specific to the Murray Mouth are not available for this report. In 2001/02, the total State-wide commercial catch of Mulloway was 114 tonnes (which was 20% above the most recent 5-year average of 95 tonnes), although less than the catch in 2000/01 (145 t) which was the highest recorded catch (Ferguson and Ward, 2003). The Lakes and Coorong Fishery, which is the dominant sector in the commercial Mulloway fishery in S.A., contributed 95.7% of the total commercial catch in 2001/02 (Ferguson and Ward, 2003). Low tonnages to several tonnes per annum of Mulloway are caught in the Marine Scalefish Fishery, from the Encounter Bay and Murray Mouth area, including deeper waters southwards. The Encounter Bay - Murray Mouth region is one of several major areas in S.A., in terms of annual yields of Mulloway from the Marine Scalefish Fishery, but note that the Marine Scalefish Fishery catches a small proportion of the total commercial catch of Mulloway in S.A. waters, compared with the Lakes and Coorong Fishery sector. Gill-netting has traditionally been the major method of catching Mulloway between Encounter Bay and Port Elliot, in waters 15m - 20m, outside of the area closed to netting (Bluff to Hindmarsh River). Marine Scalefish Fishery catch figures that are specific to the Murray Mouth area are not available for this report, however in 17 of the past 18 years, Mulloway catches by this sector for the whole State, have been less than 20 tonnes per annum, and 9t were caught Statewide in 2000/01. The largest catches in the State are taken by the Lakes and Coorong Fishery, in the Murray Mouth and Coorong area (e.g. 136t in 2000/01, according to Knight *et al.*, 2002 – see information below on **Lakes and Coorong Fishery**). From 1984/85 to 1997/98 the Lakes and Coorong Fishery caught between 66-84% of the State commercial catch of Mulloway, and from 1998/99 to 2000/01 this contribution was greater than 90%. In 2001/02, the Lakes and Coorong fishery caught 95.7 % of the total catch of Mulloway for the State, with the Marine Scalefish Fishery contributing 4% (Ferguson and Ward, 2003).

Freshwater Fish: Lakes and Coorong Fishery catches of freshwater fish (mainly from Lakes Alexandrina and Albert and the channels of the Coorong, which are not included in the area discussed in this report) include the following for example, in 2000/01: 474t Bony Bream, 274t Carp, 25t Redfin Perch and 71t Callop (Knight *et al.*, 2002).

Yellow-eye Mullet catches are high for the Lakes and Coorong fishery (e.g. 320t in 2000/01, according to Knight *et al.*, 2002), but the proportion of this catch that is taken by Lakes and Coorong fishers only in the Murray Mouth area seaward of the barrages, is not available for this report. The marine scalefish fishery takes small quantities (e.g. around half to 1 tonne per annum in some recent years) of Yellow-eye Mullet in the Victor Harbor/ Encounter Bay and Murray Mouth area.

Gummy Shark (and School Shark, which is a lesser component of the shark catch): Main methods include long-lining and gill netting in both the Encounter Bay region and in deeper offshore waters, from 10m and deeper (G.K. Jones, pers. comm. 1996, cited by Edyvane, 1999b). More than 10 tonnes per annum were recorded during the mid to late 1990s from the Encounter Bay and Murray Mouth area, including deeper waters

southwards, but the yields from that area were not amongst the top 10 in the State at that time, compared with other fishing blocks in which sharks are caught. Recent catch figures are not available for this report. Shark fishing effort has recently reduced in South Australia, due to the Commonwealth restrictions under quota management (C. Halstead, DEH, per. comm., 2003, and see AFMA, 2003a and 2003b).

Bronze Whaler Shark: Low tonnages per annum taken in the Marine Scalefish fishery, from the Encounter Bay and Murray Mouth area, including deeper waters southwards. During the mid to late 1990s, the region was one of the top five areas in S.A. in terms of annual commercial yield. The species is also caught south of the Youngusband Peninsula (e.g. 10 - 15t per annum in some years during the 1990s).

Greenback Flounder : 19t caught in total, in the Coorong estuary and Lakes area in 2000/01 (Knight *et al.*, 2002), but figures specific to the Murray Mouth are not available for this report.

Australian Salmon: Low tonnages per annum taken by both Marine Scalefish fishery (in Encounter Bay/Murray Mouth area), and by Lakes and Coorong fishery, and not one of the top 10 fishing areas in S.A., in terms of yields.

Black Bream: total catch of 7 tonnes taken in 2000/01, in the Lake and Coorong Fishery (Knight *et al.* 2002), but figures specific to the Murray Mouth are not available for this report.

Various *Ray* species: Low tonnages per annum taken in the Marine scalefish fishery, from the Encounter Bay and Murray Mouth area, including deeper waters southwards. In recent years, has been one of the top 10 fishing areas in S.A., in terms of yields.

Garfish and *Snook* (the latter caught by trolling) are taken in small quantities in the Encounter Bay area (e.g. around half to 1t per annum during some years of the past decade).

Less than 1 tonne per annum of *Tommy Ruff* and *Snapper* were caught in the Encounter Bay region in some recent year (mid to late 1990s), although Snapper catches have been higher in previous years (1980s). Up to 20 other species (mainly fish, but also including shark species other than those listed above) are commercially harvested in the area, in minor quantities by the marine scalefish fishery.

Unspecified shark species (mixed): From one tonne to several tonnes per annum were taken in the Marine scalefish fishery during the mid to late 1990s, from the Encounter Bay and Murray Mouth area, including deeper waters southwards. Both benthic and pelagic shark species may be included. Species are not known for this report.

Recent aggregated catch figures are not available for this area, for this report. Previously, according to SARDI (cited by Edyvane, 1999b), the Marine Scalefish Fishery catch from GARFIS Block 45 (Encounter Bay, all waters from approximately Waitpinga to the Murray Mouth 139°E, extending southwards to 36°S) was as follows:

- ♦ in 1995/96: a total of 52,019kg (0.50% of State total, representing 21 fishers);
- ♦ in 1996/97: a total of 35,468kg (0.35% of State total, representing 17 fishers).

On a State-wide scale, aggregated catch figures for the Marine Scalefish Fishery, for all GARFIS Fishing Blocks in South Australia during 1995/96, showed that the total marine scalefish fishery yield of fish, sharks and minor invertebrates from Encounter Bay and Murray Mouth area (GARFIS Block 45, which also includes deeper waters to 36°S) was ranked 35th in 1995/96 and 39th in 1996/97, in the list of annual fishing yields from 58 South Australian fishing blocks.

The proportion of the recent State fishing yields taken by the Lakes and Coorong Fishery in the **Murray Mouth** area is not available for this report. However, Knight *et al.* (2002) reported total commercial catch for the Lakes and Coorong Fishery, which includes the **Murray Mouth** area; both seaward and landward sides of the **Coorong, Lakes Albert and Alexandrina, and Lake George**. The catch figures for major species with a marine or estuarine component to the life cycle include:

Black Bream: 1995/96: 4t; 1996/97: 4t; 1997/98: 4t; 1998/99: 3t; 1999/00: 4t; 2000/01: 7t. Current yields are lower than during the 1980s (i.e. ranged between 10t and 58t between 1984 and 1990);
(Greenback) Flounder: 1995/96: 30t; 1996/97: 15t; 1997/98: 11t; 1998/99: 28t; 1999/00: 40t; 2000/01: 19t.
Yellow-Eye Mullet: 1995/96: 195t; 1996/97: 161t; 1997/98: 158t; 1998/99: 139t; 1999/00: 150t; 2000/01: 127t.
Mulloway: 1995/96: 57t; 1996/97: 56t; 1997/98: 50t; 1998/99: 95t; 1999/00: 69t; 2000/01: 136t.
Goolwa Cockle: 1995/96: 473t; 1996/97: 485t; 1997/98: 669t; 1998/99: 635t; 1999/00: 756t; 2000/01: 873t;
Australian Salmon: : 1995/96: 5t; 1996/97: 3t; 1997/98: 4t; 1998/99: 3t; 1999/00: 4t; 2000/01: 2t.

Knight *et al.* (2002) reported a total combined yield of around 5 tonnes of other / mixed commercially and recreationally significant fish species from the Lakes and Coorong Fishery.

It is clear from the above figures, that the catch of Mulloway by this sector has increased considerably during the past decade. Previously, Pierce (1995) reported a total catch of 34t of Mulloway being taken in 1992/93 from the Coorong estuary by Lakes and Coorong fishers (compared with 440t in 1940). The majority of the Mulloway catch is taken in the area of the Coorong estuary. For example, during the early 1990s, the catch from that area was 80% of the total annual catch of Mulloway in S.A (Pierce, 1995).

The figures above relate to the Lakes and Coorong fishery. Reported catches of fish and cockles from the Marine Scalefish fishery in the Coorong / Murray Mouth area are not available for this report.

Abalone Fishing

No figures specific to the Encounter Bay area are available, but aggregated figures for the Cape Jervis to Encounter Bay area (Map Codes 25A, 25B, 25C and 25D) are provided. Between 1990 and 1996, recorded annual yield (approximate whole weight) of Greenlip Abalone in the Cape Jervis to Encounter Bay area fluctuated between 0kg and 1.2t, and yield of Blacklip Abalone fluctuated between 0kg and 5.1t (S. Shepherd, pers comm., 2000).

Note that the current low levels of Greenlip Abalone catch (approximately 1t or less per annum) in the aggregated area from Cape Jervis to Encounter Bay are considerably lower than yields between 1979 to 1989, during which yields per annum of more than 5t (and up to 12.6t) were recorded in 9 of those years (S. Shepherd, pers comm., 2000). (see also section on ***Issues for Risk and Impact Assessment***).

Rock Lobster Fishing

Commercial yields of lobster from Encounter Bay, as well as fishing effort, are low on a Statewide scale, and also in relation to the top 10 fishing areas in the Northern Zone (e.g. also see yields listed above, for adjacent **Southern Fleurieu** area, and figures and discussion in Ward *et al.*, 2002).

A small number of fishers operate in the area. For example, during the mid-1990s, 3 and 2 Rock Lobster fishers operated in the Encounter Bay area (Fishing Zone 45), during 1995/96 and 1996/97 respectively (SARDI data).

Recreational Fishing

Victor Harbor, Rosetta Head and Granite Island / Encounter Bay area: Used for beach / shore, boat, jetty and rock fishing. A government survey during the mid 1990s, listing the main recreational fish yields in the area reported the following major species: King George Whiting, Sand Flathead, yellow-eye mullet, Australian Salmon, Snapper, Mulloway, trevally, sweep, Garfish, Tommy Ruff, leatherjacket species and Southern Calamari (McGlennon, pers. comm. 1995, cited by Baker and Edyvane, 1996). Recent fishing promotion materials and angler's records indicate that the following are commonly targeted and caught by some fishers in the area: Snook, Garfish, trevally, sweep, Australian Salmon, Tommy Ruff, Southern Calamari, Mulloway, Snapper, flathead, bearded cod, reef fish (e.g. gurnard perch species and scorpion-cod, southern Blue Morwong), mackerel, shark species (both benthic and pelagic).

Recreationally significant fish, invertebrate and shark species caught at **Granite Island** (e.g. Screwpile jetty, breakwater, rocks other locations) include Australian Salmon, Tommy Ruff (schools of both species commonly targeted), Garfish (schools occur in the area), Snook, Sand Flathead, Mulloway, Trevally, Sweep, Snook, Snapper, King George Whiting and Southern Calamari are all caught around Granite Island. Bronze Whaler shark, Port Jackson Shark, Fiddler Ray and other shark and ray species are also caught at Granite Island. Reef fish (such as Blue Groper and wrasse) are less commonly targeted and caught (SARDI data, cited by Edyvane, 1999b; FishInternet, 2000, and other recreational fishing records).

There are recreational boat charters operating in the **Victor Harbor** area, targeting Snapper, trevally, Snook, whiting, and other species (FishInternet 2000; Tourism Victor Harbor 2001 and other regional tourism promotion materials).

Inman River: Apart from those listed above, other fished species include exotics (carp, redfin perch).

Port Elliot and Middleton: Used for beach, rock, jetty and boat fishing. Major species include Australian Salmon, Sand Flathead, Yellow-eye Mullet, King George Whiting and School Whiting, Mulloway, Garfish, Tommy Ruff, trevally, leatherjacket species, Southern Calamari and ray species.

Within **Encounter Bay** and **Port Elliot** area, some recognised fishing spots and major species caught there, according to a map produced by the South Australian Whale Centre (undated) include the following:

- ♦ **Bluff area:** Garfish, Australian Salmon, Southern Calamari, Snook;
- ♦ **Yilki:** Garfish and Tommy Ruff;
- ♦ **Inman River area:** mullet, flathead, Mulloway, bream, whiting, Australian Salmon;
- ♦ South-west side of **Granite Island:** squid and Snook;
- ♦ Between **Screwpile Jetty** and **Breakwater, Granite Island:** mullet, flathead, Australian Salmon;
- ♦ Eastern side of the **Causeway:** Garfish, Tommy Ruff, Southern Calamari;
- ♦ **Hindmarsh River area:** mullet, flathead, Mulloway, whiting, Australian Salmon;
- ♦ **Watson's Gap:** Mulloway, Australian Salmon
- ♦ **Horseshoe Bay:** Australian Salmon
- ♦ **Fishery Bay, Bashmans Beach, Frenchman Rock area:** mullet, flathead, Mulloway, sharks

Recreational potting for Rock Lobster, and abalone diving occur in **Encounter Bay**. Tyrer (1994) reported that the Encounter Bay area was popular for recreational fishing of Rock Lobster, but that bag limits are not caught easily.

In the **Murray Mouth - Goolwa** area, species taken by boat fishing, surf / beach fishing, and collecting include the following (from South Coast Marine, undated, unless otherwise specified).

- ♦ *Surf and Beach Fishing:* Mulloway (particularly between November to March), Shark, Rays, Flathead, Australian Salmon, Mullet (often taken in large numbers).
- ♦ *Boat fishing at Goolwa Barrage / Coorong Mouth:* Mulloway, Bream, Salmon Trout, Mullet and Rays.
- ♦ *Freshwater fishing near the Mouth (e.g. Mundoo Island):* Callop (Yellowbelly), Redfin, Perch, European Carp;
- ♦ Black Bream, Sand Flathead, and flounder species are also popular targets in the Murray Mouth area.
- ♦ Goolwa Cockles are taken from the beaches. Goolwa Cockles are an important source of bait, as well as a food item, for recreational fishers in the area (Morelli and de Jong, 1995). Recreational catch figures specific to the area are not available, however during the National Recreational and Indigenous Fishing Survey (Henry and Lyle (2003), 1,275,985 Goolwa Cockles were collected by South Australian fishers during the survey period (March 2000 to April 2001), on a State-wide basis.
- ♦ Line fishing from boats and surf casting from the ocean beach is considered to be a popular pastime in the **Murray Mouth** area (Morelli and de Jong, 1995).

There are annual fishing competitions in the area (e.g. **Goolwa** hosts a River Murray fishing competition).

There are summer periods of heavy fishing use in the **Murray Mouth** estuary, particularly the brief seasonal periods when Mulloway are present in large numbers and migrating into the estuary. This has been referred to by Capel (1994) as the summer "red-hot spot" for "barnstorming Mulloway". Popular fishing spots include patches on both sides of the Mouth opening, inside the two peninsulas. Both large specimens (e.g. to 30+kg) and large schools of smaller Mulloway are caught over the three month season, as they migrate into the Murray system (Capel 1994). Australian Salmon, mullet and bream are also popular targets during the summer "Mulloway barnstorming" period.

Pierce (1995) described the Murray Mouth and Coorong region as supporting "a diverse recreational fishery involving tens of thousands of South Australians". Recreational activities include Goolwa cockle harvesting, spearfishing for greenback flounder, angling for the Coorong and Murray Mouth species, including Mulloway up to 50+kg and a recreational net fishery mainly targeting mullet (Pierce, 1995).

A summary of fishing activities in the **Murray Mouth** area includes line fishing, "floundering" (fishing for flounder), netting (also in the **Coorong Lagoons**), and bait digging (Bryars, 2003).

The following information on recreational fishing in the **Murray Mouth** area was documented by McGlennon

(SARDI) in a 1996 report on the Murray Mouth region (see chapter in Edyvane *et al.*, 1996):

- ♦ The recreational fishery around the Murray Mouth targets heavily on Mulloway, with lesser attention paid to Black Bream, Greenback Flounder, and Yellow-eye mullet, as well as marine species such as Australian Salmon and sharks.
- ♦ Recreational fishing in this area includes line fishing, and recreational gillnets. Recreational gill-netting was banned along the coastal waters of South Australia during the mid 1990s, but at the time, coastal permit holders with recreational gillnetting permits were allowed to transfer them to the Coorong area. As of January 1996, this resulted in approximately 1000 permits (i.e. one net per permit), or a 70% increase in potential recreational effort in the area.
- ♦ Spears can legally be used on flounder by recreational and commercial (if endorsed) fishers, while hand nets can be used for the collection of bait.
- ♦ Geddes and Hall (1990) estimated that 27% of total Black Bream catches, 28% of Flounder and 12% of Mulloway catches were taken by recreational anglers, although it is not known from what data these estimates were derived; and
- ♦ Pierce (1995) noted that 1527 recreational net licences were current at that time for Coorong waters but, as from September 1995, recreational gill netting had been banned.

Hindmarsh Island and surrounds: Provides access for both freshwater and saltwater fishing. **Sugar's Beach** is one of the fishing areas on the island. Some of the main marine and estuarine species taken by recreational fishers are Mullet, Mulloway, Black Bream, Goolwa Cockle (pipi), flounder species, Australian Salmon and shark. Fresh water fish taken in the area include European Carp (which are used for fertiliser, yabbie bait, and human consumption, and penalties apply for returning Carp to the water alive), Callop (golden perch), Murray Cod, Redfin Perch (a penalty applies for returning Redfin to the water alive) and yabbies. Rainbow Trout and Brown Trout are rarely caught in the area.

Boating access (for fishing and other boating activities) to the Murray Mouth / Hindmarsh Island / Barrage Islands area is available via ramps at Beacon 19 and on Hindmarsh Island, as well as from ramps in Goolwa with subsequent access through the Goolwa Barrage. There are boat ramps on **Hindmarsh Island** (e.g. at the Marina; at Sugar's Beach; and northern side of the island). Records have been kept for vessel usage of the Goolwa Barrage locks (Water Resources Division of DENR, 1995, cited by Edyvane *et al.*, 1996). The records showed that between 4,500 and 8,500 boats passed through the lock each year during the mid 1990s (boats are counted in each direction) and that there has been a general increase in boating during the 15 years to 1995. Beacon 19 ramp was formally opened during the mid 1980s and is regularly used by trailer boats. Recreational boat usage of the Murray Mouth region is increasing (Edyvane *et al.*, 1996), including recreational fishing.

The **Mundoo Island** area is described as a popular location for recreational fishing (Australian Heritage Commission, undated).

The recent increases in residential and tourism development in the **Hindmarsh Island** area are likely to result in increased recreational fishing in both the Goolwa and Hindmarsh Island areas throughout the 2000s, as well as the Coorong. The Goolwa Lock is close to Hindmarsh Island, and access to the Coorong waters and Murray Mouth area is available from the marina at Hindmarsh Island.

Patch reefs in deeper water, mapped to be approximately 8km south of the **Murray Mouth**, are a recognised recreational fishing mark (Fish SA, 2000).

Diving and Snorkelling

Reefs and seagrass beds in **Encounter Bay**, the **Rosetta Head (Bluff)** area, **Yilki** (inshore reef for snorkelling) as well as the islands (**Screwpile Jetty** and breakwater at **Granite Island**, and boulder habitats at **West** and **Wright Island**, amongst others) are all recognised sites for diving and snorkelling (DIASA, undated; Christopher, 1988; Tourism Victor Harbor, 2001; Dive Oz, 2002; Aquanaut, 2002, Dive South Australia web site, 2004, and various other South Australian dive promotion materials). Reefs in the **Port Elliot** area were also listed in Christopher's (1988) Divers Guide to S.A. DIASA's (undated) diving guide lists **The Bluff** and **West Island** amongst the best diving sites in South Australia. Recreational SCUBA divers are permitted to access the eastern and southern sides of **West Island**, because the restricted research area occurs only on the north-western side.

Diving schools/clubs/associations teach courses in the **Encounter Bay** area. The bay side of the **Bluff** area has

been used for more than two decades as a dive training site, and there are other dive training sites in the bay. Recreational snorkelling programs have also been regularly conducted in the **Encounter Bay** area during holiday periods (Halstead, 1987, cited by Baker and Edyvane, 1996).

A number of dive clubs from metropolitan areas and the Southern Fleurieu region have regular dive trips to Encounter Bay.

Other Tourism / Recreation

The south coast port towns have been a popular holiday destination since the 1850s. The tourism industry first gained economic importance in the Encounter Bay area during the late 1800s, at the time when the port trade was diminishing due to the establishment of steam rail links between Adelaide and the upper reaches of the Murray (Wilkins, 1999). By the early twentieth century, “many” Adelaide families owned summer residences on Encounter Bay (Australian Heritage Commission, 2000).

The **Encounter Bay** region is a major destination for local holiday-makers and visitors to South Australia. **Victor Harbor, Port Elliot, Middleton** and **Goolwa** are all popular tourist and recreation sites, chiefly due to their proximity to Adelaide, variety of coastal recreation opportunities, and aesthetic coastal outlook. Apart from diving and fishing (see previous sections of this table), popular activities include swimming and surfing at the beaches in the bays, boating / sailing, visiting **Granite Island** to see the penguins, whale watching (mainly between May and October), wind surfing / sail-boarding, canoeing / sea kayaking (in **Encounter Bay**, and around the inner islands), jet ski-ing, visiting historical sites, beach walking / beach combing and rock pool exploration, and general coastal sightseeing. There is a cage-viewing facility off **Granite Island**, in water 4m deep, for public viewing of various shark species (e.g. Port Jackson Shark, Wobbegongs, Whiskery Shark, Bronze Whaler) and fish (Australian Salmon, Snapper, Trevally, Boarfish etc).

During the mid 1990s, the **Encounter Bay** region attracted up to 1 million visitors per annum (Halstead, pers. comm. 1994, cited by Baker and Edyvane 1996). A survey during the mid 1980s showed that 71% of visitors stated that “relaxation” was their major reason for visiting the Southern Fleurieu, followed by “sightseeing” (40%) and “whale-watching” (30%) (PATA, 1986, cited by Baker and Edyvane, 1996). Halstead (1987, cited by Baker and Edyvane, 1996) reported that 83% of visitors to the Fleurieu concentrated upon the **Victor Harbor** area. In general, the **Encounter Bay region** is associated with the development of tourism on the south coast of the Fleurieu Peninsula, and the region has been a popular tourist destination since the second half of the nineteenth century (H.I.H.C. Pty Ltd, 1985, cited by Australian Heritage Commission, 2000). There are many different types and an abundance of coastal holiday accommodation in the area. More specific information about recreation / tourism activities in the region is provided below.

Aquatic recreation activities are significant in **Encounter Bay**, and of social and economic significance to the Victor Harbor area. Apart from recreational fishing, boating and swimming are described as “predominant uses” of the Encounter Bay area (Australian Heritage Commission, 2000).

Whale watching has become an increasingly significant recreation and tourism activity in the **Encounter Bay** area during the past decade, with more than 100,000 people visiting the area for whale-watching in some years of the 1990s (Madigan, 1995, cited by Baker and Edyvane, 1996). The main season is from May to October, and there are excellent vantage points in the region, such as Rosetta Head, and the cliffs between Victor Harbor and Port Elliot. There are daily cruises during the season, and whale-watching charter boat tours of the Encounter Bay coast and islands (e.g. **Granite, West, Wright**) depart from **Granite Island**.

Granite Island has a high level of tourist usage, and is a popular recreation reserve, with coastal trails and walking tracks around and across the island. Granite Island is connected to the mainland by a causeway, along which a horse-drawn tram transports visitors. At least 200,000 visitors per annum use the **Granite Island** area (Victor Harbor Business Association, and Tourism Victor Harbor, undated). Penguin watching is a major attraction on Granite Island, and tours run every evening of the year. **Wright Island** is occasionally visited by boats (including charter boats), but is of lesser tourism significance than Granite Island.

Rosetta Head has coastal walking trails, and scenic views of Encounter Bay. The unusual wave-eroded features of Rosetta Head, such as Umbrella Rock and Nature’s Eye (Robinson, 1975, cited by Baker and Edyvane, 1996), are considered to be popular tourist attractions.

Port Elliot / Middleton area has been a coastal tourism destination since the 1870s. Popular for swimming (**Horseshoe Bay, Basham’s Beach, Ladies Beach, Crockery Bay**); surfing, at sites such as **Fisherman’s Bay, Horseshoe Bay, Middleton Beach** (surfing lessons are also held here), **Boomer Beach, Knights**

Beach, Chiton Rocks, and Basham's Beach); rock pool viewing (**Ladies Beach**), whale watching (**Basham's Beach, Middleton and Port Elliot**), coastal walks along the cliffs and beaches (to view natural coastal features such as "the Blowhole" and rock formations and other scenic rock formations, as well as Aboriginal middens, for example). Four of the historic shipwrecks within the **Port Elliot** area (*Harry, Josephine Loizeau, Lapwing and Flying Fish*) are often exposed within the surf zone at Horseshoe Bay, and are considered to be of interest many visitors to the beach (DEH State Heritage Branch, 2001). Popular for seaside holidays, with various accommodations available in the region.

There is a coastal bike track around **Encounter Bay** to the **Murray Mouth**, which also includes a swamp paperbark wetland area (with boardwalk) further inland - the Tokuremoar Reserve, managed by Ngurrindgeri aboriginal groups and the Alexandrina Council (Channel 9 media report, undated).

Murray Mouth / Goolwa / Hindmarsh Island: Since the earliest days of European settlement, the **Murray Mouth** has been used as a recreation area, for activities such as cruises and sailing boat regattas (see section on European Heritage). The entire area is considered to be a popular outdoor recreational site, which provides a visitor centre, interpretation programs, many boat ramps, marinas, camping and picnic areas and viewing points (Morelli and de Jong, 1995). The **Murray Mouth** area in general, and particularly **Hindmarsh Island** (see below), has become an increasingly popular location for various recreational activities, in addition to recreational fishing (see section on Recreational Fishing). Since the early 1990s, there has been an increase in chartered cruises and adventure wilderness hire operations, marina berths and waterfront housing (see below), and increases to freshwater and marine access points (e.g. upgrading of boat ramps, increased number of private launching and mooring areas). The marina at Hindmarsh Island services around 500 to 600 boats per year (Environment Australia, 2001). A bridge has recently been built to make **Hindmarsh Island** more accessible to marina residents, tourists and recreational users. Apart from fishing, boating is considered to be the most popular recreational pursuit in the area, including power boating, yachting, canoeing, sailing, windsurfing and jet skiing (Edyvane *et al.*, 1996; Alexandrina Council, 2001, and various regional tourism promotion materials). There are commercial tour boat operators in the Murray Mouth area. Powerboats, jet skis, yachts, sailboards, and canoes can be hired in the Goolwa area. There are various annual events associated with boating activity, such as the Milang to Goolwa yacht race (reported to be the largest fresh water race held in Australia), a wooden boat festival, surfboat and yacht races at Goolwa, and various powerboat races in the region. There are yacht clubs and other boating organisations in the area. Other activities in the Goolwa area include windsurfing / sail-boarding, para-sailing, swimming, bird watching, beachwalking / beachcombing. There is a variety of tourist vessels operating in the area, including the paddle steamer style used during the 19th century river trade, providing day trips and longer cruises to the **Lakes, Coorong and Murray River** reaches. Other tourist vessels from **Goolwa** visit the **Murray Mouth and Hindmarsh Island**. According to Edyvane *et al.* (1996), there is also the potential for both large hovercraft and houseboat operations in the region. The significance of fishing in the Murray Mouth region also has value for associated recreation and tourism activities (e.g. annual fishing competition and the Goolwa Cocklefest). The steam trail between Victor Harbor and Goolwa is a tourism feature of the area, and has been used in the past to bring holidaymakers to Goolwa for recreational cockle harvesting. There is an interpretative centre at **Goolwa**, which has a tourism function in addition to its education value (see section below on education). Other features of recreation / tourism significance in the area include a restored 1908 paddle steamer, traditional wooden river boat-building at Arnfield Slip, visits to the 632m long Goolwa Barrage and other barrages in the area, and bird-watching from the coast, barrages, jetty, islands and riverside bird hides in the area.

Recreational boat usage of the **Murray Mouth** region is increasing (Edyvane *et al.*, 1996). There are boat launching areas at in **Mundoo Channel, Goolwa Channel at Beacon No. 19**, and at **Sugars Beach** (Bryars, 2003). Information about boating access and vessel usage is described above in the section on **Recreational Fishing**.

Hindmarsh Island is becoming an increasingly popular residential, recreation and tourism destination, due to its proximity to Goolwa and the entrance of the Coorong National Park, and the Murray Mouth. One of the attractions of the island is its positioning adjacent to both freshwater and saltwater environments. Until recently, the island was reached by ferry, but there is now a bridge between Goolwa and Hindmarsh Island. There is a large freshwater marina (reportedly the largest freshwater marina in the Southern Hemisphere), consisting of 320 wet-berths; dry dock facilities for 150 boats, boat ramps, 375 residential allotments in the created Barkers and Sturt Lagoons, and waterfront and other residential facilities. Another lagoon, the 7.5ha Strangway's Lagoon, is currently (2001) being constructed. An additional 700 marina berths are planned, and there will be around 880 residential allotments (including a proportion with boat mooring jetties) when the marine extensions are completed. There are also plans for a resort, helicopter landing area, new yacht club, recreation reserves, and various facilities associated with the new developments. There are various accommodations for tourists on the island.

There are commercial tour boat operators in the Murray Mouth and Hindmarsh Island areas, visiting the bird habitat of **Hindmarsh Island**, the **Murray Mouth**, **Goolwa**, the **Coorong**, the **Lakes**, and the **River Murray**. Yachts, cruisers and tinnies can be hired from Hindmarsh Island. There are also yacht clubs in the Hindmarsh Island area (for cruising and racing). Apart from fishing (see separate section) and boating / yachting, other major recreation and tourism activities in the Hindmarsh Island area include coastal walking and sightseeing (e.g. from the Sturt - Barker monument, the Barrage, Trig Point and Sugar's Lookout, and various views to the Murray Mouth from the south-eastern side of the island), coastal bird watching from the various fresh, brackish and saltwater habitats around the island (the island is described in tourism promotion materials as being "recognised internationally as a major site for observing waders and other waterbirds", and "popular with bird-watchers"), swimming, and "nature-based" holidays.

The **Mundoo Island** area is a popular location for recreational activities including canoeing, water-skiing, boating, sailing and eco-tourism activities (Australian Heritage Commission, undated). Charter boats from Hindmarsh Island visit Mundoo Island and the Coorong barrages. Part of the Mundoo Island area is farmed. Eco-tourism tours (e.g. bird-watching etc) run in the **Hindmarsh Island**, **Mundoo** and **Ewe Islands** area.

The **Murray Mouth** and **Sir Richard Peninsula** area is used for coastal walking / sightseeing / bird-watching etc (there is a coastal walking trail), camping, and hunting. **Northern Coorong**: Apart from recreational fishing (see separate section on recreational fishing at Murray Mouth, Goolwa, and Hindmarsh Island), activities include bird watching, coastal walking (beaches, estuarine banks, dunes, boardwalk etc), and swimming (Morelli and de Jong, 1995; Edyvane *et al.*, 1996, and various regional tourism promotion materials).

The following compiled statistics were presented in the report by Edyvane *et al.* (1996). Various reports exist which contain some information on the extent of general tourism to the Murray Mouth Coorong region (e.g. Reark Research Pty Ltd, 1993; Explore International Pty Ltd, 1993; McGregor Marketing Pty Ltd, 1994; Govan & Leader-Elliott, 1995). Reark Research Pty Ltd (1993) estimated that 32% of visitors to Fleurieu Peninsula visit the Murray Mouth. By comparing this with the percentage visitation and actual numbers for Signal Point (Source: SA Tourism data), it was estimated that around 60,000 Fleurieu Peninsula tourists visited the Murray Mouth annually during the mid 1990s. Additionally, 5% of Murraylands tourists visited the Coorong (McGregor Marketing Pty Ltd, 1994).

Historic / Protected Shipwrecks

Encounter Bay is considered important as a source of historical remains and shipwrecks associated with nineteenth century whaling and trading activities. At least five shipwrecks associated with the whaling industry and seven shipwrecks associated with the River Murray trade occur in Encounter Bay. These historic shipwrecks have the potential to demonstrate nineteenth-century shipbuilding techniques (Coroneos, 1997, cited by Australian Heritage Commission, 2000). There are also unprotected wrecks of historic age in Encounter Bay.

Examples of vessels protected under the *South Australian Historic Shipwrecks Act* 1981, that were associated with whaling and sealing and the transportation of oil and skins, and were wrecked in the first half of the nineteenth century, include the following (Department of Environment and Planning, 1991; C. Halstead, pers. comm. 1994, cited by Baker and Edyvane, 1996; DEH State Heritage Branch, 2001):

- ♦ *South Australian* wooden barque, a store ship for shore whaling operations, wrecked in 1837 between Wright Island and Rosetta Head;
- ♦ *Solway*, 3-masted wooden ship wrecked near Victor Harbor in 1837 whilst transporting German immigrants to Adelaide. The wreck is located on a sandy patch 150 metres inshore from the face of Blacks Reef in 3-4 metres of water. The remains include 25m of the keel and keelson, ceiling planking and frames, rigging, copper bolts and sheaths, nails, ceramics, glassware, bricks and anchors;
- ♦ *St Vincent* wrecked in 1844;
- ♦ *Alpha* schooner wrecked in 1847; and
- ♦ *Jane* and *Emma* cutter in 1852 (Australian Heritage Commission, 2000).

All vessels were wooden, and none are intact, but fittings and other vessel parts remain *in situ*. Most remains are covered with sand, in at least 3 to 4m of water (S.A. Coast and Marine Atlas, 2001; State Heritage Branch, DEP, undated). The earliest recorded wreck was the *South Australian* at Encounter Bay in December 1837, while the earliest located wreck is the *Solway*, also lost at Encounter Bay in December 1837 (DEH Heritage website, 2001). The *Lady of the Lake*, a barge, was also wrecked in the area (i.e. at "Port Victor"), in 1877 (Stone, undated).

In the **Port Elliot** area, wreck sites protected under the *South Australian Historic Shipwrecks Act 1981* include:

- ♦ *Emu* schooner, wrecked 1853;
- ♦ *Athol* brigantine, wrecked 1864;
- ♦ *Josephine Loizeau* brigantine, wrecked 1856;
- ♦ *Lapwing* ketch, wrecked 1856;
- ♦ *Harry* 2-masted wooden brig, wrecked 1856, the remains of which are located in 3-4 metres of water near Commodore Point and are considered to be an excellent example of wooden ship construction from the 1840s (unreferenced, cited in Edyvane, 1996). When periodically uncovered by water movement, well preserved remains of the vessel's hull and fittings can be seen;
- ♦ *Commodore* schooner, wrecked 1856; and
- ♦ *Flying Fish* schooner, wrecked 1860.

A number of the vessels were associated with the River Murray trade. All ships listed were wood, and none are intact. Most are positioned in 3 to 4m of water. Some have well preserved remains of the hull and fittings (e.g. *Harry*), which are occasionally uncovered by conditions in the bay. Seven ships were wrecked in **Horseshoe Bay** alone, between 1853 and 1864 (S.A. Coast and Marine Atlas, 2001; State Heritage Branch, DEP, undated). Four of the vessels wrecked within the bay (*Harry*, *Josephine Loizeau*, *Lapwing* and *Flying Fish*) are often exposed within the surf zone at Horseshoe Bay. The *Emu*, *Commodore* and *Athol* sites are thought to lie outside Horseshoe Bay and are yet to be located (DEH State Heritage Branch, 2001).

The *Emu*, *Commodore*, *Josephine Loizeau*, *Lapwing*, *Harry*, *Flying Fish* and *Athol*, are part of the Maritime Heritage Trail at Port Elliot, which has been developed to promote the State's maritime history, and to encourage community involvement in the protection and conservation of historic shipwrecks and related sites (Heritage South Australia, 2000b).

A number of other shipwrecks occurred in the Encounter Bay area, including a fishing vessel, the *Ferret* (1) in 1900, a recreation vessel, the *Triton*, in 1908, and the *Mary* in 1938 (Australian Heritage Commission, 2000).

Other European Heritage

The following information is adapted from the Australian Heritage Commission's *Register of the National Estate* listing (2000) of Encounter Bay. Encounter Bay is recognised by the Australian Heritage Commission, due to the historic associations of the area with the exploration of Australia and the settlement of South Australia.

Encounter Bay was named by British explorer Matthew Flinders after his meeting with the French explorer Nicolas Baudin in 1802, and is considered as a significant area of European heritage due to this fact. Flinders was circumnavigating Australia in *The Investigator* when he met Baudin in *Le Geographe*, which had (reportedly) been blown off course while exploring the southern and eastern coasts of Tasmania. **Rosetta Head** is culturally significant, being the nearest landmark to the meeting place of Captains Flinders and Baudin in 1802. There is a plaque at Rosetta Head, commemorating the meeting (Robinson, 1975, cited by Baker and Edyvane, 1996).

Encounter Bay was a whaling base, from 1837 until 1855. Whaling was an early southern Australian industry and an important source of export income for the fledgling colonies. Encounter Bay was the longest-lived and most productive of the South Australian whaling bases (Bell, cited by Kostoglou and McCarthy, 1991), and flourished until the 1860s. The first whaling stations at Encounter Bay were established at **Rosetta Head** and **Police Point** in 1837. Relics of this era are preserved at Whaler's Haven below Rosetta Head. The Police Point whaling station was moved to **Granite Island** in the late 1830s. A whaling station was also established on the western end of **Horseshoe Bay**, with **Freeman Knob** used as a vantage point. The large number of whales in Australian waters attracted Australian, European and American vessels in the early nineteenth centuries. Whaling sites and relics are considered to be potentially of national heritage significance (Australian Heritage Commission, 2000).

The **Rosetta Harbour** whaling station was owned by the South Australian Company, and was set up during the 1830s. In 1851 it was reported that the Rosetta Harbour station comprised between ten and twelve buildings including boat sheds, stables, workshops and sleeping berths. These buildings have since been demolished. **Rosetta Head**, which is also known as the Bluff, was used as a lookout point for whales. During the mid 1850s a wharf and access road were constructed at Rosetta Head, although it is not clear if the whalers used this wharf, as the industry ended at Encounter Bay at this time. Little visible evidence remains of whaling in this area, although it is thought that two buildings, a house and the former Fountain Inn, both located on Franklin Parade, Victor Harbor, were used by the whalers who worked at Rosetta Harbour. It is also possible that archaeological material exists in the region, both underwater in Encounter Bay and along

the coastline (Australian Heritage Commission, 2000).

Encounter Bay is the former outlet for the River Murray trade (see below). Port Elliot was established in 1851 as an ocean port for the river trade (because the Murray Mouth was unsuitable for shipping). At Port Elliot, a stone seawall and jetty were built in 1852 and a breakwater was begun in 1852, but never finished. In the same year a stone obelisk was erected at Freeman Nob as a guide to shipping (Port Elliot Obelisk is on the *Register of the National Estate*). Australia's first railway line, established in the 1850s, was used to carry inland river produce from the Murray Mouth area overland to Port Elliot, where a protected sea port had been constructed successfully for a short time. From 1851 to 1866 more than 500 vessels used the facilities of the seaport. The wrecking of seven vessels between 1853-1864 confirmed Horseshoe Bay's growing reputation as a 'ship-trap', resulting in Victor Harbor replacing Port Elliot as the coastal outlet for the Murray trade (DEH State Heritage Branch, 2001), and therefore the transport facility for river trade was relocated to Victor Harbor in the 1860s (Coroneos, 1997).

By 1850, there were about 500 people in the **Encounter Bay** area, and in 1854, the Lilliputian jetty was constructed at the eastern end of The Bluff to improve cargo handling of stores from Port Adelaide. In 1862, a larger and more protected port was established at Victor Harbor. In that year, work began on a jetty and pier at Victor Harbor, and the railway from Goolwa was extended to connect with Victor Harbor. In 1864, the Victor Harbor jetty and tramway from Goolwa at the Murray Mouth, was opened. During the latter 1800s, the town became a major port. Between 1872 and 1875 the jetty was lengthened to form a causeway between Police Point and Granite Island, and in 1879 a breakwater and Screwpile Jetty were constructed adjacent to the island (completed 1882). The breakwater, a massive stone embankment to shelter the ships at the Screwpile Jetty, is more than 300m long. The causeway and jetty are registered as a Historic Site on the Register of the National Estate) (Wilkins, 1999; Australian Heritage Commission, 2000).

Encounter Bay is important as a source of historical remains associated with whaling and also contains a series of nineteenth century port facilities, including breakwaters, jetties, a causeway and an obelisk, established to serve the River Murray trade. These features have the potential to demonstrate early port building techniques (Coroneos, 1997).

There is an interpretative centre at **Victor Harbor**, providing information about the European heritage (e.g. whaling) of the region.

Granite Island has, historically, been an important recreation area in South Australia, and was declared a Recreation Reserve in 1856 (Robinson, 1975, cited by Baker and Edyvane, 1996). The **Granite Island** causeway, breakwater and cutting are on the State Heritage Register (DEH, 2003f). **West Island** was used in the late 1880s and again during the 1930s as a source of granite for the South Australian Parliament House. There are ruins of the forge and the makeshift houses that sheltered the workers during the late 19th century. A monument associated with a lookout on **Hindmarsh Island** commemorates Captains Sturt and Barker and their party (Heyligers, 1981, cited by Baker and Edyvane, 1996).

The Encounter Bay region contains the following places on the *Register of the National Estate* that have European cultural significance: **Rosetta Head, Causeway and Jetty Historic Site, Port Elliot Obelisk, Fountain Inn, and Whalers House Museum.**

Murray Mouth / Goolwa: Goolwa is Australia's only registered inland port. The river was an important transportation route in south-east Australia in the second half of the nineteenth century. Captain Charles Sturt had been the first European to explore the Murray, arriving at Lake Alexandrina, near the Murray mouth, in 1830. As agriculture and grazing was introduced throughout the Murray-Darling Basin, the River Murray developed as a transport route, with **Goolwa** becoming a major river port. Goolwa was the final port of call for trading paddle steamers that worked along the River Murray. A permanently staffed signal station was established at Point Pullen in 1859 to communicate the state of the Murray Mouth to vessels wishing to enter the Murray through it. Today, although the river trade of the nineteenth century no longer exists, the residents of Goolwa, and other river towns, display a strong affinity with this feature of their past (Edyvane *et al.*, 1996). At **Goolwa**, Australia's first public "railway" was opened in 1854, to connect with the Murray steamboat system, thus connecting river traffic at **Goolwa** with the ocean port of **Port Elliot**. The wharf at Goolwa has historical significance, having been a major point for trade, when paddle steamers transferred their cargoes to sailing ships for the journey to Port Adelaide and other ports. Since the earliest days of European settlement, the **Murray Mouth** and **Goolwa** region has also been used as a recreation area. Show boats and day cruises would navigate to the area from upstream or through the mouth into the Coorong. Sailing boat regattas have been a feature of the area since the 1850s, with the Milang to Goolwa Regatta celebrating its centenary in 1956 (Linn, 1988, cited by Edyvane *et al.* 1996). Commercial fishing has also been a cultural part of the **Murray Mouth** region since the 1860s (Pierce, 1995). The barrages also

have some historical significance, built between 1935 and 1940 to separate the fresh water of the river from the salt water of the Southern Ocean. From the 1880s to at least the 1920s, the "Cockle Train" provided a summer holiday season service to Goolwa Beach for recreational cockle picking, transporting people from Victor Harbor, Port Elliot, and Middleton. During the early years of the service, the Cockle Train was also used to transport Goolwa cockles from the Murray Mouth to retailers. The National Trust Museum at Goolwa documents the riverine and estuarine and marine history of the area, and includes items salvaged from shipwrecks in the Murray Mouth area.

At **Hindmarsh Island**, there is a granite monument to the meeting of Captains Charles Sturt and Collett Barker. Captain Sturt used Hindmarsh Island as the highest point to locate the Murray Mouth on his journey down the River Murray in 1830.

Aboriginal Heritage

The Ramindgeri group of aborigines were one of the 18 Ngurrindgeri sub-tribes of the Encounter Bay and Coorong region. Records are unreliable, but according to Cameron (1979), there may have been up to 200 of these nomadic coastal people. During the early 1800s when Europeans arrived in the area, Ramindgeri people had semi-permanent camps in the Encounter Bay area. Other groups which reportedly lived in the Encounter Bay region include the Lampindgeri, Karkarindgeri, and the Pankindgeri (Meyer, 1879, cited by Baker and Edyvane, 1996). The Ngurrindgeri were a fishing tribe of around 3200 people, whose sub-tribes seasonally moved around the region according to the availability of food and water. The tribes used spears, fish traps and flax nets (Robinson, 1975) in Encounter Bay to catch fish, one of their main foods. According to Hodge (1932, cited by Baker and Edyvane, 1996), Ramindgeri also often fished in the **Hindmarsh** and **Inman** Rivers, where bream, salmon, Mulloway and mullet were previously common.

Many of the geological features of the Encounter Bay region form part of the Ramindgeri legend, of which there are many variations. One version recounts the legend of the great totemic being Ngurrindgeri, who ventured around the southern Fleurieu in search of his two errant wives. He created Kungkenggunar (Rosetta Head) by stamping his feet, and created rocky islands out of the bay by throwing his spears into the sea. His wives were transformed by the sea into rocks, and can be seen today at low tide. When Ngurrindgeri left Encounter Bay, he lost his son, but drew him back with a string tied to his maralengk. This legendary line is still the guide by which the dead find their way to Ngurrindgeri (Meyer, 1879, cited by Baker and Edyvane, 1996).

At **King's Beach**, there is a natural (sand) fishtrap, which was made and used by the Ramindgeri living in Encounter Bay (S. Shepherd, pers. comm. 1996, cited by Baker and Edyvane, 1996).

Before it was separated from the mainland, **West Island** was used as a campsite by aborigines, who harvested molluscs from its shores. The Aboriginal heritage significance of West Island has also been recognised by the Australian Heritage Commission, however details were not available at the time of the listing of West Island Conservation Park on the *Register of the National Estate*.

Granite Island and **Rosetta Head** are associated with the Ngurrindgeri Dreaming (see below). **Granite, Wright and Seal Islands**: At the time of nomination for the Register of the National Estate (1983), the Australian Heritage Commission considered that the islands have indigenous values of National Estate significance, and the Commission was consulting with relevant Indigenous communities about the amount of information to be placed on public record. In 1999 - 2000, the Ngurrindgeri Land and Progress association received a Coastcare grant for works required to protect Aboriginal Heritage sites, and the Granite Island landscape.

There is a stone memorial set by Europeans in 1945 on the Kent Reserve, adjacent to the mouth of the **Inman River**, commemorating the last known camping ground of the Ramindgeri (Robinson 1975, cited by Baker and Edyvane, 1996).

The following information about Encounter Bay is adapted from the Australian Heritage Commission's Register of the National Estate listing (2000) for **Encounter Bay**. The region is recognised by the Australian Heritage Commission's as significant due to the importance of Encounter Bay to the Ngurrindgeri / Ramindgeri people:

- ♦ The **Encounter Bay** area is of social, cultural and economic significance to the Ramindgeri people. The vitality and continuing oral traditions of the descendants of the Ramindgeri people highlight their identity with the landscape of the Encounter Bay area. Descendants of the Ramindgeri people maintain traditional cultural practices of hunting and fishing in the Encounter Bay area.
- ♦ The **Encounter Bay** area contains sites of Aboriginal cultural significance such as hunting and gathering

areas and story places. The area also contains a number of coastal archaeological site complexes of scientific, cultural and educational significance. These sites collectively document aspects of Ramindgeri history, including prior ownership, and are a tangible link to Ramindgeri ancestors.

- ♦ The **Encounter Bay** area is notable for its wealth of variants of the Ngurrindgeri epic myth, which are documented ethnographically, and recalled in contemporary Ramindgeri oral history. Ramindgeri myths feature strongly in describing the formation of the Encounter Bay cultural landscape, the geological features, and the characteristics of various plants and animals species of the area. Other stories recorded from Ramindgeri people at Encounter Bay describe the origin of fire and describe the activities of species of totemic significance such as the whale. These myths are an important part of contemporary Ngurrindgeri culture and are used to teach aspects of Aboriginal culture and laws today and to express their regional identity and territoriality. Islands in the area, including the **Pages** as well as the islands in and out of Encounter Bay, are also part of the myths.
- ♦ The whaling industry used Aboriginal women's cultural knowledge and labour. Aboriginal skills reportedly enabled the exploitation of the resources of a number of offshore islands in the area and the subsequent development of the whaling industry at **Encounter Bay**. Reliance on the skills and cultural knowledge of these women continued long after official settlement in 1836. Descendants of these women form part of the contemporary Ngurrindgeri community. Historical documents also record the singing of whales by Ramindgeri clever men who are said to have had the ability to sing whales into the shoreline (Australian Heritage Commission, 2000) (see also below, for details of the impacts that whaling had upon Aboriginal settlements).
- ♦ Extensive Aboriginal coastal middens have been recorded along the **Encounter Bay** coastline. Other places of Aboriginal cultural significance such as story places and hunting and gathering places are well documented in the study area.
- ♦ The evidence given by Angus to the Select Committee of the House of Commons in the 1830s provides early recognition of Ramindgeri Native Title rights. Angus's representation to the Committee stated that Aboriginal men had inherited interests in land and a subsequent grant of land by the Crown was made for the occupation and use of Aboriginal people at Encounter Bay and Port Lincoln (Australian Heritage Commission, 2000).
- ♦ According to Wilkins (1999), the presence of the whalers had a devastating effect on the local aboriginal tribes of the Encounter Bay area, because the previously self-sufficient sub-tribes, which had semi-permanent camps and relied upon the area for food such as fish marine and river fish, crustaceans and other marine foods, and bush foods, became a dependent society, feeding on the large quantities of fresh whale meat that was considered waste in the whaling process. The whalers are reported to have spread disease to the Aborigines of Encounter Bay, significantly reducing the populations. Environmental impacts such as the pollution of Encounter Bay with blood and offal from whaling, also reportedly affected the Aboriginal inhabitants and their traditional lifestyle.

The contemporary significance of the **Encounter Bay** to the Ramindgeri people is evident in a registered native title claim over the land and waters of the study area made by the descendants of the traditional owners of the area. The Ngurrindgeri Native Title Claim for the Encounter Bay and Coorong region was lodged in 1998. The claim was registered in 2000. The area comprises 10,353 square km, and includes a sea claim to approximately 3km seaward (according to map in S.A. Coast and Marine Atlas, 2001). The western boundary was specified as north of Cape Jervis and the southern boundary approximately 13km south of the southern end of Coorong National Park.

Pulleine (1921, cited by Baker and Edyvane, 1996) provided an account of the remains of a Ramindgeri camp site at **Commodore Point** near **Middleton**. The site included hearthstones and scatters throughout the sandhills; flat oval hammer stones used for cracking cockles; chopping stones; shell rests with depressions; and sharp quartz stones for opening shellfish; a thick layer of cockles and turban shells at one camp site; ochre grinding stones; and burial mounds, with skeletons in sitting position. This site no longer exists in the form in which it was found.

There are Aboriginal Heritage Sites, listed in the Register of the National Estate, at **Victor Harbor, Mundoo Islands** and **Goolwa**.

Sub-tribes of the Ngurrindgeri people lived in the **Lower River Murray** area. The Murray Mouth area, including **Sir Richard** and **Younghusband Peninsulas** are particularly rich in midden, camping and grave sites, and sites of sacred significance (Edyvane *et al.*, 1996). The Ngurrindgeri people have strong historical and cultural links with the **Murray Mouth** area, including the islands, such as parts of **Hindmarsh Island**. There are canoe and shield trees in the Murray Mouth region, the midden sites in the region are very large.

The following information about the Aboriginal heritage values of the Ngurrindgeri in the Murray Mouth area was collated in 1996 by Evans (see Chapter 4.8, in Edyvane *et al.*, 1996):

Ngurrindgeri use of water based resources was sophisticated, using many different net designs (for fish and bird capture). The manufacture of this equipment required high levels of precision and craftsmanship. Leubbers (1981) postulates that certain rock formations found in the Coorong may have been used as fish holding corals, where excess catches were stored alive for future use. The storing of dried and smoked fish occurred. Trading in these commodities and others (nets, clothing, baskets and mats) with other aboriginal groups, particularly along the Murray River and into Victoria also existed (Jenkin, 1979, cited by Evans, in Edyvane *et al.*, 1996).

The resource abundance, reliability, diversity and evidence of its use indicates that the Ngurrindgeri were able to live in semi-permanent settlements, having a population density which was likely to have been the highest for any Australian aboriginal group (Leubbers, 1981). Contemporary Ngurrindgeri describe their whole country as a "site". This is a reflection of the intensity of settlement throughout the area. Today, meeting places and middens containing cockle shells, the remains of fish and terrestrial animals and graves are frequently being found, and occur in a density not seen in other locations in Australia (Leubbers, 1981, cited by Evans, in Edyvane *et al.*, 1996).

Jenkin (1979) distinguished the Ngurrindgeri from other indigenous Australians as not only having different physical characteristics, but also by their relative sophistication in clothing, weaving, net making, intellectual and artistic development.

Contemporary Ngurrindgeri are experiencing a cultural revival. Although the full cultural richness of the old tradition is no longer available to contemporary Ngurrindgeri, knowledge is held by individuals and groups and is gradually being pieced together. Ethnographical, anthropological and archaeological sources, texts and studies are helping in this process. Ngurrindgeri leaders recognise that many of their cultural traditions have the ability to provide a positive focus for the younger members of their community. The Lower Murray Aboriginal Heritage Committee has listed heritage and culture, land and economy as its main priorities (Lampard, pers. comm., cited by Evans, in Edyvane *et al.*, 1996).

The Ngurrindgeri tribal and clan boundaries extend into marine, estuarine and freshwater "country". The water, channels and sea, river and estuary beds all belong to traditional owners. This is quite different to the European perspective on waterways, which is one of common usage, where all members of a nation may have right of passage through that waterway (Smyth, 1994). Contemporary Ngurrindgeri have maintained the tradition of using the marine and estuarine resources found in their traditional country (Evans, 1996, Chapter 4.8 in Edyvane *et al.*, 1996)

Overall, the entire **Coorong** region is considered to be one of the most significant Aboriginal archaeological sites in Australia. More than 6000 Aboriginal habitation sites including shell middens and mounds, cooking ovens, campsites and burial sites remain and are found near the ocean beach and along the shorelines of the lagoons. The estimated age of some Aboriginal deposits is 5600 to 4500 years (Morelli 1995). The physical remains of the Ngurrindgeri aboriginal settlement of the **Coorong** are recognised as one of the most outstanding records of coastal adaptation in temperate Australia, and are considered of international as well as national significance (see National Parks and Wildlife Service, 1990; Edyvane *et al.*, 1996; and Master Plan *et al.*, 2000 for overviews of cultural significance).

The whole of the Coorong National Park is subject to a Native Title Claim (DEH website, 2001). The River Murray, Lakes and Coorong region claim was lodged in 1998 and registered in 2000, and includes a Sea Claim, according to a recent GIS database compiled by the S.A. government.

Scientific Research and Coastal / Marine Education

In general, the **Encounter Bay** region is significant for marine biological and ecological research due to the variety of habitat types, as well as its accessibility from the metropolitan area (Edyvane, 1996b).

The **West Island Aquatic Reserve** is the site of the longest-running and most detailed study of abalone population dynamics in the world (i.e. studies of S. Shepherd, conducted since the early 1970s), and the site is also used by other numerous State, national and international researchers for marine biological and ecological research. The existence of West Island Aquatic Reserve (see Shepherd 1991) has spawned many dozens of scientific studies, and has resulted in internationally significant knowledge in abalone population dynamics, as well as studies in benthic ecological structure, function and processes; fish and

invertebrate behaviour; seadragon distribution, predator-prey interactions; food web studies, and macroalgal physiology, among other studies, during the past three or more decades. Johnson (1988) described the granite boulder reefs around West Island as “an ideal opportunity for SCUBA divers to observe how subtidal plant community zonation is influenced by water depth and wave action”. Because West Island is relatively small, steep and subjected to rough conditions with no protection from the south-west, it is an ideal location for studying the effects of depth and wave action upon marine benthic communities.

West Island Conservation Park: A long term study site for ornithology, including long term monitoring of tern populations (Australian Heritage Commission, undated).

West Island is also a significant area for marine biological and ecological education at tertiary level, with many experiments and field studies having been undertaken during the past 30 years, by State, national and international students.

Encounter Bay is one of the major sites of a community-based recording program for seadragon populations in S.A. (Dragon Search).

The **Encounter Bay** region is a major location for both upper secondary and tertiary level education into geological structures and processes, and field trips to locations such as **Rosetta Head** and **Granite Island** have occurred for several decades. In previous decades, the region has been significant as a geological research site. Several coastal sites of geological significance, which are considered valuable for research and teaching, have been defined as Geological Monuments by the South Australian Museum and Geological Society of Australia. Examples include **Rosetta Head**, **Granite Island**, **Seal Island** and several other areas, used for teaching geological processes such as igneous rock formation and glaciation processes. **Granite Island** and **Seal Island** are examples of Encounter Bay Granite and Kanmantoo Group formations, and Wright Island is one of only two examples in Encounter Bay of the contact between the Kanmantoo Group and the granite. All the Islands are surface indicators of a formerly extensive granite barrier scoured by glaciers in some areas (Australian Heritage Commission, undated).

Rosetta Head (including **Kings Beach** and **Rosetta Harbour / Bay** area, have reportedly been used regularly by Adelaide and Flinders universities for several decades, as an area for marine biological education. At Kings Beach, the shore reef and intertidal pools support a variety of crustaceans, molluscs, seastars, sea cucumbers, anemones and other benthic organisms of interest to biology students (Orbach, pers. comm., cited by Edyvane, 1996b).

The South Australian Whale Watch Centre at **Victor Harbor** is a focus for marine environmental information and education in the region, particularly that pertaining to whales, and also including penguins, pinnipeds and other marine fauna. Apart from whale education, the penguin watching and associated educational activities program annually attracts thousands of visitors (e.g. up to 6000 during the mid 1990s) (Halstead, pers. comm. 1994, cited by Baker and Edyvane 1996). The Whale Watch Centre has interpretative materials and displays, maintains a whale-watching database, provides regular reports to visitors and media about whale sightings, and provides information about whale watching regulations in the area. There is also an interpretative centre on **Granite Island**, which provides educational information about Little Penguins.

Ngurrindgeri stories from the Encounter Bay region are used by the South Australian Education Department to teach aspects of Ngurrindgeri culture. These stories also describe aspects of Ramindgeri culture and law (Australian Heritage Commission, 2000).

Signal Point Interpretative Centre at **Goolwa** has educational information about the legends, cultures and history of the original Aboriginal inhabitants of the area, and also educational materials and displays (artefacts, charts, paintings, models) about the Murray Mouth, and the river boat trade of the 1800's (during the time when Goolwa was a major centre for such trade).

Other features of educational significance in the area include the bird hide at **Goolwa**.

Wilderness / Aesthetic Values

In general, **Encounter Bay** is considered to offer wide and scenic panoramic views (described by the Australian Heritage Commission as “spectacular”), particularly from **Rosetta Head** (“splendid views” – Wilkins, 1999) and other elevated headlands and cliffs along the coastline, **Granite Island** and other islands and knolls (which are an unusual feature on the southern Fleurieu Peninsula region), the headland at **Port Elliot** and **Middleton**, and from the dunes near **Goolwa** (Heyligers, 1981, cited by Baker and Edyvane, 1996;

Australian Heritage Commission, undated, and tourism promotion material for the Victor Harbor region).

The entire Encounter Bay region is generally considered important to the South Australian community for its aesthetic characteristics (Australian Heritage Commission, 2000). According to the Statement of Significance for the recent inclusion of the Encounter Bay region on the Register of the National Estate, “the relatively undeveloped qualities of the Bluff, the islands and the reserves along the coastline increase the beauty of Encounter Bay as viewed from the mainland. The coastal landscape is enhanced by a range of natural features, including wide stretches of sandy beaches and low granite cliffs”.

According to the Australian Heritage Commission (2000), **Encounter Bay** “continues to be valued by artists as a subject, and was depicted in nineteenth century paintings, drawings and etchings by artists such as William Light, George French Angas and Edward Charles Frome”.

Inman River: Due to the natural vegetation around the estuary, and its location within a built-up urban area, the Inman River is considered by the Australian Heritage Commission to be of “high aesthetic significance”.

Pullen Island: Described as a “granite reef with considerable scenic value” (Australian Heritage Commission, undated), a feature of significance for the inclusion of the area on the *Register of the National Estate*.

Granite, Wright and Seal Islands: Described as providing some of the most “spectacular scenery” in the region (Australian Heritage Commission, undated). Tourism promotion materials describe Granite Island as providing “magnificent views of Encounter Bay and the Bluff”.

West Island and Seal Island: According to the Australian Heritage Commission (undated), “the close proximity of the islands to the mainland, together with their natural appearance, make them a focal point of aesthetic significance”.

The **Lower Murray** and the **Goolwa Channel** are considered to be important features of the aesthetic landscape in the Encounter region, and the (Sturt - Barker memorial) lookout at **Hindmarsh Island** also provides fine panoramic view (Heyligers, 1981, cited by Baker and Edyvane, 1996). Other aesthetic viewing areas at **Hindmarsh Island** Trig Point (described as having “spectacular 360 degree views”; and Sugars Beach Lookout, which overlooks the Murray Mouth. Edyvane *et al.* (1996) stated that the whole of the **Lower Murray** estuary is recognised as having significant wilderness and aesthetic values, particularly the wetland and coastal dunal habitats.

Mundoo Island and surrounding area: considered to have wilderness value due to its undisturbed nature, and therefore used for wildlife study, painting etc (Australian Heritage Commission, undated).

Towns and Settlements

Victor Harbor: Australian Bureau of Statistics reported a base population of 8,968 in 2001. Other sources have quoted a population of around 12,000 (Tourism Victor Harbor, 2001), but as a significant holiday / tourism centre, Victor Harbor attracts up to 1 million visitors per annum. The base population has reportedly increased nearly 50% during the past decade, a growth rate 10 times that of the state as a whole (Tourism Victor Harbor, 2001).

Goolwa region and Hindmarsh Island: The base population in the Goolwa region was around 4,345 in the early 2000s (ABS statistic, 2001). Previously, in 1990, a report by SADEP (1990, cited by Edyvane *et al.*, 1996) expected the population at the time (2000 people) to double by the year 2006, due to marina developments and associated new housing in the area, and that has occurred. The population of **Hindmarsh Island** was reportedly around 400 people at the beginning of the 21st century, but is likely to have increased due to recent housing developments.

Port Elliot: Base population around 1,527 (ABS statistic, 2001); **Middleton:** base population 887 (ABS statistic, 2001), both with seasonal increases due to tourism.

Mundoo Island and Channel: Small residential and shack settlement.

9.1.18 Upper South-East (Coorong / Otway Bioregions Boundary)

Aquaculture

Previously, PISA (now PIRSA) approved for aquaculture the development of 100ha in the **Robe** region; plus 40ha aquaculture development in the **Cape Jaffa** Aquaculture Zone, and a further 60ha in the **Kingston** Zone (**Lacepede Bay**) (Gilliland, 1996). In the mid 1990s, industry considered the area suitable for aquaculture development, and such provision was written into the 1996 Aquaculture Management Plan for the South East (see Gilliland, 1996). Following that period, the Limestone Coast Regional Development Board has also undertaken a study into the region's aquaculture potential.

In 2004, PIRSA released the Lacepede Bay Aquaculture Management Policy, which supercedes the previous Kingston Policy Area in the South East Aquaculture Management Plan. The previous Kingston Policy Area is now divided into five zones, purportedly to more closely reflect the previous aquaculture use of the area, conservation areas, and the ecological communities in the area.

According to PIRSA (2004a), the *Inner Kingston Zone* has "tight aquaculture development controls", as the zone is dominated by seagrass communities, considered by some researchers and policy makers to be more sensitive to aquaculture impacts than other types of benthos. PIRSA Aquaculture (2004a) recognised the need to restrict stocking densities of finfish in cages in inner Lacepede Bay, to reduce the likelihood of build-up of nutrients and sediments in shallow waters, in the vicinity of seagrass beds. Aquaculture expansion in the inner part of southern Lacepede Bay would be "*controlled via incremental tonnage increases linked to environmental monitoring results for both the Historical Cape Jaffa and Inner Kingston Zones*" (PIRSA Aquaculture, 2004a).

The *Intermediate Kingston Zone* is dominated by "fucoid, red and brown algal" communities and PIRSA considered these communities to be less sensitive to aquaculture impacts, and therefore permitted more aquaculture development in the Intermediate Zone. The Intermediate Kingston Zone is located seaward of the eleven metre depth contour. Being further offshore, this zone is out of the "shadow" of Cape Jaffa making it less sheltered and therefore subject to rougher conditions. PIRSA (2004a) permitted each of the lease sites in the Intermediate Zone greater area than would be allowable in the Inner Kingston Zone. Although allowance was made for an increase in stocking rates as compared to the Inner Zone, the proximity to the seagrass beds was reportedly considered in setting limits to stocking rates.

Further away from the coast, the *Outer Kingston Zone* was considered by PIRSA (2004a) to be less sensitive to impacts from aquaculture development, hence the highest stocking rates would, in theory, be permitted. However, the exposed nature of this zone and consequent high infrastructure costs would likely restrict development in the area to some extent (PIRSA Aquaculture, 2004a).

Other zones in the area include the *Historical Cape Jaffa Zone*, where the aquaculture industry already operates (see below), but the policy in 2004 did not allow for expansion or development, and "any requirement for increased production must be addressed by gaining access to sites in the other Zones" (PIRSA Aquaculture, 2004). Lastly, the *Kingston Exclusion Zone* (based on a previous zone in the 1996 aquaculture management plan) was designated to protect conservation areas, maintain navigation channels, fishing use and residential qualities (PIRSA, 2004a). The 2004 policy also included some new areas in the exclusion zone. No aquaculture is permitted within one kilometre of the mean spring high water mark of the mainland within the Lacepede Bay Policy Area (reportedly to provide a buffer between aquaculture and the drainage system, maintain accessibility and the aesthetics of the area for all resource users). The 2004 policy specified a 2km buffer around areas "set aside for harvest".

According to PIRSA's Aquaculture Public Register (August, 2003), and the S.A. Coast and Marine Atlas, (March 2003) there are existing aquaculture leases for Atlantic Salmon and Ocean Trout in **Lacepede Bay**, around 2km offshore from **Cape Jaffa**. According to the S.A. Coast and Marine Atlas (March 2001 version), since 1995 at least six leases have been approved, and at least seven further applications have been received by State government since that time (S.A. Coast and Marine Atlas, March 2001). As at March 2003, two leases, one for Atlantic Salmon and one for Ocean Trout, were listed for the Cape Jaffa area (S.A. Coast and Marine Atlas, March, 2003). The Aquaculture Public Register (PIRSA, 2003a) reported that 3 finfish farming licences are current in the **Cape Jaffa and Robe** area combined, each for 20 ha. Each of the 3 licences has Atlantic Salmon, Ocean Trout and Yellow-tail Kingfish endorsed for grow-out in sea cages. Wesfarmers Landmark (2003) advertised 2 x 20 hectare marine aquaculture leases with 40 year terms, comprising a maximum allowance of 24 cages (total capacity 500 tonnes of fish), licenced for growing Atlantic Salmon, Ocean Trout, and Yellow-tail Kingfish. It is predicted by industry in this area, that Ocean Trout will increase in popularity as a farmed species, due to the faster growth rates, compared with Atlantic Salmon.

In the **Cape Jaffa / Lacepede Bay** area, Atlantic Salmon smolt are transferred to the sea in approximately August and are grown for a further 12 – 15 months in sea cages. Ocean Trout are transferred to the sea in about April and are then grown for approximately 6-9 months (PIRSA Aquaculture, 2004a).

The South East has been identified by State government as having “the best potential” for land-based aquaculture (Chapple, ABC On-Line, December, 2000). There is an on-land aquaculture facility in the **Cape Jaffa** area, which uses artesian water for growing Barramundi (Wesfarmers Landmark, 2003).

According to Gilliland (1996), interest has also been expressed in undertaking kelp culture trials in Lacepede Bay, however this has not occurred to date.

Commercial Fishing

Scalegfish, Sharks and Minor Invertebrates

Yellow-eye Mullet are caught in bait nets in the shallow waters of sheltered bays in the South East, to a depth of 5m. Trolling for Australian Salmon occurs along most of the coast, including the area from **Cape Jaffa** to **Kingston**, and the “**Granites**”, to depth of 10m - 20m. (N.B. Salmon is used as bait in the Rock Lobster fishery). Snapper are caught all along the coast, mostly by hand lines operating at 10m to 20m. Gummy Shark and School Shark are mainly caught in waters deeper than 20m, with Mulloway as a bycatch. Ocean Leatherjackets are often caught as a bycatch species in Rock Lobster pots (Jones, SARDI pers. comm., cited by Edyvane *et al.*, 1996). According to Gilliland (1996), Southern Calamari is also caught by commercial fishers in the **Robe** area.

Recent aggregated scalegfish and shark catch figures for all State waters in the area are not available for this report. However, as an example, it was reported that in 1996/97, approximately 310 tonnes of scalegfish were landed from the area between Beachport and the Murray Mouth (i.e. which includes the **Lacepede Bay** and **Guichen Bay** areas). Some 220 tonnes of this were School Shark and Gummy Shark, with other species including Ocean Leatherjacket, Australian Salmon, Mulloway, Deep Sea (Blue-Eye) Trevalla, mullet and Southern Rock Cod (SARDI, 1998, cited by O’Sullivan, 1998).

Some Rock Lobster fishers use drop-lines for Blue-eyed Trevalla and Ling, and catch sharks out of season using long-lines or nets, and some of these activities require a Commonwealth permit (Zacharin 1997, cited by Prescott *et al.*, 1998). Target and non-target catches of more than a dozen Commonwealth-managed species (including Blue-eye Trevalla and Ling) by all sectors of the fishing industry, have recently been re-regulated under the new *SESSF Strategic Assessment* report and management plan (see AFMA, 2003a).

Regionally, examples of the major fish and shark species that are caught commercially south and south-west of the **Cape Jaffa / Kingston** and **Guichen Bay / Robe** areas included:

Gummy Shark and *School Shark* and other shark species: The fishery for School Shark and Gummy Shark is managed by the Commonwealth. Recent figures specific to the area are not available for this report. During the mid-late 1990s, yields in the low dozens of tonnes were recorded from waters south and south-west of Cape Jaffa. Additional catches recorded from Commonwealth waters only are not available for this report. The Commonwealth has recently re-regulated the fishery for School Shark and Gummy Shark in southern Australia, particularly in light of declining School Shark populations in south-eastern Australia (see Section 9.2, and references by AFMA in bibliography). Sweeney (1996b) reported that there is a well established shark fishing fleet in the **Robe** area, that moor in Lake Butler.

Ocean Leatherjacket: No recent figures specific to the upper South-East are available for this report, however a State-wide overview is provided in section 9.2. The species is also taken (in large quantities) in Commonwealth-managed waters;

various *Wrasse* species (such as *Blue-Throated*): At a State level, total catches of wrasse (such as Blue-throated Wrasse and Senator Wrasse, and other wrasse species) have increased from 9 tonnes in 1991/92 to a peak of 47 tonnes in 1998/99. A total of 20 tonnes was taken in South Australian waters in 2000/2001 (Knight *et al.* 2002). The proportion of recent catches that is specific to the upper South-East is not available for this report, however during the mid-late 1990s, yields in the order of 1.6t – 5t per annum were recorded from the area.

Snapper: the South-East of S.A. is a minor fishing region for Snapper, on a State-wide scale, with commercial fishing areas such as the South-East collectively contributing less than 2% of the total State-wide catch per annum (e.g. see McGlennon and Jones 1997, 1999; Fowler 2000; 2002). Catches in the area south and

south-west of Cape Jaffa were in the order of 1t – 2t per annum during the mid-late 1990s.

Blue-Eye Trevalla: caught in both State and Commonwealth waters. Figures specific to the area are not available for this report, however, Knight et al (2002) reported State-wide catches. The Commonwealth-managed fishery took 40t from all South Australian waters in 1997-98. Aggregated catches within the South Australian Marine Scalefish Fishery ranged between approximately 82t in 1990, and around 14t in 1996/97 (Knight et al., 2000, Figure 7). During the mid-late 1990s, yields within the area south and south-west of Cape Jaffa were less than 2t per annum.

Other species caught commercially in the area include *Bearded Cod*, *Conger Eel*, *Blue Morwong* and *Jackass Morwong* (i.e. less than 2t per annum of each species recorded during the mid-late 1990s). Other mixed scalefish species and shark are also caught, in minor quantities.

Examples of the major commercial fish and shark species that are caught in State waters north, west and north-west of the Cape Jaffa area (and excluding those which are caught mainly in the Coorong area) include:

Gummy Shark and School Shark: Over the years, this region has been one of the major fishing areas for School Shark and Gummy Shark in South Australia, although the species are both caught commercially in a large number of fishing blocks on a State-wide scale. Recent figures specific to the area are not available for this report. During the mid-late 1990s, yields in the order of 110t per annum were recorded from waters north, west and north-west of Cape Jaffa. Additional catches recorded from Commonwealth waters only are not available for this report. The Commonwealth has recently re-regulated the fishery for School Shark and Gummy Shark in southern Australia, particularly in light of declining School Shark populations in south-eastern Australia (see Section 9.2, and references by AFMA in bibliography);

Bronze Whaler; Recent figures are not available, however during the mid-late 1990s, yields of around 3t – 5t per annum were taken from this area.

Saw Sharks; Recent figures are not available, however during the mid-late 1990s, yields of between 1t – 3t per annum were taken from this area.

Shark species (unspecified), caught in the low tonnes (e.g. mid-late 1990s);

Jackass Morwong: caught in the low tonnes (e.g. mid-late 1990s);

Snapper: the South-East is a minor fishing area for Snapper on a State-wide scale (see above) with catches of less than 3t taken per annum from the area during the mid-late 1990s;

Ocean Leatherjacket: catches in the order of 0.5t – 3t per annum were taken from the area during the mid-late 1990s. See section 9.2 for information about the fishery on a State-wide scale.

Australian Salmon: catches of less than 2t per annum were taken during the mid-late 1990s from this area. The South-East is a minor commercial fishing area for salmon on a State-wide scale (e.g. see Jones, 1999, and Knight et al., 2002)

Commonwealth-managed trawl fisheries in deeper Commonwealth waters (300m - 1200m) include those targeting *Orange Roughy*, *Blue Grenadier*, and *Gemfish*, amongst other species in the South East Trawl fishery. The Commonwealth-managed dropline and bottom longline fishery (now called the Gillnet, Hook and Trap fishery component of the SESSF – see AFMA, 2003a) operates in deeper waters in part of the upper South-East, such as the waters west of Robe.

Dropline fishing in deeper (including shelf-edge waters) of the South East (100m - 900m) yields species such as Blue-eyed Trevalla and Hapuku (Jones, SARDI, pers. comm., 1996, cited by Edyvane et al., 1996). Blue-eyed Trevalla catch from South Australia was around 80t in 1997 (AFMA, 2001a). Figure 15 in Butler et al., 2002, shows an example of fishing effort during 1997 – 1999 by the Commonwealth dropline and bottom longline fishery along the deeper waters of the upper South-East in South Australia. The gillnet component of the Commonwealth fishery is considered intensive in some parts of the upper South-East (see Figure 16 in Butler et al., 2002, for example of fishing effort during 1997 – 1999 by the Commonwealth gillnet fishery along the upper South-East coastal and offshore waters). Butler et al. (2002) listed the major species from the gillnet fishery in South Eastern Australian waters, being School Shark and Gummy Shark, Whiskery Shark, Saw Shark, Elephant Fish, and Hapuku. Other species caught in the Commonwealth-managed fisheries of the South-East include Pink Ling, Blue Warehou and Spotted Warehou, Silver Trevally, Jackass

Morwong, Ocean Perch (N.B. *fully fished*, with some concern about the discard quantities), species of Flathead, and several others (see AFMA, 2001 and 2003a; AFFA, 2004).

The region borders GARFIS fishing Blocks 51 and 55. Recent aggregated catch figures are not available for this area, for this report. Previously, according to SARDI (cited by Edyvane, 1999b), the catch from GARFIS block 51 (approx. 37° S, near south of Cape Jaffa area, north to 36° S at the mid Coorong, and westwards to 139° E) was as follows:

- ♦ In 1995/96 a total of 129,998kg (1.25% of State total, representing 24 fishers);
- ♦ In 1996/97 a total of 142,979 (1.41% of State total, representing 24 fishers).

Note that these statistics also include marine waters off the southern Coorong, and the proportion of the catch that relates only to the Lacepede Bay area is not available. According to SARDI (cited by Edyvane 1999b), the catch from GARFIS Block 55 (approx. 37° S south of Cape Jaffa, south to Beachport, and including waters south-west of Beachport to 38° S) was as follows:

- ♦ In 1995/96 a total of 92,391 kg (0.89% of State total, representing 48 fishers);
- ♦ In 1996/97 a total of 56, 071 kg (0.55% of State total, representing 37 fishers).

Aggregated catch figures for all fishing blocks in South Australia, from 1995 – 1997, showed that GARFIS Fishing Block 51 was ranked 21st in 1995/96, and 19th in 1996/97, in terms of annual yield (kg) of scalefish and sharks from 58 fishing blocks in South Australia. during that period, Block 55 was ranked 24th in 1995/96, and 34th in 1996/97.

Rock Lobster

Lobsters are caught, mostly on reef substrate, from the shore to the edge of the continental shelf, over most of the South East. **Lacepede Bay** is the base for about 40 lobster boats which land their catches at the **Cape Jaffa** jetty, south of **Kingston** (SARLAC, 1999). **Cape Jaffa-Kingston** area has been recorded as having the third largest concentration of lobster fishing boats in the South East (20% of the total number in the Southern Zone) (Edyvane, 1999b). **Robe** and **Nora Creina** are the ports for approximately one third of the lobster boats in the Southern Zone (G.K. Jones pers. comm., 1996, cited by Edyvane *et al.*, 1996). There is a lobster fishing fleet of about 30 boats operating from the **Robe** area (SARLAC, 1999).

The northern part of the area discussed in this table borders Marine Fishing Area (MFA) 51 and 55. In the Southern Zone Rock Lobster fishery, the majority of the catch is taken in MFA 51, 55, 56 and 58. In 2002, 98% of the total catch came from these four fishing areas. Prior to 1983, catches were similar between MFAs 55 and 56 (see table below, on **Lower South East**) but since then the highest catches have been consistently recorded in MFA 55. Over the last 5+ years (to 2002) the catch for MFA 51 has been less than 100t per annum, considerably lower than the catch from MFAs 55, 56 and 58 (Ward *et al.*, 2002, Figure 2.5). The catch from MFA 55 during the past 6 years (to 2002) has been between approximately 600t to 660t per annum. The majority of fishing effort is expended in MFAs 55, 56 and 58. In MFA 55, effort in 2001 and 2002 amounted to around 300,000 pot lifts and 275,000 potlifts respectively, a decrease from previous decades, when more than 600,000 pot lifts per annum was recorded during the mid-late 1990s, and up to 905,000 potlifts was recorded during 1983 (see Ward *et al.*, 2002, Figure 2.5, and Ward *et al.*, 2003a). Catches (under quota) have been maintained in MFA 55 during that period of effort decline, perhaps indicating greater efficiency. Effort in MFA 51 has been less than 100, 000 pot lifts per annum since the mid 1990s, and less than 25,000 pot lifts in 2002 (see Ward *et al.*, 2002, Figure 2.5, and Ward *et al.*, 2003a).

Previously, Prescott *et al.* (1998) showed that between 1980 and 1997, the annual yield of lobster from Marine Fishing Area 55 ranged between 600t and 750t throughout that period, however nominal fishing effort decreased during the 1990s, compared with most years of the 1980s. Figures were not provided for Marine Fishing Area 51 (Prescott *et al.*, 1998, Figures 18 and 19).

Previously, in 1995/96 and 1996/97, 19 and 16 fishers operated in Fishing Area 51, catching approximately 94.4t and 91.9t (approximately 1.8% of the total catch of Southern Rock Lobster in S.A. waters (SARDI data, cited by Edyvane, 1999b). The proportion of the catch relating to the southern part of zone 51 (i.e. Lacepede Bay and Cape Jaffa) is not available for this report. The Guichen Bay - Baudin Rocks - Cape Dombey - Little Dip - Nora Creina area is in the northern part of fishing zone 55. In 1995/96 and 1996/97, 85 and 78 fishers operated in Fishing Area 55, catching 635.9t and 629.2t, (approximately 12.4% and 12.3% of the total catch of Rock Lobster in S.A. waters (SARDI data, cited by Edyvane, 1999b). Aggregated catch figures for all fishing blocks in South Australia, during 1995-1996, showed that in terms of annual yield (and hence value) of Rock Lobster, Fishing Block 55 (from northern Wright Bay, south to around Beachport, and extending seawards into Commonwealth waters) was ranked 1st in South Australia, and Fishing Zone 51 (see above) was ranked 9th at that time.

Bycatch of Rock Lobster fishing in the South-East includes Octopus, Giant Crabs, leatherjacket species (particularly Ocean Leatherjacket), with lesser quantities of wrasse (including Blue-Throated Wrasse, Western Blue Groper, and other wrasse species), Conger Eel, Slimy Cod, Barber Perch, cuttlefish, and various other fish and shark species (Prescott *et al.*, 1998; Prescott, 2001). The catch of octopus in the 1999 season, over the entire Southern Zone fishery, was 37, 639 octopus. Also, 2162 Giant Crabs were caught in the Southern Zone over that period (Prescott, 2001).

Abalone

No figures specific to the areas discussed in this table are available, but aggregated figures for the following areas are provided:

Cape Jaffa region (Map Codes 33A, 33B and 33C): Between 1990 and 1996, only one year of catch data is reported for greenlip (approximately 280kg) (Shepherd, pers. comm., 2000). For Map Codes 33A, 33B and 33C there is very little available information on the Blacklip catch. The gross catch over a 19 year period (1979/80 to 1996/7) was 88 kg blacklip and 925 kg Greenlip, and the area was fished in only 4 of those years. There are no data available for this area since 1997/98 (S. Shepherd, pers. comm., 2003).

The major fishing area for Blacklip Abalone is south of the area described in this table. Aggregated blacklip yield figures for the Cape Jaffa to Cape Banks region (33A-C, 34A-D, 35A-E, 36A-C, 37A-H, 38B-H) during 1994/95 and 1995/96 represent 51.9% and 36.9% of the southern zone blacklip catch, or 15.09% and 11.38% of the State blacklip total yield (SARDI, cited by Edyvane, 1999). Note that these aggregated figures apply to a considerably larger area in addition to the region described, which is a minor component of the catch (see previous paragraph).

Robe region (Map Codes 34A, 34B and 34C and 34D), which extends south to Little Dip: Between 1990 and 1996, reported Greenlip Abalone yield ranged from 0kg to approximately 60kg; blacklip yield ranged between 0kg and approximately 1t (Shepherd, pers. comm. 2000). Since 1979, the highest reported yields from this region occurred during the mid to late 1980's during "fish-downs", when the legal size limit was lowered (S. Shepherd pers. comm., 2002), and yields between 1.5 to 3 tonnes per annum of Blacklip Abalone were taken, with more than 5t taken in 1985/86. Yields since 1990 have mainly been less than 1 tonne per annum.

Regionally, aggregated blacklip yield figures for the Cape Jaffa to Cape Banks region (33A-C, 34A-D, 35A-E, 36A-C, 37A-H, 38B-H) during 1994/95 and 1995/96 represented 51.9% and 36.9% of the southern zone blacklip catch, or 15.09% and 11.38% of the State Blacklip total yield (SARDI, cited by Edyvane, 1999b). Note that these aggregated figures apply to a considerably larger area in addition to the region being described, and include reefs north and south of that area. The proportion of this catch that is specific to the region described cannot readily be determined for this report.

Mayfield *et al.* (2001) reported that in the Kingston to Robe area (Fishing Blocks 33 and 34), catch per unit effort has been high (i.e. more than 80kg / hour) during the period 1996 – 2000.

Recreational Fishing

Beach, jetty and boat angling occur in the area (e.g. **Kingston, the Granites, "Grassey's" and Cape Jaffa**), and major species targeted include King George Whiting, Sand Flathead, Yellow-eye Mullet, Sea Garfish, Australian Salmon, Snapper, Mulloway, Snook, Tommy Ruff, Trevally, Toothbrush Leatherjacket, Silver Drummer and Southern Calamari (SARDI data, cited by Edyvane *et al.*, 1996). Sweeney (1996b) reported that mullet, Tommy Ruff, "salmon trout" (young Australian Salmon) and Sea Garfish are the common species that can be taken at the **Kingston and Cape Jaffa** jetties, and that boat fishers can troll for Snook (which are seasonally plentiful) along the weed edges out from **Wyomi Beach**. Further offshore, boat fishers target Snapper, "notoriously" large Whiting, Trevally and Australian Salmon, from offshore reefs such as **North Reef and Margaret Brock Reef** (Sweeney, 1996b). Large Southern Sea Garfish and Whiting are a feature for recreational fishers in the **Kingston** area. Hodder *et al.* (1980) noted the prevalence of Garfish fishing in the seagrass beds of Lacedpede Bay. Regional tourism promotion materials also list the waters around **Margaret Brock Reef** as a place for "excellent fishing" by boat. "Rock cod" species and sharks are also taken by recreational fishers in the Kingston / Cape Jaffa area, according to various recreational fishers' reports. There are recreational fishing charters from **Cape Jaffa**. There is an annual surf fishing competition at **Kingston**, which draws recreational fishers from both S.A. and Victoria. Angling and sports fishing / game fishing clubs from Victoria visit the area between **Cape Jaffa and Robe** (Master Plan *et al.*, 1999).

The Granites area (Lacepede Bay) is listed as one of the top 20 shore fishing locations in S.A. for recreational anglers, based upon survey of long term recreational fishers and fishing experts (Capel, 1994). The Granites is also promoted by tourism authorities as an important place for recreational fishers to congregate. Kingston is a popular area for fishing for Garfish, more than one species of Whiting, Australian Salmon and Tommy Ruff. Sharks are also targeted by some recreational fishers in the area.

Robe provides the only sheltered harbour for recreational fishing boats between the Murray Mouth and the Victorian border (Planning S.A., 2003b). There are fishing charter trips for inshore and deep water fishing, and tuna fishing, out from **Robe** (Tourism S.A., 2002). Australian Salmon, mullet, Snapper and Sea Sweep are caught from rocks in the **Robe** area. Mulloway, Australian Salmon, rays, flathead species, Snapper, small sharks and King George Whiting are caught from beach locations at Robe. Mulloway, mullet, salmon "trout", whiting, flathead species, and Black Bream are taken from the harbour at Robe (SARLAC, 1999; South East On-Line, 2000). Sweeney (1996b) described Robe as a "must-try destination" for any visiting angler. In the lake itself, mullet is described as providing "plenty of activity for young anglers", and "salmon trout" (young Australian Salmon) and schools of small Mulloway are also found at the entrance (Sweeney, 1996b). At **Long Beach**, Mulloway and "salmon trout" are popular for beach fishers, and **Back Beach** is fished for Mulloway at night.

A summary of fishing activities in the reef areas of the upper South-East (e.g. **Lacepede Bay, Cape Jaffa, Cape Dombey, Little Dip, Nora Creina**) includes line fishing, dab netting (e.g. **Lacepede Bay**) lobster potting, spearfishing (e.g. **Cape Jaffa**, and other areas), dive-fishing for lobster and abalone, and bait-digging (e.g. beaches in **Lacepede Bay**, such as **Long Beach, Wyomi Beach, and Pink's Beach** (Bryars, 2003). Line fishers also fish from boats in the bays, over the seagrass (e.g. **Guichen Bay, Nora Creina**), and subtidal sand areas. Surf fishers fish from the shore near surf beaches in the area (e.g. between **Cape Lannes** and **Long Gully**, including **Back Beach**; and **Stinky Beach**, near **Nora Creina**) (Bryars, 2003).

Scale-fishing for multi-species occurs from jetties, breakwaters, boats, beach and rocks in the region that includes **Guichen Bay** (i.e. **Robe**), **Baudin Rocks, Cape Dombey, Little Dip, and Nora Creina**. Major species targeted in the area include King George (e.g. in **Guichen Bay**) and other whiting species, Black Bream, Sand Flathead, Yellow-eye Mullet, Australian Salmon (e.g. **Little Dip**, and smaller "salmon trout" from the rocks at **Cape Dombey**, and in **Guichen Bay**), Snapper, Mulloway (**Robe** and **Little Dip**), Sweep (particularly from rocks at **Cape Dombey**), Sea Garfish (**Guichen Bay** and **Nora Creina**), Trevally (e.g. **Guichen Bay**), Toothbrush and Ocean Leatherjackets (SARDI data by McGlennon and Kinloch, 1996, cited by Edyvane *et al.*, 1996; Sweeney, 1996b). There are boat launching areas at **Robe, Little Dip** and **Nora Creina**.

The jetty at **Robe** is used for fishing Trevally, Mullet and Garfish, and large Black Bream are taken in **Lake Battye**, and **South Reef** is also a popular recreational fishing area with local anglers (Sweeney 1996b). Boat fishers launching out from Robe to the **Baudin Rocks**, catch Snapper, shark species, Sweep, Australian Salmon and large Whiting (Sweeney, 1996b). According to SANPWS (1992), recreational fishing is a popular activity from the coast of **Little Dip Conservation Park**. Beach fishing for Australian Salmon, Mulloway, Ray species, Flathead, Snapper, and King George Whiting, is considered popular along the surf beaches in the park. Rock fishing for Australian Salmon, Mullet, Snapper, and Sweep occurs at several places, including **Stony Rise** and **Little Dip** (DEHAA, 1998; NPWSA, undated f).

Nora Creina Bay is fished from the shore or from small boats, and is considered well known for Australian Salmon, including large specimens in the 2kg – 4kg range (Sweeney, 1996b).

Rock Lobster are also taken by recreational SCUBA divers in the upper South-East, and also by other recreational fishers using pots and drop nets. Recreational fishing for Rock Lobster is considered to be one of the "key recreational fisheries" in the region (Master Plan *et al.*, 2000). McGlennon (1999, cited by Prescott and Xiao, 2001) reported that approximately 40t of Rock Lobster was taken by the recreational sector in the entire Southern Zone, during the 1998 season. This is less than 2% of the commercial catch in total, however in waters less than 15m, the recreational catch is estimated to 25% of the commercial pot catch at the same depths (i.e. most commercial fishers operate in deeper waters). Examples of locations where Rock Lobster are taken by recreational fishers, include **Robe** and **Cape Jaffa**. Diving for lobsters occurs mainly during January and February, but many divers do not catch the bag limit (compared with pot and drop net fishers) (Tyrer, 1994). Pots are used by recreational lobster fishers throughout the year, with peak effort during the major holiday periods. Most recreational fishing for lobster by tourists occurs in close proximity to ports (Tyrer, 1994) (e.g. **Robe** would be one example for the region described in this table). According to Tyrer (PIRSA, 1994), **Nora Creina** is one of the areas in S.A. where recreational Rock Lobster fishing effort exceeds commercial effort. The importance of recreational fishing (diving) for Rock Lobster and abalone in the **Kingston** area is not known for this report.

Recreational fishers also take abalone in the upper South-East. No figures specific to the area described here are available for the recreational take of abalone, however Mayfield *et al.* (2002) reported that in the entire Southern Zone, a recent recreational survey showed that the total catch amounted to approximately 1.61 tonnes per year, representing around 1.07% of the commercial catch.

Diving

Divers visit the parallel and patch reefs and “bommies” at **Cape Jaffa, Margaret Brock Reef, The Pinnacles, North Reef**, and other reefs. These sites have been listed in DIASA’s guide to the best dive sites in S.A., and **Margaret Brock Reef** is promoted in regional tourism guides. **Margaret Brock Reef** and the **Kingston jetty** were also listed in Christopher’s (1988) Divers Guide to South Australia. Shore diving out from **Cape Jaffa**, particularly for collecting rock lobster, is also promoted by Dive South Australia (web site and brochure, 2004). **The Pinnacles**, the line of reefs extending out to **Margaret Brock Reef** have also been promoted in more recent dive guides (e.g. Aquanaut, undated; Dive-Oz, 1998-2003). Aquanaut (undated) described the **Pinnacles / Margaret Brock Reef** area as follows: “Though largely unexplored by sport divers, there is fine diving here with excellent marine life”. The Dive Oz (1998-2003) diving guide promoted the reef (including the numerous ledges) all around the former lighthouse on **Margaret Brock Reef** for diving, but stated that most divers who visit the site go there to catch Rock Lobster (outside of the closed area). The dive under the lighthouse site is described as “absolutely sensational” (Dive Oz, 1998-2003). Diving off Cape Jaffa has been described (in dive guides) as “spectacular”.

Reefs south of **Cape Dombey**, reefs just offshore from **Robe, Godfrey Islands** and “**The Black Pigs**” (in **Guichen Bay**) and both headland sites and reefs offshore from **Little Dip Conservation Park** are recognised dive sites (Christopher, 1988; DIASA, undated). Shore diving in the **Robe** area, particularly for collecting rock lobster, is also promoted by Dive South Australia (web site and brochure, 2004).

Aquanaut (undated) described diving between **Cape Jaffa** and Port MacDonnell as follows: “Interesting diving off some of the headlands along this 200km stretch, but it is not frequented by too many divers”.

There are diving facilities at **Robe**, and charter boat trips for diving and snorkelling. Local shore diving has been described by one diving guide to SA as “interesting, but does not attract many visiting divers” (Aquanaut, undated). **Nora Creina** is also promoted for divers as being “worth a visit, and a boat is ideal although shore diving is possible in good conditions” (Aquanaut, undated).

The numerous reef ledges and patches in **Stinky Bay** are promoted in the Dive Oz (1998-2003) dive site directory for S.A.

Recreational diving also visit the area to take Southern Rock lobster (see section on **Recreational Fishing**).

Other Recreation/Tourism

Kingston is described as a popular seaside town by tourism promoters, and, according to regional tourism materials, fishing is a major part of the tourism industry in the area. Tourism activities that are promoted in the area include fishing, walking along the Kingston and Cape Jaffa jetties and the beaches; fishing at The Granites; swimming and boating in **Lacepede Bay**, swimming at Wyomi and Pinks Beaches; scuba diving, windsurfing, and sailing, from the beach in front of Lacepede Bay Sailing Club.

Cape Jaffa has been described as a small community that is “centred on fishing and holiday-making” (South East On-Line, 2000). There are holiday shack developments in the part of the area. Fishing from the beach, jetty or by boat, is recognised as a recreation / tourism feature of the area (see section above on **Recreational Fishing**), and other activities that are promoted include “*walking the deserted beaches, with the opportunity to see whales in season, pods of dolphins, and seals that land on the beaches to recuperate after long sea voyages*” (Limestone Coast Tourism, 2002). The view of the Margaret Brock Reef platform has been described as a popular attraction for charter boat tours (Sneath, 2003). There is a nearshore caravan park catering for visitors, and further recreational / tourism developments are planned for the town, as part of the proposed Cape Jaffa Anchorage marina (see Planning S.A., 2003b).

Robe is often described as one of South Australia’s “most popular seaside destinations”, in regional tourism promotion materials. Robe and surrounding areas are regionally important destinations for recreational fishing, surfing, windsurfing, sailing, and other aquatic activities (swimming, diving, and snorkelling). Four-

wheel driving on the beach is also promoted as a recreation / tourism activity. There are coastal walking trails at Robe, and walking and bird-watching along the clifftops is promoted as a recreational activity in the area, as is beach-walking (for the scenic views, abundant shells, “fossicking for flotsam and jetsam” etc). The annual surfing competition at **Robe** (Robe Easter Classic) is the State’s longest running surf contest, and began in 1968, according to regional tourism promotion materials. Surfing instruction is also available at **Robe**. Charter boat trips out from **Guichen Bay / Lake Butler Boat Harbour** also operate year-round, for fishing, diving (see sections above on **Recreational Fishing**, and **Diving**) and sight-seeing / sunset cruises etc. In recent years, trips on Rock Lobster fishing boats (during which tourists can learn how to catch rock lobsters) have become a tourism feature of the area. Southern **Guichen Bay**, at **Robe**, is considered to be of high value to the tourism industry, and for recreational use (Gilliland, 1996), such as fishing, boating/sailing, swimming, surfing, beach use etc. **Robe** is one of the two largest tourist destinations in the South East, and the beach at **Guichen Bay** is also one of the most intensively used in the South East. Robe is also promoted by tourism associations for the history and character of the town.

There are also some shacks at **Little Dip** beach. These shacks will eventually be removed, as they are subject to non-transferable life tenure leases (Australian Heritage Commission, undated). There are also other coastal sections of holiday shack development in the area.

Apart from fishing, the area between **Little Dip** and **Nora Creina** is a popular area for numerous recreational pursuits such as camping, walking around the coastal beaches and lakes, swimming, surfing (**Back Beach**, **Long Gully**, and **Little Dip** areas, and **Stinky Beach**) and off-road vehicle driving (e.g. **Back Beach** area) (S.A. National Parks and Wildlife Service, 1992, cited by Australian Heritage Commission, undated; Bryars, 2003). Being close to the popular holiday destination of **Robe**, the **Little Dip Conservation Park** receives its peak visitor numbers during the summer holiday period.

Historic / Protected Shipwrecks

A *Southern Oceans Shipwrecks Trail* is currently (2000) under development by the Department for Environment and Heritage’s Maritime Heritage Section, to promote the cultural significance of the wrecks that occur in South East waters.

Margaret Brock, a 3-masted wooden barque built 1848, was wrecked 1852 on Margaret Brock Reef. It is positioned in 2-10m of water, in which the remains are broken and scattered over the reef. The hull is not visible. The ship is protected under the *Commonwealth Historic Shipwrecks Act 1976* (State Heritage Branch, DEP, undated).

Three other Commonwealth-protected wrecks are known to occur in the area. Wrecks believed to be located in the **Lacepede Bay** area include the following: *Maria*, was a small sailing vessel that was wrecked somewhere off the southern Coorong in 1840, and all passengers and crew were killed while on a trek back to Encounter Bay; *Victoria* (1846); *Agnes* (1876); and *Kingston* (1880), amongst others (Maritime Heritage Section of DEH, 2000).

The following 3 wrecks in southern **Guichen Bay** are protected under the S.A. *Historic Shipwrecks Act 1981*:

- ♦ *Duilius*, (wood barque, built 1840, wrecked 1853);
- ♦ *Livingstone* (wood ship, built 1857, wrecked 1861);
- ♦ *Alma* (wood ship, built 1855, wrecked 1861).

The following 5 wrecks in southern **Guichen Bay** are protected under the Commonwealth *Historic Shipwrecks Act 1976*:

- ♦ *Phaeton*, wooden ship built 1855, wrecked 1857 (the Phaeton was an American sailing vessel that was lost while bringing Chinese immigrants into Robe) (S.A. Maritime Heritage Section, DEH, 2000);
- ♦ *Willem Koning II*, wooden ship wrecked 1857;
- ♦ *Joseph Lee Archer*, wood cutter, built 1848, wrecked 1855;
- ♦ *Thompson*, wood cutter, built 1837, wrecked 1849.
- ♦ *Sultana*, wood barque, built 1849, wrecked 1857 at Cape Dombey.

Other European Heritage

Cape Jaffa Lighthouse, included here due to its maritime association, has been re-erected by the National Trust on the foreshore at Kingston (after being removed from Margaret Brock Reef), and is listed on the *Register of the National Estate* due to its Heritage significance. The building is considered significant as a rare example of a lighthouse tower of steel-framed construction, and important as an example of an original reef

lightstation. Cape Jaffa Lighthouse, originally constructed in 1868-72, is significant as the first lighthouse in Australia to be brought ashore from a position at sea and re-erected on land (Criterion B.2). The Cape Jaffa Lighthouse is significant for its association with South Australia's maritime history and its importance as a navigational aid along the coastal shipping routes in the area (Australian Heritage Commission, undated). The Cape Jaffa Lighthouse operated until 1973, and was one of the few lighthouses in Australia in which keepers lived inside the lighthouse (Robinson *et al.*, 1996).

The **Cape Dombey** Obelisk is listed on the *Register of the National Estate*, and is still used by local mariners as a landmark and a guide for ships, since it can be seen for up to 12 miles from sea. Rockets were previously fired from the Obelisk to guide distressed ships into shore (Limestone Coast Tourism, 2002).

There is a lighthouse museum at **Kingston** (Lighthouse Computer Training & Development, 1998; Lighthouses of Australia Inc., 2002).

The lighthouse platform at **Margaret Brock Reef**, a cast iron platform dating from the early 1870s, is part of a now disused aid to navigation owned by the Commonwealth and managed by the Australian Maritime Safety Authority (AMSA). For 104 years, the cast-iron screw pile platform was home to the Cape Jaffa lighthouse. When the lighthouse was replaced by a solar beacon on the mainland, the platform remained, serving as a navigational aid for fishers, so that they may avoid Margaret Brock Reef. The platform was due for demolition in 2003, with salvageable historic material, including decorative wrought iron brackets and an access ladder, to be donated to a museum in Kingston (ABC Media reports, January, 2003; Sneath, 2003) (see section in this table on **Issues for Risk and Impact Assessment**).

There is an historic jetty at **Kingston**, built during the 1870s. The jetty has been wrecked and rebuilt a number of times, but is still functional, and has been used for a number of purposes (fishing, transporting fish to factories etc).

Apart from the heritage value of shipwrecks (see above), the town of **Robe** is listed on the *Register of the National Estate* due to its historic significance. Notes adapted from FRR (2003): Guichen Bay was sighted and named by Nicolas Baudin in 1802. Robe was regularly visited by whalers, sealers and sailors before the town was officially proclaimed and named in 1847, after Major Frederick Holt Robe, Governor of South Australia, who had selected the site in 1846. Many of the buildings in Robe from the mid 1800s are built of local limestone, and still exist today. After proclamation, wool and wheat were the main industries, and for many years, almost all exports from the South East left Robe from one of its jetties. The port was busy during the mid 1800s, and for several years Customs revenue collected at Robe were only second to those at Port Adelaide. The town grew quickly and many Irish and Scottish immigrants arrived in 1855. They were followed two years later by large numbers of Chinese men (approximately 17,000) on their way to the Victorian gold diggings. During 1857, thirty-two British, American and Dutch ships all landed the Chinese, who often had to pay the locals exorbitant fees to ferry them from the ship to shore and guide them to the Victorian border. Not all had a safe arrival, and many hundreds had to swim for their lives. When the brand new 1032 ton American-built, English-owned ship *Pheaton*, with 250 Chinese aboard, arrived on 1 February 1857, she was wrecked, fortunately without the loss of anyone. Three months later, on 27 April, the wooden hulled, 588 ton British ship *Sultana*, was lost in bad weather, but all crew and passengers were saved. The third ship to come to grief was the 800 ton Dutch ship *Koning Willem II* which tried to land 397 Chinese on 15 June. When all were landed safely the ship was smashed up two weeks later in a gale, and fifteen crew members were lost. During this busy and expansive time, ship-owners frantically sought cargo for their empty ship on the home run. Robe supplied horses for the Indian Army and wool, tallow and sheepskins for Europe. During the ten years from 1856 more than \$2 million of wool was shipped from Robe. But when the price of wheat began to fall it was uneconomical for farmers from as far away as Mount Gambier to transport it all the way to Robe. They instead carted it to the new harbour at Port MacDonnell. Other ports which took trade away later were at Beachport, and Kingston. After the 1870s a general decline set in, as Robe missed out on both railway and sea transport. Robe became an isolated town by the mid 1880s, however it had enough local and surrounding industries and trade, such as farming and fishing, to survive into the next century (FRR, 2003).

Nora Creina has been used as a fishing shack settlement, since the 19th century. For example, there are archival photos, such as the one taken in 1900 by the photographer Henry Tilbrook, of a fishing shack from the in the late 1800s, made of palings, roof thatching, and stones.

Aboriginal Heritage

There were 3 main groups along the South East Coast: the *Tanganekald* or *Tangani*; the *Meintangk*; and the

Boandik or *Bunganditj*. Each group consisted of many clans, with their own dialects, and traditionally owned and controlled individual estates of land, with reciprocal responsibilities to other clan's estates (Tindale, 1974, cited by Master Plan *et al.*, 2000). The *Meintangk* was made up of at least 7 clans, and controlled the country around **Lacepede Bay**, from around 20km north of **Kingston**, to **Cape Jaffa**, and inland to Lucindale and Naracoorte. The Boandik controlled the coastal area from Glenelg River to south of **Cape Jaffa**, and inland to east of the Victorian border.

Many indigenous sites along the South-East are considered to be invaluable records of activity and events that took place over 10 000 years, and the region is considered to be of "vast cultural significance" as well as scientific value. The sites represent for indigenous communities tangible evidence of the close spiritual connectedness that they and their ancestors have with the landscape. The relationship is reflected in the Dreaming stories of the region, which are manifested in the physical landscape (Master Plan *et al.*, 2000).

UEPG (1982) reported that a large number of Aboriginal archaeological sites exist along the coastline, "the most common type of site being the shell midden, many of which are of great significance from an archaeological and scientific perspective". The report also stated that "as a group, the Aboriginal sites of the South East coast have been claimed by researchers to be of national, if not international, importance.

Midden sites in the South East provide valuable information about ethnography. Information about the economy, technology and social structure of the indigenous groups that used the coastline, can be obtained by studying midden content, size and distribution (UEPG, 1982, cited by Master Plan *et al.*, 2000). The contents and stratigraphy of midden sites also provides evidence of the evolution of the coastal environment over thousands of years. For example, Goolwa cockle *Donax (Plebidonax) deltoides* middens may indicate smooth sandy beach environment; and other shell types in the region indicate rocky shores and reefs; and the presence of mud-dwelling bivalves indicates (former) lagoonal, sheltered estuarine environments (Master Plan *et al.*, 2000).

Other important sites include hearths (physical remains of ovens), rock shelters, burial sites, and stone artefact manufacturing sites, containing cores, flakes, scrapers, blades, tula slugs, points, hammer stones and grinding stones. Many of the finished articles were removed from the sites when completed, and used for trading (Renfrew and Bahn, 1991, cited by Master Plan *et al.*, 2000). Most tools along the South-East coast are flint, but chert, silcrete and quartz artefacts are also present.

Pteroglyph (carved) rock art has been recorded at some sites in the South East. In general, rock art provides valuable pictorial records of past indigenous activity, such as ceremonies, Dreaming stories and significant events (Master Plan *et al.*, 2000).

There are two sites at **Robe** which are listed as Indicative Places (i.e. being considered for listing) on the *Register of the National Estate*, due to their Aboriginal Heritage significance. **Lakes Robe, Eliza and St Clair** are considered to be rich in Aboriginal Heritage, with many occupation sites such as middens, rock shelters and open air campsites at the lake margins (S.A. Lands Department, 1991, unlisted reference cited by Edyvane, 1999b).

According to DEHAA (1998), "large numbers" of Aborigines lived in the **Little Dip** area from at least 10,000 years BP, and local seafood was a major part of their diet, as indicated by the various shell middens in the area.

There are rock shelters containing substantial amounts of food remains from beach, estuarine and terrestrial environments. These are particularly evident in the **Robe** and Canunda Ranges area (UEPG, 1982, cited by Master Plan *et al.*, 2000).

There are many small midden deposits on the beach ridge plains of **Guichen** and Rivoli Bays, with most middens consisting of estuarine molluscs, but some containing species from exposed conditions. Midden material around the coastal areas of **Robe** and Canunda consists mainly of modern molluscs (*Turbo*), and other seafood remains; charcoal; and flint tools. A number of midden sites also contain bottle glass, indicating that the sites were used well into the 19th century. The oldest midden sites are around 1160 BP. There are also isolated deposits crowning the dune sheets along the shoreline of the Robe Range, which have been dated between 1500 and 6000, and, in deflation zones, midden materials consisting of gastropods, flint flakes, cores and scrapers (UEPG, 1982, cited by Master Plan *et al.*, 2000). Flake tool deposits in the **Robe** and Canunda regions have been dated at 8700 BP (UEPG, 1982, cited by Master Plan *et al.*, 2000).

Baudin Rocks were significant for the Baundik people, who had a legend (in song form) that relates to that area

(Robinson *et al.*, 1996).

Nora Creina Historic Reserve, which abuts the coast at Nora Creina, is listed as an Aboriginal heritage item on the *Register of the National Estate* (Australian Heritage Commission, undated).

Scientific Research and Education

The **Kingston** and **Cape Jaffa** areas, including **Margaret Brock Reef** (the latter particularly during the 1970s) have been used for Rock Lobster population dynamics research. Abalone and Rock Lobster population monitoring occur irregularly in the region between **Lacedpede Bay** and **Nora Creina**. A long term program of Rock Lobster larval settlement monitoring occurs at **Kingston** and **Cape Jaffa** (Prescott *et al.*, 1998). A survey of juvenile Rock Lobster was undertaken at **Margaret Brock Reef** in 1999 (see Frusher *et al.*, 2000). Details of research on abalone and Rock Lobster respectively in the upper South-East area can be found in Mayfield *et al.*, 2002; and various references on Rock Lobster by Prescott and others, in the bibliography of this report.

The **Kingston** Community School has been involved in recent years, in coastal marine biology and maritime programs, Coastcare issues, and water monitoring. The coastal environment is a focus of education at this school (Master Plan *et al.*, 1999).

The **Cape Jaffa - Robe** area is the northern end of the Bonney Upwelling, in which blue whale research is conducted (see references by Gill and others, in Butler *et al.*, 2002)

Butler *et al.* (2002) considered the high productivity, species diversity, and endemism of the area to be of value for scientific research and education.

There has been a long term study and mapping project of the **Robe** Area beach levels, and sea bed stability analysis, which commenced in 1992. The work is undertaken by DEH and Planning SA (DTUPA), to monitor the excessive movements of sand, so that suitable protection methods for the coastal area around Robe can be determined.

National Parks and Wildlife SA at **Robe** monitors strandings of oceanic migratory birds, and also local bird populations (e.g. pied Oystercatchers). Also, bird watching groups from South Australia (e.g. associated with Birds SA) and Victoria (e.g. Victorian Wader Study Group – see Master Plan *et al.*, 1999) regularly record and band wading birds, and record oceanic migrant bird species in the Upper South-East. The work of these ornithology groups has been important for documenting distribution and relative abundance of many bird species in the area.

Universities undertaken education field trips to the **Cape Lannes** and **Nora Creina** areas (Bryars, 2003).

Previously (e.g. 1970s and 1980s), the region (**Guichen Bay - Cape Dombey - Little Dip - Nora Creina** area) was of scientific and educational importance for macroalgal collecting, and for the University of Adelaide Marine Botany Summer School, run by HBS Womersley (Edyvane, 1999b).

Near the coast, **Lakes Robe** and **Eliza** are considered to be important as a tertiary teaching site in limnology and as a research site in the fields of limnology, sedimentology and palaeontology (Australian Heritage Commission, undated). Note that Lake Robe is not a marine feature, although it was created from the isolation of marine water.

During the early 2000s, the **Robe** Professional Fisherman's Association, in association with CoastCare, undertook a litter survey (collection, sorting, surveying, weighing, and identification), with the aim of reducing the levels of litter pollution impacting on the local marine environment (e.g. see Marsh, 2003).

Aesthetic Values

Robe is promoted in tourism promotion materials as a picturesque area (e.g. scenic view from the Beacon Hill Lookout), and there is a coastal walking trail, to promote the scenic aspects of the coastline. Tourism materials describe Robe as “picturesque”; “attractive”; combining “a dramatic rocky, windswept coastline” with a number of “attractive and secluded beaches, including the beautiful Long Beach” (e.g. Walkabout Travel, 2000; Limestone Coast web site, 2002). The Long Beach and Little Dip areas are both promoted for “rugged beauty”, “surf-washed sands”, “wild ocean beaches” and “wind-blown dunes” etc.

Kingston is described as a “scenic fishing port” (Limestone Coast tourism brochure, 2002), and the coast around Kingston is promoted for its “scenic drives”, including the routes to **Cape Jaffa** and also towards the **Granites**, a series of rock outcrops north of the town.

In the South-East in general, the “beauty of the coastal environment and the cleanliness of the sea” have been described, by the community, as assets worth promoting the area (Master Plan *et al.*, 1999).

Petroleum and Minerals Exploration

In 2000, there was an offshore petroleum exploration license that currently exists for the region between Cape Jaffa to Nora Creina. A number of exploration wells have been drilled in offshore areas in the region (Master Plan *et al.*, 2000). At that time, there was also a petroleum exploration area “under offer”, approximately 589 km², in State waters, between Wright Bay and Lake Bonney – see map). Further exploration is considered likely to be at a low level during the early 2000s (Master Plan *et al.* 2000).

There are existing and new acreage releases for exploration in the **upper South-East** (see Figure 18 in Butler *et al.*, 2002). Exploration wells over these lease sites exist in both State and Commonwealth waters off the upper South-East, such as the waters seaward of **Robe** (see Figure 18 in Butler *et al.*, 2002).

Numerous seismic surveys have been conducted in the upper South-East, including areas close to the coast (see Figure 19 in Butler *et al.*, 2002).

Other Uses

Beachwrack Harvesting

There are several commercial beach-cast macroalgae and seagrass wrack harvesters who operate on the foreshores of **Kingston** and Beachport. According to Master Plan *et al.* (2000), there is an increasing demand for approval to harvest beachwrack, including harvesting in areas not utilised to date. PIRSA (2003b) described the harvesting of beach wrack (i.e. beach-cast seagrass and marine macroalgae) in South Australia as a relatively small, but growing, industry. In the South East, wrack harvesting takes place on beaches around the shoreline of **Lacepede** and Rivoli Bays, mainly along the **Kingston** and Beachport foreshores. Each licence holder is provided with access to a specified area of foreshore (usually only a few kilometres), but within any area, harvesting generally takes place in a concentrated area (generally <1 kilometre) where the largest wrack accumulations occur (PIRSA, 2003b). Licence conditions (issued by PIRSA) specify methods of access and harvesting and any relevant restrictions on harvesting activities considered necessary by PIRSA. Harvesting is sporadic, being carried out opportunistically whenever significant quantities of wrack are deposited on the foreshore. The majority of harvesting takes place during winter and spring, when peak accumulations occur (PIRSA, 2003b). Beach-cast *seagrass* wracks are normally harvested using machinery such as bulldozers, front-end loaders and excavators. *Macroalgae* are collected by hand immediately after storms or periods of strong wind, from beaches adjacent to offshore limestone reefs. The harvesting of macroalgae is species-specific; that is, the target species is selected specifically for its unique chemical properties. Examples include the brown macroalgae *Ecklonia radiata* and *Durvillaea potatorum*, and species of the red *Gracilaria* (PIRSA, 2003b). (See **Issues for Risk and Impact Assessment**).

Ports, Harbours and Navigation

Kingston is defined under the *Harbours and Navigation Regulations 1994*, as follows: the subjacent land underlying, and the adjacent land extending from, the waters, rivers, creeks and inlets to high water mark within 100 metres seaward of any part of the Kingston Jetty.

The **Kingston** area has very significant levels of marine traffic, particularly in relation to leisure craft, recreational and commercial fishing vessels (PIRSA, 2004a).

Port facilities at **Kingston**, **Cape Jaffa** and **Robe** service the local fishing fleets (Planning S.A., 2003b).

There is a shipping lane for interstate and international traffic, along the coast, in deeper waters (see Figure 20 in Butler *et al.*, 2002).

Towns and Settlements

Kingston: Kingston was established as a port facility in the early development history of the South East. The town services the surrounding rural district, the fishing industry and highway users travelling to and from the South East region (Planning S.A., 2003c). Population during the early 2000s was approximately 1,486 (ABS statistic, 2001).

Cape Jaffa: Cape Jaffa is a small coastal township, with a population of less than 100, consisting mainly of shack owners and fishers (Planning S.A., 2003b). The population increases to around 250 in summer, due to visitors staying in local accommodation (Kingston District Council, pers. comm. to DEH, 2003). The township provides a base for the Rock Lobster fishing industry and provides limited storage and processing facilities. Aquaculture of Atlantic Salmon is a developing industry for the town and ten to twelve cages are currently located offshore (Planning S.A., 2003b).

Cape Jaffa and Lacepede Bay provide sheltered conditions for boats, due to the north facing coastline and protection from ocean swells by offshore reefs. There is a breakwater at **Cape Jaffa**. A marina facility has been proposed in the **Cape Jaffa** area. The proposal aims to develop a safe harbour for recreational boats and for the existing commercial lobster and emerging aquaculture industries. Infrastructure and commercial facilities are planned as part of the development, as well as tourist facilities. The marina basin and canals would be surrounded primarily by residential allotments. Additional allotments without marina frontage are also proposed (see Planning S.A., 2003b).

Robe: is described mainly in terms of being a tourist resort. The main industries in **Robe** are tourism, fishing (particularly for Southern Rock Lobster), agriculture and viticulture. In 2002, the population was reported to be around 1000 (based on an ABS census statistic of 965, in 2001), which increases to around 15,000 at the peak of the tourist season (Robe District Council, unpublished correspondence to Parliamentary Joint Committee on Corporations and Financial Services, 2002).

Boatswain Point: A small coastal settlement north of Guichen Bay.

Nora Creina: A small coastal settlement of shacks, south of Robe.

9.1.19 Lower South East (Otway Bioregion)

Aquaculture

No marine leases currently exist in the area between **Douglas Point** and the **Victorian border**. Previously, PIRSA (see Gilliland, 1996) provided for aquaculture development, in the area between **Middle Point / Blanche Bay** and **Cape Northumberland**, with exclusion zones including:

- ♦ 1km seaward of the **Piccaninnie Ponds** Conservation Park;
- ♦ 1km seaward of **Douglas Point** Conservation Park (but see information below in **Issues for Risk and Impact Assessment** section on recently approved on-shore abalone farm in the vicinity of **Douglas Point Conservation Park**); and
- ♦ 2km seaward of the area between **Middle Point** and the headland between **French Point** and **Stony Point**. The latter area was designated as an exclusion zone (where no development would be permitted) due to existing socio-economic values at **Port MacDonnell**; the threat of impact upon aquaculture from the Finger Point outfall; and the cultural significance of the *Tenderten* shipwreck site.

During the early 2000s, a land-based / on-shore aquaculture licence operating in the Hundred Of Carpenters Rocks region, has approval for farming Black Bream, Blacklip Abalone, Marron, Snapper and Yabbies. Another licence in the Hundred of Kongarong has Greenlip Abalone, Snapper and Southern Rock Lobster as approved species for culture (PIRSA Aquaculture Public Register, August 2003).

There are freshwater Trout farms in the **Ewens Ponds / Eight Mile Creek** area (Morelli and de Jong, 1995),

and at a number of other mariculture facilities producing Trout, Marron, Silver Perch, and/or Yabbies, occur in the area between **Port MacDonnell** and **Victorian border** (PIRSA Aquaculture Public Register, 2003).

Commercial Fishing

Rock Lobster Fishing

The lower South East area is of significant value to the Rock Lobster fishery (Gilliland, 1996). **Port MacDonnell** is the base for the largest lobster fishing fleet in southern Australia. Between 66 and 80 boats have operated out of Port MacDonnell in recent years, comprising South Australian Southern Zone Rock Lobster entitlements and Victorian Western Zone Rock Lobster entitlements (SARLAC, 1999; South-East regional promotional literature). **Port MacDonnell** is referred to as Australia's "Rock Lobster capital" in economic and tourism promotion materials, and there are commercial Rock Lobster processing facilities in the town. During the mid-1990's, approximately 30% of the Southern Zone Rock Lobster boats were located at Port MacDonnell and Blackfellows Caves.

The Victorian Parliamentary Inquiry into Fisheries Management (2002) reported that 20 lobster fishing boats from Victoria also operate out of **Port MacDonnell**, but that catches from these fishers cannot be monitored by the Victorian fisheries management authority, which does not have jurisdiction over any S.A. waters.

The area discussed in this report borders Marine Fishing Area (MFA) 56 and the northern part of MFA 58. In the Southern Zone Rock Lobster fishery, the majority of the catch is taken in MFA 51, 55, 56 and 58. In 2001, 98% of the total catch came from these four fishing areas. Prior to 1983, catches were similar between MFAs 55 and 56 but since then the highest catches have been consistently recorded in MFA 55. Over the last 6 years (to 2002) the catch for MFA 56 has been between approximately 520t and 580t per annum, and for MFA 58, has been between 400t to 450t per annum (Ward *et al.*, 2002, Figure 2.5, and Ward *et al.*, 2003a). The majority of fishing effort is expended in MFAs 55, 56 and 58. In MFAs 56 and 58 there has been a gradual decline in effort since the 1970's. Effort sharply declined in MFA 55, 56 and 58 over the last 6 years to 2002. Effort in 2001 amounted to around 300,000 pot lifts each for MFAs 56 and MFA 58, a decrease from around 400,000 pot lifts during the late 1990s (see Ward *et al.*, 2002, Figure 2.5). Catches (under quota) have been maintained in these two MFAs during that period of effort decline, perhaps indicating greater efficiency.

Previously, SARDI data for MFA 56 (which spans waters South of Beachport and west of Nene Valley, with the south-west border being the intersection of 38°S and 140°E) were summarised by Edyvane (1999b): During 1995/96 and 1996/97, 539,764 kg and 499,739kg of lobster was caught in MFA 56, representing approximately 9.8% and 10.5% of the state Rock Lobster catch, by 66 and 60 fishers respectively. In MFA 58 (East of Nene Valley, to Victorian Border): during 1995/96 and 1996/97, 387,950kg and 397,811 kg of lobster was caught, representing approximately 7.6% and 7.8% of the state Rock Lobster catch, by 55 and 53 fishers respectively. Aggregated catch figures for all fishing blocks in S.A., in 1995-1996, showed that Fishing Blocks 56 and 58 (see above) were ranked 2nd and 3rd respectively at that time, in South Australia, in terms of yield (and hence value) of rock lobster.

The bycatch in the South East includes Octopus and Giant Crabs (Prescott *et al.*, 1998) and Leatherjackets. The catch of octopus in the 1999 season, over the entire Southern Zone fishery, was 37, 639 Octopus, and 2162 Giant Crabs were caught in the Southern Zone over that period (Prescott, 2001).

Giant Crabs are also fished by Victorian-licensed fishers in deeper waters in western Victoria, with the Western Zone of that fishery reaching the S.A. border. The majority of vessels are used primarily for Rock Lobster fishing and Giant Crab is taken as a by-product of that fishery. However, a small number of vessels target Giant Crab specifically. In 2000/ 20001, most of the Giant Crab catch was taken by less than 10 operators. Fishers target Giant Crabs using modified Rock Lobster pots that are usually attached to long lines set at depths of 150-300m for 2-4 days (Victorian DPI, 2003). The Victorian DP produced a management plan for the fishery in 2003, which includes an overview of the catch and effort in this fishery.

Abalone Fishing

Quantitative information specific to the area described, is currently not available for this report, but aggregated figures are provided below, for the following areas (S. Shepherd, pers. comm., 2000):

- ♦ **Cape Douglas** area, north of Cape Northumberland: Between 1990 and 1996; blacklip yield ranged

between approximately 3.5t and 9t;

- ♦ **Port MacDonnell** area: Between 1990 and 1996 Blacklip Abalone yield ranged between approximately 12.5t and 28.5t. Reported Greenlip Abalone catch is negligible;
- ♦ **East of Port MacDonnell to Discovery Bay**: Between 1990 and 1996, reported Greenlip Abalone yield ranged between 0 kg and approximately 2.7t; Blacklip Abalone yield ranged between 0 kg and approximately 13t. Note that greenlip and Blacklip Abalone yields in this area are highly variable between years.

The lower South East area is of significant value to the Blacklip Abalone fishery (Gilliland, 1996). Abalone is listed as one of the commercial species of economic importance in the **Port MacDonnell** area (NOIE, 2002). Periodic managed “fish-downs” (in which harvesting of “stunted” animals under legal size is permitted as an addition to regular quota yields) occur in the Port MacDonnell area and other parts of the lower South-East (see Keesing and Baker, 1998, and Mayfield *et al.*, 2002).

Regionally, aggregated blacklip yield figures for the Cape Banks to Cape Northumberland area (fishing Areas 37J, 39A-G) during 1994/95 and 1995/96 represented 31.3% and 53.4% of the Southern Zone blacklip catch, or 9.10% and 16.47% of the State Blacklip total yield, for those years (SARDI data, cited by Edyvane, 1999b). Aggregated Blacklip Abalone yield figures for the area East of Cape Northumberland to Victorian border (40A,B,C,D) during 1994/95 and 1995/96 represent 16.5% and 9.8% of the Southern Zone Blacklip catch, or 4.79% and 3.01% of the State blacklip total yield, for those years (SARDI, cited by Edyvane, 1999b). Note that these figures include a larger region than the area described in this table. Both South Australian and Victorian Blacklip Abalone licence holders fish in the lower South East.

Recent catch figures are available only for the entire Southern Zone. Figure 7 in Mayfield *et al.* (2002) showed that the Blacklip catch in the entire Southern Zone has hovered around 145 tonnes per annum since the mid 1990s (taken mostly from Fishing Areas 36, 39 and 40), and that the total Greenlip catch has been around 6 tonnes or less since that time. Mayfield *et al.* (2002) reported that commercial fishing effort in Fishing Area 39 (= Cape Banks to Middle Point) averaged 77.4 fishing days per annum over the past 5 seasons, and that over 75% of the commercial fishing effort in the entire Southern Zone was concentrated in Fishing Areas 36, 39 and 40. Fishing Area 40 encompasses reefs west of Port MacDonnell, eastwards to Discovery Bay.

According to Mayfield *et al.* (2001), the Lower South-East is one of the fishing areas in the Southern Zone in which abalone fishing effort has exceeded an average of 30 trips per year, between 1988-1992, and between 1996-2000.

Scalefish, Sharks and Minor Invertebrates

Trolling for Australian Salmon occurs along most of the coast, from a depth of 10m to 20m. Snapper are caught all along the coast, mostly by hand lines operating at a depth of 10m to 20m. Gummy Shark and School Shark are mainly caught in waters over 20m. Ocean Leatherjackets are often as bycatch species in Rock Lobster pots (Jones, SARDI, pers. comm., cited by Edyvane *et al.*, 1996). Some Rock Lobster fishers “drop-line” for Blue-eye Trevalla and Ling, and catch sharks out of season using long-lines or nets, and some of these activities require a Commonwealth permit (Zacharin, 1997, cited by Prescott *et al.*, 1998). Target and non-target catches of more than a dozen Commonwealth-managed species (including Blue-eye Trevalla and Ling) by all sectors of the fishing industry have recently been re-regulated under the new *SESSF Strategic Assessment* report and management plan (see AFMA, 2003).

Regionally, the major commercial fish species that are caught by State-based fishing in the northern part of the area described in this table comprise *Ocean Leatherjacket*, mixed species of *Wrasse* (such as *Blue-throated Wrasse*), *Hapuku*, *Bearded Cod*, *Australian Salmon*, *Deep Sea (Blue-Eye) Trevalla*, *Conger Eel*, *Jackass Morwong*, and more than two dozen other scalefish species, in lesser amounts. *Gummy Shark*, *School Shark* and other *shark* species (as well as *Ray* and *Skate* species) are caught in deeper waters (e.g. shark fishing occurs over 20m) (SARDI data, unpublished).

In the southern part of the area described in this table, major commercial species caught in the State waters, and including waters further offshore, comprise *Gummy Shark* and *School Shark* (and other *shark* species in lesser amounts), *Australian Salmon*, *Yellow-eye Mullet*, *Ocean Leatherjacket*, *Conger Eel*, various *Wrasse* species, *Deep Sea (Blue-Eye) Trevalla*, *Bearded Cod*, and *Jackass Morwong*. *Saw Shark*, *Bronze Whaler* and other *shark* species are also targeted (SARDI data, unpublished).

In addition to Rock Lobster (see section above), other commercial species of importance in the **Port MacDonnell** area include Shark species, Octopus, Giant Crabs and fresh-water Yabbies (NOIE, 2002).

Arrow Squid are also caught as a bycatch of the south-east trawl fisheries, with periodically high catch rates in waters off the Port MacDonnell to Portland area (see Lilly 2001).

Small quantities of the deeper water fish species are sold locally in the South-East.

Recent aggregated catch and effort data specific to the area described are currently not available for this report. Previously, SARDI data (cited by Edyvane 1999b) showed that catches in the region between 1995 and 1997 were as follows:

- ♦ GARFIS Block 56 (which spans waters South of Beachport and west of Nene Valley, with the south-west border being the intersection of 38°S and 140°E): 1995/96 - a total of 80,518kg (0.77% of State total, representing 37 fishers); 1996/97 - a total of 59,807kg (0.59% of State total, representing 32 fishers).
- ♦ GARFIS Block 58 (approximately 38° S - Nene Valley, South to 39° S, and including waters between 140° E and 141° E): 1995/96 - a total of 54,656kg (0.53% of State total, representing 30 fishers); 1996/97 - a total of 39,324kg (0.39% of State total, representing 26 fishers). Aggregated catch figures for all fishing blocks in South Australia, in 1995-1997, show that Fishing Block 56 was ranked 26th in 1995/96, and 33rd in 1996/97, in terms of yield (kg) of scalefish, sharks and minor invertebrates, from 58 fishing blocks in S.A.. During that period, Fishing Block 58 was ranked 32nd in 1995/96, and 38th in 1996/97.

Commonwealth-managed trawl fisheries in deeper Commonwealth waters (300m - 1200m) include those targetting Orange Roughy, Blue Grenadier, and Gemfish, amongst other species in the South East Trawl fishery. The Commonwealth-managed dropline and bottom longline fishery (now called the Gillnet, Hook and Trap fishery – see AFMA 2003) operates in deeper waters in part of the lower South East, such as the area north-west, west, and south-west of Port MacDonnell. Dropline fishing in deeper (including shelf-edge waters) of the South East (100m - 900m) yields species such as Blue-eye Trevalla and Hapuku (Jones, SARDI pers. comm. 1996, cited by Edyvane *et al.* 1996). Blue-eye Trevalla catch from South Australia was around 80t in 1997 (AFMA 2001a). Figure 15 in Butler *et al.* 2002, shows an example of fishing effort during 1997 – 1999 by the Commonwealth dropline and bottom longline fishery along the lower south-east coastal and offshore waters. The gillnet component of the Commonwealth fishery also operates in the lower South East, including waters relatively close to the coast (i.e. see Figure 16 in Butler *et al.*, 2002, for example of fishing effort during 1997 – 1999 by the Commonwealth gillnet fishery along the lower South East coastal and offshore waters). Butler *et al.* (2002) listed the major species from the gillnet fishery in South Eastern Australian waters, being School Shark and Gummy Shark, Whiskery Shark, Saw Shark, Elephant Fish, and Hapuku. Other species caught in the Commonwealth-managed fisheries of the South-East include ling species, Blue Warehou and Spotted Warehou, Silver Trevally, Jackass morwong, species of Ocean Perch (N.B. *fully fished*, with some concern also about the discard quantities), species of flathead, and several others (see AFMA, 2001 and 2003; AFFA, 2004).

Recreational Fishing

In general, some of the major species targeted in the lower south-east include King George Whiting, flathead (including deeper water, e.g. 100m), Yellow-eye Mullet (also caught inside the **Port MacDonnell** breakwater), Australian Salmon (e.g. **Green Point** and other surf fishing areas), Mulloway (e.g. **Green Point** area and **Danger Point**), Sweep, Garfish, Southern Bluefin Tuna (by trolling in deeper waters), Snapper (also caught inside the **Port MacDonnell** breakwater, and at **Danger Point** and **Green Point**, and other locations), Tommy Ruff, Toothbrush Leatherjacket, Silver Drummer, Warehou, plus Rock Lobster, Southern Calamari and Gummy Shark. Other species are also caught (“Rock Cod”, Wrasse species etc). Hodder *et al.* (1980) noted the prevalence of Snapper in the **Port MacDonnell** area, which are targeted by recreational line fishers.

Port MacDonnell is considered of “high value” for recreational use, and fishing is one of the major tourist attractions in the town (Gilliland, 1996). Fishers use boats, beaches, rocks and Port MacDonnell jetty and the Port MacDonnell breakwater. There is a boat ramp in the area for boats of all sizes. The jetty and local landing have been described as “popular with anglers” in tourism promotion materials for the South-East. The breakwater and harbour provide opportunity for recreational fishers to launch boats, however the large swells and severe weather patterns limit offshore fishing, except by larger boats (Sweeney, 1996b). Major species taken in the Port MacDonnell area include Snapper, red fish (“nannigai”), flathead, Australian Salmon, large whiting, and Blue Morwong (Sweeney, 1996b). Close to shore, the target species taken in the vicinity of the Port MacDonnell breakwater and jetty, are King George Whiting, salmon trout (i.e. young

Australian Salmon) and Garfish. During autumn and early winter, Southern Bluefin Tuna are taken offshore (e.g. around 15km from shore), and Hapuku and large Flathead are taken close to the shelf (Sweeney, 1996b).

Mako Shark is targeted by some sports fishers in deeper waters off **Port MacDonnell**, according to regional tourism promotion materials, and ANSA (undated). Sports fishers in the area also catch Gummy Shark, gurnard species, Barracouta, Redfish, Albacore and Southern Bluefin Tuna. Large Sand Flathead are also caught in the **Port MacDonnell** area (ANSA, undated, and South-East SA fishing reports).

There are day and night fishing charter trips from **Port MacDonnell**, for bottom fishing and surf fishing, and commonly targeted species include Snapper, Mulloway, Southern Bluefin Tuna (seasonally), and Rock Lobster (Tourism SA, 2002).

Surf fishers use the rocky headlands (e.g. **Orwell Rocks**) and beaches in the area (Sweeney 1996b; S.A. Regional 2003). The remote **Victorian border** area is also used by some surf fishers, to catch Mulloway and sharks (Jones, Coastcare, undated). For example, between the **Piccaninnie Ponds coast** and **Ocean Beach**, surf fishers catch such species as Elephant "Shark", Gummy Shark, Mulloway and Australian Salmon. Beach anglers fish the outflow area of **Piccaninnie Ponds**, for sharks, and Australian Salmon, and large Mulloway are caught during the summer months (Sweeney, 1996b).

The **Glenelg River Estuary** (several km over the S.A. border, in Victoria) is used by surf fishers (at the ocean side of the estuary), rock fishers and river fishers (Jones, Coastcare, undated; Parks Victoria, 2002). The ocean side of the estuary (including **Millers Beach**, east of the estuary) is described as offering "excellent surf or beach fishing conditions, with anglers bringing in Australian Salmon, Mulloway, Snapper and Gummy Sharks" (South East On Line, 2003). In general, large Mulloway, Black Bream (particularly small bream, which are plentiful), yellow-eye mullet, salmon trout (small Australian Salmon) and Estuary Perch are popular species for fishers in the Glenelg River estuarine area (Fish Victoria web site, 2002; Parks Victoria, 2002; Fishnet, 2003). The Glenelg River Estuary has been described as one of Victoria's (and southern Australia's) most popular fishing destinations (Parks Victoria, 2002, and regional tourism promotion materials). **Nelson** is a base for fishing holidays in the **Glenelg River** area, and the estuary, river, rock ledges and beaches are noted for the fishing opportunities they afford. There are fishing boat and equipment hire services in **Nelson**, and launching facilities and public wharves just below the bridge. Bait species, such as pipis, shrimps, "mudeyes" (dragonfly nymph stage), crabs, minnows (*Galaxias* species) and sand worms, are collected from the river mouth (Fairfax Publishing – F2, 2002; Fishnet, 2003; South East On Line, 2003).

In the South East, Rock Lobsters are taken by recreational fishers using pots and drop nets. Diving for lobsters also occurs, mainly during January and February, but many divers do not catch the bag limit (compared with fishers using pots or drop nets). Pots are used by recreational lobster fishers throughout the year, with peak effort during the major holiday periods. Most recreational fishing for lobster by tourists occurs in close proximity to ports (**Port MacDonnell** is one example). Most recreational lobster fishing by locals occurs at Number Two Rocks, Nene Valley, and **Green Point** (Tyrer 1994). Recreational fishing for Rock Lobster is considered to be one of the "key recreational fisheries" in the South East region (Master Plan *et al.*, 2000). McGlennon (1999, cited by Prescott and Xiao, 2001) reported that approximately 40t of Rock Lobster was taken by the recreational sector in the entire Southern Zone, during the 1998 season. This is less than 2% of the commercial catch in total, however in waters less than 15m, the recreational catch is estimated to 25% of the commercial pot catch at the same depths (i.e. most commercial fishers operate in deeper waters, and recreational fishers in shallow waters).

Blacklip Abalone are also taken by recreational fishers in the lower South-East. No figures specific to the area described here are available, however Mayfield *et al.* (2002) reported that in the entire Southern Zone, the total catch amounts to approximately 1.61 tonnes per year, representing around 1.07% of the commercial catch.

NPWSA (2000b) stated that coastal area adjacent to the **Douglas Point** Conservation Park is used for recreational fishing, and that local fishers, amongst other recreational groups, are regular visitors to the area.

There are launching facilities for recreational boats at **Umpherstone Bay, Port MacDonnell, Wool Wash, Riddoch Bay, Green Point, Nelson** (over the S.A. border) and at Donovan's Landing, around 5km inland from the S.A. / Victorian border, part of the **Glenelg River** system (Jones, Coastcare, undated; Fishnet, 2003).

Diving

Most potential dive sites in the area are relatively inaccessible for much of the year due to rough sea conditions (large waves and strong swell). **Port MacDonnell** and **Cape Northumberland** are recognised dive sites (Christopher, 1988; DIASA, undated; Edyvane, 1999b; Aquanaut, undated; and regional tourism promotion materials for the South-East). SCUBA Australia (2000) described **Port MacDonnell** as having “good shore diving”. Regional tourism promotion materials promote the nearshore area of **Port MacDonnell** for diving in kelp forests, catching Rock Lobster, and diving around shipwrecks. Recreational diving for lobsters occurs on the reefs off **Port MacDonnell**. Areas for snorkelling reportedly include **Finger Point** and **Pleasant Cove** (K. Jones K., Coastcare, undated). Rock lobster and abalone are also taken by recreational divers in the South East.

Aquanaut (undated) described diving between Cape Jaffa and **Port MacDonnell** as follows: “*Interesting diving off some of the headlands along this 200km stretch, but it is not frequented by too many divers*”.

NPWSA (2000b) stated that the **Douglas Point (Cape Douglas)** area provides opportunities for diving, and that local divers, amongst other recreational groups, are “regular visitors” to the area.

The river that drains **Ewens Ponds (Eight Mile Creek)** is used by both local and tourist divers, for drift dives and snorkelling from the ponds, down the river, to the ocean.

The best recognised dive spots in the South-East area are not marine: **Piccaninnie Ponds**, a series of limestone sinkholes and caverns filled with clear spring water, is the most popular and widely promoted diving destination in the South-East. The clarity of the water is one of the attractive features of the ponds (Hallam and Thurgate, 1992), and there is a diving access pontoon (K. Jones, Coastcare, undated). The clear waters of **Ewens Ponds** are also promoted by dive tourism materials, for both day and night dives, and snorkelling. The ponds are promoted to State, national and international divers. According to Morelli and de Jong (1995) and Environment Australia (2001b), the ponds are a renowned cave diving location and karst feature of the South East region. Both **Ewens Ponds** and **Piccaninnie Ponds** provide a unique diving experience in cave formations filled with very clear fresh water, and unusual flora and fauna.

Other Recreation / Tourism

There are coastal shack sites between **Cape Douglas** and **Port MacDonnell**.

The **Port MacDonnell** area and surrounds, are regionally important for recreational activities such as fishing (see section above), boating, swimming (e.g. **Wool Wash** beach), surfing, beach use (N.B. driving on the beach is permitted in some areas), and bird-watching (e.g. **Wool Wash** marshes). Whale-watching is a growing tourism activity in the area. In the **Port MacDonnell** area, tourism materials also promote coastal features in the area such as the historic jetty; the lighthouse built in 1858; the visible wreck of the historic *Tenterden* steamer; the coastal coves and the rock formations of the coast (which are named due to their similarity in shape to various animals etc); the safe swimming beach; **Cress Creek** (for wading, swimming etc); and the nature trail through **Germein Wetland** (Gilliland, 1996; Wilkins, 1999; Jones, 2000a and undated; Limestone Coast Tourism, 2002; SA Regional, 2003). There is also a Maritime Museum that promotes the shipping history of the area, and contains artefacts from shipwrecks sunk off Port MacDonnell between 1844 and 1947 (SA Regional, 2003). Along the shore are maritime artefacts, some from the dozens of ships wrecked on reefs in the vicinity (Wilkins, 1999). Other coastal and marine features of interest include the promotion of seafood in the area (e.g. there is a Bayside Festival held in January each year); coastal recreation areas; beachside caravan park, and a proposed marina. The **Port MacDonnell** area has been described as having very high eco-tourism potential, with studies indicating that significant expansion of the town is possible, in terms of tourism (K. Jones, Coastcare, undated).

There are guided tours operating in the region, which include the various rock formations and coastal views, **Douglas Point** Conservation Park and beaches (Tourism SA, 2002).

In addition to fishing and diving, NPWSA (2000b) and Jones (Coastcare, undated) stated that the **Douglas Point** area (including the coastal Conservation Park), offers recreation opportunities such as walking along the coast and within the park, bird watching, coastal photography, surfing, and 4WD vehicle use, along the

sandy and stony beaches, and amongst the areas of cliff top and coastal dune vegetation. NPWSA (2000b) stated that local surfers, divers, fishers, tourists and field naturalists are all regular visitors, accessing cliff top landforms and beaches throughout the Park, but that due to its location and standard of access, it is not anticipated that the use of this area will increase significantly.

The **Finger Point** area has been described as having “very high eco-tourism potential”, relating to a walking trail; Aboriginal heritage interpretation (e.g. “bush tucker”); snorkelling; coastal photography; swimming at the safe beaches, and coastal views (K. Jones, Coastcare, undated).

Scenic coastal drives in the region include the strip between **Finger Point** and **Port MacDonnell** (K. Jones, Coastcare, undated).

There is a penguin-viewing platform with interpretative signage at the **Cape Northumberland** penguin rookery. Other attractions in the area include the **Cape Northumberland** lighthouse (which is open to the public); **Shelly Island**; **Pleasant Cove**; the calcified forest, and the “unique cliff-top vegetation” near the lighthouse (K. Jones, Coastcare, undated; S.A. Regional 2003). Surfers also use the **Cape Northumberland** area.

Regional tourism materials list **Brown Bay**, **Allendale East**, coastal coves around **Port MacDonnell**, **Ewens Ponds** and **Piccaninnie Ponds** as sites in the region for water activities (swimming, diving, snorkelling etc) (see above, on **Diving**). **Brown Bay** has been described as “a very popular surf beach” and a “valuable area” in terms of eco-tourism potential (Jones, Coastcare, undated). The coastal walking track at **Feast Bay**, at the eastern end of **Brown Bay**, has been promoted for its eco-tourism potential, and **Green Point** has been described as “excellent” for observing coastal birds, including migratory species. Earl’s Cave wetland near **Racecourse Bay** is considered to have eco-tourism potential (Jones, Coastcare, undated). Other areas include the beach in the **Piccaninnie** area, which is the first beach that can be reached by Victorians driving into S.A., and is described as “very popular” and has “moderate use” (Jones, Coastcare, undated). There is a boardwalk in the dune area seaward of **Piccaninnie Ponds**. Camping also occurs in some areas (e.g. **Piccaninnie Ponds**) (Morelli and de Jong, 1995).

The **Glenelg River Estuary** and **Discovery Bay Coastal Park** region is popular for recreation, such as fishing (see above); boating; walking (e.g. a number of beach-walking and bush-walking trails exist along the lower **Glenelg River** banks and coast); bird-watching; swimming (in the estuary and river); river cruises / boat tours; canoeing / kayaking; rafting and other estuarine activities; scenic coastal drives; nature studies; and visiting the limestone gorge and caves inland of the river mouth (Parks, Flora and Fauna Division of DNRE, 1995; Parks Victoria, 2001, 2002; South East On Line, 2003; Fairfax Publishing – F2, 2003). **Nelson**, near the **Glenelg River** mouth, is a base for recreational fishing trips (see section above on **Recreational Fishing**) and holidays to the **Glenelg River** and **Discovery Bay** coastal area. There are various forms of coastal accommodation in the area, and access to all the recreation and tourism features of the **Lower Glenelg National Park** and **Discovery Bay Coastal Park**. Commercial boat trips / river cruises run from **Nelson** to the Princess Margaret Rose Caves, upstream from the mouth. There are boat-launching ramps at several points along the river, and boats can be hired. Canoes can also be hired from Nelson or the Dartmoor area, and taken either upstream or downstream for all or part of the 75km journey, and there are several companies operating in the area for this purpose. Two sections of the lower reaches of the river are set aside for power boating and water skiing. Camping is also permitted in several areas, within the **Discovery Bay Coastal Park** and the **Lower Glenelg National Park** (Parks Victoria, 2001, 2002). Apart from fishing, walking is promoted on the exposed **Ocean Beach**, as well as the **Estuary Beach**, which is also used for beachcombing, swimming, and bird-watching. A track leads through the sand dunes to the ocean beach, however the area is not safe for swimming. The beach walk to White Sands is 7km east along the coast. There is a small campsite for walkers. The **Major Mitchell Trail** meets the coast at the Glenelg River Estuary – the river mouth marks the end of Major Mitchell’s expedition of 1836. The Great South West Walk (described below) also traverses the estuary (Parks, Flora and Fauna Division of DNRE, 1995). There is an estuarine boardwalk and nature trails near the river mouth (e.g. **Livingstone’s Island Walk**, which has guide maps with several numbered stops identifying and explaining plants, bird life, the river and estuary, local history, and Aboriginal food plants). A boardwalk has been constructed at **Oxbow** (the Mud Lake), extending for more than a hundred metres around the river estuary. At the end of the boardwalk is a viewing platform, with views of the ocean and river mouth, the river, and estuary, with notes explaining Freshwater Creek, as well as facts about the river. The area is also significant for bird watching, and there is a bird hide with views over Oxbow lake (South-East On Line, 2003).

Walking trails that form part of the Great South West Walk (i.e. a 250km circuit route starting and ending in Portland) occur in the **Discovery Bay** coastal area. Part of the route follows the southern bank of the **Glenelg River** to its mouth near **Nelson**, then returns eastwards along the coastline through **Discovery**

Bay, with optional detours including the south-western Victorian lakes, bays, capes, springs, petrified forest, and seal colony. There are canoeing and camping spots along the way.

Also along the **Discovery Bay Coast** is an Historic Shipwrecks Trail (see section below) with tourism value, and some of those wreck sites are close to the S.A. / Victorian border.

Surfing spots in the lower South-East include the **Discovery Bay** coastline; the beach breaks at **Nelson, Piccaninnie** coast and **Brown Bay**; the reef breaks near **Port MacDonnell**; and the breaks at **Cape Douglas** (South East On Line, 2003).

The route of the Melbourne to Adelaide yacht race leads along the Bonney Coast (Larcombe *et al.*, 2002, cited by Butler *et al.*, 2002).

Historic / Protected Shipwrecks

A large number of historic shipwrecks, protected under Commonwealth legislation, occur in this area, but most have not been found to date.

A *Southern Oceans Shipwrecks Trail* has been developed by the Department for Environment and Heritage's Maritime Heritage Section, to promote the cultural significance of the wrecks that occur in South-East waters. The region encompassed by the Trail includes the ship remains of what was reportedly South Australia's worst maritime tragedy, the loss of the *Admella*. The *Admella* was an iron steamship, wrecked on Carpenter's Reef, north west of Cape Northumberland, in 1859, with a loss of more than 80 lives. Although the *Admella* lies on a treacherous reef, relics (including a brass cannon), have been recovered by divers, and now reside in various museums (Denmead, 1973, cited by Stone, undated).

The barque *Southern Cross* was wrecked approximately 5 kilometres west of **Douglas Point** in 1879, and the remains are still visible on the beach. Another unidentified wreck has been recorded in **Umpherstone Bay** near Douglas Point (Stone, undated; Clark, 1990, cited by NPWSA, 2000b).

Apart from the *Admella*, wrecks in the **Port MacDonnell** and **Carpenters Rocks** areas, many of which are protected by the Commonwealth include the following, some of which have not been found:

- ♦ *Witness*, a wooden brigantine, wrecked in 1853, protected under Commonwealth legislation, but not found;
- ♦ *Tenterden*, an iron screw steamer, wrecked in 1893 on **Breaksea Reef** west of **Port MacDonnell**;
- ♦ *Miame*, a wooden barque, wrecked in 1861, after blowing ashore and breaking up in a gale in Port MacDonnell Bay. After the hull washed up on the beach, there was a public auction of the remains and cargo.
- ♦ *Prima Donna*, a wooden barque, wrecked in 1880;
- ♦ *Galatea*, a wooden brigantine, wrecked in 1876;
- ♦ *Countess*, a wooden schooner, wrecked in 1876;
- ♦ *Flinders*, a wooden schooner, wrecked in 1873 after the vessel sprang a leak and began to sink, while anchored in Port MacDonnell Bay.
- ♦ *Prince of Wales*, an iron fore-and-aft schooner, wrecked in 1873, after blowing ashore in a gale. The vessel is lodged on the reef between the wreck of the *Orwell* and Pinchgut Reef, MacDonnell.
- ♦ *T. Lovett*, a wooden schooner, wrecked in 1852;
- ♦ *Bandicoot*, a wooden schooner, wrecked in 1861; and
- ♦ *Lotus*, a wooden ketch, wrecked in 1892.

(S.A. Coast and Marine Atlas, 2001; Stone, undated)

In the **Port MacDonnell / French Point** area, wrecks that are protected by the Commonwealth, include the following:

- ♦ *Orwell*, a schooner, wrecked in 1873;
- ♦ *Adelaide*, a wooden brigantine, wrecked in 1861; and
- ♦ *St Marc*, a French wooden barque, wrecked in 1876.

Several schooners that worked the coastal routes were wrecked along the **Discovery Bay** coast from the mid to late 1800s (Parks Victoria, 2002). There is an **Historic Shipwrecks Trail** along the Victorian coast, and one stage of the trail runs along the Discovery Coast between Port Fairy and **Nelson**. There are information plaques overlooking the cliffs and sandy beaches between Port Fairy and **Nelson**. Each of the 28 sites reveals details about the maritime history during the era of sailing and steam ships, and maps of the Historic Shipwrecks Trail are available as a guide to the trail sites. Examples of wrecks along the western part of the trail towards the Victorian / South Australian border, include:

- ♦ *The Triumph*: The Western Australian-built schooner disappeared during the mid-1800s whilst on a voyage from **Port MacDonnell** to Port Adelaide. The remains of the vessel were found cast ashore at **Discovery Bay**.
- ♦ *Perseverance* 1890-1898: was a passenger steamer wrecked on the sandbar at the mouth of the **Glenelg River** whilst attempting the voyage from **Nelson** to the River Murray in South Australia.
- ♦ *John Omerod* 1826-1861: The Australian brig came ashore east of the **Glenelg River** mouth, after having been blown on to its side when about fifty miles off **Cape Northumberland**. A number of crew members were drowned; however, the captain and two seamen were saved the following day by a pilot boat that was visiting the **Cape Northumberland** lighthouse. The brig continued to drift and was boarded again near **Cape Douglas** when the body of the drowned steward and personal effects were recovered. Some time later the wreck washed ashore about thirty miles west of **Portland** (Stone, undated).

Other European Heritage

Cape Northumberland Lighthouse, built in the early 1880s, is listed on the *Register of the National Estate*, and is considered significant due to its association with South Australia's maritime history and its importance as a coastal navigational aid before the development of reliable land transportation in the State. The Cape Northumberland lighthouse is South Australia's most southerly lighthouse.

The Cape Northumberland Lighthouse was built to replace the **Port MacDonnell** lighthouse. The Port MacDonnell lighthouse was built in 1858, and demolished (due to threat of sea encroachment) in the late 1880s following the construction of the Cape Northumberland lighthouse (Lighthouses of Australia Inc., 2002). There is also a monument to the former lighthouse, and the ruins of the light and the cottages are still visible on the cliffs at Port MacDonnell.

Notes on the maritime history of **Port MacDonnell**, from FRR (2003): The Port MacDonnell Lighthouse was completed in 1859, and the town of Port MacDonnell was declared a port in 1860. A jetty was built the following year. Shipping provided the main income for the town. Goods which were landed at the jetty had to be transported inland to Mount Gambier, Penola, Naracoorte and many other towns. Exports which left the town included wool, sheep and kangaroo skins, wheat (from as far away as Victoria), potatoes, flour, bark, tallow, honey, timber and many other products. By the end of the 1860s there were enough people in town and surrounding smaller settlements to warrant the proclamation of the District Council of Port MacDonnell. During the 1870s Port MacDonnell was the second busiest port in South Australia after Port Adelaide. During this decade several ships were also wrecked, including the *Orwell* in 1873, *Seabird*, also in 1873, *Geltwood* in 1875 (with the loss of twenty-seven crew members), and the *Agnes*, *Countess* and *Galatea*, all in 1876 (see section above). By the end of the 1870s, railways were started in the South East, connecting several towns but not Port MacDonnell, whose council had voted against it. Ultimately this resulted in a loss of trade and consequently a loss of population. Whereas during the mid 1870s nearly a thousand people called Port MacDonnell home, twenty years later there was less than half that number (FRR, 2003).

There is a Maritime Museum at **Port MacDonnell**, and relics of the of the ships wrecked during the 1800s and early 1900s can be seen at the museum, and along the coast.

A Marine Interpretative Centre is planned for Port MacDonnell, which would incorporate the existing Maritime Museum, as well as a new interpretive centre for the fishing industry, and a tourism information office (Halstead Management Services, 2001a).

Nelson: Nelson was named in the 1850s, after the survey ship, the *Lady Nelson*, which was used by Lt. James Grant to explore the southern coastline in 1800. Major Mitchell later explored the area during his Australia Felix expedition of 1836, and he named the **Glenelg River**. His party were the first Europeans to investigate the Glenelg River. A punt service carried people across the river at Nelson from 1849. Nelson was later affected by border disputes between the states, which caused delays in the final settlement of the surveys, in 1913. There is an historical walk through the town, which includes some sites of maritime significance, including the Punt (built 1848) and First Bridge (wooden, built 1893); the Wagons (a private property with wagons of a type believed to have been used to ford the mouth of the river from 1839 until the punt was built); and the Isle of Bags, an estuarine island where Major Mitchell left bags of provisions in 1837 (South East On Line, 2003; Fairfax Publishing – F2, 2003).

Aboriginal Heritage

Aboriginal middens have been identified in the south-eastern and northern ends of the **Douglas Point** Conservation Park. The middens are considered to possibly reflect the conclusions drawn in relation to the middens at **Cape Northumberland**, approximately 10 kilometres south-east of Douglas Point Conservation Park. These middens have been dated at 1470 ± 120 years BP and consist of the marine gastropods *Cellana*, *Turbo* (*Subnivalia*) and *Haliotis*, charcoal from hearths, stone scrapers or planes and associated debris (Luebbers, 1978, cited by NPWSA, 2000b).

Sites at Carpenters Rocks and **Port MacDonnell** are listed as Indicative Places (i.e. being considered for listing) on the *Register of the National Estate*, due to their Aboriginal Heritage significance (Australian Heritage Commission, undated). There is also an Aboriginal heritage site at **Finger Point**, and a significant Aboriginal Dreamtime story associated with an Aboriginal heritage site in the **Pleasant Cove / Cape Northumberland** area (K. Jones, Coastcare, undated).

Aboriginal sites are found along every headland of the segment of coast between Cape Banks and the Victorian border. Midden sites generally consist mostly of species of the food shell *Turbo* (previously *Subnivalia*), various limpets, and southern Rock Lobster. "Massive quantities" of flaked flint cobbles and implements litter the surface (UEPG, 1982). The **Piccaninnie Ponds** coast is considered to be a significant Aboriginal heritage site (K. Jones, Coastcare, undated).

The flake tool deposits between Cape Banks and the Victorian border are thought to represent the original settlement of the area during the Pleistocene, and are therefore older than 10 000 years (UEPG, 1982, cited by Master Plan *et al.*, 2000).

In south-western Victoria, the **Discovery Bay** coast has Aboriginal heritage significance, and a number of middens are conserved within the **Discovery Bay Coastal Park**, on the eastern side of the South Australian / Victorian border. Bull Kelp is an example of a local species used by Aboriginal people in the area, who used the dried kelp to transport water and food (Parks Victoria, 2002). Several shell middens and surface scatters exist at the **Glenelg River Estuary** (Victorian Archaeological Survey, 1992, cited by Parks, Flora and Fauna Division of DNRE, 1995).

In Victoria, there is a Native Title Claim for the Glenelg River region, which also includes a portion of the lower South-East in S.A. (Master Plan *et al.*, 2000). The native title claim by the Gournditch-Mara (Fed Ct No VG6004/98) was registered on 30th August, 1996. The area subject to that application is located in the Western District in Victoria and adjoining territorial seas, and also includes the South Australian portion of the **Glenelg River**. The claim covers a total area of about 20,360km² (NPWSA, 2001c).

In addition to specific areas of significance, notes on the Aboriginal Heritage of the South-East region in general, are also provided:

There were 2 main groups along the Lower South East, south of Lacepede Bay, down to the Victorian Border: the *Meintangk*; and the *Boandik* (a tribe of the larger *Bunganditj* group). Each group consisted of many clans, with their own dialects, and traditionally owned and controlled individual estates of land, with reciprocal responsibilities to other clan's estates (Tindale, 1974, cited by Master Plan *et al.*, 2000). The following information is taken from NPWSA (2000b): The Aboriginal people inhabiting the lower south-east region were known as the Boandik (= Booandik), one tribe among four others belonging to a larger group known as the Bunganditj (=Bungandidj). Prior to European settlement the **Port MacDonnell** area was home to the Bunganditj, who reportedly lived largely on produce from the sea (Fairfax Publishing – F2, 2000). Campbell *et al.* (1946) wrote that the Boandik tribe inhabited an area from the **Glenelg River**, through **Lower South-Eastern S.A.** to the Rivoli Bay / Robe area, including land up to 50k inland. O'Connor (1992) and Campbell (1939) indicated that the region was rich in resources, with shellfish and crustaceans commonly harvested by the Boandik from the sea and nearby lake areas. The Boandik used Karkalla (the Pigface plant) along the coastal areas, and this served as their main source of salt (NPWSA, 2000b).

Many indigenous sites along the South-East are considered to be invaluable records of activity and events that took place over 10,000 years, and the region is considered to be of "vast cultural significance" as well as scientific value. The sites represent for indigenous communities tangible evidence of the close spiritual connectedness that they and their ancestors have with the landscape. The relationship is reflected in the Dreaming stories of the region, which are manifested in the physical landscape (Master Plan *et al.*, 2000).

Urban Environmental Planning Group (UEPG) (1982) reported that a large number of Aboriginal archaeological sites exist along the coastline, “the most common type of site being the shell midden, many of which are of great significance from an archaeological and scientific perspective”. The report also stated that “as a group, the Aboriginal sites of the South East coast have been claimed by researchers to be of national, if not international, importance.

Midden sites in the South East provide valuable information about ethnography. Information about the economy, technology and social structure of the indigenous groups that used the coastline, can be obtained by studying midden content, size and distribution (UEPG) 1982, cited by Master Plan *et al.*, 2000). The contents and stratigraphy of midden sites also provides evidence of the evolution of the coastal environment over thousands of years. For example, Goolwa Cockle *Donax (Plebidonax) deltoides* middens may indicate smooth sandy beach environment; and other shell types in the region indicate rocky shores and reefs; and the presence of mud-dwelling bivalves indicates (former) lagoonal, sheltered estuarine environments (Master Plan *et al.*, 2000).

Other important sites in South-Eastern S.A. in general, include hearths (physical remains of ovens); rock shelters; burial sites; and stone artefact manufacturing sites, containing cores, flakes, scrapers, blades, tula slugs, points, hammer stones and grinding stones. Many of the finished articles were removed from the sites when completed, and used for trading (Renfrew and Bahn, 1991, cited by Master Plan *et al.*, 2000). Most tools along the South-East coast are flint, but chert, silcrete and quartz artefacts are also present.

Pteroglyph (carved) rock art has been recorded at some sites in the South East. In general, rock art provides valuable pictorial records of past indigenous activity, such as ceremonies, Dreaming stories and significant events (Master Plan *et al.*, 2000).

Marine Research and Education

Research on Abalone and Southern Rock Lobster are undertaken in the lower south-east area (e.g. see Rodda *et al.*, 2000, and Mayfield *et al.*, 2002, on abalone population monitoring; and various references on Rock Lobster by Prescott and others in the bibliography of this report).

Previously, the area has been used for studies of macroalgal distribution, biology and ecology (e.g. Shepherd, 1979 and 1981; Edyvane, 1989).

The area is part of the Bonney Upwelling, in which blue whale research is conducted (see references by Gill and others, in Butler *et al.*, 2002).

Butler *et al.* (2002) considered the high productivity, species diversity, and endemism of the Bonney Upwelling area to be of value for scientific research and education.

The fishing industry and the history of shipwrecks in the region are both considered to be of education value, as evidenced by the plan in 2002 to build and interpretative centre that promotes both of these features of **Port MacDonnell**.

Port MacDonnell Coastcare has been involved with flora and fauna surveys, and dune re-vegetation projects in the lower south-east have also been undertaken by Coastcare. A natural resources inventory has also been compiled, to assist regional management (see Jones, 2000a, 2000b, and Jones, undated).

The aquatic biology of **Ewens Ponds** and **Piccaninnie Ponds** has been comprehensively studied by Hallam and Thurgate (1992, cited by Morelli and de Jong, 1995).

A recent comprehensive survey of freshwater and estuarine fish populations and their habitat in the lower South East has been undertaken, including the **Cape Douglas** wetland; **Eight Mile Creek** system (e.g. **Deep Creek, Stratman’s Pond, Dead Pond, Bone’s Pond, Pretty Pond, 54 Foot Pond, Spencer’s Pond, Wilke’s Pond, Ewen’s Side Pond, Branch Drain 7, Jerusalem Creek, Clarke Park drain, Blackfish Lagoon, Cress Creek** and other sites) and the **Piccaninnie Ponds** system (e.g. **Hammerhead Pond, Piccaninnie Side Pond, Donovan Property Drain, Piccaninnie Outlet Drain, Pick’s Swamp**) (see Hammer, 2002).

The **Glenelg River Estuary** has been significant for studies of estuarine birds and plants, and geo-

morphological research (see discussion of the area in Parks, Flora and Fauna Division of DNRE, 1995).

The Lower South East is of significant value for Aboriginal Heritage research in the coastal area (see section above, on **Aboriginal Heritage**).

Aesthetic / Wilderness Values

The **Port MacDonnell** area has been promoted for its seclusion and the scenic value of the cliff faces along the beach. Tourism materials describe the coastal area around **Port MacDonnell** as “dramatically beautiful”, “scenic”, “spectacular”, “magnificent” and “equal to the Great Ocean Road”.

NPWSA (2000b) and Jones (Coastcare, undated) mentioned the scenic nature of the coastal area around the **Douglas Point (Cape Douglas)** area.

Umpherstone Bay has been described as having “beautiful coastal scenery and beaches”, and **Finger Point** as having “some of the best coastal views in South Australia”. **Orwell Rocks** is also described as having spectacular coastal views (K. Jones, Coastcare, undated).

The **Pleasant Cove / Cape Northumberland** area, South Australia’s most southerly headland, has been described as having “spectacular scenery”, “stunning views”, and “unique scenic headlands”, and there are elevated viewing platforms in the area (K. Jones, Coastcare, undated; SA Regional, 2003). The coastal views and rock formations at **Cape Northumberland** are promoted as a tourist attraction (Fairfax Publishing – F2, 2000), and there is a scenic coastal drive in the area (SA Regional, 2003).

The beaches near the **Victorian border** are described as “beautiful”, and the border coast is considered to be a remote and very peaceful wilderness area (K. Jones, Coastcare, undated).

Nelson and surrounding **Glenelg River** and **Discovery Bay** are described as beautiful, “picturesque” and “scenic” (e.g. Fairfax Publishing – F2, 2002). There is viewing platform at the end of the boardwalk on the **Glenelg River Estuary**, with scenic views of the ocean and river mouth, the river, and estuary. The 15km long, 50m high limestone gorge upstream from the estuary is described by tourism promotion materials as “spectacular”.

Petroleum and Minerals Exploration

An offshore petroleum exploration license exists in the region between Millicent and Port MacDonnell. Exploration wells have been drilled in offshore areas within the region (Master Plan *et al.*, 2000).

There are existing acreage releases for exploration in the **Lower South-East** (see Figure 18 in Butler *et al.*, 2002). Exploration wells over these lease sites exist off **Port MacDonnell**, and the lower south-east near the **Victorian border** (see Figure 18 in Butler *et al.*, 2002).

In 2000, there was also a petroleum exploration area “under offer”, approximately 468 km², in State waters, between Lake Bonney and the **Victorian border**.

In 2002, bids were being received (and closed April, 2003) for three areas in the western Otway Basin in South Australia (GA, 2002, cited by Butler *et al.*, 2002).

Numerous seismic surveys have been conducted in the lower South-East, including areas close to the coast (see Figure 19 in Butler *et al.*, 2002).

Towns and Settlements

Although **Port MacDonnell**, the most southerly port in South Australia, has been described as a “quiet coastal village” (K. Jones, Coastcare, undated) and a “quiet fishing town” (SA Regional, 2003), it is also considered to be one of the major towns in the South East. The population is between 600 and 750 (i.e. 606, according to the ABS census in 2001, or 750, according to SA Regional, 2003), with higher numbers seasonally due to visitors. **Port MacDonnell** is Australia’s “Southern Rock Lobster Capital”, exporting 95% of the catch to south-east Asia and Japan. Other commercial species include Shark species, Abalone (particularly Blacklip), Octopus, Giant Crabs and fresh water Yabbies. More recent developments in the area include

aquaculture / mariculture developments (NOIE, 2002), and coastal and marine tourism. During the 1990s, more than 2,400 people were living in the District Council area of Port MacDonnell (FRR, 2003).

Smaller coastal settlements include **Racecourse Bay**, **Riddoch Bay** (a residential area where there has been coastal "ribbon" development) (K. Jones, Coastcare, undated; Bryars, 2003).

Feast Bay has a small number of shacks, and there is a shack site at the headland at **Green Point** (K. Jones, Coastcare, undated).

There are also coastal shacks located throughout much of the area between **Cape Douglas** and **Port MacDonnell**. For example, there are 35 shack sites on the eastern side of **Douglas Point**, in the **Umpherstone Bay** area (Jones, Coastcare, undated; NPWSA, 2000b).

Nelson is a small, fishing and holiday township of less than 400 people located at the mouth of the **Glenelg River**, in south-western Victoria. It is 433 km west of Melbourne and only a few km from the South Australian border.

Other Uses / Other Information

Port MacDonnell area is subject to significant levels of marine traffic, particularly from commercial and recreational fishing boats (Gilliland, 1996).

There is a shipping lane for interstate and international traffic, along the coast, in deeper waters (see Figure 20 in Butler *et al.*, 2002).

A 60-berth marine is proposed for **Port MacDonnell**, for use mainly by commercial fishers (Halstead Management Services, 2001a).

Port facilities at Carpenters Rocks and **Port MacDonnell** service local fishing fleets (Planning S.A., 2003b).

9.2 Issues for Risk and Impact Assessment

The following may be considered to have actual or potential impact upon both the viability of Marine Protected Areas, and the areas surrounding MPAs. Ongoing assessment and monitoring of risks and current impacts is considered important in the development of a system of MPAs in South Australia. Following the overview presented below, tables are provided of issues for risk and impact assessment within each focus area. The information, which is current to 2003, is provided as a guide only, as risks and impacts change over time according to use and management of each area, amongst other factors.

9.2.1 Coastal Marine Discharges

This includes any or a combination of point-source effluent, stormwater, and other sources of nutrients, sediment, heavy metals, hydrocarbons, urban and rural chemicals, other sources of toxic compounds (e.g. marine paints, industrial chemicals), and solid and particulate wastes. A number of examples are discussed in detail, in the sections on *Issues for Risk and Impact Assessment*, for the recommended areas. In particular, sources and impacts of nutrients and heavy metals are discussed in detail in the tables below for **Northern Spencer Gulf** and **Northern Gulf St Vincent**.

9.2.2 Coastal Developments

Some coastal developments are demonstrated to have adverse effects upon intertidal and/or subtidal habitat quality. Effects on ecosystem functioning and/or population dynamics of biota within the developed nearshore area are also likely, but are less well known, compared with visible habitat impacts. One example of a coastal development type that requires ongoing impact assessment and remedial measures, is the construction and operation of marinas / boat harbours and associated waterfront construction. In general, marina and boating facility issues include: (i) alteration and damage to coastal and marine habitats due to construction; (ii) interruption to natural patterns of water circulation in the harbour / bay in which the facility is developed; (iii) potential for scouring of nearshore seafloor and damage to benthos; (iv) increased risk of introducing and transferring pest species; (v) declines in water quality and benthic habitat quality, due to increased sediment mobilisation; (vi) increased hydrocarbon levels from discharge of oily wastes such as bilge water, and from fuel use and leakage; (vii) chemical contamination of sediments and biota from TBT and other anti-foulants; and (viii) increased loads of nutrients (e.g. from septic discharge), other effluent and garbage associated with marina activities. A number of specific examples are provided in the sections on *Issues for Risk and Impact Assessment*, for particular areas.

9.2.3 Aquaculture Developments

Caged fish aquaculture, intertidal and subtidal shellfish culture, and land-based aquaculture all cause a variety of impacts on nearshore marine ecosystems. For example, the environmental impacts of caged fish farming, can include the following, amongst others (and see Hansen *et al.*, 1990; Tsutsumi *et al.*, 1991; Sindermann, 1992; DePauw and Joyce, 1992; Johnsen *et al.*, 1993; Wu, 1995; ERD Committee, 1998; Kemper and Gibbs, 1997 and 2001; Karakassis *et al.*, 1998, 1999; MacGarvin, 2000; GESAMP, 2001; SECRU, 2002; Planning SA, 2002a; Marsh *et al.*, 2003; DEH, 2003a):

- ◆ Potential for macroalgae, seagrass and invertebrate communities to be shaded, smothered and even killed, due to (i) increased loads of sediment and accumulation of waste products from cages, leading to physical and chemical changes in the benthos such as organic enrichment, production of “sludge”, turbidity in the water column, and growth of “fouling” flora and fauna; and (ii) reduction of sunlight reaching the bottom. *Posidonia* species are particularly slow to recolonise after being lost due to nutrient-induced impacts.
- ◆ Change to natural benthic species composition and abundance, including reduction and change in distribution of benthic cover, particularly marine plants (see above) and sessile invertebrates; the proliferation of “opportunistic” species such as worms and small crabs), and the reduction of larger benthic fauna from the site;
- ◆ Build up of ammonia and generation of methane and hydrogen sulphide (which can be toxic to marine organisms). The increase in ammonia levels in the water column and sediments, caused by caged finfish aquaculture, can be high;
- ◆ Build up of sediment, faeces and other wastes from feeding, particularly in areas of slower water flow / lower current speeds. The impacts of organic fish farming wastes on benthic environments in general have recently been summarised by SECRU (2002): “*Particulate organic wastes from cage farms have a profound effect on the benthic environment and recovery, on cessation of farming, may take several years. Impact on the sea bed is the most obvious pollution effect from fish farms and measures of this effect are the main method of regulating and controlling the size of fish farms such that the local environment is not overwhelmed. However, severe effects are generally confined to the local area*”. Wastes from intensive cultivation may elevate phosphorus and nitrogen loads in the surrounding waters, inducing eutrophication. Wu (1995) reported that the environmental impact of fish farming depends very much on species, culture method, stocking density, feed type, hydrography of the site and husbandry practices, but that in general, some 85% of phosphorus, 80 – 88% of carbon and 52 – 95% of nitrogen input into a marine fish culture system as feed, may be lost to the surrounding environment through feed wastage, fish excretion, faeces production and respiration. Furthermore, a number of studies have shown that an average of 23% of C, 21% of N and 53% of P can be accumulated in the bottom sediments (see review by Wu, 1995). Cleaning of fouled cages also adds periodic nutrient inputs. Sediment re-suspension can also occur, exacerbating the effects of excess particulate matter – for example, the consequent increased turbidity can affect both the farmed fish, and native fauna in the farm area.
- ◆ Reduced decomposition of organic matter, and stimulation of anoxic conditions (i.e. low levels of dissolved oxygen) which can be hazardous to marine organisms requiring certain oxygen levels to be maintained in the water;
- ◆ Formation of bacterial mats; and disturbance to natural seasonal cycling of elements;
- ◆ Reduction in water quality and natural sediment quality, due to the addition of dissolved and particulate nutrients, and oxygen consumption;
- ◆ Localised eutrophication due to water-borne and sediment-bound nutrient wastes, which may promote harmful algal blooms. Of particular concern would be increased incidence of algal blooms, and potential for blooms of toxic species that existed at low levels prior to added nutrients and other changes to the system. Throughout the world, there has been ongoing concern about the increased incidence of algal blooms (including toxic species) due to conditions promoted by caged fish farming, such as increased nitrogen and phosphorus, increased turbidity, increased rates of benthic to pelagic nutrient fluxes, lowered oxygen and other factors. It has been recognised by aquaculture impact experts (see SECRU, 2002) that, for those algae associated with eutrophication (such as *Gymnodinium mikimotoi*, *Phaeocystis pouchetii* and toxic flagellates), substantial blooms do seem to be stimulated by nutrient enrichment and increases in the ratio of nitrogen and phosphorus to silicon. That the abundances of the toxic species of *Alexandrium*, *Dinophysis* and *Pseudo-nitzschia* are related to changes in nutrient ratio in the field, remains speculative (SECRU, 2002). Marine botanist Professor Gustaaf Hallegraeff reported in 1995 that in Australian waters, a serious impact of eutrophication is the shift in phytoplankton species composition, from “wholesome” diatoms (i.e. which are beneficial to the marine environment) to “nuisance” flagellate species (i.e. which can cause toxic blooms), with far-reaching consequences for the structure of entire marine foodwebs;

- ◆ Potential translocation and proliferation of viruses, bacteria, protozoa, nematodes and crustacean pathogens and parasites around the coastal marine environment, which may threaten wild species as well as the caged species;
- ◆ Effects upon sea birds and sea bird colonies, pinnipeds, dolphins, sharks and wild fish, through interactions with caged fish farming, and also due to decreased water quality and changes to benthic habitat that are consequent to finfish farming operations. Finfish farms can attract sharks, dolphins and pinnipeds, which can become entangled in nets, often fatally. Sharks, dolphins and pinnipeds can become habituated to the caged fish farms, thus altering their feeding patterns. Finfish farms can also provide a food supply for some opportunistic and aggressive bird species such as seagulls, which may thus proliferate and displace other bird species at nesting / roosting sites.
- ◆ Physical damage to the seafloor, from anchoring and dragging of nets and equipment.
- ◆ Use of chemicals, and their storage and disposal, may have impact on the marine environment, including fish, invertebrates, marine plants, and the bacteria and other micro-organisms in benthic sediment. Although the use of chemicals in South Australian aquaculture is low, common chemicals used in aquaculture in general, include pesticides and herbicides, anti-fouling chemicals on farm nets (which contains toxic copper or tin compounds), petroleum products, and antibacterial, antibiotic and cleaning/disinfectant products.
- ◆ Other potential impacts include rubbish and debris from caged fish farm operation and servicing (which can entangle sea lions, dolphins, and sea birds), and build up of surface oils and scums on the waters.

Of the impacts stated above, those upon sediment, water quality, and benthos may be particularly prevalent in shallower waters, and in areas where current flow is insufficient. However, it is noted that even in situations where finfish cages are placed in deeper water, such as 20m – 30m, benthic oxygen level can still be depleted, organic carbon and nitrogen content of sediment near cages can be elevated, and benthic macrofauna can suffer impacts (e.g. see Karakassis *et al.*, 1999 and 2000). Various examples of impacts reported in South Australian finfish aquaculture facilities are provided in some of the sections on **Issues for Risk and Impact Assessment**, for particular areas.

The other major form of aquaculture in S.A. is shellfish production. Oysters, Blue Mussels, Abalone, and, more recently, Scallops are farmed in a number of areas in South Australia, and the number of shellfish farms in South Australian bays has proliferated during the past decade. Some of the major shellfish growing regions are on the West Coast; in Franklin Harbour (oysters) and off Port Lincoln (mussels) in Spencer Gulf; off southern Yorke Peninsula, and off northern Kangaroo Island. Around 171t of Blue Mussels were produced in S.A. in 2001 / 2002, and a large increase in production is planned by the mid-2000s due to expansion of farms and development of new sites (PIRSA website, 2003). The oyster industry, which has operated in South Australia since the 1970s, has also expanded in recent years. Around 3.5 million dozen oysters were produced in 2001/02, from South Australian farms. Oysters are grown on racks and rails, or on longlines, in shallow bays. In recent years, trials have also been undertaken to grow out Scallops on a commercial scale in South Australia. Monitoring programs by SARDI (e.g. Hone and Clarke, 1997; Madigan and Clarke, 1998, 1999; Madigan *et al.*, 2000) have reported that the environmental impacts of oyster farming are minor, and mostly limited to the immediate site of production, with the exception of the spread of Pacific Oysters away from the farm sites (i.e. establishment of “feral” oyster populations). Mussel farming has similar impacts to those from oyster farming, however specific results from mussel farming monitoring programs in S.A. are not available for this report. Although there may be some positive impacts of shellfish farming (e.g. mussel shells can provide sites of attachment for large epibiota such as ascidians, sponges and tube worms, as well as providing an increased food supply for epibenthic and pelagic predators),

there are also a number of negative impacts. In general, some impacts of intertidal and shallow subtidal shellfish farming, include:

- ♦ Depletion of oxygen, increase in reductive processes, and build-up of ammonia and other waste products;
- ♦ In areas where cultivation is intense and dense, excessive extraction of nutrients from the marine system is possible, which can reduce the ability of the system to support the same densities and/or abundance of native filter feeders as occurred prior to the introduction of cultured species to the site;
- ♦ At sites of intense and dense cultivation (e.g. of mussels or oysters), and in areas of limited water movement, there is potential for build-up of dead shells, sediments, faecal and pseudo-faecal matter (e.g. sediment, diatoms and other matter filtered from the water by the gills and entrained in mucus). With increasing eutrophication from nitrogen and phosphorus, organic matter, silt quantities and shell fragments can increase in sediments. Such build-up of wastes causes organic enrichment of the sediment; “bio-fouling” of structures; and can damage seagrass beds in the vicinity of the cultivation site¹; reduce the diversity of native macrobenthos beneath the farm sites, and increase the abundance of opportunistic species that consume detritus;
- ♦ Potential for increased concentrations in the sediment, of contaminants such as heavy metals, hydrocarbons, and pesticides. Research at oyster farms in the nearshore environment has shown that shellfish installations can particularly damage sandy sediments, with organic wastes and contaminants penetrating to at least 25cm deep, and such sediments may remain significantly contaminated until the oysters are removed from the area (e.g. Martin et al., 1991).
- ♦ Disruption of the nitrogen levels at the site, due to changes in benthic faunal composition and abundance, and changes in nutrient inputs;
- ♦ Changes to ecosystem structure and function (including changes to plankton composition and production, and alteration of energy flow through coastal marine food webs);
- ♦ Smothering of native invertebrate cover on sand habitat (e.g. *Pinna* Razorfish beds, ascidians, sponges etc);
- ♦ Damage to nearshore seagrass beds at the site, due to wastes from the farmed invertebrates, and reduction in light penetration under racks. Nearshore seagrass beds often have an important nursery function for juvenile fish and invertebrates, amongst many other important ecological roles (discussed in other sections of this report);
- ♦ Potential impacts upon seabird populations, in areas where large quantities of mussel spat are collected from the wild;
- ♦ Accumulation of drift seagrass around oyster racks, and buildup of decaying material;
- ♦ Risk of disease introduction and transfer to native shellfish;
- ♦ Potential escapement of oysters and mussels into surrounding areas. For example, farmed Blue Mussels at Kangaroo Island have spread out of the culture area, and the mussels have now established in a protected estuarine area on the north-east coast, and are also fouling boats and structures in the area.
- ♦ Visual impact in nearshore area (of floats, trestles, racks etc).

(Tenore et al., 1985; Gowen et al., 1989; Martin et al., 1991; Souchou et al., 1997; De Casabianca et al., 1997, 1998; SECRU, 2002; Marsh et al., 2003; McKinnon et al., 2003).

Various examples of impacts reported in South Australian shellfish aquaculture facilities are provided in some of the sections on ***Issues for Risk and Impact Assessment***, for particular areas.

¹ (For example, in France, monitoring has shown that *Zostera* seagrass stands cannot grow in waters that have become eutrophic and darkened by shellfish farm effluents, and they are replaced by algae such as *Ulva* and *Gracilaria* (De Casabianca et al. 1997, 1998).

In recent years, there has also been increasing interest in developing coastal (including land-based) aquaculture facilities, for growing out species such as Rock Lobster and Abalone. A number of issues associated with on-land Rock Lobster farms, and/or Rock Lobster holding facilities in the nearshore environment, include the following:

- ◆ Disease is a common problem in lobster aquaculture, irrespective of the species or the country. The “raceways” that are used for growing out lobsters offer advantages in management, however water quality and system failure are key issues to be addressed. Tail disease due to chitin-destroying bacteria is considered a major problem overseas, in lobsters held in groups over winter. In Australian research, tail fan damage was found to be a major problem with live-held lobsters. Tail fan damage occurred in sea-based and land-based trials, and across all diets, without apparent pattern. In some lobsters, tail fan damage progressed to unacceptable condition within the first month on live holding. The causes and management of tail fan necrosis need to be addressed before a long term live holding industry can be developed (Reuter et al., 1999, cited by T. Flaherty. MCCN, pers. comm., 2002). Furthermore, in South Australia, *Vibrio alginolyticus* has been detected in research trials of Rock Lobster aquaculture, and this organism, has been associated with skin damage, ulcers, anaemia, tail and fin disease in finfish, and mortality in eels. A number of other disease-related organisms have been found in Australian trials related to caged Rock Lobster, such as *Plesiomonas shigelloides*, *V. alginolyticus* and *Aeromonas hydrophila*. These organisms are commonly present in marine and estuarine environments. However, the handling and holding of the lobsters, in association with elevated water temperatures, could predispose them to invasion of damaged tissue by these organisms (Evans, 1999; Reuter et al., 1999, cited by T. Flaherty, MCCN, pers. comm., 2003). Important infectious diseases of lobsters in confined situations, that have occurred overseas, include “bumper car” disease caused by the ciliate *Anophryoides haemophila*; gaffkaemia caused by the bacterium *Aerococcus viridans* (a disease which can proliferate in wild stocks, as occurred in north-eastern North America during the early 1990s – see Glowka, 2001), and shell disease associated with bacterial species of *Aeromonas*, *Pseudomonas* and *Vibrio* (Cawthorn et al., 1996; Cawthorn, 2000). Other problems include fungal infections (on the body, and some also spread through the entire system), and parasitic infection. Non-infectious disease states, particularly caused by inadequate nutrition, also occur (Evans and Brock, 1994). The disease gaffkaemia, is commonly known in farmed specimens of the American lobster, *Homarus americanus*, and the disease spread to Europe (e.g. Norway), possibly through commercial import of live specimens (Joerstad et al., 2000). Gaffkaemia has been recorded in lobster culture farms as well as wildstocks. Morado (1996) reported that for the past 20 years, there has been clear evidence that systemic ciliate disease (e.g. by the protist that causes “bumper car” disease) is a major problem in the culture of the Australian crayfish, *Cherax quadricarinatus*, and in the captive maintenance of the American lobster, *Homarus americanus*, and Dungeness crab, *Cancer magister*. The ciliate has also been a significant impediment to the economic viability of coldwater lobster impoundments in eastern North America (Cawthorn et al., 1996). In European lobsters, there are records of bacterial growth on lobster eggs, resulting in massive egg mortality at the farms (Uglem et al., 1996), and that kind of problem, as with other lobster diseases, requires chemical treatment. It was noted at the 1999 International Symposium on Lobster Health Management Proceedings (see Evans and Jones, 1999) that there is “a dearth of information on lobster diseases, identifying pathogens and managing disease outbreaks” and “there is a real risk of disease from aquaculture or long term storage”.
- ◆ If effluent from lobster farms is pumped to sea, or reaches the near-shore environment in any other way, there may be a disease risk, because some of the diseases can also exist in wild lobsters, even though they are subject to different physical conditions (such as water temperature) compared with the farms. Unless there is a program to recycle effluent and sludge, and to contain the sludge on land in silage pits or settlement ponds, it is likely that wastes may be released into the marine environment. Effluent can contain pathogens, nutrients, sediments, and organic and inorganic chemicals (from disease treatment at the aquaculture facility). Some of these waste products are toxic and can have sub-lethal effects in wild conditions.
- ◆ Other common problems in lobster farms include mass mortality events; low survival rates of larvae (necessitating continued take from the wild, unless the facility can culture animals through the whole cycle); cannibalism, and fighting amongst the males, due to crowded conditions, which

can also result in mortality. Work in Japan (Takahashi et al., 1995) has shown that “*under aquaculture conditions, various stresses caused by high stocking density and resultant environmental pollution with organic matter, damage the immune system of shellfish such as lobsters, and result in an increased susceptibility to infection. To avoid such bacterial infection, the lobsters and other crustaceans must be treated with antibiotics*”.

- ♦ Lobster farm stock should not be released back into the wild. Lobster larvae travel at least in the order of tens to hundreds of kilometres, which is presumably important to maintain the genetic fitness. Release of farm animals (larvae, juveniles or adults) that all come from the same genetic stock, back into a concentrated area, near the farm, may have some genetic impact. The issue is more important in the case of lobster ranching, whereby eggs are taken from wild lobsters, hatched under controlled conditions, and grown out for about a month until they are a suitable size for being released back into the wild. In natural situation, the young lobsters would not end up at the same “concentrated” place as would those released from farms. Some work was done on this issue in Norway (Joerstad and Farestveit, 1999) and the authors concluded that any attempts at stock enhancement in a localised area should evaluate the risk for unwanted genetic impacts. They also recommended that commercial ranching operations of lobster, including selective breeding, should be carried out only in areas with low levels of genetic differentiation. Selective breeding for the fastest growing and most disease resistant lobster, which is promoted in Rock Lobster culture (e.g. Kittaka and MacDiarmid, 1994), may also have some impact on wild stocks if mixing occurs.
- ♦ Unless the facilities culture lobsters through the full life cycle, another issue may be the regular take of large numbers of puerulus from the wild stocks, for the farm, although it may be difficult to determine the stock impacts.

A number of similar potential impacts may occur with the culturing of abalone at near-shore facilities, particularly if wastes from the farm are piped into the nearshore environment, which has occurred at a number of these facilities in South Australia. Effluent from land-based aquaculture farms generally contains faeces, nutrients from uneaten food, and also bacteria, viruses and other pathogens. Waste water released from the farms may be highly saline, and also contaminated with bacteria and other pathogens. There is a potential disease risk to other organisms (particularly molluscs) in the nearshore environment, due to wastes from land-based shellfish farms being contaminated with bacteria, viruses or other pathogens. Regarding diseases, the mud worm (*Polydora* sp.), which has decimated shellfish farms in the northern hemisphere, has been recorded in one Port Lincoln hatchery. Another disease, the protozoan *Perkinsus*, has also been reported at South Australian farms. In America, bioculturists consider that a sabellid polychaete that has affected most of California’s abalone hatcheries may become established in native stocks. There is clear potential for its long range transference and successful colonisation, since it originated in South Africa and is now proliferating in Californian farms. Translocation of contaminated animals and spat is also a significant issue. A discussion paper by Fisheries Western Australia (1997) on abalone aquaculture in Western Australia, considered that an abalone culture environment can act as a reservoir for pathogens, due to the high culture densities and consequent increased physiological stress in cultured animals. However, the report considered it unlikely that high numbers of escaped disease organisms could survive in the wild, since the conditions are different from a culture environment, and wild abalone occur in lower densities than in farms. Furthermore, there are differences between the culturing facilities and the receiving environments in water temperature and other physical parameters, which may serve to reduce the risk in some areas. Nevertheless, there was still a recommendation for sound management practices and regular disease testing. The EPA in Western Australia has developed protocols for translocation, quarantine and disease testing. Apart from potential disease risk, there is evidence from overseas that shellfish farm effluents, such as organic faeces and nutrients, can (i) reduced oxygen concentrations in the receiving waters; (ii) stimulation of algal blooms; (iii) change to benthic species composition; (iv) death of

seagrasses which cannot tolerate the nutrients, organic particles, turbidity and lowered light conditions; (v) physical and chemical contamination of the benthic environment; and (vi) death of native benthic organisms, causing proliferation of “nuisance” (i.e. opportunistic) species. The extent of such effects depends upon the volume and composition of the effluent and/or sludge being released, amongst other factors. The temperature of the effluent water may also be of concern, if water released is warmer than the receiving water. There are many methods of control and remediation that are being used around the world to overcome the impacts associated with abalone aquaculture, and many of these methods are also relevant to culture of abalone in South Australia.

9.2.4 Fishing Issues

- A number of species are classified as *fully fished* in South Australia, and there is evidence that some species are over-fished, as discussed below. Additionally, a number of species for which stock assessments are not undertaken, have population characteristics that make them vulnerable to over-exploitation. Examples are provided for particular species in the following sections, and also discussed in the tables on *Issues for Risk and Impact Assessment*, for particular areas. In general, for fish, shark and invertebrate species which have a strong habitat association at any of the life stages, or for any of the life history processes (e.g. juvenile development, feeding, spawning), marine protected areas are considered one of the more useful management tools to prevent population decline, and to restore depleted populations. Examples for various species are provided in reviews by Fairweather and McNeill (1993), Rowley (1994), Kripke and Fujita (1999); Baker (2000), Roberts and Hawkins (2000) and Ward *et al.* (2001). Note that fished species in S.A. which do not have a strong habitat association at any stage of the life cycle, but for which there is conservation concern, are not discussed below. Examples include Southern Bluefin Tuna, and Pilchards. The conservation significance and status of such species is discussed in other sections of this report, in relation to locations within S.A. where the species are fished. Examples of fished species which have a habitat association at some stage(s) of the life cycle, and for which there is concern about the status of the populations in S.A., include the following:
- ♦ *Snapper*: The species is classified as fully fished in South Australia (DEHAA and EPA, 1998). Snapper is one of the main scalefish species taken by commercial and recreational fishers in South Australia, and the regional importance of the species is discussed in tables for a number of the recommended areas. McGlennon and Jones (1997), Fowler (2000 and 2002) and Fowler *et al.* (2003) provided recent assessments of the Snapper fishery in South Australia. In 2001/02, the State-wide snapper catch (647.6t) was the highest ever recorded, and the majority of the commercial catch was taken with handlines (Fowler *et al.*, 2003). There are concerns about the decline of snapper populations in both gulfs (Anon., 2001b). In some areas of the state, populations apparently declined throughout the 1980s and 1990s, which prompted a more recent (early 2000s) state-wide fishing ban in November each year. Previously, the decline in the fishery was particularly evident in southern Gulf St Vincent and Investigator Strait (McGlennon and Jones, 1997). According to PIRSA (Anon, 2000a), the fishery for Snapper in southern Gulf St Vincent declined significantly during the 1980s, and did not recover by the turn of the century, which prompted the call for a “rebuilding strategy”. The fishery in Gulf St Vincent is reported to be now showing signs of “slow recovery” (Fowler *et al.*, 2003). Concern has also been expressed about the capture of larger, older fish in northern Spencer Gulf. Some researchers and fishers in S.A. consider that the Snapper fishery is over-exploited, due to decline in the number of large (older), high-fecundity fish available in the fishery, amongst other indicators. Larger, older Snapper are easily captured due to their strong association with natural and artificial reefs, such as those in northern Spencer Gulf. There is some evidence from tagging to show that adult Snapper return to

“home reefs” annually to spawn (Fowwler et al., 2003), and thus would be particularly vulnerable to capture at that time. Additionally, Snapper populations are vulnerable to decline because the species is subject to sporadic “boom” recruitments, which results in irregular “pulses” in year class strength, and these irregular large recruitments (e.g. 1 year in 10) are required to sustain the fishery for a number of years (Anon., 2001b). The irregular large recruitments of Snapper; the long-lived nature of the fish; the aggregative nature of large Snapper at a number of sites; and the ease of capture, requires that the fishery for this species be cautiously managed over the long term. This has not occurred to date, other than the introduction of the State-wide seasonal closure during the early 2000s, and the use of minimum size limits, and bag limits and boat limits for the recreational fishery. It is noted that the commercial catches in the early to mid-2000s were the highest ever recorded, despite the November closure. Over-fishing of snapper populations may also have ecological impacts. Because Snapper are wide-ranging, relatively long lived, and have age/size classes that occupy different habitats and ecological niches, they may have considerable ecological significance in the habitats in which they occur. Snapper habitats include shallow, seagrass-lined nursery areas (for juvenile snapper); sediment-covered calcareous reef flats; and deeper water patch reef, sand, mud and seagrass / sand gutter habitats. Little detailed information is available regarding snapper ecology, however significant work has been undertaken in New Zealand on the feeding habitats and food preferences, and there are also studies from South Australia indicating habitats and food preferences. 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). It is noted that “no-take” marine protected areas have been shown to be an effective way of replenishing stock numbers of slow-growing, long-lived, site-associated fish species (see Baker, 2000, and Ward et al., 2001, for reviews), and Snapper is an example of such a species.

- ♦ ***King George Whiting:*** This fish is one of the most popular species for recreational and charter boat fishers in South Australia, and also supports a commercial fishery over much of its range. During the past decade, there has been a substantial drop in the commercial catch and effort (McGarvey et al., 2003), with many scalefish fishers now targetting other species instead of King George Whiting. Whilst some of the reduced effort may be due to changes in the fishery structure (such as a smaller number of licences in the fishery), it is clear that reduced abundance of King George Whiting has prompted some fishers to stop fishing King George whiting commercially, and in some cases target other species. McGarvey et al. (2000 and 2003) provided catch and effort statistics for the commercial fishery, and a continuing decline in catch and effort is evident in most areas of the State. The combined commercial and recreational catch during 2000-2001 was estimated to be about 1024t, only 43% of which was taken by commercial fishing (McGarvey et al., 2003), which indicates the significance of this species for recreational fishers in South Australia. Larger, older fish are found in the deeper, more exposed gulf waters, and deeper waters of northern Kangaroo Island, and the west coast. New recruits are found in shallow, upper gulf waters and west coast bays, and there are numerous nurseries for whiting in these areas (see Jones *et al.*, 1990). The majority of each year class is fished heavily by both commercial and recreational fishers when the whiting reach legal size, after moving out of the shallow bays. Smaller King George Whiting are also caught in the bycatch from prawn trawling (see section below, on prawn trawling). In addition to the heavy fishing pressure on the new recruits, both commercial and recreational fishers (the latter also including charter boats²) also target the larger, older whiting in deeper waters. There is a significant fishery for the larger, older King George Whiting that have moved out of the shallow bays closer to shore, into deeper water. Fowler and McGarvey (1997) recommended that there be sufficient escapement of immature fish, and the main targeted age class (2 to 3 year olds) from heavily fished inshore areas, to enable sufficient numbers to annually replenish spawning populations, which appear to be restricted to a few specific locations in South Australia, such as lower Spencer Gulf and northern Kangaroo Island waters (see Fowler and McGarvey, 1997; McGarvey *et al.*, 2000, 2003). The larger, older King George Whiting may be important

² In recent years, concern has been expressed about the total catch from charter boats (which is unquantified, and has been largely unregulated, to date), particularly the catch of larger King George Whiting that contribute to the spawning stock in offshore waters (e.g. see McGarvey et al., 2000; 2003).

contributors to spawning potential of the stock. It is also noted that heavy fishing since the middle of the 20th century may have affected whiting population dynamics, as suggested by Cockrum and Jones (1992), who reported that the average size of whiting at first spawning has decreased by several centimetres since the 1950's, believed to be due to fishery-induced selection pressure for fish to become fecund earlier in life. This phenomenon is considered to be an "adaptation response" of the heavily fished whiting populations to their increased mortality rate and generally shorter life span. In recent years, there has been concern amongst both scientists and fishers about a possible decrease in the King George Whiting population as a whole, and also regional decreases in abundance. There has been some evidence for declining recruitment to the fishery, at least since 1999 (McGarvey *et al.*, 2003), and possibly much longer. Concern has been expressed (e.g. see McGarvey *et al.*, 2000, and references therein) about the need to protect the spawning stock of larger whiting, that are fished commercially and recreationally in the areas where they occur. McGarvey *et al.* (2000) recommended additional regulatory measures to protect the spawning stock of King George Whiting. It is noted that, despite the very large effort on research and management of this fishery from the 1980s to the 2000s, a recent stock assessment report (McGarvey *et al.*, 2003) indicated that data (particularly recreational data) are still inadequate for a reliable stock assessment.

- ♦ *Garfish*: The species is fished commercially, and is also one of the most popular recreational fish species in some parts of the State. Garfish is a schooling species, particularly over shallow seagrass beds, and is therefore readily captured by line fishing and netting methods. Although commercial catch rates have generally been stable since the 1980s, Garfish is classified as a *fully exploited* species in South Australia (DEHAA and EPA, 1998; Ye, 1999), according to available biological performance indicators (BPIs) (see Ye, 1999; Ye, cited by Anon, 2001a; Jones *et al.*, 2002). Garfish now mature at a smaller size than was observed 40 years ago, believed to be a response to heavy fishing levels (Ye, 1999; Ye, cited by Anon., 2001a; and see also Jones *et al.*, 2002 for a detailed assessment of the stocks and the fishery).
- ♦ *Yellow-fin Whiting*: This species is more abundant in the warmer waters of the upper gulfs, than any other part of South Australia. Ferguson (1999 and 2000) provided a detailed overview of the stock status of Yellow-fin Whiting in South Australia. Cautious management of the fishery for Yellow-fin Whiting has been advised, based on the following factors (adapted from Ferguson, 1999): (i) older age classes are not common, and have been found mainly in parts of Spencer Gulf. In that gulf, fishing in the commercial grounds is considered to be responsible for a reduction in the relative abundance of older age classes; (ii) recruitment and year class strength are highly variable over space and time, likely due to oceanographic factors; (iii) the contraction of the size range in the fishery may indicate smaller numbers of the major egg producers in the population (i.e. the older females), and ultimately a decline in egg production; (iv) fisheries which target young fish (as occurs in Gulf St Vincent, where 2-year old Yellow-fin Whiting dominate the catch) are dependent upon continued high annual recruitment levels, and recruitment levels and subsequent year class strength are likely to strongly influence the biomass available to the fishery; and (v) the recreational fishery for Yellow-fin Whiting is active at a time when these fish are reproductive. Due to steadily increasing market value of Yellow-fin Whiting since the 1980s, annual commercial catches from upper Gulf St Vincent have been increasing in most years throughout the 1990s (compared with yields from the 1980s). It is also noted that targetted effort on this species by commercial netters has increased by about 100% during the past few years, in response to netting bans in some areas where King George whiting were previously netted, and the consequent shift towards targetting Yellowfin Whiting rather than King George whiting (McGarvey *et al.*, 2003).
- ♦ *Western Blue Devil: Paraplesiops meleagris* is endemic southern Australia states (Hutchins and Swainston, 1986; Edgar, 2000), and is a territorial species that occurs in the vicinity of inshore rocky reefs and caves (Scott *et al.*, 1974; Kuitert, 1996a; Edgar, 2000; Froese and Pauly, 2001). The species is captured in South Australia by spear fishers (Ottaway *et al.*, 1980), and also fished recreationally for food in S.A., Victoria and WA (see Baker, in press for examples), because the flesh is considered quite palatable (Froese and Pauly, 2002). Capel (1994) provided an example of a

South Australian reef location promoted for recreational fishing of Western Blue Devil. Complete protection from spear-fishing was first suggested for S.A. populations of Western Blue Devil back in 1967, by Dr S. Shepherd. Otway *et al.* (1980) also recommended protection for this species. A related species, the Eastern Blue Devil (*P. bleekeri*), not found in S.A., is listed as a Protected Species in NSW, and *P. bleekeri* has also been included on Australian Society for Fish Biology 2001 list as *Conservation Dependent* in status. Site-attachment to reefs, strong territoriality, and the solitary and inquisitive nature of this species, makes near-shore populations vulnerable to population decline, particularly by spear-fishing. As with the related Eastern Blue Devil, the secretive habits of the species makes its conservation status difficult to assess, however Pogonoski *et al.* (2002) suggested that the main threats to Devilfish species may be recreational fishing; habitat degradation in inshore areas, and collection for the aquarium trade. As with the Eastern Blue Devil (see Pogonoski *et al.*, 2002), habitat protection is required to protect the breeding populations of this species.

- ♦ *Western Blue Groper*: The wrasse species Western Blue Groper *Achoerodus gouldii* is a long-lived (to around 50 years, according to Gillanders, 1999), slow growing, site-associated fish, with population characteristics that make it vulnerable to over-exploitation (Jones *et al.*, 1990; Shepherd *et al.*, 2002; Pogonoski *et al.*, 2002; Shepherd and Brook, 2003). The Western Blue Groper appears to live in small social groups that comprise one male, two to three females and a few immature fish (Gillanders 1999, cited by Pogonoski *et al.*, 2002). The species eats crustaceans, molluscs and echinoderms, and groper may be a keystone species. Western Blue Groper has long been considered by some researchers in S.A. to be potentially threatened, and in need of full legislative protection, due to previous and ongoing depletion of inshore (and more recently island) populations by spearfishing, recreational line fishing and charter boat fishing, in addition to potential impacts on offshore populations due to bycatch in Commonwealth shark fisheries and scalefish trawl fisheries (Otway *et al.*, 1980; Jones *et al.*, 1990; Pogonoski *et al.*, 2002; Shepherd and Brook, 2002 and Shepherd *et al.*, 2002). Western Blue Groper in South Australia has been described as “highly vulnerable to over-exploitation” (Jones *et al.*, 1990). Juveniles occur in shallow inshore areas (see Shepherd *et al.*, 2002, and Shepherd and Brook, 2003), and move offshore with increasing size, to coastal and offshore reef locations, to depths of at least 40m (Kuiter, 1996). Juveniles in inshore habitats are vulnerable to spear-fishing and line fishing, and, because the young do not resemble the adults in colour, they may often be misidentified, and therefore killed and discarded, or used for bait when caught (see Shepherd *et al.*, 2002; Shepherd and Brook, 2003). Adults in deeper waters are taken by charter boat fishers, commercial fishers, and as bycatch in Commonwealth shark and trawl fisheries, and in Rock Lobster pots. Fully grown adults reach 1m or more in size, and large adults are highly sought after by sports fishers (e.g. in West Coast and southern Spencer Gulf waters). Adult Blue Groper are generally found in lower numbers in the more accessible areas of SA and WA due to higher fishing pressures (Hutchins and Swainston, 1986, cited by Pogonoski *et al.*, 2002). Previously (around 1980), divers reported that Western Blue Groper numbers were rapidly declining in areas south of Adelaide, evidently as a consequence of exploitation by fishers, including spear-fishers (Glover, 1987, cited by Pogonoski *et al.*, 2002). Since that time, the species has been protected in South Australian gulf waters under the *S.A. Fisheries Act 1982*, (with fishing prohibited in Spencer Gulf, Gulf St Vincent, Investigator Strait and Backstairs Passage). Western Blue Groper is still vulnerable to decline in other parts of the State. Examples of locations where the species is fished commercially, recreationally, and by charter boats, are provided in the tables below for various areas (see **Notes on Social and Economic Values, and Issues for Risk and Impact Assessment**). There are legal minimum sizes and catch limits in both South Australia and Western Australia, and possession limits in Commonwealth fisheries. Previously, Western Blue Groper was listed by the Australian Society for Fish Biology’s (ASFB) Threatened Fishes Committee (1985) as being *Vulnerable* in long term (10-15 years) (Harris, 1987, cited by Pogonoski *et al.*, 2002), and more recently, the species has been recommended for listing as *Conservation Dependent* in southern Australia (ASFB, 2001; Pogonoski *et al.*, 2002). Requests for full legislative protection of Western Blue Groper from fishing in South Australia have been recorded for over 20 years (e.g. see Otway *et al.*, 1980). The related species Eastern Blue Groper *Achoerodus viridis* (found in Victoria, NSW and Queensland), is a protected species in New South Wales. Pogonoski *et al.* (2002), suggested that continued survival of this species in southern Australian waters may rely on its protection from over-fishing by line fishers (commercial and

recreational) and spear-fishers (recreational). There is currently (2002+) a program (led by Dr S. Shepherd) to determine the distribution and relative abundance of groper, including juveniles, in various parts of South Australia. Blue Groper is currently one of the subjects of a community-based Reefwatch "Feral and In Peril" program in South Australia, which aims to monitor the distribution and abundance of a number of potentially threatened species at various diving and snorkelling locations around the State.

- ♦ Blue-throated Wrasse and other large Wrasse species: Blue-throated Wrasse is caught by commercial and recreational line fishers, spear fishers, and charter boat fishers in South Australia. Near-shore populations of Blue-throated Wrasse, Orange-spotted (i.e. Brown-spotted) Wrasse and the smaller species Senator Wrasse may be potentially vulnerable to over-exploitation by spearfishing and line fishing, due to behaviours such as strong site association with macroalgal-covered reefs and other nearshore reefs; territoriality (particularly during breeding season) and inquisitive nature. Blue-throated wrasse may be a keystone marine species (see Shepherd and Clarkson, 2001), hence fishing impacts on the species itself may have wider ecological ramifications. Shepherd *et al.* (2002) and Shepherd and Brook (2003) discussed some of the issues associated with the recreational fishing of Blue-throated Wrasse in parts of South Australia. It is probable that populations of some other wrasse species have also declined in nearshore waters of some parts of S.A., due to spearfishing and linefishing impacts. In the past, wrasse species have been taken in spear-fishing competitions in S.A. (see Johnson, 1985a and 1985b). Offshore populations of these three wrasse species are commercially fished. In South Australia, commercial wrasse catches have increased rapidly since the mid 1990s (see Knight and Johnson, 1999, and Knight *et al.*, 2002). Senator Wrasse is the smaller component of this increasing commercial catch of 3 wrasse species in S.A., and the majority taken is Blue-Throated Wrasse. Wrasse species are also taken as by-catch in lobster pots, in the Southern Rock Lobster fishery in S.A.. For example, Prescott (2001), reported that the second largest proportion of bycatch in the Northern Zone as a whole, according to a sampling of 32,000 pots in 1991 - 1992, was wrasse species, principally Blue-Throated Wrasse. See Baker (in press) for a summary of the conservation status of (and risks to) these and other wrasse species in South Australia, such as Purple Wrasse (for which Robe is the western limit of distribution), Maori Wrasse, and Rosy Wrasse.
- ♦ Harlequin Fish: The species, which is endemic to S.A. and W.A., occurs on shallow reefs to around 30m (Edgar, 2000; Froese and Pauly, 2003). Harlequin Fish, including large adults, are targeted by recreational line fishers and charter boat operations in various parts of South Australia (see Baker, in press for examples). Harlequin Fish is also promoted as a species for spearfishers to catch in S.A. (Smith, 2000; International Freediving and Spearfishing News, undated). In the past, Harlequin Fish was one of the targeted species in spearfishing competitions in South Australia during the 1970s and 1980s (see Ottway *et al.*, 1980; Johnson, 1985a and 1985b). Harlequin Fish are also caught in small numbers, as bycatch in the South Australian Rock Lobster Fishery (Sloan, 2003). The National Recreational and Indigenous Fishing Survey (Henry and Lyle, 2003) reported that 140 Harlequin Fish were caught and kept by recreational fishers in South Australia during the survey time period (May 2000 to April 2001), considerably fewer than the number caught in W.A. (i.e. 4,837 Harlequin Fish). It is likely that because W.A. is the main part of the species range, the species is more abundant in that State than in S.A., and recreational fishing records appear to support this. Near-shore population members may be potentially vulnerable to decline, due to their solitary nature, strong site association with reefs and caves, relatively slow growth, and inquisitive nature / attraction to divers. These characteristics are known to have made the species populations in South Australia susceptible to impacts from spear fishing, and Harlequin Fish numbers are reported to have been reduced in accessible areas of South Australia due to "heavy spear-fishing pressures" (Hutchins and Swainston, 1986). There is a paucity of information about population sizes, and the effects of fishing on the population dynamics of this species. Harlequin Fish is currently one subject of a community-based Reefwatch *Feral and In Peril* program in SA, which aims to monitor the distribution and abundance of a number of potentially threatened species at various diving and snorkelling locations around the State.

- ♦ Dusky Morwong: This fish species is vulnerable to over-exploitation, particularly by spearfishers and line fishers, due to the strong habitat associations of both adults and juveniles, the large size, and the ease of capture of both adults and juveniles, using a number of fishing methods (e.g. spear, line, trap). Juveniles usually occur in shallow waters, on macroalgae-covered reefs or in shallow seagrass beds, and are easily targeted by spearfishers and line fishers. Adults often occur in seagrass beds or sand near seagrass, or around rocky outcrops, to around 30m (Kuitert, 1993; Edgar, 2000). Dusky Morwong can grow to 1m long in areas where fishing pressures are minimal (Edmunds *et al.*, 2000), however large fish are not often seen in nearshore areas, in populated parts of South Australia, due to fishing pressures. There is anecdotal evidence from spearfishers of declines in a number of near-shore reef areas of SA, particularly in Gulf St Vincent. Some spearfishers reported having caught “many pounds” of Dusky Morwong per trip to nearshore reefs in past years, but that abundance has visibly declined in a number of areas (e.g. nearshore reefs in southern Gulf St Vincent). Dusky morwong is considered a traditional food for the Narungga tribe of aborigines on Yorke Peninsula, and it is reported that “quite a lot of fish” are speared in the area near Port Victoria (Bellchambers, 1999). There are no recreational no bag limits or boat limits or minimum sizes for Dusky Morwong in South Australia. The species is also caught as bycatch in Commonwealth fisheries; bycatch action plans have recently been developed. Dusky Morwong was first recommended for formal protection against spearfishing by S.A. Shepherd in 1967, and again in 1980 (Ottway *et al.*, 1980).
- ♦ Other site-associated reef fish species: Examples of site-associated reef fish species which are potentially vulnerable to over-exploitation by spear-fishing and/or line fishing, include *Morwong* species, *Boarfish* species, *Sweep* species, and various species of *Leatherjacket*. For example, Sea Sweep and Banded Sweep are strongly site-associated (territorial), and considered vulnerable to localised depletion (e.g. see submissions in Rohan *et al.*, 1991). Sweep species, Magpie Perch, Morwong species, and Long-snouted Boarfish are targeted by both spear-fishers and line fishers in South Australia. Sea Sweep (*Scorpius aequipinnis*) and Banded Morwong (*Cheilodactylus spectabilis*) were two of the most commonly caught reef fish species taken during spearfishing competitions in some parts of S.A., such as Encounter Bay, during the 1980s (e.g. see Johnson, 1985b). Banded Morwong is not common throughout most of South Australia, being confined mainly to the South-East of S.A., Victoria and Tasmania. Long-Snouted Boarfish is site-associated, particularly near reefs with caves and ledges, and has been described, in general, as “easily speared and entangled in gill nets, and therefore rare near heavily fished coast” (Edgar, 2000). Some parts of S.A. are promoted in recreational fishing literature as areas where reef fish can be readily caught by recreational fishing vessels that can access the reef areas (e.g. see Capel, 1994; Sweeney, 1996, and examples in Baker, in press). Also, Western Talma and Moonlighter are examples of species that are not usually targeted, but have been captured by some spear-fishers in nearshore areas, with potential for localised depletion in nearshore areas.
- ♦ Ocean Leatherjacket: The species was classified as “fully fished” in 1998 (DEHAA and EPA, 1998). The fishery developed rapidly in S.A. during the mid to late 1980s. The catch listed as part of the S.A. Scalefish fishery was as high as 917t in 1989/90, and 1008t in 1991/92. During the following 9 years, the annual catch of Ocean Leatherjacket reported in the SA Scalefish fishery declined every year, to around 260t in 2000/2001 (Knight *et al.*, 2002). The species has been taken in larger quantities in deeper, Commonwealth-managed waters off the eastern Great Australian Bight and southern tip of Eyre Peninsula, with catches as high as 100t - 400t per 1 degree fishing block in some years of the late 1980s (see Grove-Jones and Burnell, 1991). The species is still caught as a major part of the bycatch in the GAB Trawl Fishery, and a 2000/2001 bycatch survey showed that up to 75% was discarded in the Central Zone i.e. eastern GAB (average discarded catch of 165kg per trawl shot), and only the larger animals were retained (Brown and Knuckey, 2002). There appears to be inadequate management of the tonnage of this species taken as both target and bycatch, at both State and Commonwealth levels. It appears that no adequate stock assessment has been undertaken by the Commonwealth fisheries authorities, and the relatively low commercial value of the species means that there has also been little work at State level to ensure sustainability of the resource.

- ♦ Mulloway: The species is popular with recreational / sports fishers in some areas of SA, such as the Coorong / Murray Mouth, and the Far West coast, particularly the surf beaches (PIRSA, 1999b). Mulloway is an ocean spawner, but requires freshwater outflow from rivers/estuaries for successful recruitment, and therefore is an “estuarine dependent” species (USEDSEFM Steering Committee, 1993). In the Murray Mouth area, population levels of Mulloway are considered to be now reduced, principally due to altered flow regime (and the consequent effects upon Mulloway population dynamics), modified estuarine habitat, and over-fishing (both commercial and recreational)³ (see Chapter 4.4 in Edyvane *et al.*, 1996, and PIRSA, 1999b). The diminished flow of the River Murray water has led to a decline in the abundance of Mulloway (PIRSA, 1999b). A regular flow of water out of the Murray Mouth is considered important to ensure sufficient spawning to maintain recruitment. There is recent evidence of a small, genetically unique, geographically isolated population of Mulloway at the Head of Great Australian Bight. The population is believed to aggregate in the area due to outflow of subterranean fresh water. The GAB population, which is highly localised, is considered to be over-fished to the extent that it is now uneconomically viable to exploit (Jones, SARDI, pers comm. to K. Evans; 2000). Mulloway may be considered potentially vulnerable in S.A. due to the estuarine-dependent phase in its population dynamics. There is little freshwater outflow along the Far West Coast, and such estuarine conditions are important in the reproduction of this species. Overall, there is heavy fishing pressure by both commercial and recreational fishers on Mulloway in South Australia. Additionally, recreational catches (including catches over the bag limit) appear not to be adequately monitored in South Australia. For this species, there has been unpublished evidence of recreational catches above the bag limit in some parts of South Australia. A number of submissions received by the S.A. Department of Fisheries during the early 1990s (Rohan *et al.*, 1991) requested additional protection measures for Mulloway due to adverse changes in critical habitat for Mulloway. Reduction in bag limits, and a non-fishing zone (MPA) within 1km of either side of the River Murray mouth, were suggested as protection measures (see Jones *et al.*, 1990 and 1991). Recreational fishing regulations for this species were changed in 2001, in response to concerns about stock abundance.
- ♦ Rock Ling: In Australia, the benthic fish species *Genypterus tigerinus* occurs around the south coast (including Tasmania) to south-western Western Australia (Australian Museum, 2000; Froese and Pauly, 2003). The species is found in South Australian coastal waters, but is relatively uncommon. Juveniles inhabit seagrass estuaries, and adults inhabit reef areas, usually in deeper waters than the juveniles (Kuitert, 1993 and 1996a; Edgar, 2000; Australian Museum, 2000). Rock Ling is well regarded as a food fish, is considered “an important recreational fish” (Prokop, 2000; Froese and Pauly, 2003). The species is caught by spearfishers, and also by anglers, being taken as part of mixed catches (Prokop, 2000). In Tasmania, the species is also considered to be highly susceptible to gill netting (Edgar, 2000), and is caught by recreational gillnetters in that State (Lyle *et al.*, 2000). Rock Ling are also trawled in deeper coastal waters. The National Oceans Office Neptune Data Directory (2003) lists both *G. tigerinus* and *G. blacodes* (a deeper water species) as species caught in the Commonwealth-managed dropline and demersal (bottom) set longline fisheries (part of the South-East Non-Trawl Fishery), based on AFMA logbook data. In South Australia, capture of *G. tigerinus* is managed by the State within 3NM, and by the Commonwealth outside of 3NM (AFMA, 2002c and 2003a). Rock Ling is considered to be “an uncommon species” (Nielsen *et al.*, 1999, cited by Froese and Pauly, 2003). *G. tigerinus* is considered highly susceptible to spearfishing (Edgar, 2000), presumably referring to juveniles in estuaries and adults in shallower waters within spearfishing range (e.g. 5m – 20+m). Due to spearfishing and gill netting, Edgar (2000) reported that Rock Ling “appear to have virtually disappeared from much of the southern coast”. There is little information about the population sizes, biology or population dynamics of Rock Ling. Species-specific catch and effort data from commercial and recreational fisheries in State waters are inadequate, and there are no controls on the fishing of this species. In Tasmania, a depleted population of the species on the east coast has responded well to the protection offered by a marine reserve (see Baker, in press, and references therein).

³ (By-capture of Mulloway in shark and finfish fisheries in deeper Commonwealth waters is also an issue).

- ♦ Australian Grayling *Prototroctes maraena* may be considered vulnerable due to having a narrow habitat range (i.e. dependent upon a small number of estuaries, particularly in cool temperate regions), and impacts upon the quality of critical estuarine habitat. A large 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 (M. Hammer, Adelaide University, pers. comm., 2003). Previously, 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 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 *South Australian National Parks and Wildlife Act 1972*, and considered the species to be critically endangered in South Australia.
- ♦ Short-Finned Eel *Anguilla australis* is considered rare in South Australia (Native Fish Australia, 2002), and may also 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). 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*.
- ♦ Pouched (Wide-Mouth) Lamprey *Geotria australis* and Short-Headed Lamprey *Mordacia mordax* are dependent upon both freshwater and marine habitats. *G. australis* reportedly requires permanent creek / river headwaters in good ecological health to complete their life cycle (WRC of WA, 2000a). Both species may be considered vulnerable, due to narrow habitat range. Lampreys area dependent for part of the life cycle upon a small number of estuaries, particularly in cool temperate regions, and impacts upon the quality of critical estuarine habitat may affect these species. Although Pouched Lamprey and Short-headed Lamprey have a wide distribution in southern Australian States, they are not commonly recorded in South Australia. For example, during the early 2000s, neither species was recorded in a survey of the drainage system of the South-East of S.A., although both are believed to be present in a limited area (see Hammer, 2002). In southern Australia, lampreys are 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 lampreys are reported to die (Pen *et al.*, 1991, cited by WRC 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). The National Parks and Wildlife Council and Department for Environment and Heritage (2003) has recommended that both species be listed as *Endangered*, under a schedule of the *National Parks and Wildlife Act 1972*. See Baker (in press) for a more detailed discussion of the status of these species.
- ♦ School Shark and Gummy Shark: Both species are fished throughout South Australia, in State and Commonwealth waters (see **Notes on Social and Economic Values and Uses**). The commercial fishery is managed by the Commonwealth. School Shark (Australasian subpopulation) was listed

in the IUCN Red List 2003 as *Conservation Dependent*, and previously, Gummy Shark was included in the IUCN Red List 2000 and Red List 2002 as *Conservation Dependent*. According to AFMA (2002a), there is increasing uncertainty about the size and sustainability of the School Shark population. The latest agreed assessment for the School Shark population in the fishery reportedly shows “*extremely low numbers*”. In the 2001 assessment, productivity was estimated to be so low that under some scenarios, the agreed rebuilding of School Shark stocks to the 1996 level (by 2011) would be impossible under any level of Total Allowable Catch (TAC). If productivity is actually as low as the model currently predicts and it remains so, AFMA (2002a) considered that an unacceptably long time frame of 15 years would be required to rebuild the stock. At the 44th meeting of the Southern Shark Fishery Management Advisory Committee (SharkMAC), the committee recognised that the current ambiguities of the School Shark assessment will continue for at least 3-4 years until a time series of fixed station survey data is accumulated. In 2004, the Australian Government Department of Environment and Heritage (formerly Environment Australia) received a nomination from Humane Society International (HSI) to list the School Shark as a Vulnerable species under the *EPBC Act 1999*. In 2004, HSI also proposed that the Australian Government pursue the listing of species in the Triakidae (Hound Sharks) under Appendix II of CITES (the *Convention on International Trade in Endangered Species of Wild Fauna and Flora*), to regulate the impact of international trade on populations.

- ♦ *Bronze Whaler and Black Whaler Sharks*: Adult and young whaler sharks are fished commercially and recreationally in South Australia (as both target and bycatch, the latter of which are often killed – according to Winwood, 1994), but figures are not currently available for this report. Bronze Whalers and Black Whalers have a number of population characteristics that make them susceptible to over-exploitation and population decline. For both Bronze and Black Whalers, the extent of the nursery areas is not well known, and overall there is reportedly little information on the status of both adults and juveniles (Froese and Pauly, 2003). Whaler sharks are relatively slow growing, have delayed maturity, low fecundity, and are viviparous (live bearing). All of these population characteristics make the two species vulnerable to over-exploitation. Bronze Whalers (Copper Sharks) have around 7 to 20 pups per litter (see Kailola *et al.*, 1993 and Last and Stevens, 1994, for population characteristics). The Black Whaler (Dusky Shark) also has a viviparous reproductive cycle that makes it vulnerable to decline from over-exploitation, with litter sizes varying from 3-14. Recent research suggests that the gestation period for Black Whalers may be as long as 22-24 months, and that there may be a one-year resting period between birth and mating. The reproductive cycle may be 2 to 3 years long. Black Whalers may live for 50 - 70 years (Camhi *et al.*, in prep., and Natanson and Kohler, 1996, cited by Pogonoski *et al.*, 2002). The Black Whaler has a very low resilience to exploitation (Froese and Pauly, 2003), and has one of the lowest intrinsic rebound potentials among coastal shark species, according to Smith *et al.* (1998, cited by FAO, 2000b). Newborn whaler sharks likely occupy distinct nursery areas isolated from the rest of the population, such as inshore areas off Western Australia (Last and Stevens 1994, cited by Pogonoski *et al.*, 2002). Some parts of S.A., such as upper Gulf St Vincent, are known for seasonal abundance of Bronze Whaler pups. Also, female whaler sharks migrate up into northern Spencer Gulf waters during the reproductive period. Shark nursery areas are recognised in other parts of Australia (e.g. Victoria and Tasmania) as significant in protected area systems. Castro *et al.* (1999) listed Bronze Whaler as a Category 3 species, due to its slow growth. Category 3 species are defined as: “*Species that are exploited by directed fisheries or bycatch, and have a limited reproductive potential, and/or other life history characteristics that make them especially vulnerable to over-fishing, and/or that are being fished in their nursery areas*”. Internationally, Black Whaler Shark was listed under the IUCN Red List 2003 as a *Near Threatened* species, and a similar status for Australian populations was recommended by the Australian Society for Fish Biology (2001 list of Threatened Species). FAO recommended that the exploitation of Black Whaler should be conducted with extreme caution and under close monitoring. The IUCN Shark Specialist Group (see Cavanagh *et al.*, 2003) recommended a global status of *Near Threatened* for Bronze Whaler Shark, and the recommendation was adopted by the IUCN Red List in 2003. In South Australia, stock assessments are currently being prepared by SARDI, for both species.

- ♦ Saw Sharks: There are two species in South Australian waters, the Common Sawshark *Pristiophorus cirratus*, and the Southern Sawshark *P. nudipinnis*. Saw sharks are taken as part of the Marine Scalefish fishery in South Australia (in low tonnages per annum), and are also caught in Commonwealth fisheries, mainly as bycatch, but in higher quantities than in the State-managed fishery (see Pogonoski *et al.*, 2002 and Baker, in press, for catch statistics). Examples of locations in S.A. where Saw Sharks are caught commercially include the deeper waters south of the Coorong; south of Kangaroo Island; south of Victor Harbor / Encounter Bay; west of the upper Coorong; the lower South-East of S.A.; the Far West Coast; and southern Eyre Peninsula (see **Notes on Social and Economic Values and Uses**). There is a low level of target fishing for *P. cirratus*; most of the catch of this species is taken as byproduct to targeting Gummy Shark *Mustelus antarcticus*. One threat is their capture from fishers targeting *M. antarcticus* with gillnets of 6–6½-inch mesh-size off S.A. (Walker, 1999), Victoria and Tasmania (Walker and Simpfendorfer, in Cavanagh *et al.*, 2003). In addition, small quantities of *P. cirratus* are taken by the Great Australian Bight Trawl Fishery (Walker and Simpfendorfer, in Cavanagh *et al.*, 2003). Although *P. cirratus* is caught mainly as a bycatch, the fisheries involved in southern Australian waters are extensive and, according to Pogonoski *et al.* (2002), have the potential to impact on the populations, as most specimens are discarded dead. With changes to the management of the Southern Shark Fishery it is possible that this species may be targeted more (C. Simpfendorfer, pers. comm., cited by Pogonoski *et al.*, 2002). Although saw sharks are taken from many parts of S.A. coastal waters, catch statistics are not analysed, and there stock assessment data within S.A. is inadequate. 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. The Australian Society for Fish Biology (2001) recommended a listing of *Conservation Dependent*.
- ♦ Whiskery Shark: *Furgaleus macki* is a southern Australian endemic species, and thus has a very limited range on a global scale. Because the species occurs in commercially fishable quantities in south-western WA and across S.A., it is actively exploited in south-western Australia, and caught commercially across South Australia. The status of the species population in South Australia is not well known, compared with the south-western WA population, which has been extensively researched. Over the years, the biomass level of Whiskery Shark has been reduced significantly by commercial fishing in south-western Australia (IUCN, 2000), however there are recent management actions to improve the stock abundance (see references by McAuley in this report, and Cavanagh *et al.*, 2003). Due to its limited distribution, the Whiskery Shark is considered in principle to be more susceptible to extinction risk than wide-ranging sharks (FAO, 2000a), although the current levels of research and management of this species serve to reduce that risk in the foreseeable future (Simpfendorfer, 2000, cited by Froese and Pauly, 2003). In W.A., a biomass target of 40% of the unfished biomass by 2010 was set in 1997, however the most recent assessment of effort level risk analysis indicated that there was only a 6.5% probability that this target would be met (McAuley, 2000, cited by R. MacAuley, pers. comm., 2003). 2003 IUCN Shark Assessment Group (Cavanagh *et al.*, 2003) recommended that the species be classified as *Lower Risk – Least Concern* globally, a downgrading from the IUCN Red List 2002 status of *Lower Risk - Conservation Dependent*. The more recent recommendation was based upon the ‘tight management’ of the fishery in Western Australia. Pogonoski *et al.* (2002) suggested *Lower Risk - Conservation Dependent* on an Australia-wide basis. See Baker (in press) for further information on the fishery and the conservation status of this species.
- ♦ Dog Sharks: Dog sharks are caught commercially and recreationally in some parts of South Australia (e.g. 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 Spiny Dogfish (*Squalus acanthias*). In South Australia, the species is rarely targeted, with catches in most years being taken whilst fishing for other species. Catches from the mid 1980s to the mid 1990s, have ranged from around 2.8t to 262t per annum, with catches of less than 30t per annum in 8 of the 11 years for which data are available (see SARDI data, in Baker 2004). Piked Spurdog *S. megalops*, a deeper water species (Hutchins and Swainston, 2001), has also been recorded some parts of South Australia (e.g. see Carrick, 1997). IUCN Red List 2003 recorded the conservation status of Spiny Dogfish as *Lower Risk - Near Threatened*, and status of Piked Spurdog as *Data Deficient*.

IUCN (2002) stated that there is inadequate information to assess the species status of *S. megalops*, particularly regionally in southern Australia. The species conservation status of *S. acanthias* and *S. megalops* were reviewed in 2003 by the IUCN Shark Specialist Group, and both are 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). 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 reported to be near the lowest for any known shark, 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).

- ♦ *Wobbegong (Orectolobus) species*: The Spotted Wobbegong (*Orectolobus maculatus*) and the Banded or Ornate Wobbegong (*O. ornatus*) are both taken by commercial and recreational fishers in southern Australian states, including South Australia. On a national basis, Wobbegongs are commonly caught in trawls, beach seines, gill nets, lobster pots and traps, and by hook-and-line, and by spearfishing. Spotted Wobbegong flesh is more highly regarded in some parts of the country, however it is considered of low value in others (e.g. W.A.) (R. McAuley, W.A. Fisheries, pers. comm., 2003). In New South Wales, there is a target commercial fishery for Wobbegong species, and there is concern about the status of stocks, due to overfishing (see Anon, 2003c; Huvneers, 2003; N.S.W. Fisheries, 2003). Wobbegongs are part of the bycatch in W.A. Temperate Shark Fishery (WATSF), but generally only the larger animals are retained (McAuley and Simpfendorfer, draft report, 2003). The Banded Wobbegong is the most common wobbegong taken as bycatch in the WATSF (McAuley and Simpfendorfer, draft report, 2003). In southern Australia, wobbegongs are also taken in the Great Australian Bight Trawl Fishery (GABTF), the South East Trawl Fishery (SETF), the Southern Shark Fishery (SSF), and, in the case of Banded Wobbegong, the South East Non-Trawl Fishery (SENTF) (AFMA logbook data, unpublished, cited by Pogonoski *et al.*, 2002; Brown and Knuckey, 2002). Most of the forementioned Commonwealth fisheries take these species as bycatch, and like many bycatch species, they are often utilised. Some of the Commonwealth fisheries that catch this species as bycatch, operate in deeper waters off South Australia, but available information shows that catches may be low. For example, a study by Walker *et al.* (in press) of the bycatch from South Australia in the Commonwealth-managed Southern Shark Fishery, showed that the number of Spotted Wobbegong *Orectolobus maculatus* taken is minor, with 4 recorded (and retained) during the period 1998-2001. In South Australian waters, available commercial catch statistics indicate that the catches of Wobbegong are small in most parts of S.A. (e.g. in the order of low tonnes, in a number of the 1-degree fishing blocks in some areas of the state, during 1995/96 and 1996/97). Wobbegong are also taken by recreational fishers in South Australia. There is some unconfirmed evidence (from fishing reports) of relatively high numbers of benthic sharks, being taken by recreational fishers in the more accessible coastal waters in parts of South Australia. Examples of location in S.A. where Wobbegongs are taken by recreational fishers, include southern Fleurieu Peninsula, and southern Yorke Peninsula. The recent National Recreational and Indigenous Fishing Survey (Henry and Lyle, 2003) reported that 252 Wobbegongs and Carpetsharks (unspecified species) were caught and kept by recreational fishers in South Australia during the survey time period (May 2000 to April 2001). However, this is a small proportion of the National total recorded during that survey (i.e. 5,174 Wobbegongs, comprising 1,944 from N.S.W., 999 from Qld, 252 from S.A., and 1,978 from W.A.). It is noted that 6,858 unidentified sharks caught by South Australian recreational fishers during that survey period were reported only as "sharks", hence the figure cited above may be an underestimate. Wobbegongs are sometimes regarded as pests by lobster fishers, because they are adept at wedging themselves into lobster pots, to eat the catch and bait (Compagno, 1984, cited by Pogonoski *et al.*, 2002). Both the Spotted (*Orectolobus maculatus*) and the Banded or Ornate Wobbegong (*O. ornatus*) are components of the bycatch in the South Australian Rock Lobster fishery (Sloan, 2003), and when caught, they are retained for sale. During the 1990s, virtually

nothing was known of stock structure, stock size or population dynamics of wobbegongs (IUCN Shark Specialist Group, 1993). In response to the lack of existing knowledge of wobbegong biology and population dynamics of wobbegongs, in addition to concern about the state of the fishery in New South Wales, wobbegong biology, population dynamics, and the target fishery, are currently being investigated as part of a research project in N.S.W. (Huveneers, 2003; Marine and Coastal Community Network of N.S.W., 2003; Anon., 2003c; N.S.W. Fisheries, 2003). Wobbegongs have a number of population characteristics that make them susceptible to fishing-induced impacts. Wobbegongs are vulnerable to exploitation due to their presence in shallow habitats – e.g. coral and rocky reefs, under piers, and on sand bottom. Wobbegongs can occur in water barely deep enough to cover them, and have been observed climbing ridges between tide pools with their backs out of water (Compagno, 1984, cited by Pogonoski et al., 2002). Divers most often see the Ornate Wobbegong lying on the bottom during daylight hours (Australian Museum, 2003a, 2003b). A survey conducted in N.S.W. showed evidence of strong site association for wobbegongs. Pogonoski et al. (2002) suggested that wobbegongs may be territorial and thus particularly susceptible to fishing pressure, although further work is necessary in this area. Similarly in South Australia, divers in some areas (e.g. southern Yorke Peninsula) have reported that wobbegongs are sometimes seen in aggregations, however published evidence is not available for this report. Commercial fishing by a variety of methods, and recreational fishing, may be potentially threatening populations and contributing to a decline of both the Spotted and the Banded Wobbegong (Pogonoski et al., 2002), however, apart from the conservation concern prompted by the decline in wobbegong catches in the N.S.W. commercial fishery, there is little firm evidence for fisheries-induced population impacts, due to lack of data, and lack of information on the population dynamics of these species (Pogonoski et al., 2002). Protected areas may be a useful conservation measure, and a compliment to other fisheries management tools, for site-associated benthic species such as wobbegongs. It is noted that in 2003, the IUCN Shark Assessment Group (Cavanagh et al., 2003) recommended, for both species, a conservation status of *Lower Risk – Near Threatened* globally, and *Vulnerable* in N.S.W. Pogonoski et al. (2002) suggested for both species: *Data Deficient*, adopting the IUCN categories. The authors considered that there were insufficient catch statistics to validate any declines, but that the species needs to be closely monitored. The Australian Society of Fish Biology (2001) recommended a status of *Data Deficient*, for both species.

- ♦ *Elephant Fish / Shark*: The species *Callorhynchus milii* is a chimaera (a primitive group which have anatomical and physiological characteristics of both fish and sharks). In South Australia, Elephant Fish are caught commercially as a minor species in some parts of the State, for example, the deeper waters between Kangaroo Island and the Coorong, and parts of the South East. Annual catches during the mid to late 1990s were in the order of 500kg – 1 tonne in some South Australian fishing blocks. Statewide catches are confidential in most years due to the small number of fishers catching the species (i.e. 5 or less licences), however, the following statistics for total catch per annum are available: 1995/96 = 1.6t; 1996/97 = 1.5t; 1997/98 = 477kg. Elephant Fish was not a target species in any of those years (SARDI Aquatic Sciences data, 2003). Elephant Fish are also taken in some Commonwealth trawls (as both target and bycatch), and the catches are now limited by quota (Daley *et al.*, 2002). Elephant Fish are caught in Commonwealth fisheries operating off South Australia. A study by Walker *et al.* (in press) of the bycatch from South Australia in the Commonwealth-managed Southern Shark Fishery, showed that an average of 16 (S.E. = 5) and 9 (S.E. = 4) Elephant Fish are caught per 100,000 hook-hours (= 1000km hours), using 6 inch and 6 ½ inch mesh nets, respectively. The total catch over the 1998-2001 period was reported to be 23 animals, and around 82% of the catch was retained. Recreational and charter boat fishers in inshore waters in some parts of South Australia (e.g. north-eastern Kangaroo Island, Encounter Bay, and parts of the west coast) also seasonally target the female Elephant Fish that come inshore to deposit eggs. The species is also a minor component of the bycatch in prawn fisheries in South Australia (e.g. see Carrick, 1997). Elephant Fish have a number of vulnerable population characteristics. Female Elephant Fish migrate from deeper water (200+m) into shallow coastal waters to lay eggs, and each female lays a very small number of large eggs (e.g. two eggs). Elephant Fish is considered to be a potentially vulnerable species (Didier-Dagit, elephant fish biologist, pers. comm., 1999) due to their very low fecundity; “boom and bust”

recruitment levels; poorly known population dynamics; migratory behaviour; and vulnerability to capture when they are in shallow waters during spawning phase. Additionally, there is poor knowledge of population sizes, and little information on recreational and charter boat catch statistics. Elephant Fish have traditionally been commercially fished in south-eastern Australia for the “fish and chip” market, however during the past decade, the species has become an increasingly popular food fish targeted by recreational fishers and charter boat fishers, who target the spawning animals that have migrated to the shallows. Baker (in press) provided a more detailed summary of issues relating to the fishing of this species.

- ♦ Abalone: Greenlip Abalone *Haliotis laevis* and Blacklip Abalone *H. rubra* are the two main abalone species taken by commercial fishers in South Australia. The fishery is divided into 3 zones. In 2001 / 2002, around 140t (=137 Blacklip, and 3t Greenlip) were taken in the Southern Zone; around 194t (152t Greenlip; 42t Blacklip) were taken in the Central Zone, and around 557t were taken in the Western Zone (324t Blacklip and 233t Greenlip) (Knight *et al.*, 2002). Abalone are also taken by recreational fishers in South Australia. The recent National Recreational and Indigenous Fishing Survey (Henry and Lyle, 2003) reported that 8,267 Blacklip; 5,597 Greenlip; and 2,237 unspecified Abalone were caught and kept by recreational fishers in South Australia during the survey time period (May 2000 to April 2001). Abalone, particularly Greenlip, are vulnerable to fishing-induced population declines due to a number of population characteristics, such as their sedentary nature, ease of capture, small “home range”, localised reproduction and limited larval dispersal (Shepherd, 1987; Shepherd *et al.*, 1992; Rodda *et al.*, 1998); variable growth between metapopulations (“stocks”), and variable fecundity and fertility between metapopulations (Shepherd and Baker, 1996; Shepherd *et al.*, 1999). There is also a requirement for critical densities of adults to be present to ensure reproductive success (Shepherd, 1986a). Ward *et al.* (2001) reviewed the many population characteristics of abalone that render such species vulnerable to decline from over-fishing. The sustainability of abalone metapopulations depends upon maintaining adequate egg production and recruitment in the population, which is in turn linked to the number and density of adults. Maintaining the level of recruitment also ensures adequate larval dispersal to receiving (“sink”) populations that are not self-sustaining without larval import from neighbouring areas. Ensuring that there is an appropriate combination of size limit and exploitation rate is vital to the health of these populations (Shepherd *et al.*, 1999). Previously, Keesing and Baker (1998) and Shepherd and Baker (1998) provided some evidence of declines in long term yields, and in metapopulation abundance, respectively. Shepherd and Baker (1998) showed that smaller greenlip metapopulations are more vulnerable to decline than larger ones, and predicted that as large metapopulations are fished down to a smaller size, recruitment variability increases, so they become more vulnerable to decline. Slight overfishing can therefore destabilise a population, and if un-remedied, the population will go into a self-augmenting decline (Shepherd *et al.*, 1999). Shepherd and Baker (1998) provided examples of Greenlip Abalone populations in S.A which had declined, according to both fisheries data and independent survey, and Shepherd and Rodda (2001) showed that such trends are even more widespread than first predicted. Specifically, Shepherd and Rodda (2001) recorded long-term declines in Greenlip Abalone yields from more than 30 locations, mostly in the western part of South Australia, and the declines are considered to be an indicator of metapopulation (sub-stock) depletion. The period of assessment for individual metapopulations ranged from 10 years to 20 years, and a percentage figure for decline was calculated as present productivity (in 1998) as a percentage of original production (from 10 to 20 years previously, according to metapopulation). Statistically significant declines ranged from 50% to 99%, and areas of particular concern were centred on parts of southern Eyre Peninsula and the West Coast. Significant declines in other parts of South Australia have also been recorded (Shepherd *et al.*, 1999; Shepherd *et al.*, 2001). Fishery independent survey data for some of these meta-populations supported evidence for population decline determined from fisheries catch data. Keesing *et al.* (2003) provided statistics of long-term catch and effort in the South Australian abalone fishery. For many of the areas listed, disaggregated data show significant declines in catch since the 1970s. There is also some evidence for reduction in growth rate in heavily fished stocks of both Greenlip and Blacklip (see Shepherd *et al.*, 1999), believed to be caused by a reduction in genetic diversity. For example, over a 25 year period in Waterloo Bay, the growth rate of 2 - 3 year old Greenlip and Blacklip declined by 40% each, and

size at sexual maturity declined by 25mm. Shepherd et al. (1999) considered these changes to be indicative of fishing-induced rapid evolutionary adaptations, which select against fast growing individuals, and leads to “stunted” populations. Such changes may also have occurred in other metapopulations in the western Zone (see Shepherd and Triantafillos, 1997; Shepherd *et al.*, 1999). Blacklip Abalone appear to be more resilient to decline than Greenlip, due to their population structure and relative inaccessibility in some areas (Shepherd *et al.*, 1999). However, Shepherd *et al.* (1999) reported long term declining catches in Blacklip Abalone from 11 populations in Region A of the Western Zone, and 3 populations in the Southern Zone. The status of stocks in the Southern Zone cannot easily be determined due to a paucity of biological data. Whilst there is little evidence for significant declines in Blacklip populations (see references by Mayfield *et al.*, 2002), it is notable that the status of Blacklip populations has not been researched over the long period that Greenlip populations have assessed. Shepherd et al (1999) stated that the vulnerability of Blacklip Abalone is not well known, however earlier work by Sluczanowski (1984, 1986) alluded to this. Current evidence from extensive studies in Victoria and Tasmania suggest that a smaller proportion of Blacklip are accessible for harvesting, and hence the risk of decline is lower than for Greenlip. Apart from impacts on the stocks themselves, there may be ecological effects of abalone fishing, however to date, there has been little research into ecosystem effects, other than studies of the food webs of which abalone are part. Abalone, Western Blue Groper, larger wrasse species such as Blue-throated wrasse, crab species, and New Zealand Fur Seals have an ecological relationship (Shepherd et al., 1999). Crabs and wrasses are significant predators of abalone (Shepherd, 1998), and in some parts of S.A., the mortality rate of abalone in some size classes may be controlled by densities of their major predator, Blue-throated Wrasse, which also eat crabs (Shepherd 1998; Shepherd and Clarkson, 2001). Stingrays and octopus (Shepherd, 1990) and Western Blue Groper (Shepherd et al., 1999) are also significant predators of abalone. Shepherd *et al.* (1999) suggested that the wrasse fishery in state waters, and, to a lesser extent, the taking of Western Blue Groper in Commonwealth waters, may impinge significantly on abalone, because wrasses and goppers are principal predators of crabs (which predate on small abalone), as well being direct predators of abalone. Shepherd *et al.* (1999) also suggested that there should be increased research on the ecosystem relations of abalone in light of government policy to manage fisheries within an ecosystem framework. Such ecological studies are difficult to conduct in fished areas, since fishing confounds ecological relationships between predator and prey. Based on the population dynamics of abalone, and the fishing patterns for them, it has regularly been suggested during the past decade, that closed areas are a suitable complimentary management measure to rebuild collapsed populations, and enhance the long term sustainability of remaining fished populations (Shepherd, 1991; Tegner, 1993; Shepherd and Brown, 1993; Baker *et al.*, 1996, Shepherd and Rodda, 2001). Baker *et al.* (1996), Baker (2000) and Ward et al. (2001) reviewed the evidence for closed areas as management tool for site-associated benthic invertebrates with low dispersal, such as abalone. For example, at the Maria Island Marine Reserve in Tasmania, which was monitored over a 5+ year period, mean size of abalone increased from 12.8cm to 13.6 cm in the reserve, whilst abalone size in fished reference areas outside the reserves declined from 12.5cm to 11.8cm over the monitoring period. However, there was no overall increase in abalone density in the Maria Island reserve, because smaller abalone were found to decline in abundance. This pattern of changes in abalone was considered to be possibly caused by intra-specific competition for space and other resources (Edgar and Barrett 1999, cited by Ward et al., 2001). In three Tasmanian reserves which are smaller than the Maria Island Reserve, individuals larger than 16cm were almost exclusively confined to those reserves, and not recorded in the fished area (Barrett and Edgar, 1998). Because abalone have a small home range, they can potentially be protected in small sanctuaries (Edgar and Barrett, 1999). Other examples from British Columbian reserves, show that larger, more fecund abalone exist in the reserves compared with fished areas, particularly in one reserve in which abalone had been protected from fishing since the late 1950s (Pitcher, 1997, and Wallace, 1999, cited by Ward *et al.*, 2001). Because (i) abalone require critical densities of adults to be present for successful spawning; (ii) large individuals are more fecund, and (iii) abalone have short-lived, locally dispersed larvae, it is reasonable to assume that in some areas, local fisheries may benefit from the “local export” of larvae that results from the increased reproductive output of the larger, more abundant abalone. Reserves for abalone provide insurance against “recruitment overfishing” (Attwood *et al.*, 1997) and enhance reproductive capacity (Ward

et al., 2001). It is important to note that single reserves for abalone do not provide benefits for the fishery over a wide area, because abalone populations are usually widely dispersed into distinct, geographically separated metapopulations. For example, it has been suggested that in the case of (severely-overfished) abalone in Southern California, a single sanctuary failed to produce recovery of severely overfished populations, and that, due to the limited larval dispersal capabilities of abalone, a large number of sanctuaries would have been required to achieve recovery (Tegner, 1993; Tegner *et al.*, 1996, cited by Ward *et al.*, 2001). Similarly, at a reserve for Northern Abalone at Vancouver Island in British Columbia, abalone were not considered to be self-recruiting (Wallace, 1997, cited by Ward *et al.*, 2001). However, Thompson (1981, cited by Ward *et al.*, 2001) argued that the larvae of abalone have the potential to travel to areas outside reserves if the currents are fast enough, given that abalone are broadcast aggregate spawners. The daily minimum ebb and flood currents of 1.8 m/second and 1.5 m/second respectively that occurred at the reserve sites studied in British Columbia were found to be adequate for broad dispersal (see examples of British Columbian reserves for abalone by Pitcher, 1997, and Wallace, 1997 and 1999, in Ward *et al.*, 2001). The level of stock depletion, and the location of the reserve, are also factors to consider in the success or failure of abalone reserve areas. Reserves in marginal habitats, or for stocks which have been depleted below recoverable levels, may not successfully replenish the depleted stocks (Ward *et al.*, 2001). The specific population dynamics of the stock are also important to consider. For example, in California, red abalone populations responded positively to 10 years of area protection, but green and pink abalone populations did not recover in protected areas until mature adults were translocated. The differences between the success of the protected areas were thought to relate to differences in the dispersal capabilities between the three species, and the levels to which the stocks were depleted (Tegner, 1993, cited by Ward *et al.*, 2001). Similarly, in South Australia, a small protected area established in 1971 at West Island failed to adequately protect the local spawning population of Greenlip Abalone. That population suffered long-term decline due to (i) an extended period of oceanographically-driven recruitment failure; (ii) exacerbation of the 'natural' causes of population decline due to abalone fishing occurring adjacent to the reserve, where the majority of the local abalone population exist. These factors together reduced the critical numbers and densities of adult abalone for successful spawning and fertilisation. Once recruitment failure occurred, the distance from other populations (12–15km) in combination with minimal tidal movement (1–4km around the reserve), prevented the local population from recruiting through the dispersal of larvae. Fishing the population outside the MPA may also have reduced the replenishment of the MPA with recruits (Shepherd and Brown, 1993). However, the reserve was extended in 1992 towards the mainland, and is currently the only MPA of its type in South Australia to ostensibly provide a refuge for a regional 'source' of recruits to replenish the local population. Shepherd (1991), Shepherd and Brown (1993), Tuck and Possingham (1994), Baker *et al.* (1996) and Shepherd and Baker (1998) considered important factors in reserve design for abalone to include differences in growth and fecundity between metapopulations, oceanographic conditions, recruitment dynamics (including patterns of larval movement from "sources" to "sinks"), spawning stock size and location, so that reserves for abalone are large enough to protect the reproductive dynamics and spawning stock of regional metapopulations. Ward *et al.* (2001) reiterated the importance of most of these factors. Shepherd and Brown (1993) and Shepherd and Baker (1998) considered that 40–50% of the potential abalone egg production needs to be protected from harvesting, depending upon the size of the metapopulation and its reproductive characteristics. Additional factors that are important in determining the success of reserve areas for abalone, include the level of illegal fishing in and around the reserve. Even a small amount of illegal fishing in a reserve can reduce the opportunities for abalone stock recovery, as occurred in Southern California (Tegner, 1993) and at West Island in South Australia (Shepherd and Brown, 1993), which highlights the importance of full protection of reserve areas from fishing. "Compensatory" increases in fishing outside reserve areas can also reduce the success of reserves for sedentary species such as abalone. The strong potential for "fishing the line" and/or transferring fishing effort to areas away from the reserve, highlights the need for reserves to be one part of an overall, regional strategy for stock protection and enhancement, integrated with traditional fisheries management measures.

- Giant Cuttlefish***: The species is widely distributed in South Australia, however, there is one site known in northern Spencer Gulf where the species regularly congregates to spawn in mass numbers. During the mid 1990s, and particularly from 1996 to 1998, there was a rapid rise in commercial fishing effort on the spawning aggregations of Giant Cuttlefish in the False Bay - Point Lowly - Black Point - Fitzgerald Bay area. Total catches for the northern Spencer Gulf area were approximately 69t in 1995/96 and 242t in 1996/97, with the majority of the catch coming from the area of spawning aggregation. The catch figures for the mid-1990s represented a rapid rise from the low tonnage obtained in the preceding years, prior to the development of new markets. Since late 1998, the fishery in the Point Lowly - False Bay - Black Point area has been closed during the spawning season, due to a severe decline in spawning biomass observed in the area (see tables on **Northern Spencer Gulf**, in this report). The depletion in the number of Cuttlefish seasonally aggregating in the area was reported to be a consequence of the fishery targeting the large spawning aggregations of many thousands of cuttlefish, with an unknown proportion of these short-lived animals not having the opportunity to spawn before being caught. Apart from the impact in the cuttlefish population, there may be ecological ramifications, because Cuttlefish of various sizes form a portion of the diet of Australian Fur Seals, Australian Sea Lions (Gales *et al.*, 1993), Snapper, Yellow-tail Kingfish and other large predatory fish, dolphins and various sea bird species. Hall (1999) provided figures to show that, following the moratorium on fishing in the spawning area, abundance increased in the closed area by 100,000 animals, compared with the previous year in which the spawning aggregation was targeted. However, there are no reliable figures for the size of the spawning stock prior to the rapid and significant rise in catches. Although figures are not available, it has been suggested (Whyalla Sports Divers Club, 2000) that in 2000, based upon regular observations by divers in the area during the 1990s, the biomass at that time represented 10% - 15% of the biomass that was present prior to the rise in commercial fishing, and that the stock had not recovered to a significant extent during the initial closure of 2.5 years (i.e. 1998 - 2000). When the area was first closed to fishing, part of the reported spawning aggregation area (e.g. Fitzgerald Bay) was not included in the closed area. The closure has continued to the present (2003), and is further discussed in other parts of this report (see **Notes on Current Level of Protection and Management**).
- Southern Rock Lobster***: The commercial fishery for Southern Rock Lobster in S.A. is divided into two zones. In 2003, there were 181 commercial licences in the Southern Zone, and 69 licences in the Northern Zone. There are many management arrangements for this fishery, including a Total Allowable Catch of 1770 tonnes (divided into individual transferable quotas) in the Southern Zone; temporal closures (1st May to 30th September in the Southern Zone, and 1st June to 31st October in the Northern Zone); limited entry to the fishery; boat and gear restrictions; legal minimum sizes; restrictions on taking egg-carrying females and sub-adults, and a small number of spatial closures (Rock Lobster sanctuary areas) (Sloan, 2003a; Australian Government Department of the Environment and Heritage, 2003e). The recreational fishery has input controls including a 2 pot-per-person limit, and spatial and temporal closures. The recreational catch of Rock Lobster in S.A. is likely to increase during the 2000s, due to a recent increase in the number of recreational fishing licences granted for this species. During the mid 2000s, a Total Allowable Quota was also introduced for the commercial fishery in Northern Zone, in response to concerns about the status of the stocks. The total commercial harvest of Southern Rock Lobster *Jasus edwardsii* in 2001/02 was 2387 tonnes, and the recreational harvest during that period was around 118 tonnes (= 4.7% of total S.A. commercial and recreational catch) (Australian Government Department of the Environment and Heritage, 2003e). Around 95% of the annual catch is sold live to China, Taiwan, Hong Kong and other Asian markets. Major byproduct species (i.e. those which are sold) include the Maori Octopus *Octopus maorum*, Giant Crab *Pseudocarcinus gigas* (for which there is now a daily trip limit of 5), and lesser quantities of Leatherjacket and Wrasse species (such as Blue-throated Wrasse) (Sloan, 2003a; Australian Government Department of the Environment and Heritage, 2003e). Various other scalefish, crustacean, mollusc and shark species may also be retained as byproduct, including Anchovies, Pilchards, Barracouta, Bream, Cod species, Dory species, flathead species, flounder species, Sea Garfish, Australian Salmon, Tommy Ruff, Whiting species, Mackerel, Horse Mackerel, Leatherjacket species, Pink Ling, Morwong species, Mullet species, Mulloway, Sweep, Trevally, Red Snapper, Swallowtail, Red "Mullet", Snapper, Snook,

Sole species, Blue-eye Trevalla, Giant Crab, Velvet Crab, Cockles, Mussels, Oysters, Scallops, Southern Calamari, Arrow Squid, Cuttlefish species, Octopus species, Beach worms, Blood Worms, Tube Worms, and all species of Shark (other than Great White), Ray and Skate (Sloan, 2003a). There is a daily landing limit for Gummy Shark bycatch. Current fishery indicators during the past few seasons have shown that, in general, the stocks in the quota-managed Southern Zone are relatively stable. The Total Allowable Catch in the Southern Zone increased in 2002-03, reported to be a response to "successful stock building" (Australian Government Department of the Environment and Heritage, 2003e). Despite this, there has been some concern expressed by Rock Lobster researchers in recent years, regarding the purported low levels of egg production and juvenile abundance of lobsters, in both the Southern and Northern Zone. According to sampling by Prescott *et al.* (1999), up to 36% of the female Rock Lobsters taken in the upper part of the Southern Zone were reproductively immature, which reduces actual and potential egg production levels. Prescott *et al.* (1998, 1999) reported that: "*Although the available information suggests that present catch limits (in the Southern Zone) are sustainable, the consistently low egg production is of concern. Egg production could be increased by increasing the size limit or reducing the fishing effort*"; and "*A growing body of anecdotal information strongly suggests that juvenile lobsters were once far more abundant than they are today*". According to Prescott *et al.* (1999): "*Changes to the regulations which would enhance egg production (in the Southern Zone) without significantly affecting the commercial or recreational sectors are recommended to increase production*". In the Northern Zone, the stocks appear to be declining, and most fishery performance indicators are outside reference ranges (Australian Government Department of the Environment and Heritage, 2003e). Prescott *et al.* (1998) suggested that "*although egg production in the Northern Zone is not known to limit recruitment in this zone or elsewhere, changes to the regulations which would enhance egg production without significantly impacting catches in the commercial or recreational sectors are recommended to increase production*". In recent years, there has also been evidence of declines (e.g. 18%, in one year) in catches in the Northern Zone compared with the previous seasons, as well as a decrease in the number of undersized lobsters that will recruit to the fishery in future (media reports: Hjellevstad, 2001; Rodway, 2001; Australian Broadcasting Corporation, 2001). A stock assessment report for the Northern Zone Rock Lobster Fishery (NZRLF) in 2003 (Ward *et al.*, 2003) showed that the catch in 2002 from the Northern Zone (594.8 tonnes) was 33.2% below the lower reference limit identified in the Management Plan (891 tonnes in 1994) and the lowest reported catch for the NZRLF since 1979. The Catch-Per-Unit-Effort (calculated from season totals of catch in weight and pot lifts) for 2002 was 1.04 kg/pot lift, 16.8 % below the lower reference limit identified in the Management Plan (1.25 kg/pot lift in both 1995 and 1996) and the lowest in the history of the fishery. The mean weight of lobsters in the 2002 season (calculated from season totals of catch in numbers and weight) was 1.14 kg, which is 6.5 % above the upper reference limit identified in the Management Plan (1.07 kg in 1992) and one of the highest on record. The pre-recruit index for the 2002 season was 0.21 undersize / pot lift, which is inside the reference range identified in the Management Plan (0.180 to 0.302 undersize/pot lift in 1993 and 1996 respectively), but the third lowest recorded since 1987 (the first year in which reliable information on pre-recruit abundance was collected). The accuracy of the estimate of pre-recruit abundance for 2002 was confirmed by an independent estimate from a model, which suggested that *the level of recruitment into the fishery in 2002 was among the lowest ever*. The model also suggested that egg production in the 2002 season was 16.7 % below the lower reference limit, and the lowest in the history of the fishery. The decline in egg production reflects the decline in the abundance of female lobsters in the NZRLF (Ward *et al.*, 2003). Outputs from the model suggested that *the biomass of lobsters in the NZRLF in the 2002 season was the lowest in the fishery's history* (Ward *et al.*, 2003). At a State level, an independent scientific assessment of the Rock Lobster fishery data in South Australia (Breen and McKoy, 2002), reported that, although the fishery as a whole appears to be in a stable position, there was a downward trend noted in the pre-recruit index, which may presage a downturn in biomass of lobsters. Concern has been expressed by researchers about the possibility of increased effective effort during the past decade, leading to serial depletion of Rock Lobster stocks. Breen and McKoy (2002) considered that the evidence for serial depletion in the S.A. Rock Lobster stocks was weak, however an integrated stock assessment is required, using all relevant data, before any conclusions can be reached on the matter of serial depletion. In addition to concerns about the

stock numbers, there are several other issues in the South Australian Rock Lobster fishery, including the following:

- ♦ (i) *Bycatch*: Bycatch in the Rock Lobster fishery includes the following species, most of which are discarded, other than those that are kept and sold as by-product (see list above): Horseshoe Leatherjacket, Chinaman (Ocean) Leatherjacket, Blue Groper (small quantities, according to Prescott, 2001), Blue-throated Wrasse, Six-spine Leatherjacket, Velvet Leatherjacket, Barber Perch, Snapper, Yellow-striped Leatherjacket, Brown-striped LeatherJacket, Orange-spotted Wrasse, Blue-lined Leatherjacket, Largetooth Beardie, Moonlighter, Ocean Perch, Red Snapper, Bearded Rock Cod, Conger Eel, Jackass Morwong, Maori Wrasse, Harlequin Fish, Silver Spot, Knifejaw, Rosy Wrasse, Black-Banded Seaperch, Red Cod, Spinytail Leatherjacket, Red "Mullet", Port Jackson Shark, Banded Wobbegong, Gummy Shark (discarded other than the number permitted to be retained under quota), Juvenile Rock Lobster, Giant Crab (discarded other than the number permitted to be retained under quota), Hermit Crab species, Velvet Crab, Cuttlefish species, Maori Octopus, Sea Star species, and Sea Urchin species (Sloan, 2003a). Although there is a detailed list of bycatch species, little information about the status of particular bycatch species is readily available, other than the work of Prescott during the early 1990s (see Prescott, 2001). However, an independent monitoring program for non-target species catches was introduced in both Rock Lobster fishing zones in the 2001/02 fishing season, to monitor and record information on byproduct, by-catch and non-target species (including protected species) associated with Rock Lobster fishing. This program involves SARDI researchers undertaking low level at-sea monitoring (approx. 0.07% of total days fished in the Southern Zone and 0.08% in the Northern Zone) to record non-target species interactions and catch composition. Sampling of by-catch and by-product associated with Rock Lobster fishing is also undertaken in port (approx 1% of total trips in the Southern Zone and 0.3% in the Northern Zone). These data are used to validate Rock Lobster fishery logbook data collected by commercial fishers, and an analysis of the data was due to be undertaken in 2004 (Sloan, 2003a, 2003b). In the 2000/01 fishing season, a list of marine scalefish by-catch and by-product species was added to fishers' logbook to simplify and improve data collected on non-target species taken in the course of Rock Lobster fishing. These data sections of the logbook are compulsory. It is noted that there are few formally listed species of conservation concern that are caught in the South Australian Rock Lobster fishery (see Sloan, 2003a and Australian Government Department of Environment and Heritage, 2003e), however a number of the species that are caught in this fishery, but not formally listed in conservation schedules, are also of conservation concern. Examples include Blue-throated Wrasse, Western Blue Groper, Maori Wrasse, Rosy Wrasse, Harlequin Fish, Mulloway, Blue-eye Trevalla, Ocean Perch, Banded Wobbegong, Gummy Shark, other shark species, and various species of ray and Skate (see listings for fish and shark species above, in section on **Fishing Issues**, and Baker, in press). Prescott (2001, Table 5), reported that, in terms of numbers caught, wrasses (Labridae) were the second largest group of bycatch species (after Leatherjacket species) in the Northern Zone Rock Lobster fishery in South Australia, according to a sampling of 32,000 pots in 1991 – 1992. During that period, 1127 Labrids were caught in pots during the bycatch sampling program, of which 177 fish were Blue-throated Wrasse, 10 were Blue Groper, and 938 were unspecified species "in the Labridae family". For the Southern Zone (21,000 pots sampled), 205 Labrids were reportedly caught during the 1991-92 season (Prescott, 2001, Table 5). There is a low incidence of entanglement of sea turtles in Rock Lobster fishing gear in South Australia low (i.e. 7 occurrences, between 1967 and 1997, according to Bone, 1998, cited by Flaherty, MCCN, pers. comm., 2003). In the Northern Zone Rock Lobster fishery, there are fishery interactions with Australian Sea Lions, because Sea Lions (and Fur Seals) remove bait from freshly baited pots (Prescott, 2001). Fur Seal interactions with lobster pots occur in both zones. Pinniped interactions are recorded informally in the voluntary catch sampling program. There have been reports of juvenile Sea Lions being trapped in pots in the past, however where Sea Lions are prevalent, most fishers have adopted the use of "seal excluders" (i.e. 12mm stainless steel round bars, which are sharpened at one end and fixed to the pot, extending upwards to the funnel entrance). The excluders work by effectively reducing the area of the pot entrance (Prescott, 2001). In terms of numbers caught, bycatch of marine mammals (including pinnipeds) is reported to be low in the South Australian Rock Lobster fishery, and mainly involves the drowning of Fur Seal and Sea Lion pups, which become trapped when trying to take bait from pots (Australian Government Department of the Environment and Heritage, 2003e). It is noted that some Tasmanian Rock Lobster fishers have developed methods

of attaching “seal proof” bait-holders to pots, and others have improved the design of bait holders to make it more difficult for seals to remove the bait (Shaughnessy, 1996). The Seal Action Plan (Shaughnessy, 1999) suggested a number of research and management actions to minimise interactions of pinnipeds with Rock Lobster fisheries, including pot modifications (which have occurred in the S.A. Rock Lobster fishery, as stated above), and the requirement to develop a best practice strategy for the dumping of old baits, unwanted catch and undersize lobsters, aimed at reducing the seals’ association of fishing vessels and set gear with foraging opportunities.

- ♦ (ii) *Illegal Fishing*: Although the majority of the catch in South Australia is taken by commercial fishers, there is some (unquantified) level of illegal harvesting of Rock Lobster, by both recreational and commercial fishers. Illegal take of Rock Lobster appears to be more prevalent in the Southern Zone than the North. According to recent Rock Lobster stock assessment reports (e.g. see references by Ward et al., 2002), recent improvements in the system for monitoring the Total Allowable Commercial Catch, and the dockside monitoring system have reduced opportunities for illegal catches. Ward et al. (2002) considered that it is likely that recent rapid improvement in the status of stock partially reflects the decline in illegal catches in recent years. During the 2001 season Fisheries Compliance (PIRSA Fisheries) recorded only 16 minor infringements by commercial fishers in the SZRLF from 621 checks, while 21 infringements were recorded in the recreational sector. Ward et al. (2002) reported that, on the basis of the high level of compliance with the regulations, it is considered unlikely that illegal fishing is currently a significant source of fishing mortality. It is noted that a previous report on the status of the fishery (Prescott et al., 1998) differed in its summary of the significance of illegal fishing: “*Fisheries compliance officers reported a relatively high degree of non-compliance with recreational Rock Lobster pot fishing regulations (in the Southern Zone). Over-potting by registered and unregistered (non-commercial) fishers is probably the most serious problem from a resource protection aspect*” (Prescott et al., 1998). “*It is widely speculated that some catch taken by commercial fishers is not recorded ...there is sufficient circumstantial evidence for this to warrant a study to formally estimate the source of the catch*” (Prescott et al., 1998).
- ♦ (iii) *Ecosystem Impacts*: There is potential for changes to reef ecosystem structure and composition due to heavy fishing of species such as Rock Lobster. In a review of the ecological impacts of Rock Lobster fishing, Hall (1999b) stated that there was “*potential for changes in the abundance of lobsters through fishing, to lead to dramatic changes in marine communities*”, particularly kelp-dominated communities, although some of the available evidence is equivocal due to other factors besides fishing, as discussed below. Kelps and other large macroalgae are highly productive and often the dominant structural component in lobster habitat, and they support a highly diverse community of organisms association with them (see DPIWE, 2001, and Edyvane, 2003). In some areas, there is considerable evidence for trophic linkages within ecosystems in which lobsters are fished, contributing to large changes in ecosystem structure, particularly in areas where Rock Lobster abundance has been depleted by fishing. Rock Lobster predators include Gummy Sharks, Maori Octopus (and other octopus species), some large predatory fish species (including Wrasses), flathead species, morwong species, eels and ling (Kailola, 1993, cited by O’Sullivan, 1998). Some of the species that are part of the bycatch in lobster pots (see above) are also predators of Rock Lobster. Prey of Rock Lobster includes sea urchin species, small crustaceans and bivalve molluscs such as mussels (Lewis, 1983; Ward et al., 2001). Although little research has been undertaken on the impact of lobster population declines on predator species, it is the prey species that have been studied in depth to elucidate such ecosystem impacts. Lobsters are important predators on urchins, and can play a major role in controlling urchin populations (Tegner and Levin, 1983; Tegner and Dayton, 1999). It follows that a reduction in lobsters through fishing, can lead to an increase in urchins, which are herbivorous on macroalgae, thereby leading to reductions in cover of kelp and other macroalgae. In areas where the cover of macroalgae is severely reduced, such a transition is dramatic, from an ecosystem perspective, with large changes in primary productivity and available habitat for the rest of the community (Hall, 1999b). Lobster also prey on mussels, and in some areas, lobsters can play a critical role in structuring reef invertebrate assemblages. In high densities, lobsters in some areas can reduce cover of mussels and other filter feeders, and can therefore cause a change in ecosystem dynamics (Barkai and Branch, 1988; Edgar and Barrett, 1999, cited by Ward et al., 2001). Large lobsters have been observed to undertake summer migrations to deep offshore patch

reefs to scavenge for bivalves, and to aggregate into groups (MacDiarmid and Breen, 1993; Kelly et al. 1999, cited by Ward et al., 2001). Similarly to the lobster / urchin interaction, in areas where lobsters and mussels co-exist, a reduction in the abundance of lobsters can increase the cover of mussels, which can consequently out-complete other attached surface fauna for space, thereby altering the structure of the community. There are numerous examples of “trophic cascades” and associated “shifts” in the state of ecosystems (see Dayton *et al.* 1995, 1998; Goni, 1998, and Tegner and Dayton, 1999) and fishing is, in some cases, an instigating factor. Examples of ecosystem changes involving lobsters include studies undertaken in North America (reviewed by Tegner and Dayton, 1999) and South Africa (Tarr et al., 1996; Anderson et al., 1997). In South Africa, increases in the abundance of spiny lobsters coincided with disappearance of urchins at sites on the South-western Cape, and increases in kelp were predicted, along with decreases in other lobster prey (Tarr et al, 1996, Anderson et al. 1997, cited by Hall, 1999b). Studies in northern New Zealand “no-take” areas showed greater abundance of lobsters (and fish), an increase in kelp cover, and lower abundance of sea urchins. Higher urchin mortality rates were also demonstrated in reserves (Jones and Andrew, 1990; Andrew, 1988; Andrew and MacDiarmid, 1991, all cited by Hall, 1999b). Research into the effect of reserves in New Zealand that reverse the trend to “barrens”, is still ongoing after 25 years (S. Shpeherd, pers. comm., 2004). Similarly in Tasmania, some evidence for habitat changes / ecosystem effects was observed in the 7km-long Maria Island reserve, an area in which lobsters had previously been fished prior to the declaration of the reserve. Apart from significant increases in the average number of some fish species, relative to fished reference sites of the same habitat type, the number of invertebrate and seaweed species increased by 31% and 13% respectively in the Maria Island protected area. Such changes in invertebrates and seaweed diversity were not noted at fished reference sites, or at small reserves (e.g. 1km of coastline) (Edgar and Barrett, 1997, 1998, 1999; Barrett and Edgar, 1998). The studies by Edgar and Barrett (cited by S. Shepherd, pers. comm., 2004) in an area protected from lobster fishing, also demonstrated a 70% reduction in abundance of sea urchins, implying a trophic cascade effect that can lead to “barrens” in areas where sea urchins are abundant. The importance of Rock Lobsters in structuring the marine ecosystems of which they are part, varies geographically, and also according to other factors besides fishing. Tegner and Dayton (1999) and Hall (1999b) provided international examples of the additional biological and physical factors implicated in the changes to (often kelp-dominated) ecosystems in which lobsters occur, which include oceanographic influences such as storms and El Nino (Tegner and Dayton, 1987), disease outbreaks in urchins (Elner and Vadas, 1990); and predation by other species, particularly large predatory fish that prey on urchins (e.g. Dayton, 1985; Cole and Keuskamp, 1998). Similarly in Tasmania, a combination of fishing and environmental factors has been implicated in the decline of Giant Kelp communities (Edyvane, 2003), including (i) the effects of El Nino events, which increase the severity of storms that periodically destroy kelp stands; (ii) increases in Sea Urchins, due to fishing-induced depletion of populations of Abalone (which compete with urchins for algal food sources) and Rock Lobster (which eat urchins) and (iii) the effects of climate change (i.e. global warming), which purportedly can reduce kelp distribution by a number of means, if reproductive success of Giant Kelp is negatively affected by water temperature (see Edyvane, 2003). Therefore, as discussed by Hall (1999b), although there is strong evidence for the “keystone” role of lobsters in some ecosystems, it cannot be assumed that all predators that occupy a similar trophic position will determine system structure in the same way, nor can it be assumed that fishing of Rock Lobsters will always have the same ecological effects in all areas in which it takes place. Hall (1999b) concluded that “*while lobsters certainly can be key species in systems (with the consequent potential for fishing to induce marked changes in the ecology of lobster habitat), they are not always*”. Hall (1999b) suggested that dedicated research is required order to understand the ecological role that lobsters play in a specific system, and to determine in which circumstances lobster fishing is more or less important as an agent of ecosystem change. Such research often has only limited support among fishers, and is likely to be strongly resisted in cases where, to establish the effects of fishing, excluding Rock Lobster fishing from some areas is proposed (Hall, 1999b). There is some rationale for closed areas, because, in contrast to many fin fish species, most shellfish have small home ranges once they have settled. Adult rock lobsters are highly site associated, and individuals may move less than a kilometre over several years. Therefore, during sedentary phases of their lifecycles, benthic invertebrates such as Rock Lobster (and Abalone) can potentially be protected in small sanctuaries (Edgar and Barrett 1999, cited by

Ward et al., 2001). However, the evidence that no-take areas can replenish Rock Lobster populations is equivocal. Many examples show an improvement in size, biomass and/or abundance of lobsters *within* the reserve areas, and in some cases immediately adjacent to the reserves (e.g. see Roberts and Polunin, 1993; MacDiarmid and Breen, 1993; Barrett and Edgar, 1998; Edgar and Barrett, 1997, 1998, 1999; Haskell, 2000, Kelly et al., 2000; and for reviews of the benefits of lobster sanctuaries, see Baker, 2000, and Ward et al., 2001). However, few studies have demonstrated population replenishment away from the reserve areas, which is discussed later in this section. Commonly cited examples of reserve benefits for Rock Lobster relate to the closed areas in New Zealand. For example, after a reserve was established to protect the rocky reef and kelp beds in northern New Zealand, surveys of the area over 12 years showed significantly increased sizes and densities (ie from 2.5 to 20 times higher) of Rock Lobster (*Jasus edwardsii*) (Ballantine, 1987, 1988, and 1989; Cole et al., 1990, cited by Baker, 2000; Jones and Andrew, 1990; Andrew, 1988; Andrew and MacDiarmid, 1991, cited by Hall, 1999b). An increase in both density and size was noted in a study of Rock Lobster sanctuaries in New Zealand (MacDiarmid and Breen, 1993; Kelly et al., 2000a, cited by Ward et al., 2001). The mean size of the lobsters in these populations was estimated to increase by 1.14mm for each year of reserve protection, while the mean biomass was estimated to increase by between 5.4% and 10.9% for each year of reserve protection (Kelly et al., 2000b, cited by Ward et al., 2001). Increases in density and/or abundance of lobsters were also observed in 4 closed areas in New Zealand, with the increases being proportional to the age of the reserves (Kelly et al. 2000b, cited by Ward et al., 2001). MacDiarmid and Breen (1992, cited by Ward et al., 2001) argued that a reserve in New Zealand contributes to increased catches of Rock Lobster (*Jasus edwardsii*) outside its boundary. The CPUE of research fishing near the reserve is similar to that in other nearby areas, and is maintained by spillover from the reserve, at a level of CPUE higher than the regional mean CPUE in the broader fishery for this species (Kelly et al., 2000a, cited by Ward et al., 2001). Furthermore, in 4 New Zealand reserves, egg production from Rock Lobster (*Jasus edwardsii*) populations has been estimated to increase between 4.8% and 9.1% for each year of reserve protection (Kelly et al. 2000b, cited by Ward et al., 2001). Another well-publicised example comes from Tasmania. Following a 5+ year monitoring period in the Maria Island Marine Reserve, a significant increase (260%) in the abundance of Rock Lobster inside the reserve was noted, and a small increase (12%) was noted in the abundance of Rock Lobster outside the reserve. The average size of Rock Lobsters in the reserve also increased, with numerous lobsters between 11cm and 20cm recorded, with some individuals increasing 2cm in size every year. Outside of this reserve, very few individuals exceeding the legal minimum size were recorded. The total weight of Rock Lobster inside the Maria Island reserve increased 10-fold in 5 years, and the weight of lobsters above legal size increased by 20 times. Even in the smaller reserves, the number of large Rock Lobster increased, and since lobsters are heavily targeted outside of the reserve areas, the results indicated that lobsters in Tasmania do not move far from “home” reefs. Large lobsters (e.g. 18cm) produce more than 4 times the eggs of legal-sized (11cm) lobsters, and the researchers (G. Edgar and N. Barrett) concluded that the total number of eggs released from the Maria Island reserve was more than 10 times the number released from a similar sized area of fished reef, and that closed areas have potential to contribute significantly to recruitment of fished species, by acting as “propagation” areas (Edgar and Barrett, 1997, 1998, 1999; Barrett and Edgar, 1998). In Tasmanian reserves, increases in reproductive potential of the Rock Lobster population appeared to corresponded with sanctuary size (Edgar and Barrett 1999, cited by Ward et al., 2001). The monitoring work of Edgar and Barrett suggested that the Tasmanian reserves have not yet “stabilised” in their beneficial effects, and further increases in diversity and abundance (and “spill-over” effects that benefit fisheries) should be expected. It is noted that effects of the sanctuary were only observable to within 1km outside the boundaries, and beyond this buffer zone the Rock Lobsters were very rare (due to heavy fishing). Therefore, “spill over” benefits appeared to be limited to within 1km from the sanctuary boundary for this species, in this location (Edgar and Barrett, 1999, cited by Ward et al., 2001). The monitoring results, as well as the abundance of pots set at the boundary of the reserve, to catch the “spill over” lobsters, led Barrett and Edgar (1998) to suggest that “rotating” closures would provide new avenues for fisheries management. In other words, Barrett and Edgar considered that periodically closing small sections of coast to Rock

Lobster fishing, and reopening them over 3 to 5 year cycles, after biomass and abundance have built up, should increase the overall weight of Rock Lobster caught⁴. Within the Rock Lobster fishing industry, there has been some disagreement about the benefits of Tasmanian reserves for Rock Lobster. The Tasmanian Fisheries Industry Council (TFIC – see Lister, 1998, cited by Ward et al., 2001) considered that the management arrangements in Tasmania for Rock Lobster and Abalone (Total Allowable Catch) are adequate and sustainable, and reserves are therefore not needed. In relation to the assertion that reserves create an increase in egg production due to increased size of focal species, TFIC considered that the relationship between eggs and weight of lobsters results in slightly fewer eggs produced by a tonne of large females, compared with a tonne of small females (due to the increased number of small individuals in a tonne) (Lister, 1998, cited by Ward et al., 2001)). This relationship would therefore mean, according to TFIC, that protecting female lobsters in a reserve would either maintain current yields or decrease them. Since the larval dispersal mechanism for lobster is unknown, Lister (1998) suggested that it would be safer to protect egg production regionally until there is more research conducted. In that article, the author doubted that reserves allocated to increase growth would increase yields, as effort would have increased elsewhere, thereby resulting in growth overfishing in the fishable areas. He concluded that while it is important to protect lobsters from harvest for the purposes of scientific research, the perceived benefits of reserves to the fishery will occur at the expense of areas outside the reserve (Lister, 1998, cited by Ward et al., 2001). In response, Edgar and Barrett (1998, cited by Ward et al., 2001) asserted that an increase in density of rock lobsters in reserves would result in a density decrease in areas outside the reserve if the reserve was closed to fishing. However, in terms of Total Allowable Catch (TAC), emigration of protected specimens (which are usually about twice the weight of specimens in fished areas) from the reserve into surrounding areas would maintain the TAC and save at least two non-reserve organisms for each lobster that emigrates from the reserve. Rock lobsters inside reserves grow to a much larger size than lobsters outside sanctuaries (Edgar and Barrett, 1998, cited by Ward et al., 2001). In some areas, evidence for lobster population replenishment outside of reserves is scant, possibly due to factors such as the long-range dispersal of rock lobster larvae (which limits the potential for local increases in recruitment as a benefit from the reserves), poaching inside the reserves, and/or increased fishing outside the reserve areas (see reviews in Hall, 1999b; Baker, 2000; Ward et al., 2001). For example, in South Africa, reserves created to support the Rock Lobster fishery are considered to have failed, because the densities of lobsters inside the reserves are similar to those outside the reserves, and the proportion of egg production from lobsters in the reserves is proportional to the area of the overall coast, indicating no enhancement of the lobster population by the MPAs (Mayfield et al., 2002). This situation is considered to result from a lack of controls on fishing in the MPAs, but also because the reserves were arbitrarily situated in locations that do not have good habitat for Rock Lobsters (Ward and Hegerl, 2003).

⁴ Other examples of successful reserves for lobsters (see Baker, 2000, for details), of lesser relevance to southern Australia, come from tropical ecosystems. For example, Davis and Dodrill (1980; 1989) considered that a small protected area for Spiny Lobster in Florida had a greater reproductive output than the larger, fished area, because the lobsters in the reserve included a high proportion of large, reproductively active females, compared with fewer, smaller ones in the fished areas. Similarly, Davis (1989) reported greatly increased growth of juvenile lobsters in a reserve area in Florida, and increased lobster numbers adjacent to the protected area. Tagging studies have demonstrated movement of Spiny Lobster out of a Florida reserve and into the fishery. According to the authors of the Florida studies, the protected area is assumed to provide larvae and recruits to both adjacent and distant fishing zones. The studies from Florida, where almost all adult Spiny Lobsters are reported to be removed from Florida reefs every year, showed that local reserves appear to have sustained the fishery despite such intense harvesting, by protecting a portion of the spawning stock biomass.

- ♦ *Giant Crab Pseudocarcinus gigas*: The species is endemic to southern Australia, and is fished mainly in Tasmania, Victoria⁵, South Australia and Western Australia (Australian Government Department of the Environment and Heritage, 2003f). Historically, Giant Crabs have been taken as a by-product by Rock Lobster fishing operations in southern Australia for more than 80 years. Targeted commercial fishing for Giant Crabs was commenced in 1990 in Tasmanian waters, and in 1992 in South Australia (Sloan, 2003b). Giant Crabs are caught in relatively deep water at the edge of the continental shelf, and on the continental slope, between 140 and 270m, although the depth range of the species is 18-400m (DPIWE, 2002b; Australian Government Department of the Environment and Heritage, 2003f). The species is often caught over soft, muddy substrate on the shelf break (Department of Primary Industries, 2003; Sloan, 2003b), and this narrow zone is dominated by fragile bryozoan communities (Department of Primary Industries, 2003). In South Australia, management jurisdiction for *P. gigas* from the low water mark out to 200 nautical miles in the waters adjacent to S.A., is under an Offshore Constitutional Settlement (OCS) Agreement between the South Australian and Commonwealth Governments (Sloan, 2003b). During the 1990s, Giant Crab became increasingly valuable as a commercial species (McGarvey et al., 1998). There are two fishers in S.A. who have special licences to target Giant Crab in the Commonwealth waters adjacent to S.A. (Sloan 2003b), and the species is also taken by Rock Lobster fishers who have endorsements to fish in Commonwealth waters. A small number of Commonwealth-endorsed Rock Lobster fishers also target Giant Crab specifically. Between 1992/93 and 2001/02, total Giant Crab catches (target and byproduct catches combined) have ranged between 7t in 1992/93, and 33t in 1998/99, with a steady decline between 1999 and 2002 due to the introduction of quotas (e.g. 31t in 1999/00; 24t in 2000/01, and 18.5t in 2001/02) (Knight et al., 2003, cited by Sloan, 2003b). The fishery now operates under a quota-based management system with a total allowable commercial catch (TACC) of 13.4 and 8.7 tonnes for the Northern Zone and Southern Zone, respectively (Sloan, 2003b). Rock Lobster fishers may hold a portion of the annual quota for Giant Crabs. Rock Lobster fishers who do not hold quota, are permitted to take 5 Giant Crabs per fishing trip (Sloan, 2003b). The closed seasons for this fishery, match those of the Rock Lobster fishery. There is also a spatial closure, with no dedicated fishing for Giant Crabs being permitted within 60 fathoms (Sloan, 2003b). The legal minimum size of Giant Crabs taken is 15cm CL, in both fishing zones, and there is a ban on the taking of egg-bearing females. There is a gear limit of 100 pots per fisher. Fishers are also required to fill out daily catch forms, and a daily log book. Information collected by fishers includes location and depth of the catch; number of pots set; the numbers and weights of male and female crabs caught (which is also verified, as far as possible, by the processor); and the number of undersized crabs, spawning crabs, and legal-sized crabs (i.e. over quota) returned to the water. Changes in mean weight of the crabs in the catch are used to provide an indirect estimate of recruitment strength, in the absence of fishery independent data. Pre-recruit abundance and spawning female abundance indices are calculated from the logbook data on the numbers caught and returned to the water (Sloan, 2003b). The key performance indicators used to assess the performance of the fishery, are the nominal catch per unit effort; total catch relative to each TAC; mean weight; and pre-recruit index. A review of the management arrangements and, in particular, the TACCs may be undertaken if any of the performance indicator estimates fall more than 15% ± outside of the established range, over a specified period. However, the analyses used to estimate values for these performance indicators are not considered to be robust, due largely to insufficient data and the need for more quantitative assessment tools. All of the performance indicators currently used are considered to require further refinement (Sloan, 2003b). Nominal Catch per Unit Effort (CPUE) estimates indicate that a possible decline in the abundance of Giant Crabs may have occurred in the Southern Zone from

⁵ In Commonwealth and State waters off Tasmania, there is a quota-managed fishery for Giant Crab (commercial catch = 98t in 2001/02), and the species is considered to be "growth overfished", meaning that more crabs are caught each year than recruit into the minimum legal size through growth (Australian Government Department of the Environment and Heritage, 2003f). In the western Victorian fishery, the 2001/02 catch under quota was 20t (Department of Primary Industries, 2003), however catches of 122t and 226t were recorded during the early 1990s. In 2002, the status of the stock in Victoria was uncertain, however the resource is considered to be fully fished (Department of Primary Industries, 2003). The Commonwealth DEH has requested that a sound stock assessment be undertaken in Victoria, accounting for removal of the species across its range. In 2003, a management plan was developed for the Victorian Giant Crab fishery, containing a number of arrangements to allow the stocks to rebuild. This included the introduction of a total allowable quota, and the removal of "latent effort" in the through the reduction of Giant Crab pot endorsements in the Rock Lobster fishery, from 3000 to less than 200m pots (see Department of Primary Industries, 2003).

1996 onward (Sloan, 2003b). Catch limits have been reduced in response and the Southern Zone is currently considered to be fully fished. In contrast, nominal CPUE estimates for the northern zone, which PIRSA considers to be “under-exploited”, increased through the mid to late 1990s and started to stabilise in recent years. However, it is noted that in the Northern Zone, monitoring the nominal CPUE may provide fewer insights, because controlled expansion continues under a slightly higher TACC, and high nominal CPUE in previously unfished areas may mask possible declines in nominal CPUE in areas that have been fished more heavily (Sloan, 2003b). Other concerns regarding Giant Crab stocks include the fact that (i) to date (2004), there is no estimate of the population size of Giant Crabs in South Australia, and little information on the population dynamics, although a stock assessment is planned, following the completion of a quantitative stock assessment model project that is being undertaken in Tasmania, and for which the results may also be relevant to South Australia (Sloan, 2003b); (ii) the Giant Crab population in southern Australia is considered to represent a single genetic stock (Levings *et al.*, 1999), hence it is important that the assessment of population status, the setting of TAC, and the management arrangements for each fishery, be integrated between the southern states, and the current level of integration is not adequate; (iii) Giant Crabs have a number of population characteristics and behaviours that may render the populations vulnerable to over-exploitation. For example, the species is slow growing; long-lived; has depth-segregated age/size classes; and migrates along shelf margins during the reproductive phase. Giant Crabs may require strict management controls to ensure sustainability of harvest (Kailola *et al.*, 1993; Yearsley *et al.*, 1999; Gardner *et al.*, 2002; cited by Australian Government Department of the Environment and Heritage, 2003f); (iv) although all berried female and undersized Giant Crabs, as well as any Giant Crabs caught that exceed the quota number per fisher, must be returned to sea, the survival rates of these crabs might be low, considering the relatively deep depths at which Giant Crabs live (e.g. to more than 200m), and hence the transfer from surface waters back to deeper waters could be physiologically traumatic; (v) there is difficulty in determining the age and size at which male Giant Crabs are functionally mature, because breeding opportunities are subject to heavy competition among physiologically mature (enlarged cheliped) males of different size groups; consequently, modelling work (McGarvey *et al.*, 1999, cited by Sloan, 2003b) has shown that although the current legal minimum size may protect the level of egg production in female Giant crabs, only limited protection might be provided for males under the existing size limit because of issues associated with male functional maturity (Sloan, 2003b); (vi) Commonwealth trawlers also catch Giant Crabs, and incidental damage to Giant Crabs and their bryozoan-dominated habitat may occur due to trawling activity in southern states (Department of Primary Industries, 2003; Australian Government Department of the Environment and Heritage, 2003f); (vii) there is poor knowledge of the habitat of Giant Crabs, which exist mainly in a narrow band at the edge of the continental shelf and upper continental slope, and in southern Australia, only a fraction of this area has been mapped (Department of Primary Industries, 2003); and (viii) there is the possibility that removal of Giant Crabs from the marine environment may have impacts upon ecologically related or dependant species (Flanigan, 2002). There is very little knowledge of the ecological relationships of Giant Crabs with other species (Department of Primary Industries, 2003), and the Commonwealth has recommended that work be undertaken in this area.

- ♦ Mud Cockles (*Katelysia* spp.): Mud Cockle species have previously been used only for bait but more recently for food, including export to interstate markets (see Fowler and Eglinton, 2002). On the West Coast, a significant population collapse of the Mud Cockle population in Coffin Bay occurred during the 1990s, considered with high likelihood to be caused by over-fishing (Fowler and Jones, 1997). In upper Gulf St Vincent, yields of Mud Cockles escalated during the 1990s, as the fishery developed in response to increased demand. At the time, there was insufficient biological information to indicate sustainable harvest levels in any area of the State. These circumstances prompted the call for a cautious management approach to Mud Cockle fishing in all parts of S.A.. Suggested measures included control of fishing effort, setting of minimum legal sizes, and regular monitoring of stock indicators (Fowler and Jones, 1997). A gear restriction of one harvesting rake per fisher has been introduced (Fowler and Eglinton, 2002). The species is also taken by recreational fishers in a number of areas, such as northern Gulf St Vincent. It is clear from SARDI's 1996 recreational boat survey in S.A., that considerable quantities are taken for bait

in specific areas (McGlennon and Kinloch data, cited by Fowler and Jones, 1997). The recent National Recreational and Indigenous Fishing Survey (Henry and Lyle, 2003) reported that 339,180 Mud Cockles were caught and kept by recreational fishers in South Australia during the survey time period (May 2000 to April 2001). Recreational fishing regulations have recently been introduced for the taking of *Katelysia* species, including a 3cm legal minimum length (3.8cm in Coffin Bay), and a bag limit of 300 (PIRSA, 2003c). A stock assessment in 2001 (Fowler and Eglinton, 2002) concluded that there was no evidence that would currently cause concern about the status of the stocks in the northern GSV region, however the following points were made, indicative that Mud Cockle species are potentially vulnerable to population decline: (i) between 1999 and 2001 there was a substantial change to the species composition and population structure of Mud Cockles at Section Bank in northern Gulf St Vincent, believed to be environmentally-driven. One species, *Katelysia rhytiphora* disappeared from the bank, and two other species showed reductions in abundance; (ii) recruitment appears not to be an annual event, and any cohort that does eventuate, must sustain the population (and the fishery) for several years; (iii) Mud Cockle species are relatively long lived and slow growing. For example, a study of *K. scalarina* at Section Bank showed that the species grows slowly, and individuals at the study site were aged up to 10 years. A Tasmanian study of the same species showed that larger individuals were aged up to 29 years (see Fowler and Eglinton, 2002, and references cited therein). Mud Cockles are also vulnerable to decline from habitat impacts. For example, a study in Princess Royal Harbour in W.A. showed that populations of two of the same species of Mud Cockle that occur in S.A. (*Katelysia scalarina* and *K. rhytiphora*) significantly declined (to almost zero individuals) in the study area over a 10 year period. Apart from adult mortality, growth rates also considerably slowed over that period, and recruitment of young *Katelysia* was negligible, at levels two orders of magnitude less than observed during the early-mid 1980s. The dramatic declines in abundance of *Katelysia*, which was previously dominant component of the fauna of Princess Royal Harbour, co-occurred with eutrophication, seagrass die-off and macroalgal blooms, and the authors suggested that the environmental problems of the harbour have cascaded through the ecosystem to alter its ability to sustain natural secondary production and ecosystem function (Peterson et al., 1994). Another threat to Mud cockle populations is introduced species, such as the European Shore Crab *Carcinus maenas*. In other parts of Australia, a number of studies have shown that *C. maenas* can have a significant impact on native species such as Mud Cockles and other bivalves (see papers in Thresher, 1997). For example, Mackinnon (1997) showed that a large portion of the European Shore Crab's diet in Tasmania consists of bivalves such as Mud Cockles, and small mussels of two species. The study also reported that the crab is capable of consuming vast quantities of the juveniles of various bivalve species over short time periods, and that the European Shore Crab has the ability to drastically reduce numbers of smaller sized mussels and clams (cockles), and alter bivalve assemblages. Similarly, a study by Walton (1997) showed that juvenile *K. scalarina* Mud Cockles in Tasmania are preyed upon heavily by European Shore Crabs (particularly by large male crabs), and that the introduced crab species is a more important predator upon juvenile Mud Cockles than are native crabs and whelks. The study suggested that *Carcinus* may have a very large impact upon the abundance and distribution of *K. scalarina*, and, subsequently, the fishery (Walton, 1997). Both Mud Cockles and mussels are found in the Port River – Barker Inlet system, and the existence of the introduced European Shore Crab in this area is therefore of concern regarding populations of these bivalve species.

- ◆ Scallops: (species of *Pecten*, *Chlamys*, *Equichlamys* and *Mimachlamys*). In contrast to the situation in Tasmania and Victoria, Scallops are not a significant commercial species in South Australia. In 1999, the small fishery for Scallops in S.A. was working towards the development of a management plan, and was zoned with one fisher per zone and “considered to have the potential for further growth” (PIRSA, 1999). In 1999, there were 6 or fewer licence holders in the fishery (Extracts from Legislative Hansards, July 1999; PIRSA, 1999). Scallops are also taken as byproduct by prawn trawl fishing on the West Coast of S.A. (PIRSA, 2003d). There are 3 main scallop species in S.A. King: *Pecten fumatus*, Queen: *Equichlamys bifrons* and Doughboy *Mimachlamys asperima*. The Scallop fishery in Coffin Bay, in the lower west coast of S.A., was closed in 1999 due to depletion, considered to be caused by a combination of over-fishing (both commercial and recreational fishing occurred in the area), and the effects of ongoing micro-algal

blooms in the bay at the time. Prior to the closure there was no bag limit on the commercial catch from Coffin Bay, although a minimum size restriction applied. Scallops in South Australia exhibit variable recruitment over space and time, as occurs in Tasmania (see below), and scallop fishery management must therefore take a cautious approach. Scallop divers operate in various areas such as waters off Yorke Peninsula, and Eyre Peninsula, including bays in the Ceduna area. Scallop species are also taken by recreational fishers in some parts of South Australia. The recent National Recreational and Indigenous Fishing Survey (Henry and Lyle, 2003) reported that 47,818 Scallops were caught and kept by recreational fishers in South Australia during the survey time period (May 2000 to April 2001). In South Australia, the recreational bag limit set by PIRSA is 100 Scallops per person per day (recently reduced from the previous bag limit of 200), and there is now a boat limit of 300 (PIRSA, 2003c). In Tasmania, the recreational bag limit is 200 Scallops per person per day or 400 per boat per day, but there appears to be no basis in stock assessment for this allocation. Voluntary recreational logbooks have been available through some dive shops and other local shops in past years, and information about recreational catches has been provided by some recreational divers (DPIWE, 2002a). There are anecdotal reports of Scallop population declines in some parts of S.A. due to recreational over-fishing and habitat damage, but published accounts of scallop population status are lacking. Scallops have a number of population characteristics that render them vulnerable to over-exploitation. Scallop fisheries worldwide are notorious for their variability in recruitment (DPIWE, 2002a), and settlement patterns are very erratic. Scallops spawn during the spring and early summer, with juvenile settlement in the late summer/autumn. Fishing during the juvenile settlement period appears to have a detrimental effect on the settlement process. The exact timing of spawning and settlement varies from year to year and from region to region. There appears to be a direct relationship between the levels of adult stock and amount of larvae, but no such relationship between the amount of larvae and number of juveniles that settle. The latter is likely to be influenced by one or more environmental factors. The history of the commercial scallop fishery in Tasmania is a classic example of a fishery going through boom and bust cycles, in which new aggregations are discovered, dredged heavily, and depleted. This type of fishing occurred even up till the 1990s. In Tasmania, a rapid increase in fishing effort, and unrestricted issue of licences, led to over exploitation and the complete closure of the fishery for a number of years (DPIWE, 2002a). The Tasmanian fishery is now subject to stricter controls than occurred in the past, through limited entry, bag limits, size limits (8cm minimum), zoning, and closed seasons. Even in Tasmania, where scallop fishing has occurred for decades, scientific data are insufficient, and the level of recruitment of juvenile Scallops into the fishery is highly dependent on largely unknown environment conditions. The amount of latent effort and current low stock levels are of particular concern to the Tasmanian Government (DPIWE, 2002a). The operation of the fishery in Tasmania has indicated that the sole use of minimum size limits is inadequate as a fisheries management measure, and area closures have been necessary. The advent of Scallop Aquaculture may relieve some of the pressure on wild stocks. In S.A., the development of a scallop aquaculture farm off Wallaroo was approved in 2000 (see <http://www.ypct.com.au/news/00/09/19/5.html>). There is a collaborative research and development program in South Australia to provide support to investors interested in introducing scallop farming to South Australia, and SARDI Aquatic Sciences has been undertaking research into larval rearing and hatchery growth rates. Although the main use of Scallops is for food, it is noted that some scallop specimens that are sold in the shell trade are trawled from South Australian waters, between 20m and 40m. South Australian and other Australian specimens were selling for \$4 - \$10 in 2002, depending upon colour and quality.

- In addition to over-exploitation of some fished species, regardless of the fishing method used, it is recognised that all fishing practices change ecosystems and adversely affect their component populations to various degrees (e.g. see reviews by Dayton *et al.*, 1995 and Leadbitter, 1999), and these changes are rarely quantifiable. However, there are some techniques that are considered by MPA planners to warrant particular attention due to their more evident impacts. In components of Marine Protected Area planning frameworks for Victoria (ECC, 2000), Tasmania (Tasmanian T.A.T., 2000⁶), and Western Australia (CALM), *trawling* and *spearfishing* are considered in this category, and other fishing methods are also included in the Tasmanian example. Effects of other methods, such as netting and boating in shallow seagrass beds, charter boat fishing, and fish trawling in deeper State and Commonwealth waters, are also discussed in the tables below for each focus area.
- **Spear-fishing:** Spear-fishing can deplete populations of some fish species, particularly long-lived and/or strongly site-associated reef species such as Western Blue Groper and other wrasse species; Harlequin Fish; Dusky Morwong; Luderick, and Western Blue Devil, amongst others (see Pogonoski *et al.*, 2002; Baker, in press, and references therein). Documented effects of some of the fishing methods used in S.A. are provided in the sections on ***Issues for Risk and Impact Assessment*** below, for each focus area.
- **Charter Boat Fishing:** There has been a substantial increase in the number of fishing charter boats operating in South Australia during the past decade. A number of charter boats target large individuals, including the spawning stock, of species such as King George Whiting and Snapper. Other operators catch species of conservation concern, such as Western Blue Groper, Harlequin Fish, and various shark species (e.g. Gummy Shark, Hammerhead, Whaler Sharks). In the review during the early 2000s of the *South Australian Fishery Act 1982*, it was recognised that the charter boat fishery in South Australia has been insufficiently regulated, and a management plan was being drafted in 2004. Examples of species taken and locations where charter boats operate, are provided in tables in this report on ***Social and Economic Values and Uses***, and Baker (2004) provided regional examples of species of conservation concern taken by charter boats in South Australia.
- **Trawling (General Notes):** In general, bottom trawling (whether for fish or prawns) has demonstrated adverse impacts on benthic species composition, abundance and condition of benthic habitat. For example, a field study by Collie *et al.* (1997) showed that sites which are undisturbed by trawling have higher biomass, species abundance, and species diversity than disturbed sites. Dayton *et al.* (1995) and Goni (1998) provided detailed reviews of the bycatch effects of fishing (particularly trawling and other forms of netting), as well as the significant reductions in benthic species abundance, size structure and biodiversity from trawling. Prena *et al.* (1999) showed that otter trawling can cause significant decreases in the abundance and diversity of benthic fauna such as crabs, basket stars, sea urchins, sand dollars, brittle stars and soft corals. One of the most significant effects of benthic habitat damage from trawling is the destruction of living benthic structures, such as bryozoa, corals and calcareous algae (from fish trawling), and sponges and seagrass beds (from prawn trawling). Stands of macroalgae can also be damaged in areas where trawling takes place in that habitat type. Attached benthic biota

⁶ Trawling has been considered as a potential threatening process in Tasmania (see Tasmanian TAT, 2000), and an issue relevance in the development of a representative system of MPAs. For example, it has been suggested that 10% of certain areas (of unspecified size, in that example) should be closed to destructive fishing methods such as trawling and netting (Barrett pers. comm., cited by Major, 1998). It is a difficult and contentious issue to decide which 10% of an area to close, or to even decide the actual percentage of an area to close, to achieve benefits in fisheries' sustainability and other goals such as habitat restoration and biodiversity protection.

provides physical support for marine communities, and help to maintain biodiversity. Apart from reduction in abundance and spatial cover of these types of biota, their removal can adversely affect the survival of fish and invertebrates that used the benthic structures for recruitment, feeding, and/or shelter from predators. In New Zealand, for example, destruction of bryozoan beds by trawlers was correlated with a reduction in the number of juvenile fish of commercial importance, which relied upon the bryozoan habitat (Bradstock and Gordon, 1983). Damage to the benthos fragments available habitat, which can reduce the chance of successful recruitment and colonisation for a variety of species with limited dispersal capabilities (see references in Ruckelshaus and Hays, 1998). Apart from disturbing the benthic topography, trawling can result in increased turbidity from benthic damage and sediment mobilisation (Dayton *et al.*, 1995; Collie *et al.*, 1997; Engel and Kvikek, 1998; Prena *et al.*, 1999). In South Australia, fish trawling occurs almost always in Commonwealth waters, and a number of methods have been adopted to reduce impacts such as bycatch (see references by AFMA, in the bibliography of this report).

- **Prawn Trawling:** The Spencer Gulf prawn trawl fishery has the largest production of Western King Prawn *Melicertus latisulcatus* in Australia, with an average production of 2,246t, between 1997/98 and 2000/01 (PIRSA, 2003d). Prawn fisheries in Gulf St Vincent and the West Coast waters are also regionally important, with average productions of 342t and 119.1t respectively, during the period 1997/98 – 2000/01. In South Australia, prawn trawling occurs in State waters, and the prawn trawl fishery in S.A., particularly that in Spencer Gulf, is considered to be well managed by global standards. In addition to traditional management measures such as limited entry to the fishery, and vessel and gear restrictions, a large number of measures have been taken during the past decades to minimise the environmental effects of prawn trawling (e.g. see Macdonald, 1998; Carrick, 1997; Broadhurst *et al.*, 1999; South Australian Prawn Industry Association web site, 2000; PIRSA 2003d). Examples include (i) seasonal closures (e.g. trawling in Spencer Gulf normally does not occur from late December to March, and from mid-June to November each year); (ii) the closure of some shallow water nursery areas and spawning areas to prawn trawling (N.B. according to Carrick and Williams, 2001, cited by PIRSA, 2003d, less than 10% of the area of Spencer Gulf is trawled); (iii) rotation of trawling grounds; (iv) the spatial and temporal organisation and “real time” management of the fishing fleet in some areas (e.g. Spencer Gulf) to minimise capture of undersized prawns and bycatch species; and (v) developments in gear design to reduce bycatch and improve the size-selectivity of prawns. Examples of gear improvements include (a) adoption of square-mesh cod-ends by commercial prawn trawlers in Gulf St. Vincent (see Broadhurst *et al.*, 1999), (b) the fitting of exclusion devices to the cod end of trawl gear in Spencer Gulf, to reduce the amount of bycatch such as Blue Swimmer Crabs and sponges; to reduce the mixing of large (e.g. sharks and rays) and small bycatch species in the trawl net; and to assist the survival of caught and discarded species, by ensuring a more rapid return to water; and (c) the use of “crab racks”, and hoppers with conveyers, on the sorting table. These measures have resulted in a sustainable prawn fishery, particularly in Spencer Gulf, and have assisted in reducing bycatch mortality of species such as Blue Swimmer Crabs. A number of studies on particular impacts of prawn trawling have been undertaken, such as bycatch quantification in 4 major fishing zones in Spencer Gulf (Carrick, 1997); effects of prawn trawling on the attached benthos and infauna of Gulf St Vincent (see Drabsch, 1999; SARDI, 2001d; Tanner, 2003), and the ecology of bycatch species in Spencer Gulf, based on the fate of discards (Svane *et al.*, 2000). However, benthic damage from trawling activities has occurred over a long period, and due to the difficulty of finding suitable control sites to compare with areas trawled over the long term (amongst other reasons), few objective studies of trawling-induced benthic damage have been undertaken in South Australia. One of the few specific studies on benthic impacts that has been done, is a 3-year experimental trawling study in an area of Gulf St Vincent

that had not been trawled for some 15-20 years (see SARDI, 2001d; Tanner, 2003). The study reported that (i) although there was a “significant trawling by location effect for all multivariate analyses, and most individual taxa, trawling had an overall negative effect on the benthos; (ii) epifauna at trawled sites decreased in abundance by 28% within 2 weeks of trawling, and by another 8% in the following 2-3 months (compared to control sites); and (iii) seasonal seagrasses were less likely to colonise trawled sites than untrawled sites (i.e. “persistence of most taxa declined significantly in trawled areas compared to untrawled areas”); and (iv) the recruitment rates of several taxa into visible size classes increased after trawling, presumably because of a reduction in competition. The study concluded that trawling had an overall negative impact on the benthos (SARDI, 2001d; Tanner, 2003). The study by Tanner (2003, cited by PIRSA, 2003d) also showed that although epifaunal assemblages experienced substantial trawling mortality overall, the level of mortality varied depending on sediment characteristics. Locations with strong currents and coarse sediments experienced minimal effects, whereas those with weak currents and fine sediments experienced larger effects. Overall, trawling caused a 36% reduction in the number of large epifaunal organisms. However, recruitment of some taxa into trawled sites was higher than into untrawled sites, suggesting that recovery, at least for the most opportunistic organisms, may be relatively rapid. More recently, Tanner (2005) described how deeper beds of *Heterozostera* (now reinstated within the *Zostera* genus) in Investigator Strait have been degraded due to the impact of prawn trawling, and beds of Hammer Oysters in south-eastern Gulf St Vincent have also been eliminated. In Spencer Gulf, a previous bycatch study by Carrick (1997, and see below) also demonstrated habitat impacts. Carrick reported occasional “large catches of sponges” in prawn nets, and suggested that prawn trawling may be modifying the topographic complexity of the sea floor in Spencer Gulf. Ecosystem impacts due to the level of *bycatch* are also likely to have occurred over a long period. Although the proportion of bycatch species to target catch (i.e. the “bycatch ratio”) is low in Spencer Gulf and Gulf St Vincent compared with other prawn fisheries in Australia and overseas (Carrick, 1997), significant numbers of some species are caught, most of which are considered to be not commercially valuable. In general, by-catch in South Australia includes ‘trash fish’ that are not valued by industry; juveniles of commercially and recreationally significant fish species; blue swimmer crabs and other crustaceans; sponges; ascidians; echinoderms; molluscs; sharks and rays and other taxa. There is some published information regarding specific bycatch impacts of prawn trawling in South Australia (see examples from Carrick, 1997, cited below for a number of areas). In general, Carrick’s studies during the early and mid 1990s found that in Spencer Gulf, 15 fish species from 10 families dominated (97%) the bycatch, with the most abundant being trevally (average 38% of catch) and Degen’s leatherjacket (average 32%). Capture of leatherjackets was sometimes so high that it affected the efficiency of trawling. A significant impact of trawling on small-toothed flounder (a sandy mud/muddy sand habit fish species) was detected, with the fleet having the capacity to “*reduce local populations by at least 60% over 14 days of intensive fishing*” and “*Generally, regions more intensively fished had fewer large individuals (of flounder) than areas not fished, and densities of flounder were significantly lower*”. Other examples included the bycatch of leatherjackets, which was “*sometimes so high that the efficiency of prawn trawling was substantially affected*”. King George Whiting, juvenile Snapper and Sand Whiting were “*sometimes caught in large quantities by prawn trawls*”, although “*there was substantial spatial and inter-annual variation in catches*”, and overall, Carrick (1997) suggested that there was little evidence that the Spencer Gulf prawn fishery is affecting commercial fisheries for Snapper or whiting. Blue Swimmer Crabs and sponges were, in some areas, “*a substantial component of the prawn bycatch*” (Carrick, 1997), although the number of crabs caught as bycatch has now decreased due to improvements in cod end configuration of prawn nets, which reduces capture of Blue Swimmer Crabs. Carrick

(1997) reported that there is evidence from other studies, and from the species richness of the bycatch in the Spencer Gulf fishery, that the diversity and abundance of fish are greater on topographically complex habitats than on open sand” (Carrick, 1997). Other documented reports of prawn trawling effects in South Australia comes from a review of the marine scalefish fisheries in South Australia in 1991, which concluded that prawn trawling had affected the ecology of the seabed by reducing diversity of animals and changing seabed characteristics (Rohan *et al.*, 1991). There is also some evidence of impact on an uncommon species in Spencer Gulf, such as hard coral. The occurrence of large (e.g. 1 to 3m diameter) old colonies of the scleractinian coral *Plesiastrea versipora* has apparently diminished in South Australia, due to dredging by trawlers (Southcott and Thomas, 1982, cited by Edyvane, 1999b). Large colonies are now rarely recorded in S.A. due to physical damage to colonies and associated habitat.

- Shell Collecting:** Another fishing-related issue is the collection of molluscs for the shell trade. Little is known about the status or habitat requirements of many species of mollusc in South Australia, including exploited species. Molluscs which have direct development of young are particularly vulnerable to over-exploitation and population decline (see Ponder and Grayson, 1998; Wilson and Clarkson, 2004). Volutes as a group have particularly vulnerable population dynamics, as do the southern Australian species of *Zoila* and *Notocypraea*, and some of the *Conus* species (e.g. *Conus anemone*) and *Melo miltonis*, which have direct development of young and no planktonic larval phase. This localised reproduction and direct development results in limited dispersal of juveniles away from the habitats of the mother shells where they were produced, and therefore geographically distinct sub-populations and varieties exist, with little mixing. Such characteristics makes populations of these species with limited dispersal vulnerable to decline from over-collecting. For example, in the *Zoila* and *Umbilia* cowries, the female may stay with the young for several months after they hatch, and the male may also remain in close proximity (Wilson and Clarkson, 2004), which renders breeding populations susceptible to capture due to their strong site association in “family” groups. Geographically distinct populations of species of *Zoila* and *Notocypraea*, *Conus* and volutes (e.g. *Amoria*, *Ericusa*, *Notovoluta* and other volute genera) often have distinctive colours and patterns, and some of the less common patterns and colours are highly sought after by collectors. It is recognised that species with small extent of occurrence (i.e. narrow geographic range) can be vulnerable to extinction from local impacts (IUCN, 1994; Jones and Kaly, 1994, cited by O’Hara and Barmby, 2000). Some shell species in the shell trade have specialised feeding habits and therefore also have restricted habitats (e.g. some of the *Zoila* and *Notocypraea* rely on host sponges). This feature makes such species more vulnerable than those with more generalised feeding requirements. There is a need to conserve such required habitats and food resources of limited distribution (such as sponge beds), and a need to not over-collect in the critical habitats for those species. The existence of geographically isolated sub-populations and varieties or forms of some species, such as some of the *Zoila* and *Notocypraea* species, and the vulnerability of such sub-populations / varieties / forms, should be considered in formal assessment of population status. For example, *Zoila friendii thersites* is considered by some to be a geographically isolated eastern sub-species of the widespread *Z. friendii* complex (Wilson et al. 1993; Wilson and Clarkson, 2004), and others consider it to be a separate species, endemic to S.A. (Lorenz and Hubert, 2000; Lorenz, 2001; Academy of Natural Sciences, 2003). Irrespective of the taxonomy, *Zoila friendii thersites* is considered vulnerable to population decline from collecting (Ponder and Grayson, 1998), and within the species, there are also distinct forms according to geographical area, some of which are considered rare by collectors and therefore attract high prices (see Baker, 2002, for examples), which stimulates further collecting. O’Hara and Barmby (2000) recommended that more research should occur on sub-specific forms of specimen shells, because concern has been expressed in Victoria about the over-collecting of identifiable subspecies and regional forms of more widespread species. For many specimen shell species collected in South Australia, larger adult specimens are the most valuable on the market, and are therefore highly sought. The continued collecting of the largest specimens may have implications for the reproductive potential of populations, particularly geographically distinct and isolated sub-populations, in cases where the large mature adults of a shell species are important for the reproductive potential of the population. Management of specimen shell collecting should also consider impacts of removal of juvenile shells, particularly if the shells are not yet of reproductive age and have therefore not had opportunity to contribute to the population replenishment before they are taken. Therefore, removal of juveniles or sub-adults may also have an impact upon the long term sustainability of some populations. Ponder and Grayson (1998) developed a scale of

vulnerability for Australian molluscs in the shell trade, and the authors reported that it is of considerable concern nationally that of the top 27 specimen shell species exported (>300 specimens in 2 years; 1998 figure), close to half (45.3%) are in the top 3 categories of vulnerability. However, it is notable that according to Ponder and Grayson (1998), the impact of habitat disturbance due to fishing (especially trawling and dredging), pollution from terrestrial run off, the development in coastal areas, are much more significant than specimen collecting in many cases, and may ultimately affect the long-term survival of even some relatively common taxa.

9.2.5 Introduced Marine Pests

There are more than 25 species of introduced marine pests South Australia, and many of these are found in major port areas, such as Port Adelaide. Most, but not all, marine pests have been introduced through the discharge of ships' ballast water and / or from the external surfaces of the hulls (Parliament of South Australia, 2000). Control of ballast water discharge is a difficult problem because many of the methods and chemicals commonly suggested for control are also harmful to the environment (SAFIC, evidence presented to Parliament of South Australia, 2000). There are mandatory ballast water management requirements in Australian ports, administered by the Australian Quarantine and Inspection Service (AQIS), however further introduction and spread of harmful aquatic organisms remains a significant, and ongoing, threat. During the early 2000s, port authorities in S.A. were considering investigations to assess the current extent of introduced pests around each port facility. Marine pests have potential to significantly degrade the quality of large areas of nearshore marine habitat in South Australia. Furthermore, some marine pests have invaded existing marine protected areas in South Australia, such as the Barker Inlet, Noarlunga and American River Aquatic Reserves. Some examples of introduced species of concern in South Australia include the following (from Furlani, 1996; CSIRO, SARDI Aquatic Sciences and South Australian Museum sources, compiled by MCCN SA, undated; Joint SCC/SCFA National Taskforce, 1999; Reefwatch, 2003; S. Shepherd, pers. comm., 2004):

- ♦ *Carcinus maenas* (European Shore Crab), which is a major predator of native bivalves and farmed shellfish species, and can form dense population, thus altering ecosystem function (Joint SCC/SCFA National Taskforce, 1999). The European shore crab is found in a wide variety of habitats, such as on the shore; in rock, mud and sand habitats; in estuaries, seagrass beds and marshes (Reefwatch, 2002). The species is very hardy, able to tolerate extremes of temperature and salinity. The species has potential to impact populations of native molluscs, crustaceans, and other invertebrates. In South Australia, there is some concern that European shore crabs may affect populations of the native Blue Swimmer Crab, because it preys on the juveniles (see SARDI, 2001d). European shore crabs have also been observed killing native anemones in northern Gulf St Vincent (J. Emmett, AMCS, pers. comm., 2001). In other parts of Australia, a number of studies have shown that *C. maenas* can have a significant impacts on populations of native species such as Mud Cockles, mussels, and other bivalves, and on the composition of bivalve assemblages (see MacKinnon, 1997; Walton, 1997; Thresher, 1997).
- ♦ *Sabella spallanzanii* (Mediterranean Fan Worm), which is now widespread in northern and central Gulf St Vincent, and may already have colonised up to 3500 hectares in the gulf (CSIRO, 2002). The species competes for phytoplankton food with native bivalves and other shellfish; and changes the marine environment, affecting water circulation, nitrification, fish breeding, and seagrass beds (Joint SCC/SCFA National Taskforce, 1999). The species is found on a variety of hard substrates (shells, jetty pylons, channel markers, wrecks, rocks, etc.) but can also be found in sand (Reefwatch, 2002). Mediterranean Fan Worm is fast growing, and can rapidly cover a large area, forming dense, mono-specific stands that alienate other species.
- ♦ Several mollusc species, that can out-compete native species, and eventually dominate bottom communities, in some cases changing water and nutrient flows. Examples include the New Zealand Green-lipped Mussel *Perna canaliculus*; the Asian Mussel *Musculista senhousia*, and

the New Zealand Screwshell *Maoricolpus roseus*, the latter of which is capable of forming very large infestations. (Joint SCC/SCFA National Taskforce, 1999).

- ◆ *Crassostrea gigas*: Pacific Oyster, which can escape from aquaculture farms, and establish in the wild. Reported impacts in southern Australia include competition for space and nutrients with native species; sediment enrichment, from faeces of dense colonies; loss of aesthetic and amenity value; and transfer of a parasitic copepod (*Mytilocola orientalis*) to mussels (Joint SCC/SCFA National Taskforce, 1999).
- ◆ *Gymnodinium* and *Alexandrium* species (toxic dinoflagellates, red tides): Some of these species are widespread in algal blooms, and are prevalent in various port areas of South Australia (such as Port Adelaide and Port Lincoln), as discussed in the tables below. Some of the dinoflagellate species recorded in South Australia are toxic (e.g. *Alexandrium minutum*, *A. catenella*, and various others), and form microalgal blooms. Red tides by the toxic dinoflagellate *A. minutum* were first recognised in the Port River area in 1986, and the Port River is one of a few estuaries in Australia that have annually recurrent algal bloom problems (Hallegraeff, 1995b). Dinoflagellate cysts are especially prevalent in the sediments of the river (Cannon, 1990, 1991, 1993; Hallegraeff, 1995a and 1995b), and *A. minutum* now produces seasonal red water blooms in Port River – Barker Inlet area (Hallegraeff, 1995b; Parliament of South Australia, 2000). Microalgal blooms are stimulated by discharges (particularly nutrients) into the marine environment, and are influenced by the tidal regime, temperature stratification in the water column, salinity and light levels, nutrient supply for the substrate, and seasonal variability in nitrogen levels (see Cannon, 1990, 1991, 1993). Toxic microalgal blooms (which can contain, for example, around 9 hundred million cells per litre, according to Cannon, 1991), are responsible for oxygen depletion of the waters, periodic fish kills, contamination of molluscs such as mussels (which can result in paralytic shellfish poisoning in consumers of mussels), and reduction in light available for aquatic plant growth, amongst other impacts.
- ◆ *Caulerpa taxifolia*: During the early 2000s, the invasive macroalga *Caulerpa taxifolia* was recorded in West Lakes and parts of the Port River (SARDI / PIRSA brochure, undated; City of Charles Sturt, 2003). The species grows extremely rapidly, and is capable of covering many hectares of sea floor in a short time. The species can out-compete native seaweed species; displace bottom-dwelling communities, and is considered to be a threat to seagrass meadows. Invasions of this species in the Mediterranean have resulted in reduced fish density and a marked decline in coastal fisheries production (SARDI, / PIRSA undated). The aquarium strain can aggressively overgrow native species to form massive monocultures, and is toxic to browsing fish and invertebrates (Joint SCC/SCFA National Taskforce, 1999). Another introduced *Caulerpa* (a strain of *C. racemosa*) with similar invasive properties, is now present in the Port River – Barker Inlet system, and in eastern Gulf St Vincent (Shepherd, pers. comm., 2004)
- ◆ Some of the other introduced marine species that occur in South Australia waters include the pearl oyster *Pinctada albina sugillata*; the “sea moss” *Bugula* sp.; *Botryllus schlosseri* (a colonial ascidian); the ascidian *Ciona intestinalis*; *Cassiopea ndrosia* (tropical jellyfish), and the Oriental grass shrimp *Palaemon macrodactylus* (Furlani, 1996; Joint SCC/SCFA National Taskforce, 1999; CSIRO, SARDI Aquatic Sciences and South Australian Museum sources, compiled by MCCN SA, undated; S. Shepherd, pers. comm., 2004). Some of these species can compete with native species for space and resources, resulting in altered community composition, or other ecological effects.
- ◆ Introduced species which occur in Tasmania and/or Victoria, and which may have the potential to establish in parts of South Australia, include the seaweed *Undaria pinnatifida* (wakame), a recent invader that is rapidly spreading, and which has the potential to form large stands that out-compete native species and habitats for space and light; *Corbula gibba* (European clam), which can form major outbreaks that out-compete other shellfish and native species; and *Codium fragile tomentosoides* (broccoli weed), which smothers and competes with native species (Joint SCC/SCFA National Taskforce, 1999).

9.2.6 Oil Spills

Examples are included for specific areas, in the tables below. In general, much of the hydrocarbon contamination in the nearshore marine environment is caused by disposed oil (e.g. heating oil and motor oil) in stormwater drains; runoff from roads and dockside facilities, and from small spills and leaks from commercial and recreational craft. There have been few major oil spills from single ships and vessel collisions in South Australia, other than periodic spills from ships in the Port Stanvac, Port Adelaide, and Port Pirie / Whyalla areas. The impacts of a major spill in 1992 around Port Pirie is discussed below in the section on **Northern Spencer Gulf**. Although most oil comes from multiple small sources, it is notable, however, that if the background concentration of toxic compounds from oil is high in a given area (e.g. industrialised coastal zones), then small spills that would normally dilute rapidly to insignificant levels, may raise the ambient background concentration to a level of concern for a significant length of time (National Academy of Sciences, 2002, cited by Pidcock *et al.*, 2003). Impacts of the toxic components of oil include both sub-lethal and lethal effects on invertebrates, fish, sea birds and mammals. Exposure to, or biological metabolism of, the aromatic structures in oil, is considered to be the most significant impact. Some studies have indicated that the soluble aromatics of an oil (such as benzene, toluene, ethylbenzene, xylenes, and naphthalenes) produce the majority of its toxic effects in the environment (Irwin, 1997; Overton *et al.*, 1994, cited by Pidcock *et al.*, 2003). However, even within one oil type (bunker, crude, lubricating, diesel, gasoline, or jet fuel), the concentrations that cause toxic effects can vary considerably according to many factors, including the *in situ* conditions. Several compounds in petroleum products are carcinogenic (e.g. benzene and possibly naphthalenes), but carcinogenic effects are considered to be associated more with chronic exposure (Overton *et al.*, 1994) than the short-term exposure likely in a high-energy open marine environment. The chemicals used to disperse and clean up oil spills in some areas, also have toxic effects. Commonly reported effects of petroleum and individual PAHs on living organisms include impaired immune systems for mammals and altered endocrine functions for fish and birds (Pidcock *et al.*, 2003). Some components of oil can be bioaccumulated by marine organisms, particularly the group of longer-lasting polycyclic aromatic hydrocarbons. Bioaccumulation can occur to some degree in detritus-feeding bivalves and suspension feeders, however it is unlikely that biomagnification up the food chain occurs in most cases, due to the ability in fish and possibly other organisms to process aromatic hydrocarbons relatively efficiently (NOAA, 1992; Irwin, 1997, cited by Pidcock *et al.*, 2003). Avoidance of oil-contaminated food and feeding areas may also cause impact. The three main exposure routes of marine animals to petroleum products are direct surface fouling; direct and indirect ingestion with the affects of bioaccumulation; and, in the cases of higher vertebrates, inhalation of the toxic vapours released from the petroleum hydrocarbons as they evaporate. In Australia, it has been reported oil spills may be pose a significant risk in terms of direct and indirect (i.e. through contamination of prey species) impacts on marine mammals such as Australian sea lions and fur seals. One example comes from the oil spill in Bass Strait in July 1995, which resulted in a reduced number of Fur Seal pups born at Tenth Island, following the spill. There was a strong relationship between the productivity of the seal colonies and the proximity of the islands to the oil spill (Pidcock *et al.*, 2003). Other impacts from oil spills on pinnipeds include inhibition of maternal recognition of young covered with oil; endocrine or stress impacts leading to premature delivery or spontaneous abortion of pups; and disturbance of pinnipeds through clean-up activities associated with coastal oil spills (Pidcock *et al.*, 2003).

9.2.7 Oil and Minerals Exploration and Mining

Oil spills can also result from pipeline leaks and/or pipeline failure, accidents on a platform, accidents related to the onshore production facility (Redoubt Shoal Unit Development Project,

2002), with similar effects to those outlined above. Treated oily water from drilling fluids, deck drainage and bilge water could also potentially affect marine animals, including mammals (White Rose Oilfield Comprehensive Study Report, 2001; Heyward *et al.*, 2000, cited by Pidcock *et al.*, 2003). In general, oil and mineral exploration and mining are not considered suitable activities in marine protected areas in coastal waters, and will not be discussed further here.

9.2.8 Marine Debris and Dumping of Wastes

Marine debris is a significant issue in terms of entanglement of marine mammals, sharks and sea birds, and ingestion. Common debris includes plastic bags, rope, bait boxes, ties / packing tape, trawl netting, mono-filament gill netting, fishing line and hooks, rope, and tyre pieces. Examples of issues associated with marine debris are provided in the tables below, for particular areas. Although littering the marine environment with such wastes is common in some areas, it is notable that deliberate dumping at sea is prohibited under the *International Convention for the Prevention of Pollution from Ships 1973, as modified by the Protocol of 1978 (MARPOL)*, and also under South Australian legislation.

9.2.9 Acoustic Pollution

Examples of activities that may affect marine animals include jet skiing; seismic testing; and motor boats used in sensitive areas such as estuaries and mangroves, and/or in areas with high concentrations of marine mammals or birds. The impacts of human-induced noise on marine biota depend upon the type of noise, its frequency and duration, and impacts vary widely depending upon the type of marine animal. In general, impacts from power-boating and jet skiing including hydrocarbon pollution (particularly for jet skis, for which fuel consumption is high, and fuel burning is inefficient); benthic scouring in shallow water (e.g. impacts on seagrasses have been observed in other countries); water turbidity; bank erosion and consequent damage to aquatic vegetation, and acoustic disturbance to fauna (e.g. nesting waterbirds in estuarine areas, and marine mammals – see below). Impacts of jet skiing in general are discussed by Tiarnlund *et al.*, 1993; Krueer, 1994; Sargent *et al.*, 1995; Burger, 1998; Blue Water Network, 1998). Motor boat activity may also be a potential source of acoustic and physical disturbance to whales and other marine mammals, particularly crowding of boats in specific areas, motor revving and fast manoeuvring (Bannister *et al.*, 1996). In general, acoustic disturbance can cause stress, disorientation, physical harm, and/or abandonment of feeding, calving, nursery or migration areas, and has been highlighted as a major threat to the recovery of cetacean populations in Australian waters (Bannister *et al.*, 1996). According to Pidcock *et al.* (2003), there is considerable national and international concern that human-induced sounds in the marine environment could be having detrimental effects on marine mammals, by interfering with their ability to detect calls from individuals of the same species, echolocation pulses or other important natural sounds (Richardson *et al.*, 1995, cited by Pidcock *et al.*, 2003). Potential effects of the elevated background noise levels caused by this introduced man-made noise include: limiting the detection by the mammals of natural sounds; disturbing their normal behaviour resulting in possible displacement from areas, and causing temporary or permanent reductions in hearing sensitivity. These potential effects depend to a degree on the type of marine mammal involved. The potential area or zone of influence of a man-made sound is also influenced strongly by the levels and types of ambient noise (Richardson *et al.*, 1995, cited by Pidcock *et al.*, 2003). Airborne noise is also of concern, mainly to pinnipeds during their haul-outs onto land areas, but also to some species of whales. There is a large volume of literature concerned with the description of various acoustic impacts upon marine mammals (Richardson *et al.*, 1995; McCauley, 1994; Tasker and Weir, 1998; Gisiner, 1998; Davis *et al.*, 1998; McCauley and Duncan, 2001; and

O'Brien, 2002). Generally, these impacts are measured through observations of behavioural responses to noises, and the responses are therefore used as a surrogate measure for sensitivity or susceptibility. Despite the number of reviews, there are limited experimental and observational data. Consequently, when considering the possible impacts of underwater noise on marine mammals, in general McCauley and Duncan (2001, cited by Pidcock *et al.*, 2003) suggested that it is necessary to recognise that:

- ◆ Each species in question has receptor systems for detecting the signal and that the noise frequency content must be such that it overlaps the hearing range of any species impacted;
- ◆ Different types of noises may have different effects;
- ◆ Different effects may be elicited from an approaching noise source as compared to a stationary or departing noise source; and
- ◆ The scale of the noise disturbance needs to be considered (i.e. is it frequent, infrequent or continual over short and long time scales?).

Marine mammals are acoustically diverse, with wide variations in ear anatomy, frequency range and amplitude sensitivity. The general trend is that larger species tend to have lower frequency ranges than smaller species (Pidcock *et al.*, 2003). Baleen whales (e.g. Humpback whales, Southern Right whales), are believed to have sensitive hearing at low frequencies, inferred from their anatomical characteristics. Baleen whales reportedly produce underwater sounds at frequencies ranging from 12 Hz up to 8 KHz, although predominantly below 1 KHz, and there is reported to be considerable overlap between the frequencies of sounds produced by baleen whales, and frequencies produced by seismic shots, and the potential for disturbance of baleen whales from seismic survey activities is considered higher than the potential for disturbance of toothed whales. Behavioural responses including changes in respiration rates and avoidance of the seismic vessel have been observed. Sudden turning on of the seismic source can elicit a startle response, even with the whale up to 3 km from the source. Whale cow / calf pairs are considered more susceptible to disturbance and displacement by seismic operations (WA Department of Mineral and Petroleum Resources, undated). All marine mammals have sensitive ears that are simultaneously adapted to sustain moderately rapid and extreme pressure changes, and which appear capable of accommodating acoustic power relationships several magnitudes greater than in air. This is likely due to the fact that the aquatic environment propagates sound significantly more efficiently than air, and so aquatic auditory systems are adapted to these conditions. In addition, virtually all marine mammals are potentially impacted by sound sources with a frequency of 500 Hz or higher, but relatively few species are likely to be impacted by lower frequencies. An animal's sensitivity to sounds varies with frequency, and its response to a sound is expected to depend strongly on the presence and levels of sound in the frequency band or range of frequencies to which it is sensitive (Richardson *et al.*, 1995, cited by Pidcock *et al.*, 2003). Another example, of potential disturbance to blue whale populations in south-eastern Australia (see Butler *et al.*, 2003) is provided in the table below on **Issues for Risk and Impact Assessment** for the **Lower South East**.

9.2.10 Physical Disturbance to Habitats (including Recreation & Tourism Impacts)

Physical disturbances includes dredging; bottom trawling; unregulated physical impacts from diving; uncontrolled boat anchoring / mooring; benthic scouring by boats in shallow waters; and, in shallow subtidal and intertidal areas, physical disturbance also includes damage due to vehicle use, trampling by foot traffic, and bait collecting. Specific examples of physical disturbances and associated impacts affecting a number of coastal and near-shore marine habitats throughout South Australia, are discussed in the tables below.

Some of these issues, as well as a number of other risks and potential impacts, are discussed in more detail below, using examples for each of the areas recommended for the SARMPA. Information is provided for issues and impacts of relevance to the areas within the past two decades, up till the early 2000s. *It is important to note that is an overview only, for each of the recommended areas.* Many of these issues require further investigation through research and/or monitoring programs. Also, issues and impacts must be investigated in more detail though consultation with all relevant industry and community bodies, during any management planning phase for marine protected areas. It is also important to note that environmental impact issues (including site-specific impacts, regional impacts, and the extent of cumulative impacts) will change over time, according to the uses within each area. For **Northern Spencer Gulf** and **Northern Gulf St Vincent**, an overview of some of the recent measures to control impacts is also included, because parts of both of these recommended areas have been subject to numerous impacts over many decades, and ongoing remedial measures are required to ensure that the ecological values of these areas are not further degraded.

9.2.11 Issues for Risk and Impact Assessment in Recommended Areas

9.2.11.1 Nuyts Archipelago, St Francis Isles and Coastal Embayments (Murat Bioregion)

- The GAB 1000 West Coast Strategy (Ellis, 1999a) provides detail of the current programs and plans for addressing a number of impacts and threats in the far West Coast region. The following information is provided as background to some of the impacts and threats that require control and/or management.
- According to the District Council of Streaky Bay (2002), the District Council's Strategic Plan "*reinforces the need for natural resource management planning which must be cognisant of offshore and marine issues, including the effects of recreational and professional fishers, aquaculture and the protection of key habitats*".

Coastal Habitat Issues

- In general, some of the activities reported to damage **West Coast** areas include trampling of coastal vegetation, in the supratidal and intertidal areas, damage to the coastal zone by vehicles (motor bikes, dune buggies, 4WD, and sand boards), coastal and marine littering, and wildlife disturbance (Ellis, 1999a). Bryars (2003) also listed the physical disturbance due to off-road vehicle use, as a potential threat to habitats in the West Coast region, including bays such as **Murat** and **Bosanquet**. For many years, concerns have been raised about indiscriminant access to coastal features, with resulting impacts including sand dune degradation, erosion and loss of amenity, and threats to biological and cultural heritage conservation values (Ellis, 1999a). Such activities have resulted in impacts that require coastal reserves and conservation parks (as well as private property) to be "rehabilitated". Recreational sectors principally involved are reported to be recreational fishers, surfers and 4WD clubs (Ellis, 1999a).
- Destruction and degradation of habitat on the Eyre Peninsula, particularly in spawning and nursery grounds of fish and crustaceans, was considered by Buckley (1986) to be a serious potential threat.
- Coastal camping and associated vehicle use along the West Coast is considered to have "high environmental impact levels" on the coastal area (Ellis, 1999a). The accumulated impacts of indiscriminate camping and uncontrolled vehicle access are considered to be the most important coastal land management issues on Eyre Peninsula (Ellis, 1999a).
- Headlands along the West Coast are considered to be "generally the most degraded sites, because they are often the focal points of camping, surfing and fishing activities" (Ellis, 1999a).
- **Point Gibson (Streaky Bay)** and **Davenport Creek** were listed in the GAB 1000 West Coast Strategy (Ellis, 1999a) as being areas of "high conservation significance (but) currently subject to high levels of

disturbance”.

- The **Davenport Creek** area is considered to have “high visitor pressure”, with inadequate management (Ellis, 1999a). In peak periods, up to 200 people in 60 to 80 4WD visit the area per day; degradation at the site is “clearly evident” and pressure on the site is “likely to increase in the future if other areas are closed off to recreational fisheries and 4WD vehicles (Ellis, 1999a). Unrestricted access by vehicles and trail bikes has reportedly caused some damage to juvenile mangroves, and has contributed to sand drift and litter in the area, particularly at **Point James** (Morelli and de Jong, 1995). There is also stock grazing in the **Davenport Creek** area (potential for increased nutrients in the near-shore area).
- At **Wittelbee Conservation Park**, the picnic / recreation area is reported to attract moderately heavy usage, and consequently suffers some damage and substantial littering. The coastal vegetation is essentially “disturbed natural vegetation, and vagrant sheep have on occasions been a problem” (Australian Heritage Commission, undated).
- The coastal area in the vicinity of **Laura Bay Conservation Park** has been described as being in “disturbed condition” (Australian Heritage Commission, undated). Hames Sharley Australia (1989) reported the use of the area for fishing and passive recreation pursuits, with boat access in shallow areas, and vehicle access through the samphires. Such activities may be responsible for some physical impacts in that coastal area.
- There have been reports that stock grazing and off-road use of vehicles is damaging peripheral mangrove and samphire in the area (e.g. **Gibson Peninsula / Blanche Port / Streaky Bay / Acraman Creek** area) (Morelli and de Jong, 1995). Physical disturbance caused by off-road vehicle use, and also due to stock grazing, has been listed as a perceived threat to saltmarsh habitats in **northern** and **southern Streaky Bay** (Bryars, 2003).
- There is some concern that new holiday housing development being developed in the **Streaky Bay** area (see Ellis, 1999a) may result in further physical damage and aesthetic impacts in the coastal and near-shore marine environment, particularly linear / ribbon developments.
- One of the main recreation and tourism issues highlighted by public submissions to the GAB 1000 West Coast Strategy (Ellis, 1999a) was that tourism / recreational activities are considered to be inadequately managed. The number of uses and users has increased over time, and strategies for coastal and marine environmental protection measures, particularly for coastal conservation reserves and other sensitive areas, have not kept pace with development. Specific issues included the potential impacts from bush camping (which is a popular activity in coastal areas of the West Coast) and other informal camping in areas with no facilities, as well as damage to beach areas due to recreational vehicles, particularly at remote sites (Ellis, 1999b).
- “Conflicting recreational use of the water” at **Davenport Creek** was listed as a public concern by Ellis (1999b).
- Physical destruction of habitat due to construction of a proposed marina in north-eastern **Murat Bay** has been listed as a potential threat to habitats in that area (Bryars, 2003).

Coastal Discharges / Effluent / Run-off

- Septic disposal and near-shore contamination are considered to be issues along parts of the West Coast (see Ellis, 1999a), and the need to establish drainage networks is recognised. In general, pollution of water and sediments along the developed parts of the Eyre Peninsula coast has long been recognised (e.g. Buckley 1986, who stated that such pollution may have “possible toxic effects on detritivores, sessile flora and fauna, and hence to larger mobile fauna”).
- Towns and other developments exist on or abut low-flow bay areas along the West Coast. The relatively sheltered bays (e.g. **Streaky Bay, Ceduna** and smaller bays) are potentially impacted by urban and industrial development, including stormwater runoff, industrial-processing discharges, and high nutrient discharges from septic drainage and outflows, and sewage treatment processes. As an example, disposal of stormwater runoff from the **Blancheport Rise** residential subdivision has been noted as an important issue, as it is possible that stormwater runoff from this area, which is likely to increase, is received by wetland environments in part of **Streaky Bay** (Connell Wagner Pty Ltd, 2003). Freshwater runoff may have a detrimental effect on samphire areas, by changing the water quality (e.g. reducing salinity), and contaminants in residential stormwater runoff, such as fertilisers and other garden supplements, may result in increased nutrient levels. Such runoff may have impacts upon native wetland species, and also encourage weed proliferation. Other pollution sources identified along the **West Coast** include

contaminated groundwater, land-applied treated wastewater systems, effluent reuse systems, and fish processing plants. Catchment-derived discharges of agricultural fertilisers and chemicals are also a concern, and the increased level of nutrients from agricultural run-off entering the **West Coast** bays (such as **Smoky Bay**, **Laura Bay**, **Streaky Bay** and **Acraman Creek**) has been listed as a potential threat to habitats in the area (Bryars, 2003). There is a substantial amount of farming and cropping in area adjacent to nationally important wetlands and estuaries of the West Coast, and good farm management skills are needed to prevent losses of nutrients to the marine environment in catchment run-off. All of the above-mentioned discharges are considered to have adverse effects on water quality and marine ecosystems in general (Ellis, 1999a).

- **Smoky Bay:** Septic systems have disposed of household waste water onto impervious sand and shell grit bases, however, overflows of untreated effluent form freshwater mounds above layers of sea water which permeates these materials. At low tide, the contaminated freshwater percolates directly into the adjacent marine environment (Ellis, 1999a). Likely visible indications of localised nutrient pollution from this freshwater septic discharge impact include (i) an approximately one metre wide band of the sea lettuce *Ulva* around the low tide mark of the Smoky Bay foreshore; and (ii) a noticeable retreat from the foreshore area of the two major seagrass species in the Smoky Bay township area. Faecal contamination of near-shore waters has also been identified as a potential impact in the Smoky Bay area (Ellis, 1999a). During the late 1990s, plans were underway for effluent drainage works at Smoky Bay (Ellis, 1999a). Impacts from sewage disposal are also recognised as a threat to waters and biota in other coastal settlements without connections to common effluent drainage systems (Ellis, 1999a).
- **Denial Bay:** Previously, a specified effluent issue in the area has been waste-washing water from oyster processing plant entering Denial Bay, about 300m north of the jetty (Hames Sharley Australia, 1989). Also, an increased level of nutrients caused by septic tank overflows in the **Denial Bay** area, was listed as a potential threat to habitats in the area (Bryars, 2003).
- **Streaky Bay and Ceduna:** According to the District Council of Streaky Bay (2002), pollution impacts of the near-shore marine environment are of particular importance in the development of a Strategic Plan. The townships are serviced by a common effluent treatment system adjacent to the coast. There was previous concern that not all residences were connected to the septic drainage system, particularly where premises are located close to the water's edge (Ellis, 1999a), however at the time the Great Australian Bight 1000 West Coast Strategy was produced (during the late 1990s) there were plans to connect all residences to the system (see Ellis, 1999b). An increased level of nutrients caused by septic tank overflows in the **Haslam** and **Perlubie Beach / Eba Island** areas, was listed as a potential threat to habitats in the area (Bryars, 2003). The District Council of Streaky Bay's Strategic Plan (2002), reported that a major issue identified in the consultation process was the management of the STED scheme, especially in terms of overflow. Investigations into the re-use of water and the establishment of treatment ponds is considered by the Council to be critical from an environmental and health perspective. Other related issues were the associated problems caused by the expansion of coastal urban development, and new areas which may need to be covered by a STED scheme. Waste management in the towns is considered "crucial" (District Council of Streaky Bay, 2002), in terms of limiting impact on the environment.
- According to a South Australian government report (2003), a tidal creek emptying into **Streaky Bay** releases effluent waste. This is a considered cause for concern, as it may be an associated factor (along with the relatively enclosed nature of the bay, the seasonal slow water movement and periodic low oxygen levels) that contributes to microalgal bloom formation.
- There is some concern that new holiday housing developments in the **Streaky Bay** area (see Ellis, 1999a) may result in further discharges into the near-shore marine environment.

Aquaculture Issues

- Following government, industry and community consultation, the Murat Bay Aquaculture Management Plan (Bond, 1991, for Department of Lands), identified areas which were unsuitable or unacceptable for aquaculture. These areas included **Tourville Bay** (for conservation and economic reasons); **Murat Bay** (due to conflict with recreational users and fishers); **St Peter Island** (for conservation and economic reasons); **Laura Bay** (for conservation, scientific and recreation reasons), and **Smoky Bay** (due to conflict with recreational users). However, in 1996, PIRSA recommended aquaculture development in a number of these areas (see **Notes on Social and Economic Values and Uses**), despite no significant assessment of the suitability of sites in the interim between the two reports, and the unchanged conservation status of those areas during that time. For some areas, the potential environmental impacts were mentioned in the 1996 management plan, although provision for aquaculture development in those areas was still made. For example, PIRSA (1996) recognised that the low water mark boundary of the **St**

Peter Island portion of the Nuyts Archipelago Conservation Park extends into the waters of the **Decres Bay Zone** for aquaculture development, and that an adequate buffer should be kept between the park and aquaculture development, particularly due to the inter-tidal flats providing feeding sites for wading birds.

- PIRSA's Far West Coast Aquaculture Management Plan Aquaculture (Ashman, 1996b) specified that: "Aquaculture development should not occur within one kilometre of a Reserve proclaimed under the National Parks and Wildlife Act 1972", although there is no explanation for the distance chosen, or of the possible impacts on estuarine species, including bird populations, associated with some of the coastal reserves. According to the S.A. Coast and Marine Atlas (2001), aquaculture development has been approved between 0.8km - 1.5km of at least two declared reserves on the West Coast.
- PIRSA (Ashman, 1996b) also stated that "Aquaculture should not occur within 250 metres of an aquatic reserve proclaimed under the Fisheries Act 1982", although there is no clear explanation for the distance chosen, and no indication of the potential impacts of aquaculture developments on the function of protected estuarine areas as fish nurseries and conservation zones for benthic biota.
- "Aquaculture development should not adversely impact on seagrass beds considered to be environmentally significant by the Director of Fisheries" (Ashman, 1996b, for PIRSA), although guidelines for the assessment of "environmental significance" appear not to have been stated prior to the installation of aquaculture leases. Recent government / consultant surveys of the potential for increased aquaculture in **Streaky Bay** reported the significance of the extensive seagrass in the bay, in addition to the diverse (and in some areas, dense) invertebrate assemblages, and concluded that aquaculture may have a negative effect on these habitats, particularly the area immediately under the lease sites.
- "Aquaculture development should not occur within 250 metres of areas considered to be environmentally significant by the Director of Fisheries, including significant mangrove stands, nursery areas, estuaries and creeks" (Ashman, 1996b, for PIRSA). However, assessment of "environmental significance" appears not to have been stated or formally assessed prior to the installation of aquaculture leases, and no explanation was given for the size of the buffer area.
- Pacific Oyster (*Crassostrea gigas*) escapees from aquaculture farms have been recorded during previous monitoring programs at **Denial Bay**, **Smoky Bay** and **Streaky Bay**, according to Ellis (1999a and 1999b). However, Madigan and Clarke (1998), reported that feral oysters were not recorded at Streaky Bay and Smoky Bay during a 1998 monitoring program, despite having been previously recorded in these areas (e.g. Hone, 1996). These feral populations are reproductively viable, but are reported to be currently restricted to "isolated areas". Feral populations of Pacific Oysters also occur in **Murat Bay**, and have been observed on Razorfish (*Pinna bicolor*) in **Tourville Bay** (Hone 1996; Ashman, 1996). Madigan and Clarke (1998), reported that feral Pacific Oysters observed in **Murat Bay** during the 1998 monitoring program, were located predominantly on human-built structures (boat ramps, jetties and oyster racks), although one small population was recorded on a granite outcrop in **Murat Bay**. Apart from the granite outcrop, feral oyster populations were recorded in 1998 at **McKenzies Landing**; two abandoned lease sites in **Murat Bay**, and both the northern and southern boat ramps at **Thevenard** (Madigan and Clarke, 1998). The size frequency histogram of shell length of all feral oysters measured at **Murat Bay**, indicated at least two, and possibly three, peaks of previous settlement. Feral oysters have bred on 3 to 4 occasions since 1990 at **Murat Bay** (Vandeppeer, 1995, cited by Hone and Clark, 1997). Due to differences in survey methods between a 1995 survey (Hone, 1996) and the 1998 survey, it was not possible to determine whether there was an increase in the feral oyster population at **Murat Bay** over that period (Madigan and Clarke, 1998). Control strategies to prevent spread are in place (see Ashman, 1996), however the success of these strategies is not known for this report.
- Localised increases in nutrients and waste levels may result from aquaculture in its various forms on the West Coast (Ellis, 1999a). Public submissions to the *Streaky Bay Aquaculture Management Plan* (Bond 1994) listed waste water from aquaculture facilities as a concern in the **Streaky Bay** area, requesting that waste water should not be allowed to re-enter the sea unless adequately treated. Previously, PIRSA (Ashman, 1996) also recognised that aquaculture along the West Coast may, in cases where supplementary feeding is required (particularly in semi-enclosed waterways), reduce water quality through nutrient increases. According to Madigan and Clarke (1998), monitoring of water quality showed that the parameters exceeded the minimum standard requirements set by the EPA (Executive Summary, p. 1), and the authors recommended that monitoring continue to ensure that the water quality parameters do not exceed the minimum EPA requirements. The EPA standards were not provided in the report by Madigan and Clarke (1998), and the report did not stipulate the extent to which water quality parameters in the West Coast monitoring sites (**Murat**, **Smoky**, and **Streaky Bays**) exceeded the standards.
- Hone and Clarke (1997) reported that commercial farming of the native oyster *Ostrea angasi*, particularly if ploidy manipulation was used to enhance production, may have some impact on wild populations, due

to interbreeding. Genetic impacts due to Pacific Oysters are less likely, because Pacific Oysters reportedly do not interbreed with any native oyster species in South Australia (Hone and Clarke, 1997).

- Oyster leases in the southern **Streaky Bay – Blanche Port** area are located close to shore and occupy seagrass meadows (*Posidonia australis*), and some leases generally extend no more than 50 metres from the high water mark (Bond 1994). Previously, some impact on seagrass cover and on Razorfish (*Pinna bicolor*) stocks has been evident within aquaculture lease sites within the **Streaky Bay – Blanche Port** area, according to Bond (1994). Madigan *et al.* (2000) reported that a study of lease sites in **Murat Bay** showed that seagrass biomass within 1m of oyster racks was reduced by 49%, and seagrass directly under the racks was reduced by 83%, relative to control sites. The authors considered that the principal cause of reduction of seagrass biomass at oyster rack sites was due to insufficient light penetration. Such results were not observed for the BST longline method of culture. Madigan *et al.* (1999) reported that a study of broad-scale changes in seagrass distribution in **Murat Bay**, through the analysis of a time series of 1:10 000 aerial photographs, showed that there was no detectable change in broad-scale seagrass cover attributable to oyster farming, during the period 1994 to 1998. The authors considered that detectable changes were not dependent upon the location of oyster leases, and therefore reflected natural changes in seagrass abundance over time.
- Physical disturbance caused by oyster aquaculture operations has been listed as a potential threat to habitats in **Denial Bay, Murat Bay**, around **St Peter Island** and in **Streaky Bay** (e.g. **The Spit**) (Bryars, 2003).
- Also, an increased level of nutrients caused by land-based aquaculture facilities (i.e. abalone farm) near **Pigface Island**, was listed as a potential threat to habitats in the area (Bryars, 2003).
- There is potential for harmful algal species to bloom and proliferate in west coast waters, which affect both cultured and native shellfish. There is a tidal creek in Streaky Bay that releases sewage waste into the sea, which can help to stimulate the growth of microalgae. Mass blooms of microalgae can also result in deoxygenation of the water, which can result in fish deaths. Some of the harmful microalgal species that have been identified in the **Streaky Bay** and **Smoky Bay** areas during monitoring by the Shellfish Quality Assurance Program include *Dinophysis acuminata* and a species of *Alexandrium*. Shellfish toxins (such as Neurotoxic and Diarrhetic Shellfish Poisons, or NSP and DSP) resulting from microalgal blooms, have been recorded in **Streaky Bay** and **Smoky Bay**, resulting in periodic health warnings (e.g. November, 2001 and December 2003) about consumption of oysters, mussels, Scallops and Razorfish from these bays (ARNAT, 2004). In late 2003, concentrations of *D. acuminata* exceeded 2000 cells/L (defined as “Critical Level 2”), and the taking or processing of shellfish in the area was consequently banned, until early 2004. During the height of the bloom, levels of *D. acuminata* were around 18,000 cells/L, and patches of bloom were counted as high as 50,000 cells/L (ARNAT, 2004).
- There have been concerns, particularly from professional line fishers and prawn fishers, about the impact of the populations of Pacific Oysters on the commercial fishery. There is a reported perception that the oysters are in such large numbers that they may be impacting fish (populations) through direct predation on their larvae or through competition for food sources and habitat space. Little scientific evidence is available with which to assess these issues (Ashman, 1996).
- Other potential aquaculture impacts in the Far West Coast area, listed by PIRSA (Ashman, 1996), include: (i) Impact on sensitive areas of coastline, and damage to coastal facilities, due to vehicle and boat access to aquaculture sites; (ii) Visual impacts (from emergent structures etc); Water quality impacts from processing and waste disposal (*Note that specific effects of organic wastes were not discussed*); and Social impacts (e.g. competing uses for inshore waters).
- Hames Sharley Australia (1989) noted that the “emptiness and sense of wilderness” is an essential part of the scenic attraction along the Far West Coast, and that developments can destroy these wilderness qualities. **Laura Bay** was considered to be an example of an area that would suffer in this way if even minor developments were permitted. Also potential for diminished visual amenity in the popular, well used area of **Ceduna** if developments such as oyster culture were to proliferate in the region (Hames Sharley Australia, 1989).
- The recognised impacts of shellfish aquaculture in general, are discussed in section 9.2 of this report, and many of these impacts were recognised during the late 1980s as potential threats to the far west coast if aquaculture proliferated in the area (see report by Hames Sharley Australia, 1989).

Shipping Issues

- PIRSA (Ashman, 1996) recognised the threat of oil spills, due to international shipping in the **Murat Bay / Denial Bay** area. Bryars (2003) listed hydrocarbons from shipping and boating activity, and hydrocarbons from petro-chemical spillage during shipping operations at **Thevenard**, as potential threats to habitats

(such as bays) in the West Coast region.

- Also recognised is the threat of introduction of exotic organisms via ballast water, due to international shipping in the **Thevenard / Murat Bay / Denial Bay** area (Ashman, 1996; Bryars, 2003). In general, ballast water discharge has been identified as a pollution source along the West Coast, and port operations at **Thevenard** are considered to be the main risk area regarding ballast water introductions (Ellis, 1999a). It is possible that “large quantities of potentially contaminated ballast water” could be released into **Bosanquet Bay** (Ellis, 1999). Ellis (1999a) reported that the spread of the toxic dinoflagellate *Alexandrium minutum* in South Australia has been directly related to shipping, as well as recreational craft, and a 1990 survey reported cysts of *A. minutum* in the sediments at **Thevenard** and **Streaky Bay**, and that several other dinoflagellates and cyanobacteria have been recorded in West Coast waters. Upwelling events have been implicated in phytoplankton blooms of such species. Other introduced marine organisms that have established in West Coast waters include *Botryllus schlosseri* (a colonial ascidian) and *Maoricolpus roseus* (New Zealand screw shell) (Ellis, 1999a). Approximately 107 international ships visited the **Thevenard** port in 2002 (Flinders Ports web site, 2003).
- There is some anecdotal evidence that work practices at **Thevenard** harbour may have resulted in localised contamination of marine waters (Ellis, 1999c). Spills of grain and fertiliser into the water during loading have also been reported.
- TBT anti-foulant is still used on large commercial vessels, and large vessels use the Port of **Thevenard**. TBT accumulates in marine food chains, and can concentrate in molluscs at levels hundreds of thousands of times higher than surrounding sediment or seawater. The toxic effects of TBT in marine organisms include, amongst others, immuno-suppression, physical deformities, reduced growth rate, reproductive abnormalities in molluscs (including sex change); death of eggs and larvae in molluscs; reduction in population numbers of molluscs; and inhibition of body organ function in some higher animals (Nias *et al.*, 1993; AMCS and EPA, 1999). Bryars (2003) also listed organo-metals from cargo vessels at **Thevenard**, as being a potential threat to habitats in the area.

Fishing and Boating Issues

- Shepherd and Rodda (2001) recorded a statistically significant 11 year decline in the yields (70% reduction) of Greenlip Abalone from the **Franklin Islands** area (Map Code 3B). Shepherd (pers. comm. 2000) also recorded long term declines (1984 - 1998) in the **Denial Bay** region, including **Lacy, Evans and St Peters** Island, noting a halving of the annual greenlip yield to approximately 5t (compared with original production). Relationship of declines to fishing pressure is complicated by 6 year cycles in productivity. Lesser declines were noted for the coast north of **Point Brown**, and also at **St Francis Isles**, for both greenlip and blacklip (production of the latter declining from 7t in 1988 to 2t in 1998).
- Mayfield *et al.* (2002) reported that reductions in the abundance of adult and juvenile abalone suggest that, with the exception of Thorny Passage, Greenlip Abalone populations in the Western Zone may be declining; and (iii) the catch per unit effort on Greenlip Abalone has declined significantly since 1986, and has been below the long-term average since 1995.
- *Western Blue Groper and mixed Wrasse species*: Blue Groper (including large, older individuals) and other wrasse species, and other reef fish species, are taken by recreational fishers and charter boats, off the coastal headlands and around islands of the Far West Coast (see section above on recreational fishing). To a lesser extent, wrasses are also caught as bycatch in the Northern zone Rock Lobster fishery (see section above). Fishing may pose a risk to populations of strongly site-associated reef fish species, including groper and other wrasses, as discussed in section 9.2, which also provides notes on the reported status of these and other reef fish species.
- *Harlequin Fish and other Reef fish species*: The species is a relatively large, long-lived site-associated reef fish, vulnerable to depletion by fishing. Section 9.2 discusses the current conservation status and risks to populations of Harlequin Fish, and other reef fish species (e.g. *Western Blue Devil*).
- *Sweep*: The Far West coast has been one of the major commercial fishing areas for sweep in recent years. Sweep are also caught recreationally. Sea Sweep and Banded Sweep are strongly site-associated (territorial), and therefore vulnerable to localised depletion (e.g. see Rohan *et al.*, 1990).
- *King George Whiting, Snapper and Garfish* are caught in the Far West Coast area, commercially and recreationally. All three species are classified as *fully fished* in South Australia (DEHAA and EPA, 1998). In particular, the larger, older King George Whiting and Snapper may be important contributors to spawning potential, and larger individuals of both species are targeted at Far West coast locations (see section above on commercial and recreational fishing). Notes on the current status of these three species, and potential risks to populations of these species, are discussed in section 9.2.

- *Mulloway*: The species is popular with recreational / sports fishers along the Far West coast, particularly the surf beaches (PIRSA, 1999b). There is recent evidence of a small, genetically unique, geographically isolated population at the Head of Great Australian Bight. The GAB population is considered to be over-fished to the extent that it is now uneconomically viable to exploit (Jones, SARDI, pers comm. to K. Evans, 2000). Mulloway may be considered potentially vulnerable in S.A. due to the estuarine-dependent phase of its population dynamics. There is little freshwater outflow along the Far West Coast, and such estuarine conditions are important in the reproduction of this species. Overall, there is heavy fishing pressure by both commercial and recreational fishers on Mulloway in South Australia, and recreational catches (including catches over the bag limit) appear not to be adequately monitored in S.A. By-capture of Mulloway in shark and finfish fisheries in deeper Commonwealth waters is also an issue. Bycatch action plans have recently been developed for the Commonwealth fisheries in southern waters. The current possession limit for Mulloway in the Southern Shark Fishery is 100kg per trip (AFMA, 2001b), because Mulloway is a State-managed fishery.
- *School Shark and Gummy Shark*: the Far West is a commercial fishing area for school and Gummy Shark, and the species are also taken by recreational sports fishers along the west coast. School Shark (Australasian subpopulation) was listed in the IUCN Red List 2003 as *Conservation Dependent*, and previously, Gummy Shark was included in the IUCN Red List 2000 and Red List 2002 as *Conservation Dependent*. The Commonwealth has recently re-regulated the fishery for School and Gummy Shark, in light of the *over-fished* status of School Shark populations in southern Australia since the early 1990s (see AFFA, 2000b; AFMA, 1999b; AFMA, 2003a) and the *fully-fished* status of Gummy Sharks (AFMA, 2000d). The status of (and potential risks to) School Shark and Gummy Shark populations are discussed further in section 9.2.
- *Bronze Whaler and/or Black Whaler Sharks*: Caught commercially in Far West Coast waters and also by recreational fishers, however the extent of recreational fishing in the area is not known for this report. Bronze Whaler and Black Whaler were both included in the IUCN Red List 2003 as *near threatened* species. Whaler sharks have a number of vulnerable population characteristics, and are species of conservation concern in South Australia (see section 9.2, and Baker, in press).
- *Ray, Stingray and Stingaree* species: Various “ray” species known from southern Australian waters (e.g. Southern Eagle Ray; Southern Fiddler Ray; Short-Tail Torpedo Ray; Black Stingray; Smooth Stingray; Common Stingaree; Banded Stingaree, Coastal Stingaree, Sparsely-Spotted Stingaree, Coffin Ray / Numbfish, Tasmanian Numbfish) are all caught as bycatch in the Commonwealth fish and shark fisheries (SESSF) (AMFA, 2002c). The Coastal Stingaree *Urolophus orarius* is endemic to South Australia, and has a limited known distribution, between Ceduna on the west coast, and Beachport in the upper South-East (Last and Stevens, 1994; museum and survey records in Baker, in press). *U. orarius* is considered to be a threatened species (P. Kyne, IUCN Shark Specialist Group, pers. comm., 2004; Baker in press). Many ray, stingray and stingaree species may be of future conservation concern due to poor knowledge of population sizes, and few or no regulations on their capture in Commonwealth commercial fisheries and State commercial and recreational fisheries. A number of these species are marketed as “ray flaps” in southern Australia. In South Australia, no recreational bag limits have been set for ray species, and these species are not included in regular stock assessments, hence population status may be largely unknown for many ray species in South Australia. There is some unconfirmed evidence from fishers, of relatively high numbers of benthic rays being taken by recreational fishers in the more accessible coastal waters in parts of South Australia. Rays are also caught as bycatch in prawn trawlers and commercial fishing nets in S.A.
- *Rock Lobster*: Current stock assessment details, and potential threats to the Northern Zone Rock Lobster stocks, are discussed in section 9.2. In 2001, low levels of egg production, pre-recruit abundance, and adult biomass were estimated to currently exist in the Northern Zone (a very large fishing area covering waters from the WA border, through to Encounter Bay, and deeper waters south of Kangaroo Island), and reductions in fishable biomass were predicted to occur in the Northern Zone over the next few seasons (Ward *et al.*, 2002).
- *Great White Shark*: There are irregular reports to government of illegal fishing for Great White Shark in waters off Western Eyre Peninsula. The extent of this practice is not known for this report. Great White Shark is formally a protected species at State and national levels, and was listed under the IUCN Red List (2003) as *vulnerable* and *conservation dependent*.
- *Blue Swimmer Crabs*, which are considered to be a “popular item” for fishers in the southern **Streaky Bay – Blanche Port** area, are severely recruitment-limited (Grove-Jones, 1987). Crab stocks, described as being “severely reduced” by experimental commercial fishing over the period 1983-86, are dependent for their recruitment success on favourable off-shore coastal upwelling phenomena (Wallner, 1985, cited by Bond, 1994). Although Blue Swimmer Crab stocks in S.A. as a whole are not considered threatened by

fishing levels (Boxshall *et al.*, 2000 for a more recent stock assessment), the geographically-isolated Streaky Bay stock requires special consideration because it may be locally vulnerable to depletion due to irregular recruitment, and therefore limited abundance over space and time (e.g. see Grove-Jones, 1987; Baker and Kumar, 1994).

- *Pilchards*: Although the Far West Coast is not currently a major fishing area for pilchards (see Ward *et al.*, 2000), future increases in yield may have potential ecosystem impacts, due to the significance of this species in marine food webs, particularly in the cool water upwelling regions of South Australia. The ecological significance of pilchards, and the issues associated with fishing the species, are discussed in other sections of this report.
- *Western King Prawn*: According to Carrick and Williams (2001), the west coast prawn fishery is prone to severe periodic declines which are associated with environmental events, and that over-exploitation when stock naturally declines will reduce the potential for stock recovery and the fishery will collapse without the supply of adequate post-larvae to nurseries. In recent years for which fishing of the west coast prawn stocks is reported (e.g. Carrick and Williams, 2001), the authors note that industry has maintained a responsible approach to management by reducing trawl hours when stock and recruitment were relatively low.
- Collection of *Razorfish* and other molluscs such as native oysters in the southern **Streaky Bay – Blanche Port** area is considered to be “a popular past time” and Bond (1994) reported “obvious localised depletion” (Bond, 1994).
- There is reported to have been a significant decline in the *Native Oyster* population in **Streaky Bay**, which has been fished since the middle of the 19th century.
- Marine litter and disposal of unwanted fishing tackle have been listed by Ellis (1999a) as management issues arising from fishing activity on the west coast. Although there are no available statistics for the upper West Coast bay and island areas, results of an ongoing marine litter survey in Anxious Bay, showed that 65% of the litter collected comprised hard plastic (an increase from 35% in 1991), and around 35% of all litter during the survey period originated from commercial fishing operations in the Great Australian Bight and offshore from the West Coast (SARDI data, cited by Ellis, 1999a). The proportion of this litter that was not related to fishing was not specified.
- Damage of benthic areas by boat anchors, is listed by Ellis (1999a) as a management issue arising from fishing activity on the west coast.
- Wastes from fish processing plants were identified as a pollution source at the West Coast (Ellis, 1999a).
- TBT anti-foulant is still used on fishing and recreational craft in S.A. TBT accumulates in marine food chains, and can concentrate in molluscs at levels hundreds of thousands of times higher than surrounding sediment or seawater. The toxic effects of TBT in marine organisms include, amongst others, immunosuppression, physical deformities, reduced growth rate, reproductive abnormalities in molluscs (including sex change); death of eggs and larvae in molluscs; reduction in population numbers of molluscs; and inhibition of body organ function in some higher animals (Nias *et al.*, 1993; AMCS and EPA, 1999).
- Hydrocarbons from boating activity in West Coast bays (e.g. the **Blanche Port** area) has been listed as a potential threat to habitats in those areas (Bryars, 2003).
- Poaching (illegal fishing) and non-compliance with bag and boat limits, were identified as issues of concern in some areas (e.g. **Smoky Bay**) by local fisher respondents to the GAB 1000 West Coast Strategy (see Ellis, 1999b and associated West Coast Strategy papers).
- Ellis (1999a) reported that, as a consequence of undertaking traditional subsistence fishing practices, there is some lack of compliance with gear specifications, seasonal closures and bag and size limits recognised under S.A. legislation for the protection of fish stocks.
- Pinnipeds, cetaceans (mainly dolphins) and fish can become entangled (often fatally) in discarded line and net from fishing activities. Figures are not available for this report, but entanglements are known to regularly occur in South Australian waters, according to reports received by S.A. Museum.

Aboriginal Heritage Issues

- Martin (1988) considered that the Aboriginal fish-traps of the West Coast region are a fragile and non-renewable cultural resource of great significance, and may be endangered by: (i) erosion (the effects of which can be which can be exacerbated by any of the following); (ii) reclamation of channel and swamp areas for housing, boat harbours or other coastal developments; (iii) recreational use, particularly 4WD vehicles and bike use, which can erode embankments and beach sites, redirect tidal flow away from fish

trap sites (which isolates and buries the fish-traps), and also breaks down stone walls and wooden stakes and branches; (iv) waste disposal (sewerage, industrial and rubbish); (v) road building (which can contribute to silting of the tidal channels; and (vi) fishing impacts (e.g. movement or removal of fish trap boulders to assist bait collecting, boat launching and netting).

- According to Ellis (1999a), at the numerous sites of aboriginal significance along the West Coast, there is reported to have been widespread destruction of sacred sites, archaeological sites, and cultural objects, especially in areas away from Aboriginal controlled land.
- In the **Denial Bay / Murat Bay** area, Hames Sharley Australia (1989) reported that “numerous tracks have been forged indiscriminately through the aboriginal reserve to gain access to beaches for fishing and other recreational activities.
- Heritage sensitivities may not be adequately recognised or considered in consultation processes regarding aquaculture developments on the West Coast (Ellis, 1999a).

Potential Impacts on Coastal Birds

- The GAB 1000 West Coast Strategy (see Ellis, 1999a) stated that the West Coast contains “very important wading bird habitat for species”, including those protected under international agreements. These areas are considered to be poorly identified, and are reportedly being impacted by aquaculture and other disturbance activities. Identification of specific areas and determination of their conservation values was considered to be “a major issue”, with a view to developing a strategy for protection of such areas (Ellis, 1999a). Birds in general along the West Coast coastal area, but also including “rare native and protected migratory species” are also considered to be threatened by foxes, cats, and dogs (Ellis, 1999a).
- Hames Sharley Australia (1989) identified the major 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**. Hames Sharley Australia (1989) considered that any degradation of these habitats through traffic, compaction, nutrient alteration or noise, will have some effect upon the large populations of wading birds in the upper West Coast areas.
- White-bellied Sea Eagle and Osprey numbers along the west coast are reported to have been considerably reduced due to “inappropriate development and human disturbance along coastal breeding habitats”, and remaining sites of occupation and suitable habitat require adequate protection (Ellis, 1999a). Bird species which nest along coastal cliffs, such as the White-bellied Sea Eagle, may be vulnerable to disturbance from foot, vehicle, and fishing vessel traffic (Flaherty, pers. comm. cited by Edyvane and Baker, 1999b).
- In deeper areas seaward of the bays, potential threats to sea birds include fisheries entanglements (e.g. long lines), competition with fishers for prey species (e.g. pilchards, Southern Calamari), and marine litter entanglements (Flaherty, 1996, pers. comm., cited by Edyvane and Baker, 1999b).

Other Issues

- In the National Land and Water Resources Audit’s assessment of estuaries in South Australia (1999-2001) **Blanche Port** was classified as *Modified* (based mainly on clearance of natural land cover), and described as “*under high to very high pressure*” (GeoScience Australia, 2001).
- Acid sulphate soils have been listed as a potential problem in **Blanche Port**, however no mapping or assessment has been undertaken (GeoScience Australia, 2001).
- A marina and waterfront housing development has been proposed at **Ceduna**. A preferred location has been identified, and preliminary design work has been completed (Ellis 2000; Austin, media report, September, 2003). The general impacts of marinas and associated facilities are discussed in Section 9.2.
- **Eyre Peninsula**: Buckley (Australian Mineral Development Laboratories consultancy to the Department of Environment and Planning, 1986) considered that fur seals and sea lions were being shot by some fishers, but that this was difficult to control due to inadequate surveillance resources.
- Gypsum mining occurs near the coast (Hames Sharley Australia, 1989), which may have some near-shore impacts.
- Parts of the whaling station site at **Point Collinson** are under threat from the activities of 4WD vehicles and their owners, who appear to regularly visit the area. Significant amounts of broken glass, ammunition and plastic were observed during survey work during the 1990s (see Staniforth, 1998 and 1999).
- Purported introduction of an exotic flatworm species into **Streaky Bay** (public submission, cited by Bond,

1994), which preys on molluscs in the area.

- **The viviparous starfish *Patiriella parvivipara*, which has no planktonic larval stage and narrow habitat limits, is considered vulnerable to pollutants, especially hydrocarbons (Environment Australia, 1998a).**

West Coast: Environmental monitoring in the coastal and marine area was considered to be inadequate, according to respondents to the draft GAB 1000 West Coast Strategy (Ellis, 1999b).

9.2.11.2 Baird Bay to Cape Bauer (including nearshore islands) (Murat/Eyre Bioregions Boundary)

Coastal Issues

- There is some concern about housing development on the **Calca Peninsula** (e.g. see McWaters, 2003; ABC News Online, 15/10/03 and 16/10/03), the narrow, eroding and unstable piece of land that separates **Baird Bay** from **Searcy Bay**. The area was previously sub-divided for housing, and cliff-top housing was approved in October, 2003. Issues include potential increased coastal erosion; damage to remnant coastal vegetation; alleged degradation of the Heritage significance of the area; disturbance of the Sea Lions and sea bird species of conservation concern (such as Osprey) in the peninsula area, and visual impacts, amongst others. Coastal disturbance seems to be responsible for Osprey leaving the area as reported by T Dennis and Birds Australia (2003).
- In the National Land and Water Resources Audit's assessment of estuaries in South Australia (1999-2001) **Baird Bay** was classified as *Modified* (based mainly on clearance of natural land cover), and described as "*under moderate to high pressure*" (GeoScience Australia, 2001).
- Acid sulphate soils have been listed as a potential problem in **Baird Bay**, however no mapping or assessment has been undertaken (GeoScience Australia, 2001).
- **Baird Bay:** The **Unnamed Island** in Baird Bay is degraded, according to the Australian Heritage Commission's *Register of the National Estate* description for Baird Bay Conservation Park.
- Previously, some of the issues listed for **Baird Bay** have included the following:
 - ♦ In the past, there were reported to be three extractive mineral leases approved to mine silica gravel from Silica Beach (Morelli and de Jong, 1995). In general, mining in estuarine areas has potential impacts on the habitat quality and ecology of the area (e.g. due to noise, runoff, physical damage from removal of sand habitat). Mining is not listed as currently occurring in the area (National Land and Water Resources Audit for Baird Bay, cited by GeoScience Australia, 2001).
 - ♦ There is an annual license and perpetual lease for stock grazing purposes, and grazing to the waterline occurs (Morelli and de Jong, 1995). It is possible that this activity may have adverse impacts on water quality, bird habitat and associated breeding, nesting, resting or feeding activities.
 - ♦ Uncontrolled access to beach by off road vehicles has also been listed as an issue (Morelli and de Jong, 1995), and may have an adverse impact on sites for bird breeding, feeding or resting.
 - ♦ Other issues previously noted include aesthetic impacts, due to abandoned fishing sheds, rubbish dumping etc (Morelli and de Jong, 1995).

Fishing Issues

- **Abalone:** Shepherd and Rodda (2001) recorded:
 - ♦ a statistically significant 13 year decline (1986 to 1998) in the yields of Greenlip Abalone from the **Point Labatt** area, reporting a 50% decrease in yield over that period;
 - ♦ a 20 year decline (1979 to 1998) in the yields of Greenlip Abalone from the **Baird Bay** area, reporting a 39% decrease in yield over that period, however the figures were not statistically significant;
 - ♦ a 20 year decline (1979 to 1998) in the greenlip yields from the **Cape Blanche** area, which includes Slade Point and northern **Searcy Bay**, reporting a 45% decrease in yield over that period, however the figures were not statistically significant.
 - ♦ a statistically significant 15 year decline (1983 to 1998) in the yields (91% reduction) of Greenlip Abalone from the **Cape Bauer** (Map Code 3C);
 - ♦ a highly statistically significant ($P < 0.001$) long term decline (1979 to 1998) in the yields (63% reduction) of Greenlip Abalone from the **Highcliff** area (4A, 4B, 4C), south of Cape Bauer.
 - ♦ a statistically significant ($P < 0.01$) long term decline (1979 to 1998) in the yields (98% reduction) of

Greenlip Abalone from the **Sceale Bay** area (4D, 4E).

- The **Sceale Bay** population of abalone is considered to be severely depleted (Shepherd and Rodda, 2001, Rodda *et al.*, 2000).
- Mayfield *et al.* (2002) reported that reductions in the abundance of adult and juvenile abalone suggest that, with the exception of Thorny Passage, Greenlip Abalone populations in the Western Zone may be declining; and (iii) the catch per unit effort on Greenlip Abalone has declined significantly since 1986, and has been below the long-term average since 1995.
- Illegal fishing for abalone is reported to occur along the section of the West Coast described in this table (R. Minnican, pers. comm., 2002).
- *Western Blue Groper and mixed Wrasse species, and other Site-Associated Reef Fish Species*: Mixed wrasse species have been fished commercially from the mid West Coast region, including the waters near Baird Bay. Blue Groper (including large, older individuals), and other reef fish are taken by recreational fishers and charter boats, off the coastal headlands and bays (see section above on recreational fishing). In addition to Blue Groper, *Blue-throated Wrasse*, *Brown-spotted Wrasse* and *Senator Wrasse* are the main wrasse species caught commercially in South Australian waters (e.g. see Knight and Johnson, 1999). To a lesser extent, wrasses are also caught as bycatch in the Northern zone Rock Lobster fishery (see section above). Fishing may pose a risk to populations of strongly site-associated reef fish species, including Blue Groper and other wrasses, as discussed in section 9.2, which also provides notes on the reported status of these and other reef fish species of conservation concern (e.g. *Harlequin Fish*, which are caught by recreational fishers and charter boats in the area).
- *King George Whiting, Snapper and Garfish* are caught in the area, by both commercial and recreational fishers. All three species are classified as *fully fished* in South Australia (DEHAA and EPA, 1998). Notes on the current reported status of King George Whiting, Snapper and Garfish, and potential risks to populations of these species, are discussed in section 9.2.
- *Rock Ling*: Caught commercially and recreationally in mid west coast waters. Rock Ling is recognised nationally as a species of conservation concern (see notes on population status and threats, in section 9.2, and Baker, 2004).
- *School Shark and Gummy Shark*: The deeper mid west coast waters constitute one of the major commercial fishing areas in State waters for School and Gummy Shark, and the species are also taken by recreational sports fishers along the west coast. School Shark (Australasian subpopulation) was listed in the IUCN Red List 2003 as *Conservation Dependent*, and previously, Gummy Shark was included in the IUCN Red List 2000 and Red List 2002 as *Conservation Dependent*. The Commonwealth has recently re-regulated the fishery for School and Gummy Shark, in light of the *over-fished* status of School Shark populations in southern Australia since the early 1990s (see AFFA, 2000b; AFMA, 1999b; AFMA, 2003a) and the *fully-fished* status of Gummy Sharks (AFMA, 2000d). The status of (and potential risks to) School Shark and Gummy Shark populations are discussed further in section 9.2.
- *Bronze Whaler and/or Black Whaler Shark*: Caught commercially in mid west coast waters, however the extent of recreational fishing in the area is not known for this area, for this report. Young Bronze Whalers are also fished recreationally in South Australia (as both target and bycatch, the latter of which are often killed – according to Winwood (1994), but figures are not available for this report. Bronze Whaler and Black Whaler were both included in the IUCN Red List 2003 as *near threatened* species. Section 9.2 discusses the vulnerability of these species to over-exploitation, due to the vulnerable characteristics of their life history.
- *Saw Shark and Whiskery Shark*: Both caught in mid West coast waters. Whiskery Shark was classified as *Lower Risk (Conservation Dependent)* in the IUCN Red List 2000 and 2002, but not included in the 2003 IUCN Red List. 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.
- *Rock Lobster*: Current stock assessment details, and potential threats to the Northern Zone Rock Lobster stocks, are discussed in section 9.2. In 2001, low levels of egg production, pre-recruit abundance, and adult biomass were estimated to currently exist in the Northern Zone (a very large fishing area covering waters from the WA border, through to Encounter Bay, and deeper waters south of Kangaroo Island), and reductions in fishable biomass were predicted to occur in the Northern Zone over the next few seasons (Ward *et al.*, 2002).
- *Great White Shark*: There are irregular reports to government of illegal fishing for Great White Shark in waters off Western Eyre Peninsula. The extent of this practice is not known for this report. Great white shark is formally a protected species at State and national levels, and was listed under the IUCN Red List

(2003) as *vulnerable* and *conservation dependent*.

- There is an anecdotal report of “constant interactions” between pinnipeds (Australian Sea Lions and New Zealand Fur Seals) and recreational and commercial fishing operations in the region (Media Release: Friends of Scele Bay, 16/01/02).
- Marine litter and disposal of unwanted fishing tackle have been listed by Ellis (1999a) as management issues arising from fishing activity on the west coast. Although there are no available statistics for the upper West Coast bay and island areas, results of an ongoing marine litter survey in Anxious Bay, showed that 65% of the litter collected comprised hard plastic (an increase from 35% in 1991), and around 35% of all litter during the survey period originated from commercial fishing operations in the Great Australian Bight and offshore from the West Coast (SARDI data, cited by Ellis, 1999a). The proportion of this litter that was not related to fishing was not specified.

Diving/Snorkelling

- Swimming and snorkelling by visitors in the protected area were listed by Morelli (1995) as a threat to the **Point Labatt** area, but no details were provided.
- Excessive interactions with marine mammals has generally been recognised by industry and government as a potential threat to those populations.

Aquaculture

- Due to the abundance of marine mammals in the area, caged fish farming may pose a significant threat to members of these populations, due to entanglement and other interactions. It is possible that pinnipeds preying on caged fish may also be deliberately harmed by efforts to drive them away from the fish cages. Habituation of pinnipeds to cage fish farms (e.g. reliance on the farmed fish as a major food source) is another potential concern. Seabirds, predatory fish, dolphins and sharks are also attracted to fin fish cages, and may be harmed through entanglement, drowning and other means. Such interactions are known and reported in other parts of South Australia in which caged fish farms exist (see section 9.2).
- Although Bond’s (1994) assessment of aquaculture site suitability recommended that commercial development of aquaculture in the Scele Bay – Searcy Bay area be considered, the report noted that prior to any approval of commercial aquaculture in the region, there was a need for an understanding of the assimilative capacity of the bay environment, backed by research and data on water quality, water movement and environmental impact.
- Bond’s (1994) assessment of aquaculture potential in the region (e.g. **Scele Bay** and **Searcy Bay**) recommended that
- *onshore (land-based) aquaculture* would be acceptable providing discharges into the sea meet Primary Industries SA and the Environment Protection Authority requirements. The type of land-based aquaculture that recommended for these areas was not specified, although an application for onshore abalone farming was received by government during the early 1990s (S.A. Coast and Marine Atlas, 2001). It is noted that there are recognised impacts from land-based aquaculture facilities, particularly if effluents are not properly managed. Potential impacts of land-based aquaculture in general are discussed in section 9.2.

Other Issues

- **Point Labatt:** In 2000, reports were received by government (DEH), that some visitors have been disturbing / harassing the sea-lions in the **Point Labatt / Baird Bay** area. In the early 2000s, National Parks and Wildlife SA, industry, and marine mammal experts formed a working group, to set formal regulations for viewing, swimming and other eco-tourism activities.
- **Olive Island:** The pup population of Australian Sea Lions is reported to have been declining since 1979 (Rowley 2001). Reasons for declining pup production and high mortality rates at some colonies in South Australia are being investigated by CSIRO.
- Specimen shells are collected along some areas of the coast (e.g. **Speeds Point**). The extent of this practice is not known for this report. A number of specimen shell species in South Australia are of conservation concern (see discussion above in section 9.2 of this report, and Baker, 2002).

9.2.11.3 Venus Bay and Surrounds (Eyre Bioregion)

Estuarine / Habitat Issues

- The GAB 1000 West Coast Strategy Draft (1999) reported that in areas where towns or other developments abut low flow areas (including **Venus Bay**, amongst other locations), such areas are potentially impacted by urban and industrial development, including stormwater runoff, industrial-processing discharges, and high nutrient discharges from septic drainage and outflows, and sewage treatment processes. Other pollution sources identified along the West Coast include contaminated groundwater, land-applied treated wastewater systems, and effluent reuse systems. Catchment-derived discharges of agricultural fertilisers and chemicals were also listed as a general concern along the West Coast (see Ellis, 1999a). Where farming and cropping occur in areas adjacent to nationally important wetlands and estuaries of the West Coast, good farm management skills are needed to prevent losses of nutrients to the marine environment in catchment run-off. All of the above-mentioned discharges are considered to have adverse effects on water quality and marine ecosystems in general (Ellis, 1999a).
- The GAB 1000 West Coast Strategy Draft (1999) reported that “apparent habitat change” in the vicinity of **Port Kenny** jetty and causeway should be investigated.
- Acid sulphate soils have been identified as a potential problem in **Venus Bay**, however no mapping (or assessment) has been undertaken (GeoScience Australia, 2001).

Aquaculture Issues

Land based aquaculture

- **Venus Bay:** Bond’s (1994) assessment of aquaculture potential in the region suggested that “onshore aquaculture is acceptable (in Venus Bay area), providing discharges into the sea meet PISA (PIRSA) and the Environment Protection Authority requirements”. Applications for onshore abalone farming (on the eastern side of the entrance to Venus Bay) were received by the State Government in 1994 and 1995. It is noted that there are recognised impacts from land-based aquaculture facilities such as abalone farms, which are discussed further in Section 9.2.

Offshore aquaculture

- The eastern side of **Venus Bay** was zoned for shellfish aquaculture (the **Port Kenny Zone**) by PIRSA in 1996 (Ashman, 1996), and leases have been trialled in the area during the 1990s (see section on Social and Economic Values and Uses). Potential impacts associated with shellfish farming are discussed further in Section 9.2.
- Ashman (1996) stated that aquaculture has the potential to impact visually on the natural amenity of some areas of the West Coast, particularly those in close proximity to conservation parks or lookouts, and that aquaculture development should consider other uses in the West Coast area (such as popular water sport, recreation and other tourism sites).

Fishing Issues

- **Abalone:** Shepherd and Rodda (2001) recorded (i) a 16 year decline (1983 to 1998) in the yields of Greenlip Abalone from the **Venus Bay** area, reporting a 38% decrease in yield over that period compared with original production during the 1970s; and (ii) a highly significant decline in the yields of Greenlip Abalone from the **Anxious Bay** area, reporting an 85% decrease in yield over the period 1988 to 1998, compared with original production during the 1970s. Mayfield *et al.* (2002) reported that reductions in the abundance of adult and juvenile abalone suggest that, with the exception of Thorny Passage, Greenlip Abalone populations in the Western Zone may be declining; and (iii) the catch per unit effort on Greenlip Abalone has declined significantly since 1986, and has been below the long-term average since 1995.
- **Mixed Wrasse species:** Regionally, caught in deeper mid west coast waters seaward of the bays. Wrasse species are generally slow-growing, strongly site-associated species with distinct structure to population groups. *Blue-throated wrasse*, *Brown-spotted wrasse* and *Senator Wrasse* are the main wrasse species caught commercially in South Australian waters (e.g. see Knight and Johnson, 1999), and to a lesser extent, wrasses are also caught as bycatch in the Northern Zone Rock Lobster fishery (see section above). Fishing may pose a risk to populations of strongly site-associated reef fish species, including

wrasses, as discussed in section 9.2, which also provides notes on the reported status of these reef fish species.

- *King George Whiting, Snapper and Sea Garfish* are caught in the area, by both commercial and recreational fishers. All three species are classified as *fully fished* in South Australia (DEHAA and EPA, 1998). Notes on the current reported status of King George Whiting, Snapper and Sea Garfish, and potential risks to populations of these species, are discussed in section 9.2.
- *Rock Ling*: Caught commercially and recreationally in mid west coast waters. Rock Ling is recognised nationally by marine researchers to be a species of conservation concern (see notes on population status and threats, in section 9.2, and Baker, 2004).
- *School Shark and Gummy Shark*: The deeper mid west coast waters (North, West and South of the Venus Bay area) is one of the major commercial fishing areas in State waters for school and Gummy Shark. Gummy Sharks are also fished recreationally along the coast out of Venus Bay, including fishing competitions which seek the largest individuals. School Shark (Australasian subpopulation) was listed in the IUCN Red List 2003 as *Conservation Dependent*, and previously, Gummy Shark was included in the IUCN Red List 2000 and Red List 2002 as *Conservation Dependent*. The Commonwealth has recently re-regulated the fishery for School and Gummy Shark, in light of the *over-fished* status of School Shark populations in southern Australia since the early 1990s (see AFFA, 2000b; AFMA, 1999b; AFMA, 2003a) and the *fully-fished* status of Gummy Sharks (AFMA, 2000d). The status of (and potential risks to) School Shark and Gummy Shark populations are discussed further in section 9.2.
- *Bronze Whaler and/or Black Whaler Sharks*: Caught commercially in mid west coast waters, however the extent of recreational fishing in the area is not known for this area, for this report. Young Bronze Whalers are also fished recreationally in South Australia (as both target and bycatch, the latter of which are often killed – according to Winwood (1994), but figures are not available for this report. Bronze Whaler and Black Whaler were both included in the IUCN Red List 2003 as *near threatened* species. These species are considered potentially vulnerable to population decline, due to their life history and reproductive characteristics, as discussed in section 9.2.
- *Elephant Fish / Shark*: The species is fished in the coastal waters outside Venus Bay, including a recreational fishing competition in which the largest elephant fish are sought. The conservation status of elephant fish in general, and potential risks to populations of this species, are discussed in section 9.2.
- *Saw Sharks and Whiskery Shark*: Both caught in mid West coast waters. Whiskery Shark was classified as *Lower Risk (Conservation Dependent)* in the IUCN Red List 2000 and 2002, but not included in the 2003 IUCN Red List. 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. Section 9.2 provides more detail about population status, and vulnerable characteristics of these species
- *Rock Lobster*: Current stock assessment details, and potential threats to the Northern Zone Rock Lobster stocks, are discussed in section 9.2. In 2001, low levels of egg production, pre-recruit abundance, and adult biomass were estimated to currently exist in the Northern Zone (a very large fishing area covering waters from the WA border, through to Encounter Bay, and deeper waters south of Kangaroo Island), and reductions in fishable biomass were predicted to occur in the Northern Zone over the next few seasons (Ward *et al.*, 2002).
- *Western King Prawn*: According to Carrick and Williams (2001), the west coast prawn fishery is prone to severe periodic declines which are associated with environmental events, and that over-exploitation when stock naturally declines will reduce the potential for stock recovery and the fishery will collapse without the supply of adequate post-larvae to nurseries. In recent years for which fishing of the west coast prawn stocks is reported (e.g. Carrick and Williams 2001), the authors note that industry has maintained a responsible approach to management by reducing trawl hours when stock and recruitment were relatively low.
- *Great White Shark*: There are irregular reports to government of illegal fishing for Great White Shark in waters off Western Eyre Peninsula. The extent of this practice is not known for this report. Great white shark is formally a protected species at State and national levels, and was listed under the IUCN Red List (2003) as *vulnerable* and *conservation dependent*.

Other Potential Impacts

- Uncontrolled access to beaches, internal islands and other coastal sites by off road vehicles may have adverse impacts on coastal vegetation, and sites for bird breeding, feeding or resting. For example, white-bellied sea eagles in coastal cliff areas may be disturbed by increased human visitation and use of coastal areas, including foot, vehicle and vessel traffic (T. Flaherty, pers. comm. cited by Edyvane and

Baker, 1999b).

- Boating activity and even walking may disturb some bird nesting sites. For example, a pelican nesting site on **Island C** inside **Venus Bay**, is easily accessible by flat-bottomed boat. Pelicans are easily disturbed during the breeding season. If disturbed, fleeing adult birds that are sensitive to noise may abandon the chicks, which can be readily attacked by gulls (Robinson *et al.*, 1996).
- Ocean-based (including ship-based) marine litter has been significant in the Great Australian Bight area. According to a long running survey involving SARDI Aquatic Sciences staff and community groups (reported in Edyvane *et al.*, 2003), over the 1991–1999 period, a large but gradual decline in the amount of beach washed litter was recorded. Beach-washed litter decreased by approximately 86%, from 344 kg recorded in 1991 (13.2 kg/km) to 49 kg in 1999 (i.e. 1.9 kg/km), reaching a maximum of 390 kg in 1992 (or 15 kg/km of beach). However, a sharp increase in litter was recorded in 2000 (i.e. 252 kg or 9.7 kg/km). This increase in litter yield in 2000 was reported to be probably due to stronger than average onshore surface flow in the western Eyre Peninsula and Bight region. The yields and type of litter collected from the annual survey indicated that the majority of litter washed ashore originated from commercial fishing activities within the Great Australian Bight. Most of the fishing-related litter was directly sourced to the Southern Rock Lobster Fishery (i.e. bait buckets, baskets, pots), the Great Australian Bight Trawl Fishery (i.e. codends, trawl nets) and the Southern Shark Fishery (i.e. monofilament gillnets and longlines) (Edyvane *et al.*, 2003).
- There is potential for entanglement of marine mammals, fish, sharks and sea birds in fishing gear and marine litter in **Anxious Bay**.
- Morelli and de Jong (1995) listed disturbances or threats in the **Lake Newland** area including: encroachment of sand dunes into lake, stock grazing, water withdrawals, and vegetation clearance, the latter of which may have a possible slow salinisation effect in spring catchment zones. Duck shooting was previously an issue but has been banned since the area was declared a conservation park.
- DEH (2001) reported that some of the main management issues in the **Newland Lake Conservation Park** are to (i) maintain the volume and integrity of the groundwater available for the fresh water springs on which the wildlife species, particularly waterbirds, depend; (ii) protect (from groundwater extraction, for example) the freshwater springs and seepage systems and the saline lakes; (iii) protect the wildlife, particularly waders and other wetland birds in the wetland habitats; (iv) protect the coastal dune system (and its binding vegetation) by rationalising vehicle access (and also restricting foot traffic), monitoring the drift of mobile dunes, and rehabilitating where necessary. Part of the northern dune area has become unstable due to inappropriate vehicle use, and grazing by rabbits, and mobilisation of the damaged dune system is considered a threat to the lakes, springs and seepages. The DEH report also specified that the soils, salt lakes, salt pans, and samphire flats of Lake Newland are fragile, and may be easily damaged by vehicles and pedestrians.
- Vehicle use on dunes, and predation by foxes and cats, may affect the population of hooded plover which nest in the dune area of the **Newland Barrier** (see DEH, 2001). According to T Dennis and Birds Australia 2003, some long standing nest sites for Osprey have been deserted due to disturbance.

Other Information

- In the National and Water Resources Audit's assessment of estuaries in South Australia (1999-2001), although **Venus Bay** was classified as *Largely Unmodified*, it was considered to be "under moderate to high pressure" (GeoScience Australia, 2001).

9.2.11.4 Investigator Group of Islands (Eyre Bioregion)

Note comparatively low level of threat from land-based pollution in this area, due to the distance of most of these islands from the coast.

Fishing Issues

- **Greenlip Abalone:** Shepherd and Rodda (2001) recorded: (a) a highly statistically significant long term decline (1981 to 1998) in the yields of Greenlip Abalone from **Pearson Island**, reporting a **97% decrease in yield** and (b) a 19-year decline in the yield of greenlip from **Ward Island** = 12% decrease in yield, compared with previous productivity. Mayfield *et al.* (2002) reported that reductions in the abundance of adult and juvenile abalone suggest that, with the exception of Thorny Passage, Greenlip

Abalone populations in the Western Zone may be declining; and (iii) the catch per unit effort on Greenlip Abalone has declined significantly since 1986, and has been below the long-term average since 1995.

- *School Shark and Gummy Shark*: The mid west coast waters are one of the major regions in the State where these species are fished commercially. School Shark (Australasian subpopulation) was listed in the IUCN Red List 2003 as *Conservation Dependent*, and previously, Gummy Shark was included in the IUCN Red List 2000 and Red List 2002 as *Conservation Dependent*. The Commonwealth has recently re-regulated the fishery for School and Gummy Shark, in light of the *over-fished* status of School Shark populations in southern Australia since the early 1990s (see AFMA, 1999b; AFMA, 2003a) and the *fully-fished* status of Gummy Sharks (AFMA, 2000d). The status of (and potential risks to) School Shark and Gummy Shark populations are discussed further in section 9.2.
- *Bronze Whaler and/or Black Whaler Sharks*: Caught commercially in mid-west coast waters, however the recreational yield is not known for this area, for this report. These species may be considered potentially vulnerable, due to relatively slow growth, delayed maturity, viviparous (live bearing) reproduction, and low fecundity (see section 9.2). Both adults and young are caught as part of the fishery in S.A.. The extent of the nursery areas is not well known, and overall there is reportedly little information on the status of both adults and juveniles (Froese and Pauly, 2003). These two species are also fished recreationally in S.A., but figures are not available. Bronze Whaler and Black Whaler were both included in the IUCN Red List 2003 as *near threatened* species. Section 9.2 discusses the vulnerability of these species to over-exploitation, due to their life history characteristics.
- *Saw Sharks*: Saw Sharks are fished commercially by shark fishers in deeper waters north, south and west of Elliston, although capture of Saw Shark 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. Southern Saw Shark has not been listed by IUCN, but threats to populations are similar to those for Common Saw Shark (see Cavanagh *et al.*, 2003, Baker, in press and references therein).
- *Reef Fish*: A number of reef fish species of conservation concern occur in the area. The Investigator Islands are popularly known, particularly amongst divers and fishers, for their *Western Blue Groper* population, including very large individuals. Blue Groper are caught both commercially (in central west coast waters) and recreationally (N.B. there is some spear-fishing at island sites), and as bycatch, particularly in Commonwealth fisheries. It is possible that charter fishing boats visiting the island group also catch Blue Groper, as occurs in other parts of S.A. where offshore charter fishing trips occur, however no specific information is available for this report. Notes on the reported status of Blue Groper are provided in section 9.2. Although the Investigator Islands are relatively inaccessible, further promotion of the area in future, for tourism and fishing purposes, may increase the potential for population impacts on groper and other strongly site-associated reef fish species as well, such as *Boarfish* species; *Maggie Perch*; *Dusky Morwong*; larger, older *Snapper* which have a reef association (N.B. Snapper are classified as *fully fished* in South Australia – DEHAA and EPA 1998); *Western Blue Devil*; *Harlequin Fish*; species of *sweep* and *wrasse* (both sweep and wrasse are also caught commercially in mid west coast waters), amongst other reef fish species. *Blue-throated Wrasse*, *Brown-spotted Wrasse* and *Senator Wrasse* are the main wrasse species caught commercially in South Australian waters (e.g. see Knight and Johnson 1999), and to a lesser extent, wrasses are also caught as bycatch in the Northern zone Rock Lobster fishery (see section above). Fishing may pose a risk to populations of strongly site-associated reef fish species, including wrasses, as discussed in section 9.2.
- *Ocean Leatherjacket*: This species was classified as *fully fished* in 1998 (DEHAA and EPA, 1998).
- *Rock Ling*: A benthic species that is considered susceptible to over-fishing (see Baker, in press, and references therein).
- *Rock Lobster*: Reported status of the Northern Zone Rock Lobster stocks, and potential ecosystem impacts from Rock Lobster fishing, are discussed in section 9.2.
- *Western King Prawn*: According to Carrick and Williams (2001), the west coast prawn fishery is prone to severe periodic declines which are associated with environmental events, and that over-exploitation when stock naturally declines will reduce the potential for stock recovery and the fishery will collapse without the supply of adequate post-larvae to nurseries. In recent years for which fishing of the west coast prawn stocks is reported (e.g. Carrick and Williams 2001), the authors note that industry has maintained a responsible approach to management by reducing trawl hours when stock and recruitment were relatively low.
- *Gastropod molluscs*: Specimen shells important in the shell trade occur in the Investigator Islands area.

The extent of commercial and recreational fishing for shells in the Investigator Islands group is not known for this report. The potential risks to such species are described in section 9.2.

Aquaculture Developments

- **Flinders and Topgallant Islands:** A site suitability assessment for offshore aquaculture (Petruševics *et al.*, 1998) suggested that the western sides of both Flinders and **Topgallant** Islands may be suitable for aquaculture development (to 30m depth). The terrestrial area of **Topgallant** is a Conservation Park, and the area is a breeding site for seabirds such as White-faced Storm Petrel and Short-tailed Shearwater, and a haul out site for Australian sea lions. PIRSA (1997) stated that breeding sites for many species are particularly sensitive to disturbance from aquaculture, such as boats servicing farms.
- A lease for farming Blue Mussels has been approved north of **Waldegrave Island** (South Australian Coastal and Marine Atlas, 2003). Marine environmental risks associated with shellfish farming are discussed in Section 9.2.

Diving

- Gorgonian corals in South Australia are considered to be susceptible to impacts from recreational diving (Environment Australia 1998). Although the Investigator Islands are relatively inaccessible, care should be taken in the future promotion of the area for tourism and diving purposes, which may increase the potential for population impacts on vulnerable benthic species such as corals.
- Dive tourism has increased in the area during the past decade. There is potential for the Blue Groper population to be disturbed by human contact. For example, trips during which divers could “pat and feed” the large groupers, were suggested during the late 1990s as a tourism marketing strategy for the area.

Other Issues

- Potential disturbance of pinniped colonies by visitors, particularly if tourism activities continue to increase in the Investigator Group area during the 2000s. Haul-out sites for seal and seal lions on island beaches may be particularly vulnerable.
- The introduced marine species *Botrylloides leachi* (a colonial ascidian) has been reported from Topgallant Island (Furlani 1996).
- There are irregular reports to government of illegal fishing for Great White Shark in waters off Western Eyre Peninsula. The extent of this practice is not known for this report, nor whether the activity occurs specifically at the Investigator Group islands in addition to known locations in mid and upper west coast waters.
- A diamond mine has been approved for **Flinders Island**. Exploratory drilling commenced in 2002, with discovery of indicator minerals close to the surface (Tawana Resources, 2002; Mining Australia, 2003). Most of the exploratory drill sites are on the north-west side of the island, including a number of drill sites around 1km from the coast (see map in Stoian and Cooper, 2003). Five target sites have now been selected for further work and drill testing for diamond-bearing kimberlite (Tawana Resources, 2002), and drilling commenced in 2003 (Mining Australia, 2003). In general, mineral mining on islands, may include impacts such as (i) increased turbidity and decreased light penetration in coastal waters, and increased sedimentation in nearshore areas (e.g. due to wash-off of waste rock / slurries from the extraction process, and increased surface erosion from mining operations); and (ii) noise impacts (from surveys, extraction equipment and processes, vehicles etc), which may disturb bird and mammal colonies.

9.2.11.5 Thorny Passage (Eyre Bioregion)

Fishing Issues

Note that description of some of these issues is provided for information only. Issues such as stock and ecosystem impacts from fishing highly mobile, migratory and short-lived species such as pilchards, cannot be addressed by marine protected areas, because such impacts are primarily a fisheries management issue relating to quota and effort control etc.

- **Pilchard Fishing:** Due to the potential ecosystem impacts of pilchard fishing, there is a need to determine

whether the high fishing yields of Pilchards from the southern Eyre region are ecologically sustainable over the long term. Baitfish (mainly pilchards) are an important part of the diet of predatory fish (e.g. Australian Salmon and Snook), seabird species (e.g. Little Penguin, short-tailed shearwaters, Australian pelican, and many others), and some cetaceans and pinnipeds. Because Pilchards are a primary food source for Little Penguins, local depletions of pilchards may have significant local impacts upon penguin populations (Copley, 1995). Note that due to the importance of Pilchards in the diet of sub-adult West Australian Salmon, Dimmlich and Jones (1997) recommended that information on the distribution and size of Australian Salmon schools be regularly obtained from fishery independent assessments, to assist in monitoring the effect of the developing pilchard fishery on the salmon population in South Australian waters. In turn, the predatory fish that eat Pilchards are also an important part of the diet of some marine mammals and sharks (such as Bronze Whalers). At the top of the food chain, the Great White Sharks eats many of the other species associated with the Pilchard food web, such as Southern Bluefin Tuna and other tuna species, West Australian Salmon, Snapper and other predatory fish, young pinnipeds and cetaceans, and even sea birds and Pilchards. These food web interactions are important in the parts of South Australia where all of these species occur in highest abundance (e.g. **Lower Eyre Peninsula**; and **North-western, Western and South-Western Kangaroo Island**). The Commonwealth's Senate Inquiry into Marine and Coastal Pollution (October 1997) and the Commonwealth's 1995 State of the Marine Environment Report both highlighted as a major issue: *a high demand for wild capture fisheries (e.g. pilchards and anchovies) for aquaculture stock food*. Pilchards and other bait fish are a major feed source for caged tuna in the South Australian aquaculture industry. The continued use of pilchards as a major food source for caged tuna may have significant ecosystem impacts: There is concern that excess nutrients and other waste products of feeding can affect both the benthic environment and the water quality. A disproportionately large amount of pilchard feed is required to raise tuna (reported food conversion ratios of 15:1 or even 20:1), and much of this is uneaten waste, or converted to waste products which pollute the benthic and pelagic environments. Additionally, there is concern that persistently high, and increasing, yields of native Pilchards for industry may impact upon marine food webs, by reducing natural food supplies for fish, and birds, and also affecting other animals higher in the food web (e.g. dolphins, sharks). The catch in S.A. is purportedly around 15% of the annual pilchard biomass, but stock assessment methods (based upon egg counts) may not give an unquestionably accurate estimate of stock numbers per annum. Furthermore, studies to determine the ecological impacts of pilchard fishing (particularly on food webs) have only recently commenced, despite the Pilchard fishery having operated for more than 10 years in S.A., with a substantially increased increasing yield in recent years. In addition to the depletion of native Pilchards, the demand for bait fish in the caged fish industry encourages over-fishing of bait fish in other countries which supply pilchards, herring, sprats and other species to feed caged fish in Australia. The S.A. Pilchard catch contributes to the feeding of caged tuna, but is reported to currently account for less than 20% of the Pilchard biomass required by caged tuna (Fish Information and Services, 2001). The remainder of the Pilchard feed for tuna is reported to have recently consisted of Californian pilchards, Swedish herring and sprats and other food sources from overseas (Fish Information and Services, 2001).

- Major scale-fish fisheries in the south-western Spencer Gulf region include those for scalefish and sharks that are considered to be *fully fished* (Gummy Shark, King George Whiting, Snapper, Southern Calamari, West Australian Salmon, Sea Garfish) or *over fished* (School Shark). The current reported status of populations of these species is discussed in section 9.2. (NB: The specific significance of Thorny Passage in relation to populations of these species is not known for this report).
- *Snapper* are caught in the lower Eyre Peninsula area, although at a State level south-western Spencer Gulf is not a major fishing area for this species. Potential impacts on Snapper are discussed in section 9.2. The Snapper catch in Southern Spencer Gulf was the highest ever recorded in 1999/2000, due to a strong 1991 year class making its way through the fishery (Fowler, 2000), but the specific significance of Thorny Passage in relation to Snapper is not known for this report.
- *King George Whiting*: Although spawning is not known to occur in this area, larger, older fish are found in the more exposed gulf waters (e.g. around Sir Joseph Banks Islands and south-western Spencer Gulf). Southern Spencer Gulf contains a significant fishery for larger, older King George Whiting that have moved out of the bays closer to shore. The current status and potential threats to this species are discussed in section 9.2 of this report.
- *Wrasse species*: Wrasse species (e.g. Blue-throated Wrasse) are commercially fished in waters of south-western Spencer Gulf. The extent of spearfishing and line fishing in the Lincoln National Park area and associated islands of Thorny Passage, is not known for this report. The potential threats to Wrasse species are discussed in section 9.2.
- *Western Blue Groper*: Blue Groper occurs on reefs in south-western Spencer Gulf, and in deeper waters. Note that the taking of Western Blue Groper by recreational fishers is prohibited in Spencer Gulf. The

extent of spearfishing and line fishing in the Lincoln National Park area and associated islands of Thorny Passage, is not known for this report. The potential threats to Western Blue Groper are discussed in section 9.2.

- Potential vulnerability of other site-attached reef-associated species to population declines due to fishing activity, including line and spearfishing. Examples include Boarfish species, Magpie Perch, Dusky Morwong, adult Snapper, Moonlighter, Western Talma, Western Blue Devil, Harlequin Fish, and Sweep, amongst others. The extent of spearfishing and line fishing in the Lincoln National Park area and associated islands of Thorny Passage, is not known for this report. The potential threats to site-associated reef fish species in general are discussed in section 9.2 of this report.
- *Rock Lobster*: Current stock assessment details, potential risks to the Northern Zone Rock Lobster stocks, and potential ecosystem impacts from Rock Lobster fishing, are discussed at the beginning of this chapter. In 2001, low levels of egg production, pre-recruit abundance, and adult biomass were estimated to currently exist in the Northern Zone (a very large fishing area covering waters from the WA border, through to Encounter Bay, and deeper waters south of Kangaroo Island), and reductions in fishable biomass were predicted to occur in the Northern Zone over the next few seasons (Ward *et al.*, 2002).
- *Gummy Shark and School shark*: South-western Spencer Gulf is one of the major fishing areas for these species in SA waters. The status and potential risks to populations are discussed earlier in this chapter. The Commonwealth has recently re-regulated the fishery for school and Gummy Shark, in light of the *over-fished* status of School Shark populations in southern Australia since the early 1990s (see AFFA, 2000b; AFMA, 1999b; AFMA, 2003a) and the *fully-fished* status of Gummy Sharks (AFMA, 2000d). AFMA (2002a) reported that part of the southern Eyre Peninsula area (e.g. **West Point to Cape Wiles**, including **Sleaford Bay**) is one of several sites in South Australia that are important for pregnant female School Sharks and their pups; and that such sites are also important for breeding Gummy Sharks. According to AFMA (2002a), there is increasing uncertainty about the size and sustainability of the School Shark population (fished under Commonwealth management). The latest agreed assessment for the School Shark population in the fishery reportedly shows "*extremely low numbers*". In the 2001 School Shark assessment, productivity was estimated to be so low that under some scenarios, the agreed rebuilding of School Shark stocks to the 1996 level (by 2011) would be impossible under any level of Total Allowable Catch (TAC). If productivity is actually as low as the model currently predicts and it remains so, AFMA (2002a) considered that an unacceptably long time frame of 15 years would be required to rebuild the stock. At the 44th meeting of the Southern Shark Fishery Management Advisory Committee (SharkMAC), the committee recognised that the current ambiguities of the School Shark assessment will continue for at least 3-4 years until a time series of fixed station survey data is accumulated. SharkMAC recognised that additional measures were required to reduce the potential for targeting the long lived breeding stock as pregnant School Sharks are particularly vulnerable in the sheltered shallow waters of the pupping grounds (e.g. southern Eyre Peninsula coast, south of Thorny Passage).
- *Bronze Whaler and/or Black Whaler Sharks*: Whaler sharks are caught commercially in the area, and also by recreational fishers, but figures are not available for this report. These species may be considered potentially vulnerable, due to relatively slow growth, delayed maturity, viviparous (live bearing) reproduction, and low fecundity (see section 9.2). Both adults and young are caught as part of the fishery in S.A.. The extent of the nursery areas is not well known, and overall there is reportedly little information on the status of both adults and juveniles (Froese and Pauly, 2003). Bronze Whaler and Black Whaler were both included in the IUCN Red List 2003 as *near threatened* species. Section 9.2 discusses the vulnerability of these species to over-exploitation, due to their life history characteristics.
- *Greenlip Abalone*: Shepherd and Rodda (2001) recorded a long term decline (1979 to 1998) in the yields of Greenlip Abalone from the southern Thorny Passage area (Map Code 18C,D,E,F between northern Thistle Island and the Eyre Coast, and including Hopkins and Grindal Islands), reporting a 13% decrease in yield over that period, but the figures were not statistically significant. The rest of the Thorny Passage area is highly productive for abalone, particularly greenlip, and therefore the local decline is of less significance compared with the long term declines reported by Shepherd and Rodda (2001) for other areas in the region (such as the foot of the Southern Eyre coast). Mayfield *et al.* (2002) reported that reductions in the abundance of adult and juvenile abalone suggest that, with the exception of Thorny Passage, Greenlip Abalone populations in the Western Zone may be declining; and (iii) the catch per unit effort on Greenlip Abalone has declined significantly since 1986, and has been below the long-term average since 1995.
- Pinnipeds, cetaceans (especially small cetaceans such as dolphins) and fish can become entangled (often fatally) in discarded line and net from fishing activities. Figures are not available for this

assessment, but entanglements are known to regularly occur in South Australian waters, according to reports received by the S.A. Museum.

- *Gastropod Molluscs*. There is a small fishery for specimen shells (e.g. cowries, volutes), operating in Thorny Passage waters (Aquaculture Group, PISA - Fisheries, 1997). At least a dozen species are collected in the Thorny Passage area (see Baker, 2002 and references therein). Some of the specimen shells in South Australia are of conservation concern because molluscs which have direct development of young are particularly vulnerable to over-exploitation and population decline (see Ponder and Grayson, 1998). Volutes as a group have particularly vulnerable population dynamics, as do the southern Australian species of *Zoila* and *Notocypraea*, and some of the *Conus* species (e.g. *Conus anemone*), which have direct development of young and no planktonic larval phase, and therefore limited dispersal, and geographically distinct sub-populations and varieties, with little mixing. Such characteristics makes populations of these species with limited dispersal vulnerable to over-collecting. Geographically distinct populations of species of cowries (*Zoila*, *Notocypraea*), cone shells (*Conus*) and volutes (e.g. *Amoria*, *Ericusa*, *Notovoluta* and other volute genera) often have distinctive colours and patterns, and some of the less common "varieties" or "sub-forms" (*rare* in some cases) are highly sought after by collectors. It is recognised that species with small extent of occurrence (i.e. narrow geographic range) can be vulnerable to localised extinction from local impacts (IUCN, 1994; Jones and Kaly, 1994, cited by O'Hara and Barmby, 2000). Furthermore, some shell species in the shell trade have specialised feeding habits and therefore also have restricted habitats (e.g. some of the *Zoila* and *Notocypraea* rely on host sponges). This feature makes such species more vulnerable than those with more generalised feeding requirements.

Diving

- Gorgonian corals in South Australia are susceptible to impacts from recreational diving (Environment Australia 1998). Gorgonian corals are known to occur at a number of Thorny Passage headland and island areas, however the level of recreational dive activity in this area and potential site-specific impacts are not known for this report.

Aquaculture

- During the early 2000s, there were no aquaculture leases in Thorny Passage (SA Coast and Marine Atlas, 2003). However, according to Aquaculture Group, PISA - Fisheries (1997), there has been a high level of interest in undertaking aquaculture in the waters from Thorny Passage to Point Bollingbroke, and that report recommended that provision be made for the current (at the time, 1997) interest in aquaculture development in Thorny Passage. Potential was expressed for aquaculture development in the northern part of the area (North of **Little Island** and **Lewis Island**). Assessment of site suitability for offshore aquaculture (Petruševics *et al.*, 1998) suggested that the coastal waters (excluding a 1km buffer around Lincoln National Park) north of **Little Island** would be suitable for offshore aquaculture development. Proposed area included **Taylor** and **Grindal** Island, and the northern end of **Thistle Island**. The Lower Eyre Peninsula Aquaculture Management Plan (Aquaculture Group, PISA - Fisheries, 1997) also suggested that **Taylor** and **Grindal** Island would be suitable for trials of tuna farming and other aquaculture developments in exposed sites, to a maximum of 40 hectares around Taylor Island, and six hectares around Grindal Island. Applications for aquaculture development (finfish, and Rock Lobster) in the **Thorny Passage** area were received during the 1990s, but none have been approved to date. The environmental impacts of sea cage fish farming in general, as well as other subtidal aquaculture developments, have been well documented and are outlined in Section 9.2.
- Aquaculture Group, PISA - Fisheries (1997) stated that aquaculture development may impact on the values of the Lincoln National Park area by lowering scenic amenity and through alteration of a predominantly undisturbed area.
- *Abalone aquaculture*: Aquaculture Group, PISA - Fisheries (1997) noted that the protozoan parasite *Perkinsus* has been recorded in wild Blacklip Abalone populations north of the area described here (e.g. Port Lincoln), and concern has been expressed that the parasite may impact upon the viability of abalone aquaculture in the region. However, some abalone fishers have expressed concern that *Perkinsus* has been recorded in an abalone aquaculture facility in the Port Lincoln area, and concern has been expressed by fishers that the parasite may spread to wild abalone populations in the south-eastern Eyre Peninsula area. However, it is important to note that the environmental conditions in culturing facilities are quite dissimilar to those in the natural environment, and this may provide limited opportunity for pests in cultured conditions to spread to wild populations. This has not been verified.

Other Issues

- North of Thorny Passage, at Cape Donington, there was (in 2000) unpublished evidence from divers in the area, of stunted and “unhealthy” (potentially diseased, epifauna-laden and “slime”-covered) abalone. Some members of the community have expressed concern about the declining water quality in the Boston Island / Donington Island region north of the area discussed in this table.
- Throughout the mid to late 1990s, community groups (e.g. CCSA, MCCN) have expressed concern about the injury and killing of pinnipeds, dolphins and sharks, following their attraction to towed pontoons of tuna, and/or their movement through Thorny Passage to the tuna pens further north. There is considerable anecdotal evidence to support this concern (see section 9.2).
- Australian Sea Lion populations are not increasing in SA, and pup mortality rates can be high in some areas (CSIRO media releases 1998 and 2000b; Shaughnessy, 2001b). The reasons for the high pup mortality are uncertain. During the early 2000s, factors (both natural and anthropogenic) that may be related to the recent high death rates were being investigated by CSIRO’s Wildlife and Ecology section (P. Shaughnessy).

9.2.11.6 Sir Joseph Banks Group and Dangerous Reef (including Tumby Bay) (Eyre/Spencer Gulf Bioregions Boundary)

Estuarine and Coastal Issues

- Shack development along the **Tumby Bay** foreshore has caused some erosion (Morelli and de Jong, 1995).
- There is some evidence of sewage discharge into **Tumby Bay**. Algal growth (including *Ulva*) found in **First Creek** may indicate septic tank seepage (Morelli and de Jong, 1995), and PIRSA (1997) suggested that built up urbanised areas such as Tumby Bay are subject to effluent discharge into waterways and the adjacent marine environment. PIRSA Sustainable Resources unit reported that water quality problems were evident in First Creek, immediately south of the causeway. Mats of the green alga *Ulva* (sea lettuce) have been observed, an indicator of nutrient pollution, presumably from stormwater run-off from *The Island* residential development. The main cause appears to be due to reduced flushing capacity as a result of the installation of a culvert over the mouth of the creek which, whilst allowing for the bulk of tidal exchange, has restricted natural flows.
- There is an increased level of nutrients caused by agricultural runoff from the **Salt Creek** catchment, and from diffuse agricultural runoff in the Tumby Bay area (Bryars, 2003).
- At **Tumby Bay**, there is heavy access by boats through **First Creek** (Morelli and de Jong, 1995). An increased level of hydrocarbons has been reported due to boating activity in **First Creek**, and at the **Tumby Bay** marina (see section below) (Bryars, 2003). Other issues in the area include decreased tidal flow due to the location of a causeway at **First Creek** (Bryars, 2003).
- Channel dredging operations carried out since 1978 have altered sand movements around the mouth of **First Creek** at **Tumby Bay** (Morelli and de Jong, 1995).
- PIRSA (1997) suggested that the nearshore area adjacent to built up areas such as **Tumby Bay** may be subject to pollution from stormwater discharge.
- **Tumby Island**: Considered to be in disturbed by introduced species such as boxthorn, numerous mice and rabbits (Australian Heritage Commission, undated).

Marina and Waterfront Development Issues

The Amendment to the Assessment Report for the Environmental Impact Statement for the Proposed Tumby Bay Marina (Minister for Transport and Urban Planning, 1998) described the Tumby Bay District Council’s amended marina and waterfront residential development as comprising:

- ♦ A permanent 100 berth marina (~ 40 berths to be initially provided);
- ♦ approximately 55 serviced allotments (33 with direct water frontage to the basin) and associated access roads;

- ♦ associated excavation of an entrance channel, marina basin and waterways and the construction of edge treatments;
- ♦ two lane public boat ramp with a hardstand area and car/trailer parking (for ~ 100 vehicles);
- ♦ repair yard with a slip-way and dry storage area;
- ♦ boat refuelling dock and marine toilet pump-out facility;
- ♦ public toilet associated with the public boating facilities; culverts; and public open space reserves.

The Tumby Bay Development Plan (Planning S.A., 2000) specified a Residential Waterfront Zone for Tumby Bay, accommodating residential waterfront development, canal system development, marina berths and a range of marina-based facilities. The zone was designed to accommodate activities to create an urban waterfront / maritime environment: dry storage, jetties, boat launching ramp, pontoons, moorings, minor buildings, car parking and refuelling dock. The Development Plan specified that, as part of the marina development, there is a need to:

- ♦ “retain, protect and manage” mangroves, other vegetation and dune systems associated with First Creek;
- ♦ protect the scenic amenity and appearance of landscape;
- ♦ protect water quality within the channel and the marina basin.
- ♦ preserve and manage sites of heritage, cultural, scientific, environmental and educational importance.
- ♦ not adversely affect coastal processes through pollution, erosion, damage, depletion of physical or biological resources;
- ♦ amongst other objectives of the development.

The Tumby Bay Development Plan (Planning S.A., 2000) provided a list of guidelines for development. Those which relate to the marine and coastal environment include specifications that the proposed development should:

- ♦ be primarily for low to medium-density residential development on allotments ranging between 300 to 1200 square metres in area;
- ♦ provide for the management of septic tank effluent into an approved septic tank effluent disposal system or sewage into a sewage system, and harvesting and reuse of the wastewater.
- ♦ not occur unless served by a reticulated water supply and an approved septic tank effluent disposal system or sewerage system.
- ♦ protect mangroves, seagrass and saltmarsh areas, by prohibiting public access to these areas;
- ♦ have allotments designed and constructed to prevent stormwater flows entering into the waterways, and to ensure management of stormwater, to prevent pollution of the waterway system;
- ♦ not impede tidal flows associated with First Creek;
- ♦ not occur unless stormwater is capable of being drained safely and efficiently from the allotment both during and after construction in such a manner as to prevent erosion and pollution of surface or ground water resources;
- ♦ ensure the maintenance of suitable water quality within the marina basin to protect public health and amenity.
- ♦ not be undertaken on coastal dune systems, tidal wetlands, mangroves, sand dunes or other environmentally-sensitive areas.
- ♦ not be undertaken where it will create or aggravate coastal erosion, or if it will require coast protection works which will cause or aggravate coastal erosion.
- ♦ not impair the environmental significance of the area, or adversely impact upon coastal processes.
- ♦ not be detrimental to the amenity of the area as viewed from the adjoining roads and the gulf waters; and
- ♦ land that has a boundary with a water body should be developed with a water frontage, provided that the edge will not cause or be subject to erosion.

Other relevant specifications in the Development Plan include recommendations that:

- ♦ development near sites of heritage significance, including places of Aboriginal significance, should not

detract from the character and significance of the land;

- ◆ development should be designed to avoid the need for the clearance of native vegetation;
 - ◆ all stormwater runoff from car parking, driveways and hard paving areas should be diverted into a stormwater treatment system capable of removing litter, sediment and oil products, and then utilised on-site, where possible;
 - ◆ development should be designed and constructed to incorporate water conservation measures; collect and store roof runoff in water storage tanks; and include measures for on-site harvesting and reuse of stormwater.
 - ◆ The Tumby Bay Development Plan also included recommendations to reduce impacts from the mooring of boats, and from fuelling.
- According to a report by the Minister for Transport and Urban Planning (1998), the expansion of residential development along the Tumby Bay coast could lead to further, more serious water quality problems (and subsequent environmental implications) developing in the long-term, if not properly managed. This further reinforces the need to reduce inputs to the basin as far as possible. The marina and residential development was considered by Minister for Transport and Urban Planning (1998) to be “unlikely to become a serious point source for the discharge of pollutants”, although the report considered the possibility that “long-term detrimental impacts on biological communities could occur as a result of chronic exposure to low levels of pollutants and nutrients carried by tidal flows”.
 - The construction of the marina facility was considered likely to result in a diversion of tidal flows from First Creek to the basin. The current restriction of flows to First Creek would result in increased flows to the basin, which would have a greater hydraulic capacity than First Creek, as the water follows the path of least resistance. The installation of a culvert at the northern extent of the basin may further exacerbate the problem by allowing a through-flow of water from the basin to the adjacent samphire flats. Further reduction of flows to the wetland to the south is considered a long-term threat to the sustainability of the wetland system, which is already under threat. Subsequent detrimental effects on important nursery areas for fishery resources were considered also likely to occur. Other impacts include loss of around 1ha of mangroves, less than 1ha of dune area, and some of the *Melaleuca halmaturorum* (Swamp Paperbark) stand adjacent to the present marina channel (Minister for Transport and Urban Planning 1998).

Fishing Issues

- *Greenlip abalone*: Shepherd and Rodda (2001) recorded a 16 year decline (1983 to 1998) in the yields of Greenlip Abalone from **Dangerous Reef** and **Porter Rock**, reporting a 49% decrease in yield over that period, yet the figures were not statistically significant.
- *Pilchard Fishing*: Pilchard is one of the highest yielding fisheries in the Southern Eyre region. Due to the potential ecosystem impacts of Pilchard fishing, there is a need to determine whether high Pilchard yields from fishing in the southern Eyre region are ecologically sustainable over the long term. Issues associated with the fishing of this ecologically significant species, are discussed in other sections of this report.
- Major scale-fish fisheries in the south-western Spencer Gulf region include those for scalefish and sharks that are considered to be *fully fished* (Gummy Shark, King George Whiting, Snapper, Southern Calamari, Australian Salmon, Southern Sea Garfish) or *over fished* (School Shark). The current status of populations of these species, according to recent stock assessment reports and State of the Environment reports, is discussed in section **9.2**.
- *King George Whiting*, *Snapper* and *Garfish* are caught in south-western Spencer Gulf, by both commercial and recreational fishers. All three species are classified as *fully fished* in South Australia (DEHAA and EPA 1998). South-western Spencer Gulf contains a significant commercial and recreational fishery for the larger, older *King George Whiting* that have moved out of the bays further north and closer to shore, to more exposed waters, such as the Sir Joseph Banks Group area. Both commercial and recreational (including charter boat) fishers target the larger older whiting in the south-western Spencer Gulf area, including the Sir Joseph Banks islands. South-western Spencer Gulf is also one of several major commercial fishing areas in the State for *Snapper*, and a number of sites in the area are also popular for recreational Snapper fishing. Larger, older King George Whiting and *Snapper* may be important contributors to spawning potential of the stocks, and larger individuals of both species are targetted in a number of locations. The Snapper stocks in South Australia are characterised by irregular large recruitments, which later sustain the fishery for a number of years when the fish recruit to the fishery. The irregular “good” recruitments of Snapper; the long-lived nature of the fish; and the aggregative nature of large Snapper at a number of sites in Spencer Gulf, requires that the fishery for

this species be cautiously managed over the long term. In recent years, there has been concern (e.g. see SA Country Hour media release, 2001) about a possible decrease in the King George Whiting population in Spencer Gulf. Concern has been expressed (e.g. see McGarvey *et al.*, 2000, and references therein) about need to protect the spawning stock of larger whiting, that are fished commercially and recreationally in the areas where they occur. Concern was also expressed about the total catch (which is unquantified, and largely unregulated, to date) from charter boats, particularly the catch of larger King George Whiting that contribute to the spawning stock. McGarvey *et al.* (2000) recommended additional regulatory measures to protect the spawning stock of King George Whiting. Smaller King George Whiting and Snapper are also taken by recreational fishers, and are also caught in the bycatch from prawn trawling. Ye (1999) reported that *Sea Garfish* is a fully exploited species in S.A.. Although commercial catch rates have generally been stable since the 1980s, the Sea Garfish stock in S.A. is considered to be fully exploited, according to available biological performance indicators (BPIs). Garfish now mature at a smaller size than was observed 40 years ago, believed to be a response to heavy fishing levels (Ye 1999, Southern Fisheries, 2001). Catch rates are not considered to be a sensitive indicator of stock abundance for schooling species such as Sea Garfish.

- *School Shark and Gummy Shark*: The species are fished commercially in the south-western Spencer Gulf area. School Shark (Australasian subpopulation) was listed in the IUCN Red List 2003 as *Conservation Dependent*, and previously, Gummy Shark was included in the IUCN Red List 2000 and Red List 2002 as *Conservation Dependent*. The Commonwealth has recently re-regulated the fishery for School and Gummy Shark, in light of the over-fished status of School Shark populations in southern Australia since the early 1990s (see AFFA, 2000b; AFMA, 1999b; AFMA, 2003) and the fully-fished status of Gummy Sharks (AFMA, 2000d). The status of (and potential risks to) School Shark and Gummy Shark populations are discussed further in section 9.2.
- *Bronze Whaler and Black Whaler Shark*: Caught commercially in south-western Spencer Gulf waters and also by recreational fishers, however the extent of recreational fishing in the area is not known for this report. Bronze Whaler and Black Whaler were both included in the IUCN Red List 2003 as *near threatened* species. The status of (and potential risks to) Bronze Whaler and Black Whaler populations are discussed further in section 9.2.
- 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 (Shepherd, pers. comm.; and see discussion in section 9.2).
- *Pinnipeds* (e.g. sea lions), *cetaceans* (mainly dolphins) and *fish* can become entangled (often fatally) in discarded line and net from fishing activities. Figures are not available for this report, but entanglements are known to regularly occur in South Australian waters, according to data received by the S.A. Museum (Kemper and Gibbs, 1997 and 2000; SCA, 2001). The incidence of entanglement from offshore fisheries is virtually undocumented. Most fishing crews appear unwilling to report incidents at sea, but it has been suggested that the pilchard fisheries operating in South Australian waters to supply tuna farms with feed may have some 'interactions with dolphins' (T. Flaherty, pers. comm., 2002). Local dolphin populations may decline even if a small number (e.g. 10 to 20 dolphins a year) are killed by fishing interactions, especially if female or young dolphins are killed. There is documented evidence of dolphin populations declining off the coasts of South Africa where there were losses of up to ten dolphins a year due to entanglements in shark nets (T. Flaherty pers. comm., 2002). Packaging straps, nylon ropes, loops of cotton cord, plastic bags and/or fishing line all pose hazards for coastal dolphins (Prideaux and Bossley, 2000), causing entanglement and in some cases death by ingestion or drowning. If any such materials, such as straps, rope and plastic bags, are associated with fishing operations, then any disposal to sea, either intentional or accidental, should be avoided.
- Prideaux and Bossley (2000) reported and that (i) some fishers believe that dolphins are competing with them for fish, and, although it is illegal and shunned by most in the Australian fishing industry, some operators take action by shooting them, and (ii) a small number of fishers still illegally use dolphins for bait. A number of dolphin carcasses examined by the S.A. museum have shown signs of deliberate harm (bullet wounds, knife cut marks etc).
- Entanglement in fishing nets, particularly shark nets, and crayfish pots is considered to be a main threats to the Australian Sea Lion (SCA, 2001).
- There have been occasional reports to government (PIRSA Fishwatch) in recent years of unattended nets being set at the **Sir Joseph Banks** group.

Aquaculture Issues

- According to Primary Industries Fisheries – Aquaculture Group (1996), aquaculture developments have the potential to negatively impact conservation areas such as the **Tumby Bay** wetlands by detracting from the scenic amenity, and through pollution, noise and disturbance associated with operations. Breeding colonies and roosting areas for sea birds are particularly sensitive to disturbances associated with aquaculture development. Primary Industries Fisheries – Aquaculture Group (1996) therefore considered that a suitable buffer from aquaculture development should be provided around these sensitive areas, and thus declared the Port Neill Aquaculture exclusion zone, which includes much of the Tumby Bay area. However, aquaculture development has been approved in the zone north of **Tumby Bay**, in the Tumby Management Zone, which also includes waters in the vicinity of the **Lipson Island Conservation Park**.
- South of Tumby Bay, PISA-Fisheries Aquaculture Group (1996) previously made provision for aquaculture development west of the Sir Joseph Banks Islands, in the Offshore Tumby Management Zone. In that zone, there is also potential for lease sites in the coastal area north of Point Bolingbroke to move further seaward, towards **Kirkby, Marum, Partney** and **Lusby** Islands. PISA Fisheries – Aquaculture Group (1996) considered that, because the specified zone was still at least two nautical miles from the Sir Joseph Banks Group, it would not interfere with the conservation value and recreational use of the islands. However, there is concern that two nautical miles may be an insufficient buffer between aquaculture and populations of sea lions, sea birds, and sharks (as outlined below, in relation to the Sir Joseph Banks Group, and discussed in more detail in Section 9.2).
- There are no aquaculture leases operating at the Sir Joseph Banks Group. However, in recent years, caged fish culture has moved further east from the bays of the south-western Spencer Gulf, towards the island group, and the number of leases in south-western Spencer Gulf has increased (see section on Aquaculture, in **Notes on Social and Economic Values and Uses**). Petrusevics *et al.* (1998) suggested that waters to the west of the islands, towards the Eyre coast, would be suitable for aquaculture due to their oceanographic features and relative accessibility, and some of more recent studies by other consultants (see PIRSA 2002d) have supported that opinion. There is provision for further seaward extension of lease sites into south-western Spencer Gulf waters, as part of the recently declared *Aquaculture (Finfish / Port Lincoln) Management Zone* (see maps in Planning S.A., 2002b). The zone's eastern boundary is, according to a map from Planning S.A. (2002a), approximately 5km from **Sibsey Island**, the most western island in the Sir Joseph Banks Group. In 2003, the most seaward leases in the zone were approximately 10km – 12km from the coast of the nearest islands in the Sir Joseph Banks Group, Sibsey and English Islands.
- Potential environmental impacts due to caged fish culture have been recognised by government agencies, researchers, and conservation bodies, both nationally and at State level. The Parliament's ERD Committee (1998) inquiry into aquaculture in South Australia, discussed in detail some of the impacts of finfish farming in South Australia. A number of actual and potential impacts of finfish farming in South Australia, including the south-western Spencer Gulf area, are discussed below.
- Sea bird populations may be at risk from caged fish operations, including oceanic migrants; penguins (see paragraph below) and other breeding populations of native bird species in south-western Spencer Gulf. The Commonwealth's Senate Inquiry into Marine and Coastal Pollution (October 1997) and the Commonwealth's 1995 State of the Marine Environment Report both highlighted as a major issue: the culling of natural predators such as seabirds, involved with caged fish aquaculture operations. Sea birds are attracted to the farms due to the baitfish used as feed, and also due to the prevalence of some wild fish species (e.g. Tommy Ruff) that congregate around the farm sites. Birds attracted to the farms may become entangled, and/or habituated to feeding at the farm sites, thus disrupting the natural food web dynamics of which sea birds are part. The attraction of penguins and other seabirds to pelletised foods (which a number of the farms now use) which have had feeding attractants added, should also be considered. Apart from penguins (see above), other birds are known frequent tuna farms in the Port Lincoln area, such as Silver Gulls, Giant Petrels, Pacific Gulls, and White-Chinned Petrels, (Dr D. Pemberton, Tasmanian National Parks Service, 1996, cited by T. Flaherty, MCCN, pers. comm., 2002) and some of these species become entangled in fish farms, or become apparent 'pest species', (such as cormorants, silver gulls). Australian pelicans also fish in the area, and there is potential for pelicans to be attracted to feeding at caged fish farms in the area. At least 17 of the Sir Joseph Banks islands, plus Dangerous Reef, support silver gull populations, with breeding populations of Silver Gulls on Sibsey, Stickney, Boucaut, Marrum Islands, and Dangerous Reef (Robinson *et al.*, 1996). The increases in local populations of silver gulls related to fish farming practices can impact on the breeding of other seabirds such as terns, and Black-Faced Cormorants. Seagulls can displace local bird populations, prey on eggs and chicks, and at some sites may also cause disturbance to migratory shorebirds. There are significant

Black-Faced Cormorant breeding populations on some of the Sir Joseph Banks islands (Sibsey, English, Lusby, and Winceby Islands, and Dangerous Reef), and silver gulls are a major predator of cormorant chicks and eggs (Robinson *et al.*, 1996). Furthermore, adult black cormorants go to sea to fish and bring back food for the nest, whilst the other parent tends the nest (Robinson *et al.*, 1996). There is therefore further potential for impact upon these populations (particularly the food supply to the young nestlings), if the fishing parents are attracted to tuna cages to feed on pilchards or other small fish, and are entangled or shot. Other species in the Sir Joseph Banks Group region that may be susceptible to impacts through increased Silver Gull populations due to fish farming may include Fairy terns; Crested Terns, Caspian Terns, and Pacific Gulls.

- *Penguins* are found on a number of the Sir Joseph Banks islands. Island-dwelling penguins regularly leave nesting areas to fish at sea. Pilchards, a major food source for penguins, are abundant in lower Eyre Peninsula / far south-western Spencer Gulf. Both native and imported pilchards have been, to date, the major food source used in tuna farms. There is now a move towards pellet feeds for caged tuna, and a number of operators in the Port Lincoln area have now introduced pellets to the tuna. This should be encouraged for all caged tuna operations, so that pilchards can be phased out as a food source for aquaculture. It has been reported by industry (see media report by Stuart, 2001) that the pellet food does not attract seabirds, and that the food conversion ratio is 7:1 or 8:1, compared with 15:1 to 20:1 for pilchards, resulting in less wastage of an important food source. However, to date there have been two ongoing concerns regarding the potential impact of tuna farms on penguins: (i) the fact that thousands of tonnes of wild pilchards are taken every year in S.A., with the bulk of the catch going to feed caged tuna, thus removing part of the natural food source for penguins and other seabirds that eat these “baitfish”. Pilchards are a primary food source for penguins, and local depletions of pilchards may have significant local impacts upon penguin populations (Copley, 1995); and (ii) interactions between tuna farms and penguins, because Little Penguin colonies occur east of the tuna farm lease areas. Penguins eat pilchards and other bait fish, and such fish are a major food source used to feed tuna in a number of the farms. There is a possibility of entanglement or deliberate harm to penguins and other seabirds that are attracted to tuna cages.
- *Pinnipeds* (i.e. *Sea Lions*, in the case of south-western Spencer Gulf), are attracted to caged fish farms and have been known to be injured or killed (Pemberton, 1996; Kemper and Gibbs, 1997, 2000, 2001; SA Museum records, cited by MCCN, undated). Although sea lions eat a variety of food sources (squid, octopus, fish, some crustaceans) there is evidence that pinnipeds are attracted to tuna cages to feed on the fish that are associated with the cages, and both entanglements and deaths have occurred. According to Kemper and Gibbs (2000): *The 1997 report (Kemper and Gibbs 1997) also recommended minimising wastage when feeding tuna, since overfeeding attracts other fish species to the vicinity of the feedlots. The evidence from our study of carcasses strongly suggested that (dolphins and) sea-lions are eating these other species in the vicinity of the feedlots, and then becoming entangled.* Both New Zealand Fur Seals and Australian Sea Lions are known to be involved in current entanglement problems in the Port Lincoln area (SA Museum records, cited by MCCN, undated). The proposed eastward expansion of the lease sites would be within the feeding range of pinnipeds in the region, particularly sea lions in the **Dangerous Reef** and **Sir Joseph Banks** areas. There is also concern that acoustic deterrent devices used in the caged fish industry in South Australia may have impacts on sea lions and seals. There are concerns that such devices can damage seal hearing and lead to deafness. Disabled animals may be more inclined to further habituate fish feed lots, as their hunting skills may be impaired. Experience overseas and in Tasmania suggests that seals will eventually become habituated, continuing stock losses (T. Flaherty, MCCN, pers. comm., 2002). Some acoustic deterrents that have been used in Tasmania have been found to be ineffective (Pemberton 1989, cited by T. Flaherty, pers. comm. 2002), and it has been suggested that the new high energy acoustic deterrents (e.g. the Airmar dB Plus TM which transmits at 10 kHz with an average output of 194 dB re 1µPa at 1 m) should to be tested in carefully designed trials before they are adopted for use (Shaughnessy, 1999, cited by T. Flaherty, MCCN, pers. comm., 2002). Consideration should be given to the proposed location of new aquaculture ventures, as it has been demonstrated in Tasmania that the number of incidents between farms and seals increases with the proximity of those farms to haul out sites (Pemberton and Shaughnessy, 1993, cited by T. Flaherty, pers. comm., 2002);
- *Dolphins*: There is evidence that dolphins are attracted to tuna cages to feed on the fish that are associated with the cages, and both entanglements and deliberate killings have occurred (Kemper and Gibbs, 1997 and 2000; SA Museum records, cited by MCCN, undated). Both Common Dolphins and Bottlenose Dolphins are known to be involved in current entanglement problems in the Port Lincoln area (SA Museum records, cited by T. Flaherty, pers. comm., 2002). The Marine Mammal section of the South Australian Museum has been collecting records of dead and stranded dolphins around the South Australian coast for many years. According to Kemper and Gibbs (1997, 2000): *“In South Australia, at least 13% of all dolphin carcasses studied are believed to have died as result of entanglement, including*

many in the tuna feedlots near Port Lincoln (Kemper and Gibbs 1997). With the aquaculture industry set to expand in Australia in the next few years, monitoring and mitigating incidental captures should be a priority for new and existing operations. Tuna feed-lotting has been practiced in the Port Lincoln region since 1992 and there are now 110 cages operated by about 12 companies in an area of about 200 km². Predator exclusion nets (8 to 30 cm stretched mesh size) surround the main nets of many cages. Our initial study identified that large-meshed predator nets were probably responsible for most of the dolphin deaths and the 1997 report recommended either removing them or ensuring that mesh size was less than 8 cm. An unknown number of feedlots have made these changes.

- Kemper and Gibb's reports also recommended minimising wastage when feeding tuna, since overfeeding attracts other fish species to the vicinity of the feedlots. "The evidence from our study of carcasses strongly suggested that dolphins and sea-lions are eating these other species in the vicinity of the feedlots, and then becoming entangled. The total known dolphin mortalities in the Port Lincoln tuna feedlots stands at 30 reported and 4 suspected for the period 1990- 1999. Twenty-four carcasses were collected for study at the South Australian Museum. There were about twice as many bottlenose as common dolphins. Seven feed-lotting companies have assisted by reporting mortalities, and in the past two years these have been accompanied by detailed information on the nature of the entanglement and net characteristics. These data (on six entanglements) have shown that large-meshed predator exclusion nets were responsible for the mortalities and that body extremities (flipper, nose, tail, head) were caught. Many dolphins, especially bottlenoses, were juveniles and young sexually mature animals. Of the sexually mature females, most were lactating or pregnant. This could have negative impacts on the population in the Port Lincoln region but the effect of all the mortalities will not be known unless the size of this population is estimated. In addition to the reported and suspected entanglements, there have been 33 beach-cast or floating carcasses reported in the Port Lincoln region between 1990 and 1999, with most since 1995. Ten have died as a result of accidental or intentional injury by humans and the rest from undetermined causes, possibly including disease. The number for the first half of 2000 is already in excess of 12 dolphins. The South Australian Museum has been collecting records of dead and stranded dolphins around the South Australian coast for many years. These data suggest that the Port Lincoln region (about 100 km of coast from Cape Donington to Point Bolingbroke) has a disproportionate number of dolphin deaths. Excluding the known tuna feedlot entanglements, 12% of all South Australia's dolphin mortalities between 1990 and 1999 were recorded there. We know that some were intentionally killed and others possibly died of disease but there were many that died of unknown causes because the carcasses were often very decomposed when they were dissected. The cause of so many mortalities needs to be investigated so that the viability of the region's dolphin populations is ensured" (Kemper and Gibbs 2000). Of the dolphin deaths in S.A. that are attributable to human causes, it is reported that around 31% are due to entanglements of dolphins in tuna cage nets (Flaherty, pers. comm. 2002, citing S.A. Museum data). Prideaux and Bossley (2000) also reported that dolphins are regularly caught in the tuna ranching operations in Port Lincoln in South Australia. The Commonwealth's Senate Inquiry into Marine and Coastal Pollution (October 1997) and the Commonwealth's 1995 State of the Marine Environment Report both highlighted as a major issue, the "culling" of natural predators such as pinnipeds, involved with caged fish aquaculture operations.
- Whales: Although whales are not commonly seen in south-western Spencer Gulf, a number of species frequent the waters further south of the area described in this table (see **Thorny Passage and Islands** table in this report). Whales may become entangled in fish farm nets, although the occurrence is infrequent, compared with other marine mammals, and sharks. A Humpback Whale was entrapped in a Port Lincoln tuna cage in June 1993, and it was released after 2 days with a loss of stock from the cage, (L. McDiarmid, Whale Information Centre, pers. comm. to T. Flaherty, MCCN, 1997).
- Acoustic Harassment: There is potential for *whales* (and also *dolphins*) to be affected by acoustic harassment devices, which are used on tuna farms. Internationally, experts in aquaculture impacts (see SECRU 2002), have recognised that current methods to reduce net damage and consequent fish farm escapes by the use of acoustic deterrents to exclude seals and other predators from farm area, may exclude whales and dolphins from a much larger area than the vicinity of the farms, owing to their great sensitivity to underwater acoustic noise (SECRU, 2002). Although there is no research available on this issue in South Australia, there is evidence from overseas research showing that Acoustic Harassment Devices (AHDs) can have impacts on the sonar of whales, thus disrupting whale travel patterns. For example, there is compelling evidence from a recent study in Canada, showing impacts on whales from fish farm acoustic harassment devices (Morton and Symonds, 2002). Some of the methods that are being trialled in fish farms to reduce pinniped attack, may in the long term also impact whale and dolphin populations. In the Port Lincoln area, some farms adopted the use of acoustic harassment Devices (AHD's) to deter seal attacks on stock. Other sorts of devices called acoustic deterrent devices (ADD's) or "pingers", send out regular pulses to notify dolphins and other cetaceans that nets are present, to try and alleviate entanglements. The AHD devices apparently in use in Pt. Lincoln send out a shock wave of

up to 200 decibels into the water, to discourage seals. There is also concern about the possibility of acoustic equipment driving dolphins, whales, and other marine mammals out of sheltered bays, which have been used as resting, feeding or calving and nursery areas. Noise pollution has been identified as a threat to bottlenose dolphin populations (T. Flaherty, MCCN, pers. comm. 2002). The long-term concern for dolphin populations from aquaculture is that as more fish farms become established around the coast they may displace local marine mammals. Some researchers fear that sonic devices to reduce entanglements could result in avoidance of large areas of the coastline used by species such as Southern Right Whales.

- **Sharks:** various shark species, including the protected Great White Shark, are also attracted to caged fish farms. Although there is little documented evidence, there is regular anecdotal evidence of Great White Sharks, Bronze Whalers, and other shark species interacting with tuna cages, resulting in the entanglement and in some cases intentional killing of the sharks. The Commonwealth's Draft Recovery Plan for Great White Sharks (Environment Australia, 2000) noted that the targeted killing of "nuisance" white sharks entering cages or harassing stock during capture and transport, has been reported by several commercial fishers, but that the number of white sharks (a legally protected species) that continue to be taken intentionally (and illegally) by people, is unknown. Shark population numbers in South Australia are not well documented, and any intentional or accidental deaths of sharks associated with the fish farming industry should be avoided, as a precautionary measure against potential population impacts. A related issue is the potential for sharks to become 'habituated' (as occurs in the cage-viewing industry) to feeding at or near tuna cages, which may have a number of both ecological and social impacts. It is probable that the large number of sharks attracted to tuna cages would not normally occur in the areas in such large numbers, in natural conditions. The aggregation of sharks in areas where caged fish are kept may interrupt natural movement / travel patterns and feeding patterns in these sharks, particularly oceanic species. There has been scientific and community concern in recent years about the potential for zoning in south-western Spencer Gulf to place aquaculture developments closer to areas that are of renowned importance for Great White Shark, such as **Dangerous Reef** and surrounds. There have also been regular reports, largely undocumented, of various shark species being attracted to both stationary and towed tuna cages. Indirect evidence of the prevalence of sharks following tuna cages during the towing season has been highlighted by the Abalone Fisheries Management Committee in 1999, which reported that the situation was a hazard to divers working in the area. Furthermore, a professional diver working on the tuna farms at Port Lincoln reported numerous encounters with various species of sharks during the ocean tow phase of the fishing season. Some of the species travelling with the towed pens, observed during the period in which the diver worked in the industry, included Bronze Whalers (most common species observed), Blue Sharks, and occasionally Mako sharks (tangled in the net, and usually dead) and Hammerheads, with 1 report of a Thresher shark.
- **Scalefish:** Wild fish in south-western Spencer Gulf may be attracted to feed at tuna farms, thus disrupting natural feeding processes. Wild fish may also be adversely affected by the decreased quality of water and damage to benthic habitat that is consequent to tuna farming operations (see section below). According to evidence supplied to the Parliament's ERD Committee (2000), pilchard fishers have been concerned about the effects of the oil contained in pilchards that are used for feeding tuna, "drastically" affecting pelagic, surface feeding fish, as they come to the surface to breathe. The oil is described in terms of being extremely persistent, difficult to break down, and of large quantity, running off the farms as slicks (Evidence, p. 86, cited by ERD Committee 2000, p. 21). Evidence presented before a Parliamentary inquiry into tuna farming in South Australia (ERD Committee 2000) included photographs showing the visual extent of pollution in the south-western Spencer Gulf. Also of concern for scalefish would be increased incidence of algal blooms, and potential for blooms of toxic species that exist at low levels prior to added nutrients and other changes to the system. Damage to benthic habitat, such as reduced plant cover, increased densities and abundance of "opportunistic" species such as worms that thrive in altered conditions, and increased bottom sediment and pollutants such as hydrogen sulphide and ammonia, could affect fish which feed in the benthic environment (e.g. those that feed on marine plants, or the epifauna and epiflora attached to plants, or those that feed in the sediment).
- **Pilchards:** The use of Pilchards for feeding caged tuna is also of concern. Baitfish (mainly pilchards) are an important part of the diet of predatory fish (e.g. Australian Salmon and Snook), seabird species (e.g. Little Penguin, Short-tailed Shearwaters, Australian Pelican, and many others), and some cetaceans and pinnipeds. Because Pilchards are a primary food source for Little Penguins, local depletions of pilchards may have significant local impacts upon penguin populations (Copley, 1995). Note that due to the importance of Pilchards in the diet of sub-adult West Australian Salmon, Dimmlich and Jones (1997) recommended that information on the distribution and size of Australian Salmon schools be regularly obtained from fishery independent assessments, to assist in monitoring the effect of the developing

pilchard fishery on the salmon population in South Australian waters. In turn, the predatory fish that eat Pilchards are also an important part of the diet of some marine mammals and sharks (such as Bronze Whalers). At the top of the food chain, the Great White Sharks eats many of the other species associated with the pilchard food web, such as Southern Bluefin Tuna and other tuna species, West Australian Salmon, Snapper and other predatory fish, young pinnipeds and cetaceans, and even sea birds and Pilchards. These food web interactions are important in the south-western Spencer Gulf and lower Eyre Peninsula area, because all of these species occur there, some in high abundance. The Commonwealth's Senate Inquiry into Marine and Coastal Pollution (October 1997) and the Commonwealth's 1995 *State of the Marine Environment* Report both highlighted as a major issue: a high demand for wild capture fisheries (e.g. pilchards and anchovies) for aquaculture stock food. The continued use of pilchards as a major food source for caged tuna may have significant ecosystem impacts: There is concern that excess nutrients and other waste products of feeding can affect both the benthic environment and the water quality. A disproportionately large amount of Pilchard feed is required to raise tuna (reported food conversion ratios of 15:1 or even 20:1), and much of this is uneaten waste, or converted to waste products which pollute the benthic and pelagic environments. Additionally, there is concern that persistently high, and increasing, yields of native Pilchards for industry may impact upon marine food webs, by reducing natural food supplies for fish, and birds, and also affecting other animals higher in the food web (e.g. dolphins, sharks). The catch in S.A. is purportedly around 15% of the annual Pilchard biomass, but stock assessment methods (based upon egg counts) may not give an unquestionably accurate estimate of stock numbers per annum. Furthermore, studies to determine the ecological impacts of pilchard fishing (particularly on food webs) have only recently commenced, despite the pilchard fishery having operated for more than 10 years in S.A., with a substantially increased increasing yield in recent years. In addition to the depletion of native pilchards, the demand for bait fish in the caged fish industry encourages over-fishing of bait fish in other countries, such as the pilchards, herring, sprats and other species that are imported to feed caged fish in Australia. Note that due to the importance of pilchards in the diet of sub-adult Australian Salmon, Dimmlich and Jones (1997) recommended that information on the distribution and size of salmon schools be regularly obtained from fishery independent assessments, to assist in monitoring the effect of the developing pilchard fishery on the salmon population in South Australian waters. The S.A. pilchard catch contributes to the feeding of caged tuna, but is reported to currently account for less than 20% of the pilchard biomass required by caged tuna (Fish Information and Services, 2001). The remainder of the pilchard feed for tuna is reported to have recently consisted of Californian pilchards, Swedish herring and sprats and other food sources from overseas (Fish Information and Services, 2001). A number of operators in the Port Lincoln area have now introduced pellet feeds to the tuna, as a trial. This should be encouraged for all caged tuna operations, so that Pilchards can be phased out as a food source for aquaculture. It has been reported by industry (see media report by Stuart, 2001) that the pellet food does not attract seabirds, and that the food conversion ratio is 7:1 or 8:1, compared with 15:1 to 20:1 for pilchards, resulting in less wastage of an important marine food source.

- ***Invertebrates:*** Although baseline surveys of invertebrate composition and abundance are inadequate for the area between Sir Joseph Banks island group and the Lincoln coast, there may be potential for damage to benthic communities of invertebrates if aquaculture proliferates in the region, due to build up of organic wastes, and alteration of the physical and chemical composition of the sediment associated with tuna farming. Benthic macrofauna (i.e. invertebrates) are known to be affected by organic waste from fish farms, particularly below the pens (Johnsen *et al.*, 1993, Ye *et al.*, 1991). Smothering of invertebrates by farm waste (e.g. sediment, faeces etc) may also occur.
- ***Viruses and Diseases:*** The use of large quantities of pilchards may result in introduction of viruses or other diseases into the area which could impact on native pilchards and other fish and seabirds (such as penguins). It has been alleged by some scientists that the death of millions of pilchards over the southern Australian coastline in 1995 and 1998, has been related to a herpes-type virus, and evidence was presented in the South Australian Parliament in 1999, a claim that was vigorously denied by industry (see Environment Resources Development Committee Hansard Reports on the Pilchard Fishery, 1998 and 1999, and associated documentation). In 2001, pilchard fishers in WA filed writs in the WA Supreme Court over the mass death of pilchards in 1995 and 1998, with legal representatives citing scientific evidence that the pilchard deaths may have been caused by a herpes-type virus from imported pilchards used as tuna feed in South Australia. More recently, a fish virus (viral haemorrhagic septicaemia virus – VHSV) has been found in California, in pilchards and mackerel, and Californian pilchard is one of the species used to feed tuna in South Australia. The disease can be fatal in several fish species, and is easily spread in both cultured and wild fish, prompting Biosecurity Australia (AQIS) to review its import laws on fish feed (AFFA, 2002c). The Commonwealth's Senate Inquiry into Marine and Coastal Pollution (October, 1997) and the Commonwealth's 1995 *State of the Marine Environment* Report both highlighted as a major issue: an increased risk of introducing exotic diseases, as a consequence of aquaculture operations. Bureau of Resource Sciences (2000) noted that the introduction of fish and fish products (for

example, feed) for the fish farming and aquarium industries has the potential to introduce pests and disease organisms. The attraction of large numbers of Silver Gulls to tuna farms, as occurs in the Port Lincoln area, may lead to an increased transfer of parasites and diseases between aquatic production sites and waste disposal areas (Pemberton, 1996, cited by Flaherty, pers. comm. 2002). Introduction and transfer of diseases could impact populations of penguins and other seabirds populations, as well as the fish in the farms.

- *Yellow-tail Kingfish*: Concern has been expressed in recent years about the potential ecological impacts of Yellow-tail Kingfish escaping from farms in Spencer Gulf, including impacts on other fish species in the gulf, and on food supply (e.g. O'Toole, 2002; Grosser, 2003; Office of the Minister for Agriculture, Food and Fisheries, 2003). In the region described in this table, there is a Yellow-tail Kingfish farm, between Point Bolingbroke and Red Cliff. The lease is positioned around 5km east of the coast, and around 8km west-north-west of Partney and Marum Islands, the northern islands in the Sir Joseph Banks Group (S.A. Coast and Marine Atlas, 2003). Although no escapes have been recorded to date from that lease site, thousands of kingfish have escaped from a farm further north, in Arno Bay (Office of the Minister for Agriculture, Food and Fisheries, 2003). However, it is noted that a recent study of farmed and wild kingfish in northern Spencer Gulf (Fowler et al., 2003) noted significant differences in the diet of escaped farm kingfish compared with wild kingfish: - the farmed kingfish were reported to be incapable of feeding properly, which would suggest limited potential for impacts on other marine species.
- There is also potential for impacts on the water quality, benthic environment and both sessile and mobile biota of the Tumby Bay area and Sir Joseph Banks Islands, if finfish aquaculture operations continue to move closer to these areas. The Commonwealth's Senate Inquiry into Marine and Coastal Pollution (October 1997) and the Commonwealth's State of the Marine Environment Report (1995) both highlighted as a major issue, waste production from aquaculture, leading to local increases in nutrients and excessive algal growth. In South Australia, concern has been expressed by the Parliament's ERD Committee (2000) about "*the lack of control that the Environment Protection Authority has over an industry which is a heavy polluter of the environment. The Committee believes that finfish farming should be put into Schedule 1 of the Environment Protection Act*" (ERD Committee 2000, p. 22). The impacts of organic fish farming wastes on benthic environments are discussed in section 9.2.
- *Water Quality*: Planning SA (2002a) reported that seasonally, there is high variability in ammonia / ammonium, oxidised nitrogen and chlorophyll-a concentrations in the water column, although the precise causes for this are purportedly not clear. In the past there has been little environmental monitoring to accurately assess the levels of environmental impact produced by the aquaculture industry in the region, and the relative contribution of aquaculture to the total loads of pollutants entering and affecting the system. According to Planning SA (2002a), *the available water quality data for the region indicates that the ammonia levels are presently higher than that recommended by the ANZECC (1999) draft water quality guidelines for the protection of marine ecosystems. Whilst the water quality data set is small and patchy, if the existing ammonia concentrations are high, this suggests that an increase in stocking density above current levels poses a potential risk to the marine environment and to the industry itself. It is important that finfish aquaculture development should not result in significant increases in nutrient inputs to the system, above that which currently occurs, until the system's "carrying capacity" is better understood* (Planning S.A. 2002a). Citing recent technical investigations by SNK, Planning S.A. (2002a) stated that "*unfortunately, although previous studies on the concentrations of nutrients in the water column have collected some interesting information, it is not possible to describe the state of the local waters as pristine, nor is it possible to state that there has been no influence of human activities on the water quality of the region. The available information indicates that the water quality of the region is presently potentially threatened by human activities. This includes occasionally high levels of nutrients that can instigate algal blooms, the occurrence of regular algal blooms, and a potentially seasonal fluctuation in the amount of chlorophyll-a in the region (which can indicate the presence of algal blooms and increased primary productivity). It is recommended that a thorough and carefully designed monitoring program be initiated in the region to assist managers in the future to determine the impacts of activities in the region on the marine environment, and requirements for mitigation and impact reduction*".
- *Enrichment, and Impacts upon the Benthos*: Although there is little publicly available information specific to the lower Eyre Peninsula area, a number of studies have shown impacts due to benthic enrichment. For example, Cheshire et al (1996) reported localised impacts on the benthic environment under the tuna cages, as follows, indicating changes to the benthic composition and abundance of fauna in the vicinity of the cages: "*In general the epibenthic communities were impacted up to 150 m from the cages. Surveys at 200 m indicated that epibenthic communities were not different to those on the control transect. Effects on infaunal communities were significant within 20 m of the cage but beyond this communities*

were not significantly different to those on the control transects" (Cheshire *et al.*, 1996). In a review of the 1996 study and more recent studies, PIRSA (2002d), stated that "it can be seen that there is a level of human impact upon the region in terms of water quality, and in some cases faunal biodiversity (e.g. Proper Bay [Hall *et al.* 2000], Boston Bay West [Cheshire *et al.*, 1996a and b] and Boston Island East [Clarke *et al.*, 2000]). It appears that various inputs into the coastal region (including sewage waste, fisheries processors waste, runoff from stormwater, agriculture and aquaculture) have all acted in a synergistic fashion to contribute to a decline in water quality in the region". Nutrient-rich waste material and animal by-products generated by aquaculture can lead to impacts on marine ecosystem health, particularly the abundance of seagrass and macroalgae both directly adjacent to and distant from the source of nutrient input (Planning S.A. 2002a). Some of the concerns with nutrient enrichment in the Port Lincoln area have been publicised in Parliament. For example, Gilfillan (2000) stated that: "The tuna feedlot industry generates substantial waste (either uneaten food or faeces) underneath each pen. Much of the waste disappears because it becomes food for other species, although it thereby alters the food chain. However, as far as the fish are concerned, the presence of organic matter in or below tuna feedlots might adversely affect them in at least two ways: either through algal blooms stimulated by the increased nutrient levels in the water or through anaerobic microbes producing hydrogen sulphide as they decompose sediments on the sea floor. These are potential problems of which the industry is well aware". Evidence presented before a Parliamentary inquiry into tuna farming in South Australia (ERD Committee 2000) included statements by pilchard fishers and others who were concerned about the concentration of nutrients and other pollutants in the system, from the many thousands of tonnes of pilchards that are used as tuna feed, and the wastes generated by the caged tuna. The President of the Australian Tuna Boat Owners Association, reported to the inquiry that 'There is a lot of rubbish underneath the pontoons from the excrement and other things...' (Pilchard Fishery Inquiry Evidence, p154, cited by ERD Committee, 2000).

- **Algal blooms:** A number of toxic species are associated with the eutrophic environment of Boston Bay. For example, water from Boston Bay was examined by algal specialist Professor G. Hallegraeff following the 1996 mass mortality of tuna in that bay, and the sample was reported to be teeming with a toxic microalga of the *Chattonella* genus, the same organism killed half a billion dollars worth of fish in Japan in 1972 (see Burchfield 2000). *Chattonella* toxin was also present in the livers of the dead tuna. The findings are discussed in more detail, by Hallegraeff *et al.* (1998). Hallegraeff reported that the methods used by the government's tuna kill inquiry destroyed any chance of testing for algae. This was confirmed by the government report which conceded that the method used for preserving samples at the site had actually destroyed "fragile forms such as *Chattonella*". Professor Hallegraeff stated that in Japan *Chattonella* is an example of an algal bloom phenomenon which is actually induced by the waste products of the aquaculture industry. Also of concern are research reports from North America which suggests that some algal blooms, previously benign, are now turning toxic and, stimulated by pollution in the marine environment, are posing threats not only to farmed species but also to human health (Burchfield, 2000; Gilfillan, 2000). A report on Professor Hallegraeff's evidence that the 1996 tuna mortalities were likely to have been associated with a bloom of the neurotoxic flagellate alga *Chattonella marina*, induced by excessive nutrients, was cited during the Commonwealth's Senate Inquiry into Marine and Coastal Pollution (October 1997). Further evidence was cited in the South Australian Parliament in 2000. According to Gilfillan (2000): "One year after the 1996 tuna kill another researcher attached to Flinders University's Lincoln Marine Science Centre conducted tests at tuna feedlot sites near Port Lincoln and found 47 species of algal bloom in cyst form. These included unidentified species of *Chattonella*. One potentially toxic bloom affected all monitored sites near Port Lincoln in May and June 1997". In another study, McMinn *et al.* (2000), undertook an intensive phytoplankton survey in Boston Bay, and identified the presence of the toxic dinoflagellate *Gymnodinium catenatum*, the first report for South Australian waters. The results of the study supported the conclusion that the species was not native to the area, and had been introduced some time during the past 25 years.
- Damage to benthic habitat, such as reduced plant and sessile animal cover, increased densities and abundance of "opportunistic" species such as worms (that thrive in the physically and chemically altered environment), and increased bottom sediment and pollutants such as hydrogen sulphide and ammonia, could affect fauna which feed in the benthic environment (e.g. on marine plants, or the epifauna and epiflora attached to them, or in the sediment) (see Section 9.2, and references cited therein). Note however, that although localised impacts of finfish aquaculture are known (see Cheshire *et al.*, 1996, for examples from the Port Lincoln area), little work has been undertaken on the spatial spread of impacts from finfish farming in the south-western Spencer Gulf area. There is current uncertainty in the distance that finfish farms should be sited away from the Sir Joseph Banks Islands, to ensure that such impacts do not occur.
- Other potential impacts include rubbish and debris from caged fish farm operation and servicing (which

can entangle sea lions, dolphins, and sea birds – see section above on **Fishing Issues**), and build up of surface oils and scums on the waters, which has impact on other users of the area.

- PIRSA (2002d) considered that the acceptable “carrying capacity” of the inshore areas of south-western Spencer Gulf may be reviewed with the intent of limiting aquaculture stocking rates, and eventually making these areas closed to aquaculture requiring supplementary feeding. Planning S.A. (2002a) reported that, in broad terms, “*there is the potential for a larger area of the marine environment to be impacted by subsequent development as the size of area available for aquaculture increases*”.
- Planning S.A. (2002a) considered that that finfish aquaculture development should not result in significant increases in nutrient inputs to the system above that which currently occurs, until the system’s “carrying capacity” is better understood.
- Planning S.A. (2002a) cited a number of recommended measures to mitigate or prevent potential impacts. Some of the recommendations included moving the location of finfish farms periodically to allow the seafloor to recover; placing farms in deeper water with better flushing characteristics; and increasing feeding efficiencies to reduce the amount of nutrients and waste material entering the marine environment. Other recommendations included the need for any farmed area be assessed immediately after removal of farm devices, and a requirement that the area be left fallow for an extended period. During that fallow period if remediation works are required that can be undertaken by human intervention, these should form part of a remediation / rehabilitation program. The area would need to be assessed and confirmed as having returned to a satisfactory state prior to the re-introduction of fish farming activities on that site. Planning S.A. (2002a) also recommended that, given the “unclear impacts” of different loadings of organic material on the benthos beneath the sea cages, and the unknown effect of how quickly the seabed recovers following the cessation of fish farming, alternative durations of farming / fallowing / farming return periods should be trialled. Planning S.A. (2002a) reported that “*Different return periods have been suggested by scientists to potentially impact on the rate of recovery of the benthos, with subsequent implications for nutrient sinks and sources, and industry sustainability. Monitoring of change should not be based solely upon single cages or leases, but more appropriately, across the entire zone. The obvious smallest unit of change is at the sea cage scale. In terms of further consideration of carrying capacity, all leases within the hydro graphic region should be considered, such that when combined with the other sources of inputs in this region, a mass balance nutrient source/sink model can be compiled. This will assist in determining the assimilative capacity of the environment, and therefore the potential holding capacity of the region. It is in the long term interests of both industry and environmental managers to take into account the large scale, system wide effects and feedbacks*” (Planning S.A., 2002a).

Diving / Collecting

- Gastropod molluscs that are important in the shell trade (such as Cypraeidae and Volutidae families) are vulnerable to over-exploitation due to low population densities and restricted habitats (Environment Australia, 1998). A number of gastropod molluscs are collected in the area (see **Chapter 9**, and Baker, 2002).

Recreation / Tourism Issues

- **Potential for Sea Lion Disturbance:** Populations of sea lions are considered to be highly susceptible to disturbance by humans, particularly during the breeding season (SCA, 2001). According to the Australian Heritage Commission’s Register of the National Estate listing (undated) for Dangerous Reef, the sea lion populations “experience some disturbance from humans visiting the Island, particularly from shark fishers and film crews”. Although fishing for great white shark is now banned in South Australia, shark dive tourism and filming expeditions still occur at Dangerous Reef. It is not known for this report whether or not the activities associated with shark viewing operations are disturbing to sea lion colonies. It was suggested by DENR (1995, cited by Presser, 1995), that a five month exclusion period from berleying and cage viewing operations be instigated, to ensure that the “critical pupping season” for sea lions is not interrupted. There is no available evidence to determine whether or not the current regulations contribute towards this purpose. Shark viewing tour operators currently comply with regulations set by NPWSA, required to be followed by operators who berley for sharks within the buffer zones around Sir Joseph Banks (2NM) and Dangerous Reef (2km).
- According to the Australian Heritage Commission’s Register of the National Estate listing (undated), visitor access to the Sir Joseph Banks islands is difficult to control and “visitation may cause difficulties for certain species during their breeding season”. Species that may be disturbed during breeding were not listed, but presumably this included *pinnipeds* and *sea birds*.
- There has been concern expressed in recent years by community group, that the habituation of great

white sharks to feeding operations that form part of the shark cage viewing industry, may have adverse effects on the white shark population.

Sea Lion Pup Mortality

- Rowley (2001), CSIRO (2000b), and ABC (Science and Environment News 2000) reported that mortality rates for sea lion pups at **Dangerous Reef** have been high in recent years, such as 41% in the 1999 breeding season (a record for the area) and 30% in 1996. There are concerns that the colony's population is stagnating as a result. Furthermore, Australian sea lion populations are generally not increasing in South Australia as a whole, and pup mortality rates are high in some other areas in addition to Dangerous Reef (CSIRO media releases, 1998 and 2000b; Shaughnessy, 2001b). The reasons for the high pup mortality are alarming, given the relatively small global population size for this species, in SA and WA. Factors (both natural and anthropogenic) that may be related to the recent high death rates are currently being investigated by CSIRO's Wildlife and Ecology section (i.e. P. Shaughnessy). It is thought that the most likely cause of the high mortality at Dangerous Reef was infanticide by aggressive adult sea lions, with other factors such as food shortages also being a possibility. However no definite cause has yet been found (SCA, 2001).

Other Issues

- There are numerous point-source and diffuse pollutant types entering the nearshore waters of south-western Spencer Gulf, in the Port Lincoln area. Some of these were described by PISA Fisheries – Aquaculture Group (1997), Planning S.A. (2002a) and PIRSA (2002d). The nearshore pollutants are not detailed in this table because the zone of influence is considered to be mainly local, within the bays and nearshore island areas, and thus of less relevance to a discussion of impacts in the Sir Joseph Banks Group and Tumby Bay areas.
- South-western Spencer Gulf is a major shipping lane, used by international tankers and other large vessels (PIRSA 2002d). The presence of international shipping within these waters poses a threat to the south-western Spencer Gulf ecosystems from oil spills and the introduction of pest species in ballast water or on hulls of ships.
- The need to protect the Sir Joseph Banks group islands from disturbing activities was highlighted in the Australian Heritage Commission's Register of the National Estate listing, which noted that visitor access to the Sir Joseph Banks islands is difficult to control and "visitation may cause difficulties for certain species during their breeding season". Species that may be disturbed during breeding were not listed, but included pinnipeds and sea birds.

9.2.11.7 Neptune Islands Group (Eyre Bioregion)

Fishing

- *School Shark and Gummy Shark*: The deeper water in the Southern Eyre region south of the Spencer Gulf mouth (which includes waters around the Neptune Islands, as well as western Kangaroo Island) has traditionally been a significant fishing area for School and Gummy Shark, and in recent years (e.g. mid to late 1990s) has been one of the top 10 fishing areas in S.A., in terms of yield. School Shark (Australasian subpopulation) was listed in the IUCN Red List 2003 as *Conservation Dependent*, and previously, Gummy Shark was included in the IUCN Red List 2000 and Red List 2002 as *Conservation Dependent*. The Commonwealth has recently re-regulated the fishery for School and Gummy Shark, in light of the *over-fished* status of School Shark populations in southern Australia since the early 1990s (see AFMA, 1999b; AFMA, 2003) and the *fully-fished* status of Gummy Sharks (AFMA, 2000d). According to AFMA (2002a), there is increasing uncertainty about the size and sustainability of the School Shark population (fished under Commonwealth management). The latest agreed assessment for the School Shark population in the fishery reportedly shows "*extremely low numbers*". In the 2001 assessment, productivity was estimated to be so low that under some scenarios, the agreed rebuilding of School Shark stocks to the 1996 level (by 2011) would be impossible under any level of Total Allowable Catch (TAC). If productivity is actually as low as the model currently predicts and it remains so, AFMA (2002a) considered that an unacceptably long time frame of 15 years would be required to rebuild the stock. At the 44th meeting of the Southern Shark Fishery Management Advisory Committee (SharkMAC), the committee recognised that the current ambiguities of the School Shark assessment will

continue for at least 3-4 years until a time series of fixed station survey data is accumulated. The status of (and potential risks to) School and Gummy Shark populations are discussed further in Section 9.2.

- *Bronze Whaler and Black Whaler Shark*: Caught commercially south of Spencer Gulf and southern Eyre, and also recreationally, however the extent of recreational fishing in the area is not known for this report. These species may be considered potentially vulnerable, due to relatively slow growth, delayed maturity, viviparous (live-bearing) reproduction, and low fecundity (see section 9.2). Both adults and young are caught as part of the fishery in S.A.. The extent of the nursery areas is not well known, and overall there is reportedly little information on the status of both adults and juveniles (Froese and Pauly, 2003). Bronze Whaler and Black Whaler were both included in the IUCN Red List 2003 as *near threatened* species. Section 9.2 discusses the vulnerability of these species to over-exploitation, due to their life history characteristics.
- *Ocean Leatherjacket*: This species was classified as “fully fished” in 1998 (DEHAA and EPA, 1998).
- *Blue Groper, Blue-Throated Wrasse and other reef fish*: Blue Groper are caught commercially in deeper waters north of the Neptunes, and as bycatch in Commonwealth fisheries. Reef fish such as Blue Groper and Blue-Throated Wrasse have also been caught by charter fishing in the Neptune Islands area. Notes on the conservation status and risks to Blue Groper and other reef fish populations are discussed in Section 9.2.
- *Whiskery Shark*: Caught commercially in deeper waters of southern Eyre Peninsula. The conservation status of and potential risks to this species are discussed in Section 9.2.
- *Common Saw Shark* is fished commercially in deeper waters of southern Eyre Peninsula, and as bycatch in the Great Australian Bight Trawl Fishery. The conservation status of and potential risks to this species are discussed in Section 9.2.
- *Rock Lobster*: Current status of, and potential risks to Northern Zone Rock Lobster populations, are discussed in Section 9.2. In 2001, low levels of egg production, pre-recruit abundance, and adult biomass were estimated to currently exist in the Northern Zone (a very large fishing area covering waters from the WA border, through to Encounter Bay, and deeper waters south of Kangaroo Island), and reductions in fishable biomass were predicted to occur in the Northern Zone over the next few seasons (Ward *et al.*, 2002).
- Pinnipeds, cetaceans (whales and dolphins) and fish can become entangled (often fatally) in discarded lines and nets from fishing activities. Figures are not available for this report, but entanglements occur regularly in South Australian waters, according to reports received by government departments (S.A. Museum, PIRSA Fishwatch, NPWSA).

Other Issues

- *Great White Shark berleying*: Prior to the development of shark-viewing operations in S.A., concern was expressed by a shark expert, in a submission to the former S.A. Department of Fisheries in 1992, that regular berleying in a single area may cause individual sharks to become habitually associated with food near boats, and/or associated with feeding in one area, which may therefore interfere with the sharks' natural hunting and movement patterns, and reproductive circuit. Further concerns included the potential for sharks to be damaged by biting the cages. Other potential concerns with shark berleying have been expressed by government during the 1990s (see comments by DEHAA, in Presser, 1995), regarding the potential for increased predation by sharks on pinniped populations in areas where sharks are attracted by berleying operations. Examples of concerns included potential for increased predation on seal pups, and on nursing female seals, that traverse nearshore waters at weekly intervals for 8 – 12 months during the nursing period (see submissions to PIRSA in Presser 1995 and 1996, and Shaughnessy, 1999). There is no available evidence to show that increased predation on pinnipeds occurs in areas where shark viewing occurs in South Australia (Shaughnessy, 1999), however, in the Commonwealth's Action Plan for Australian Seals, Shaughnessy (1999, Section 4.6.3) recommended that *a precautionary attitude should be adopted; that (ideally) berleying should be prohibited in the vicinity of all seal colonies; and that if berleying... is to be permitted, the type of berley and handling procedures should be controlled*. It is noted that the cage-viewing operation at the Neptunes operates in accordance with other recommendations listed by Shaughnessy (1999), whereby the activity occurs in a remote area away from human habitation, and in an area in which seal populations are increasing. DEH has a set of guidelines for shark cage-viewing operations in S.A.
- Potential disturbance to New Zealand Fur Seal and Australian Sea Lion colonies from shore visitors. There is a need to ensure that tourist interaction with seals on the Neptune Islands does not disturb

9.2.11.8 Gambier Islands Group (Eyre Bioregion)

Note that the region has a comparatively low level of threat from land-based pollution, due to the undeveloped nature of the coastline.

Fishing Issues

The reported status of (and potential threats) to the following species are discussed further in section 9.2.

- *School Shark* and *Gummy Shark*: In terms of weight landed, shark fishing is one of the major fisheries in the region between Yorke and Eyre Peninsulas. The Commonwealth has recently re-regulated the fishery for School and Gummy Shark, in light of the *over-fished* status of School Shark populations in southern Australia since the early 1990s (see AFFA, 2000b; AFMA, 1999b; AFMA, 2003) and the *fully-fished* status of Gummy Sharks (AFMA, 2000d). The status of (and potential risks to) School Shark and Gummy Shark populations are discussed further in section 9.2.
- *Bronze Whaler* and *Black Whaler Sharks*: Caught commercially in the area. The species is also fished recreationally in South Australia, but figures are not available for this report. Bronze Whaler and Black Whaler were both included in the IUCN Red List 2003 as *near threatened* species. The status of (and potential risks to) Bronze and Black Whaler Shark populations are discussed further in section 9.2.
- *Snapper* are caught in the waters off south-western Yorke Peninsula, and at island sites in southern Spencer Gulf.
- *Western Blue Groper* is caught both commercially and recreationally in the area, but the yields from the Gambier Islands are not known for this report. Blue Groper is recognised as a species of conservation concern in South Australia (see section 9.2, and Baker, 2004). Charter boats are known to catch large Blue Groper in the area (and the practice is promoted by some charter companies). Charter boats have not been required to provide information to government about how many Blue Groper are caught per annum during charter trips. There are records from both charter boats and sportsfishing associations of large Blue Groper being caught at the **Gambier Isles**. As an example, ANSA SA Division (undated) listed record sizes for fish captured by members, and a 24kg groper caught from Wedge Island in 1994, was included in that list.
- *Various other wrasse species* are caught both commercially and recreationally in the area.
- *Harlequin Fish* are present on reefs in the area and are caught around the Gambier Islands by recreational fishers (e.g. charter boats). Other fish of potential conservation concern found in the area include *Western Blue Devil*, *Boarfish*, *Sweep*, *Magpie Perch*, and *Dusky Morwong* (see section 9.2).
- *Rock Lobster*: Current stock assessment details, potential risks to the Northern Zone Rock Lobster stocks, and potential ecosystem impacts from Rock Lobster fishing, are discussed in section 9.2. In 2001, low levels of egg production, pre-recruit abundance, and adult biomass were estimated to currently exist in the Northern Zone (a very large fishing area covering waters from the WA border, through to Encounter Bay, and deeper waters south of Kangaroo Island), and reductions in fishable biomass were predicted to occur in the Northern Zone over the next few seasons (Ward *et al.*, 2002).
- *Whiskery Shark*: Caught commercially in minor quantities, in deeper waters south of Spencer Gulf, and in Southern Yorke / Investigator Strait waters. Charter boats also catch whiskery sharks in the southern Spencer Gulf / western Investigator Strait area. Whiskery Shark was classified as *Lower Risk, Conservation Dependent* in the IUCN Red List 2000 and 2002, but not included in the 2003 IUCN Red List. The extent to which Whiskery Shark is fished in the Gambier Islands area is not known for this report.
- *Gastropod molluscs*: Specimen shells important in the shell trade occur in the Gambier Islands area. Potential threats to specimen shell populations in South Australia are discussed in Section 9.2. The extent of commercial and recreational fishing for shells around the Gambier Islands is not known for this report.
- Pinnipeds, cetaceans (mainly small cetaceans - dolphins) and fish can become entangled, often fatally, in discarded line and net from fishing activities (see Section 9.2).

Diving Issues

- Gorgonian corals in South Australia are susceptible to impacts from recreational diving (Environment Australia 1998). Other attached biota (particularly brittle taxa, and taxa that are affected by sedimentation) may also be susceptible to impacts from unregulated diving.

Other Issues

The **Wedge Island** and **North East Rock** area is reported to be periodically used for bombing by the Royal Australian Air Force, and public access is restricted in this area during these times (PIRSA, 1996). Specific impacts related to this use are not known for this area, however in general, bombing can cause acoustic impacts upon some marine fauna, avoidance response by some marine fauna that use such areas, and benthic habitat damage.

9.2.11.9 Franklin Harbor and Surrounding waters (Spencer Gulf/North Spencer Gulf Bioregions Boundary)

Coastal / Estuarine Issues

- In the National Land and Water Resources Audit's assessment of estuaries in South Australia (1999-2001) Franklin Harbour was classified as *Severely Modified*, and described as "*intensively modified, and under high to very high pressure*" (GeoScience Australia, 2001). Assessment criteria included catchment natural cover, land use, catchment hydrology, tidal regime, floodplain, estuary use, pests, weeds, and estuary ecology (Barnett, 2001, cited by DEH, 2003a).
- Acid sulphate soils have been identified as a potential problem, however no mapping (or assessment) has been undertaken (GeoScience Australia, 2001).
- Potential impacts upon estuarine benthos, water quality and/or sediment movement patterns may occur due to foreshore developments at **Franklin Harbour**, discharges from Cowell, deepening of the boating channel, and potential dredging of the harbour (e.g. the latter may increase if the proposed ferry operation between Cowell and Wallaroo were to be approved in future).
- PIRSA (1997) suggested that the nearshore area adjacent to built up areas on western Spencer Gulf may be subject to pollution from stormwater discharge, although Franklin Harbour was not specifically mentioned in this context.
- Increased nutrients in the **Franklin Harbour** area have been listed as a potential threat to habitat quality in the area, and sources of excess nutrients include agricultural runoff from the **Ullabidinie / Poondra Creek** catchment; diffuse agricultural runoff, and also nutrients from sea cage farming in the area (Bryars, 2003). There are also reported to be increased levels of nutrients caused by septic tank overflow at **Port Gibbon** and **Cowell** (Bryars, 2003).
- Boating activity in **Franklin Harbour** has caused an increase in hydrocarbon levels in the tidal flats, tidal creeks, mangrove forests, and saltmarsh (Bryars, 2003).
- A minor threat reported for the area is the altered pattern of water and sediment movement to **Poondra Creek**, caused by the location of a road bridge, however flows are reported to have improved due to recent modifications (Bryars, 2003).
- Other issues include physical disturbance to the tidal flats from aquaculture operations (see section below); physical disturbance to the mangrove forests from bait-digging and trampling by humans; and physical disturbance to the saltmarsh caused by offroad vehicle use, and by stock grazing (Bryars, 2003).

Prawn Trawling

- Prawn trawling occurs in waters deeper than 10m, seaward of Franklin Harbour.
- The western king prawn fishery in Spencer Gulf was reported in 1991 to be fully fished (Commonwealth

of Australia, 1991), and more recently the same status was reported by a South Australian State of the Environment report (DEHAA and EPA 1998, cited by DEH, 2003a). Prawns are an important food source for various fish species (e.g. young Snapper) and other marine fauna, however the impact of long term prawn trawling yields on the feeding potential and abundance of prawn predators, or on nutrient recycling, is apparently not known in South Australia. There is indisputable evidence that prawn trawling modifies benthic habitat (see section 9.2), and that bycatch is also an issue (e.g. see below). Prawn trawling issues are discussed in more detail in section 9.2.

- Bycatch studies by Carrick (see Carrick, 1997) in the deeper waters seaward of Franklin Harbour, across the gulf to the Wallaroo area (sampling region No. 3) showed that the catch from tows in February 1996 comprised around 41% Western King Prawn, 33% various fish species; 23% Blue Swimmer Crabs; and 3% cephalopods.
- Most results from the bycatch study were discussed in relation to the entire sampling area (i.e. 4 large sampled regions in Spencer Gulf, collectively extending from the Whyalla area down to Corny Point. According to Carrick (1997), although the proportion of bycatch species to target catch (i.e. the “bycatch ratio”) is low in Spencer Gulf compared with other prawn fisheries in Australia and overseas, the following occurred in the prawn trawler bycatch surveys during the early and mid 1990s, in Spencer Gulf:
 - ♦ 15 fish species from 10 families dominated (97%) the bycatch, such as Sand Trevally (average 38% of catch) and Degen’s Leatherjacket (average 32%), Blue Swimmer Crab, stinkfish species, Bridled Leatherjacket, Rough Leatherjacket, strawberry prawn, Southern Silverbelly, Southern Calamari, spiky gurnard, Sand Whiting, Red “Mullet”, Toothbrush Leatherjacket, Slender Bullseye and Southern Cobbler;
 - ♦ A “large significant impact of trawling on small-toothed flounder (a sandy mud/muddy sand habit fish species) was detected, with the fleet having the capacity to reduce local populations by at least 60% over 14 days of intensive fishing” and “generally, regions more intensively fished had fewer large individuals (of flounder) than areas not fished, and densities of flounder were significantly lower”;
 - ♦ Capture of leatherjackets “was sometimes so high that the efficiency of prawn trawling was substantially affected”;
 - ♦ King George Whiting, juvenile Snapper and sand whiting were “sometimes caught in large quantities by prawn trawls”, although “there was substantial spatial and inter-annual variation in catches”; “the survival of Snapper and whiting caught in prawn trawls in Spencer Gulf was evidently high”; and “there is little evidence that the Spencer Gulf prawn fishery is affecting commercial fisheries for Snapper or whiting”;
 - ♦ Blue Swimmer Crabs and sponges were, in some areas, “a substantial component of the prawn bycatch” (Note that the number of crabs caught as bycatch has now decreased due to improvements in cod end configuration of prawn nets, which reduces blue crab capture);
 - ♦ Occasional “large catches of sponges” in prawn nets “suggest that prawn trawls may be modifying the topographic complexity of the sea floor”;
 - ♦ “There is evidence from other studies, and from the species richness of bycatch in the Spencer Gulf fishery, that diversity and abundance of fish are greater on topographically complex habitats than on open sand”;
 - ♦ “a wide range of predators” are known to feed on prawn bycatch discards e.g. dolphins and crabs, and research in other parts of Australia has shown that “up to 33% of the diet of blue crabs is based on prawn trawler discards”;
 - ♦ further methods and devices to reduce bycatch in the Spencer Gulf fishery were recommended, such as the use of TEDs, to potentially reduce the capture of sponges and large elasmobranchs (sharks and rays), and other modifications to reduce the potential impacts on commercially and recreationally important species.

Fishing Issues

- Major scalefish and shark fisheries in the mid-western Spencer Gulf region include *King George Whiting*, *Snapper*, *Southern Calamari*, *Sea Garfish*, and *Gummy Shark* (all classified as *fully fished* - see DEHAA and EPA, 1998), and *School Shark* (classified as *over-fished*). The Commonwealth has recently re-regulated the fishery for School Shark and Gummy Shark, in light of the *over-fished* status of School Shark populations in southern Australia since the early 1990s (see AFFA, 2000b; AFMA 1999b; AFMA, 2003) and the *fully-fished* status of Gummy Sharks (AFMA, 2000d). However, the specific significance of the area between Point Gibbon and Shoalwater Point in relation to population sizes of the scalefish, calamari and sharks listed above, is not known for this report. The reported status of and potential risks to populations of these species are discussed further in section 9.2.

- *Whiskery Shark*: Caught commercially in small quantities in the mid-western Spencer Gulf region. Classified as *Lower Risk (Conservation Dependent)* in the IUCN Red List 2000 and 2002, but not included in the 2003 IUCN Red List (see section 9.2 and Baker, in press, for further information).
- *Bronze Whaler and/or Black Whaler*: Whaler sharks are caught commercially in the area, and may also be taken recreational fishers. These species may be considered potentially vulnerable, due to relatively slow growth, delayed maturity, viviparous (live bearing) reproduction, and low fecundity (see section 9.2). Both adults and young are caught as part of the fishery in S.A.. The extent of the nursery areas is not well known, and overall there is reportedly little information on the status of both adults and juveniles (Froese and Pauly, 2003). Bronze Whaler and Black Whaler were both included in the IUCN Red List 2003 as *near threatened* species. These two species are also fished recreationally in S.A., but figures are not available. Section 9.2 discusses the vulnerability of these species to over-exploitation, due to their life history characteristics.
- Bait digging has caused physical disturbance to the mangrove area in **Franklin Harbour** (Bryars, 2003).

Aquaculture Issues

- Physical disturbance of the tidal flats in **Franklin Harbour** has occurred due to oyster farming (Bryars, 2003).
- According to Smallridge (1995), the productive South Western Basin, in which the majority of aquaculture development in Franklin Harbour is concentrated, covers approximately 2,200ha and has “a virtual complete cover of seagrasses”. The Franklin Harbour Aquaculture Management Plan (Smallridge, 1995) recommended that, given the lack of knowledge regarding the average assimilative capacity of the productive South Western Basin of Franklin Harbour (in which the majority of shellfish leases are located), a cautious approach should be adopted and intertidal farming should be limited to around 10% of the available area. In 1995, allocation approximated 5% of the intertidal area, however this may now be greater due to the number of leases that have been approved since that time. The local oyster growers have proposed that an upper limit be adopted for oyster lease allocation within the South Western sub-zone. During the late 1990’s, the growers committed to undertake a monitoring program to investigate the carrying capacity of this sub-zone and to reassess management practices accordingly at the end of the program.
- Oyster leases within Franklin Harbour are involved in a state-wide *Oyster Environmental Monitoring Program*. Previously, a Shellfish Environmental Monitoring Program (cited by Aquaculture Group - PISA Fisheries 1996) reported the following impacts, detected during a monitoring program between 1992 - 1994 in **Franklin Harbour**: (i) an increase in oyster litter in only two of the oyster growing regions; (ii) at the time, detectable changes in seagrass communities were limited to some localised loss associated with seed trays; and (iii) wild Pacific Oyster populations were well established in Franklin Harbour (see section below on **Marine Pests**, for details of measures to control this). The Shellfish Environmental Monitoring Program has since been replaced by the Oyster Environmental Monitoring Program. During the late 1990s, concern was expressed by DEHAA about the ability of the previous shellfish monitoring program to detect and adequately monitor effects of oyster farming on seagrass beds and native, filter-feeding organisms in the vicinity of the farms (see Parliament of South Australia, 1998, page 46). DEHAA recommended that the Oyster Environmental Monitoring Program being developed at the time, should monitor the health and abundance of native filter feeders, as a key element of the program; that all shellfish growing areas in S.A. should be monitored, and that the methods used for monitoring should be evaluated by an independent statistician (Parliament of South Australia 1998, page 46).
- In 2002, when considering an application for the relocation of part of an oyster lease in the **Victoria Point** area, the Coast Protection Board expressed concern (through the EPA) about (i) the potential impacts of shellfish farming on dense beds of seagrass in the shallows off Victoria Point, close to the coast; (ii) the potential impact on “important habitat for wading birds” in that area, and (iii) visual impact of aquaculture sites situated close to the coast. Loss of seagrass is considered to be environmental harm in accordance with the *Environment Protection (Marine) Policy 1994*. The Environmental Protection Authority considers development applications and relocations in accordance with its charter in Section 57 of the *Environment Protection Act 1993*, and seeks to further the objects of the *Environment Protection Act*; the General Environment Duty, as defined in Part 4, Section 25 (1) of the Act; and relevant Environment Protection Policies made under Part 5 of the Act.
- The Environmental Protection Authority recommended an environmental monitoring program as per Schedule 5 of the Act. According to the Development Assessment Commission (2002), the monitoring program (for the Franklin Harbour area) was soon to be reviewed and “possibly changed by the

Aquaculture Environmental assessment group". A licence-based environmental monitoring program "will be supported by a regional monitoring program that will include broader aspects of environmental monitoring such as water quality issues and seagrasses" .

- Nutrient enrichment from caged fish farming in the **Franklin Harbour** area, has been recorded as potential threat to habitat the area (Bryars, 2003).
- In general, apart from potential effects on seagrass beds (e.g. see above), Aquaculture Group - PISA Fisheries (1996) reported that aquaculture developments have the potential to negatively impact conservation areas such as wetlands by detracting from the scenic amenity, and through pollution, noise and disturbance associated with operations. Breeding colonies and roosting areas for sea birds are considered particularly sensitive to disturbances associated with aquaculture development. The potential impacts associated with shellfish farming in general, are discussed in section **9.2**.
- Two of the Objectives of Development listed in the *Franklin Harbour Development Plan* (Planning S.A. 2000) were (i) limited shellfish cultivation and other marine aquaculture development in Franklin Harbour, and (ii) minimising the visual and environmental impacts of shellfish cultivation and other forms of marine aquaculture development. According to the *Franklin Harbour Development Plan* (Planning S.A. 2000), the District Council of Franklin Harbour proposes to "undertake a redrafting of the sections of the *Development Plan* relating to shellfish cultivation and other aquaculture, after the completion of a management study into shellfish cultivation and aquaculture in Franklin Harbour, proposed to be conducted jointly by (PIRSA and Planning S.A)". There is now a Code of Practice to address management issues, operational procedures and environmental considerations.
- Caged fish farms are starting to develop in parts of this area (see information on leases and applications in the section on **Notes on Social and Economic Values and Uses**). The environmental impacts of sea cage fish farming in general have been well documented, and are summarised in section **9.2**. Fish farm escapes, resulting in an increased number of Yellow-tail Kingfish in the **Franklin Harbour** area, is recorded as a potential threat (Bryars, 2003). However, it is noted that a recent study of farmed and wild kingfish in northern Spencer Gulf (Fowler et al., 2003) noted significant differences in the diet of escaped farm kingfish compared with wild kingfish: - the farmed kingfish were reported to be incapable of feeding properly, which would suggest limited potential for impacts on other marine species.
- During the early 2000s, there were technical investigations of the potential of areas outside Franklin Harbour (e.g. **Lucky Bay**, to the north) to support subtidal shellfish aquaculture. The area is dominated by seagrass meadows, which might be adversely affected by aquaculture developments. The potential impacts of aquaculture developments on seagrass beds are discussed in section **9.2**.

Marine Pests

- Furlani (1996) reported that cysts of the toxic dinoflagellate *Alexandrium minutum* have been found in the sediments in **Franklin Harbour**.
- The Pacific Oyster also occurs outside of the oyster leases where it is grown, in **Franklin Harbour** (Furlani, 1996, cited by PIRSA, 1999e). According to Aquaculture Group - PISA Fisheries (1996), PIRSA and the oyster industry are taking steps to limit the occurrence of "naturalised" populations of feral oysters. These include clumping Pacific Oyster farms in one location, excluding Pacific Oyster culture from certain areas, especially areas where the risk of naturalisation is high, developing triploid animals with low fecundity, and the manual removal of oysters around farms. The Shellfish Environmental Monitoring Program (now known as the Oyster Environmental Monitoring Program) reportedly will also continue to monitor the occurrence of naturalised Pacific Oyster in areas where this species is cultured.

Other Issues

- In a document describing the national significance of the **Franklin Harbour** wetland area, Morelli (DENR, 1995) listed under "Threats", a proposal to provide a ferry service from Franklin Harbour across Spencer Gulf to Wallaroo on the west coast of the Yorke Peninsula. This proposal would entail dredging a channel through Franklin Harbour and adjacent to Wallaroo, with the establishment of a permanent route across the Gulf. A Draft Environmental Impact Statement for the Spencer Gulf Ferry Proposal was prepared in 1992 by Burchill Bate Parker & Partners Pty. Ltd. One of the objectives of the *Franklin Harbour Development Plan* (Planning S.A., 2000) was the possible use of Franklin Harbour as a ferry terminal, whilst ensuring that the development is compatible with other uses in the area (stated to be tourism, recreation, fishing, boating and oyster cultivation). If the ferry operation were to be approved, it would operate out of Franklin Harbour.
- According to the Australian Heritage Commission (undated), although the islands within **Franklin**

Harbour remain relatively undisturbed, the narrow peninsula is suffering from “recreational pressures” (no other details provided).

- Aquaculture Group - PISA Fisheries (1996) considered that a number of areas within Spencer Gulf are “sensitive to changes and development”. Such areas include “substantial mangrove stands, seagrass beds and significant breeding sites for commercially fished species, protected birds and marine mammals”. Aquaculture Group - PISA Fisheries (1996) recommended that suitable buffer areas should be determined for the protection of all conservation areas, and the impacts of aquaculture on these should be considered when assessing “on-merit” aquaculture applications.

9.2.11.10 Upper Spencer Gulf (North Spencer Gulf Bioregion)

- Dainis (1994) described the main impacts in northern Spencer Gulf, in order of importance according to scientific assessments during the past decades, as being nutrients, industrial effluents, airborne discharges, pollutants from stormwater run-off, high salinities and water temperatures, ballast water discharges, “exploitative fishing practices”, and shipping accidents.
- Previously, in an inventory of Australian estuaries, Bucher and Saenger (1989, cited by Edyvane, 1996a) identified **northern Spencer Gulf** as being a threatened estuarine area (in terms of conservation value and fisheries), due to poor water quality from port facilities, sewage treatment plants, the power station, and urban run-off (e.g. from Port Augusta). Specifically, the conservation values of the following estuarine areas in northern Spencer Gulf were considered to be under threat: **Second Creek** near Port Pirie, due to the threat from the nearby sewage treatment works; **Port Pirie**, due to run-off and discharges from shipping, residential and heavy industrial development; and **northern Spencer Gulf**, due to potential poor water quality from port facilities, sewage treatment, power stations and urban run-off from **Port Augusta**.

A summary of some of the major impacts and threats in the region is provided below, according to results of major studies and reviews during the past several decades.

General Notes on Metal Contamination

- One of the most highly researched marine environmental impacts in northern Spencer Gulf is the metal contamination, particularly around Port Pirie, the site of the lead-zinc smelter. The Port Pirie area is highly polluted with industrially-derived heavy metals, although metal levels are much lower in bottom sediments deposited outside Germein Bay, in the central gulf (Harbison, 1984, cited by Harris and O’Brien, 1998). In general, high levels of heavy metals and metal compounds can accumulate in mudflats, mangroves and shallow subtidal sediments, and the environment of northern Spencer Gulf has been susceptible to this kind of contamination for the entire 20th century, and continues to the present. Examples include cadmium, zinc, copper, lead, and mercury, amongst others. All of these metals are known to have detrimental effects upon marine biota. In northern Spencer Gulf, heavy metals have been recorded in sediments, seagrass, infauna, fish, crustaceans, molluscs and other invertebrates, and dolphins, and many studies into the effects of metal contamination have been conducted (e.g. Depers, 1974; Dossis and Warren, 1981; Thomas, 1981; Miller, 1982; Ward and Young, 1981, 1982 and 1984; Ward *et al.*, 1982; McLaren and Wiltshire, 1984; Harbison, 1984 and 1993; Ward *et al.*, 1986; Norrish *et al.*, 1986; Tiller *et al.*, 1989; Lent *et al.*, 1992; Kemper *et al.*, 1994; Boxall, 1994; Ward and Hutchings, 1996; Edyvane and Boxall 1997; Edwards *et al.*, 2001).
- Heavy metals bio-accumulate in many marine organisms (Ward *et al.*, 1986), and affect them through acute toxicity, sub-acute toxicity or chronic sub-lethal effects, depending upon the amount and time length of exposure. There are biochemical indicators available to indicate physiological stress in marine organisms (such as fish), due to metal contamination (e.g. see Boxall, 1994; Edwards *et al.*, 2001). Sub-lethal effects from metal accumulation in marine organisms include a reduced ability to withstand environmental and direct body stresses (i.e. depressed immune response). In marine animals, abnormal changes in growth, fecundity and reproductive success due to metal contamination have been observed. Studies in gulf waters of South Australia have shown that almost all biota sampled from metal-contaminated areas displayed elevated levels of heavy metals such as cadmium, lead and zinc.
- Bio-availability of common heavy metals and metal compounds in South Australian marine environments, and consequent contamination of the marine food chain, has been considered a cause for concern since at

least the 1980s (e.g. Thomas, 1981; McLaren and Wiltshire, 1984). Benthic invertebrates such as molluscs, crustaceans and polychaete worms are particularly susceptible to metal accumulations, ingesting the metal either directly from the water, or from ingesting detritus in the sediment. Several heavy metals that readily attach to fine particulate matter, can be taken up as food by bivalves and other benthic organisms (Ward and Young 1982; Ward *et al.*, 1982 and 1986; Harbison, 1993; Ward and Hutchings, 1996). Fish may accumulate metals by consuming benthic invertebrates (Harbison, 1993), and humans may accumulate metals from eating metal-contaminated fish, crustaceans or molluscs (Harbison, 1993).

- Studies by CSIRO during the 1980s, concluded that over 600 km² of sediments were contaminated by particulate cadmium, lead and zinc, the main sources being the smelter stack emissions (which have now ceased), ore spillage and fugitive dusts. Copper, arsenic and manganese contaminated other areas. Almost all biota (and particularly molluscs) found in contaminated areas displayed elevated levels of cadmium, lead and zinc (Ward *et al.*, 1986, cited by Lewis *et al.*, 1998). Studies by CSIRO of metal-contaminated areas in Northern Spencer Gulf have shown a number of impacts, including (i) reduction or elimination of 20 of the most common species that occurred in the vicinity of the metal-contaminated area (see Ward *et al.*, 1982, cited by Harbison, 1993); and (ii) changes to the structure, species richness and composition of an adjacent seagrass community that was affected by the metal content, and all of these variables decreased with increasing contamination levels (Ward and Young, 1982).
- Using core samples taken from supratidal estuarine sediment near the smelter, and analysing for heavy metal content (Cu, Pb, Zn, Fe, Cd and Ag) and excess Pb-210 activity, Lent *et al.* (1992) reconstructed historical pollution levels in the marine environment near the smelter, and recorded the highest maxima fluxes (particularly during the 1950s and 1960s) of lead, zinc and cadmium ever reported for an aquatic environment. The core samples exhibited trace metal enrichments well above the expected background concentrations for uncontaminated sediments. One of the cores, collected 8 km down-wind from the smelter, contained high concentrations of Pb (2960 µg/g), Zn (5390 µg/g), and Cd (120 µg/g). In subtidal muddy sediments, adjacent to the shipping channel, concentrations of lead, zinc and cadmium were found to be 970, 1850, and 14 µg/g, respectively (see Norrish *et al.*, 1986 and Lent *et al.*, 1992). Although lead and zinc concentrations decrease with distance from the smelter, cadmium is more mobile and appears to be associated with seagrass detritus (Ward and Young, 1981, cited by Harris and O'Brien, 1998), hence the possibility for cadmium pollution to be spread wider than the site of contamination.
- Ward and Hutchings (1996) examined the effects of trace metals on the infaunal species composition in polluted intertidal and subtidal marine sediments (including seagrass habitats) near the lead-zinc smelter in Northern Spencer Gulf. The polluted intertidal sediments had some of the highest metal concentrations ever recorded in marine sediments; lead (Pb) up to 5270 µg /g, and zinc (Zn) up to 16,700 µg /g in sediments. These extremely high concentrations of heavy metals appeared to affect both the abundance and distribution of some species. For example, fifteen species of polychaetes, five crustaceans and four molluscs found elsewhere in the study area were absent from the metal-polluted sites; these represented 26%, 20% and 17% respectively of the total number of species in each group. The patterns were much clearer in the most polluted (intertidal) sites, where multivariate techniques could be used to detect which species were affected, compared with the less polluted (subtidal) sites where only a few individual species could be unambiguously correlated to the presence of the metals.
- TBT, a tin-based anti-foulant, is also released from ships and boats, and from slipways during ship and boat maintenance. TBT accumulates in marine food chains, and can concentrate in molluscs at levels hundreds of thousands of times higher than surrounding sediment or seawater. The toxic effects of TBT in marine organisms include, amongst others, immuno-suppression, physical deformities, reduced growth rate, reproductive abnormalities in molluscs (including sex change); death of eggs and larvae in molluscs; reduction in population numbers of molluscs; and inhibition of body organ function in some higher animals (Nias *et al.*, 1993; AMCS and EPA, 1999).

Examples of recent work on heavy metal contamination in the Northern Spencer Gulf region include:

- a study of cadmium levels in the liver of Bottlenose Dolphins. Cadmium levels in dolphins from the northern part of both gulfs in S.A. were the highest of those recorded in the study (which also included dolphin populations from WA, NSW and Tasmania), and the emissions from the lead smelter at Port Pirie were implicated as a prime source of the cadmium in the Spencer Gulf populations (Kemper *et al.*, 1994).
- a study of metal levels in Razorfish (Edyvane and Boxall, 1997), which showed that levels of cadmium and zinc had significantly increased since the studies by CSIRO during the early 1980s;
- a study of cadmium, lead and copper levels in the estuarine dependent fish species Yellow-eye Mullet and Yellow-fin Whiting, compared with levels measured in the seston sediment at polluted and unpolluted sites (Edwards *et al.*, 2001). The study showed that seston levels of cadmium, lead and copper at Port Pirie were high, and varied considerably with season, with generally higher levels in winter samples. The study

showed a strong positive correlation between metal levels in fish flesh, and in the seston. Mean flesh levels of cadmium and copper did not exceed Australian health based maximum permitted levels of fish for human consumption, whereas flesh levels of lead in fish from Port Pirie exceeded these standards in each of the seasons monitored (Edwards *et al.*, 2001); and

- a study of the effects of metal contamination in the genetic diversity of invertebrate populations at contaminated sites in the Port Pirie area, compared with that of reference populations. The genetic diversity (as determined using random amplified polymorphic DNA analysis) of a population of the prawn *Leander intermedius* from the smelter discharge site was found to be lower than that found in one reference population, and not significantly different from two other reference populations. The genetic diversity of the isopod *Platynympha longicaudata* from the smelter discharge site was found to be significantly lower than that of all reference populations.

Point Source Industrial Pollution

- During the mid 1990s, there were 12 registered point pollution discharges into northern Spencer Gulf, comprising six at Port Pirie, four at Whyalla, and two at Port Augusta. Both Whyalla and Port Pirie are highly industrialised small cities. Port Pirie is located on the Pirie River, and is surrounded by a number of creeks, all of which flow into Spencer Gulf. In general, the main discharges into the northern Spencer Gulf system are nutrients from sewage treatment, metals and oils from industry, and thermal pollution (Aquaculture Group - PISA Fisheries, 1996; DEH, 2003a).
- During the past decade, registered marine point pollution sources in the **Whyalla** area have included metals from the Whyalla steelworks (OneSteel Manufacturing, formerly BHP long products division, which has operated in the area since 1964); nutrients (SA Water, formerly E&WS), and oil (SANTOS, **Port Bonython**). During the mid-1990s, the registered marine pollution discharges in the **Port Pirie** area include metals from the Port Pirie lead smelter (PASMINGO metals), oil (Flinders Petroleum and Australian National Port Pirie Station Yard) and nutrients (SA Water discharge into **Second Creek**, and a number of other creeks in the Port Pirie area discharge nutrients and other pollutants into northern Spencer Gulf) (Aquaculture Group - PISA Fisheries, 1996). During the mid 1990's, there were two registered point sources of pollution at **Port Augusta** which discharge into the marine environment, these being nutrients from the SA Water (formerly E&WS) plant and thermal heat from the power station at Port Augusta (Aquaculture Group - PISA Fisheries, 1996).
- Some of the impacts from point source discharges in the area have been outlined by Dainis (1994), and documented in detail in specific scientific monitoring studies during the 1980s, 1990s and 2000s. Some of the impacts include the following:
- **Lead-Zinc Smelter at Port Pirie:** The smelter at Port Pirie is the largest lead smelter in the world. Previously, there were regularly-occurring, long term discharges of copper, arsenic, lead, zinc, cadmium, mercury, iron, manganese and selenium (all released into a shallow intertidal outfall), as well as stack emissions and atmospheric "fall-out" which have also penetrated into the marine environment. Examples of annual pollutant loads of some metals (and their associated compounds) from the smelter include 1100kg of arsenic; 890kg of cadmium; 160kg of cobalt; 120,000kg of fluoride; 13,000kg of lead; 1.2kg of mercury; and 2200kg of nickel (EPA 2002 statistics, cited by DEH, 2003a). There has been a well-recognised, long term environmental improvement program at this smelter, however many of the effects of the pollutants reaching the marine environment remain, due to the long-lived nature of such pollutants in the physical and chemical environment of northern Spencer Gulf. A new effluent treatment plant at the smelter was opened in 2001, and metal-rich waste water is now recycled on land, and not released into Spencer Gulf (Australian Broadcasting Commission, 2001). Prior to the development of the treatment plant, liquid effluent reportedly containing 250t of zinc and 100t of lead (Rozenbids 1991, cited by Edyvane, 1996a) was discharged into Spencer Gulf via **First Creek**. To date, the long term discharge has resulted in high levels of metals in the sediments, and in biota that take up the metals, and has also depleted the benthic fauna. Some impacts of metals in the area, principally due to long-term contamination from the smelter, are discussed above in the section on **Metal Contamination**. Another effect of the smelter activity has been encroachment of slag heaps into the intertidal zone. There are also occasional spills from the Pasmenco plant. For example, the EPA issued a prosecution during the 2000 / 2001 year, for escapement of approximately 20 k/L of zinc electrolyte solution (ZE) into the waters of **First Creek**, where 50 fish were later found dead (EPA, 2001b).
- **Steel Works and Pellet Plant at Whyalla:** Suspended solids, iron, lead, zinc, manganese, ammonia, cyanides, phenols, and contaminated and heated cooling water are released in the area from the steelworks, blast furnace and coke ovens (Dainis, 1994; Lewis *et al.*, 1998; EPA statistics, 2002). The pollutants are advected into **False Bay**, which is a major prawn nursery area (Dainis 1994) and aggregation site for some other marine species, such as Giant Cuttlefish. Within the False Bay nursery

area, Carrick (2003) reported low densities of young prawns at a number of sites in the vicinity of coke-furnace settling ponds, and attributed the low densities to the high level of chemical contamination in the area. Historic discharges from the steelworks have resulted in elevated concentrations of metals such as lead, manganese, zinc and cadmium in the intertidal mudflats in the **Whyalla** area (Harbison, 1984 and 1993), with some concern for the accumulation of metals through marine food chains, as well as localised loss of seagrass (2000 ha) (Harbison, 1984, cited by Lewis *et al.*, 1998 and Harris and O'Brien, 1998). A previous estimate of the amount of contaminated wastewater discharged into **False Bay** (via a settlement pond), is around 429,000 m³/day. This water contains ~ 5 g/l suspended solids, which in turn contains high concentrations of lead, zinc, copper and manganese (McLaren and Wiltshire, 1984, cited by Harris and O'Brien, 1998). Discharges from the tailings dam, which contain elevated levels of dissolved iron, can also percolate into the nearshore marine environment though the walls of the settlement pond system (Miller, 1982, cited by Lewis *et al.*, 1998). There is also reported to be some seepage from the effluent dams (Bryars, 2003), which contributes to metal contamination in the area. Also, the "physical disturbance" caused by the dumping of steelworks effluent into dams adjacent to **Whyalla**, is listed as a minor threat to mangrove habitat in the Whyalla area (Bryars, 2003). Examples of annual loads of pollutants from the steel works include 310kg of lead and compounds; 2900kg of manganese and compounds; 3100kg of zinc and compounds, and 210,000kg of nitrogen (EPA statistics, 2002, cited by DEH, 2003a). Studies over a number of years have identified the effluent from coke ovens as a significant source of organic pollutants (e.g. phenols) and ammonia (Environment Australia, 2001c). Apart from metal contamination of the sediments and biota, other reported impacts in the area include degradation of seagrass, and occasional fish kills (Dainis, 1994). A serious decline of *Posidonia* seagrass in **False Bay** has been attributed to pH change in sediment, due to iron deposition (data by P. Harbison, cited by S. Shepherd, pers. comm., 2004). Concern has also been expressed about dioxin levels emitted from the steel works (Extract from Hansard, Legislative Council 4 July 2001). Prior to the installation of the waste gas cleaning plant on the Pellet Plant's exit gas stack in November 1998, the reported concentration of dioxin in waste gas was 1.2-1.4ng/m³. This equated to a total emission of ~4g/year of dioxins. After the installation of the waste gas cleaning plant on the Pellet Plant exit gas stack, the concentration of dioxin has been measured as averaging 0.08ng/m³ in the exit gas (average of 4 samples). This equates to a total mass emission of less than 0.5g / year of dioxins (Extract from Hansard, Legislative Council 24th July, 2001). The section **Notes on Impact Management** provides information about environmental improvement programs undertaken by this industry.

- **Liquid Hydrocarbons (Storage and Shipping):** The **Port Bonython** Liquids Processing Plant (mostly owned by SANTOS) is located near **Whyalla**. Port Bonython processes crude oil, condensate and LPG recovered from the Cooper / Eromanga Basins and it also has the capacity to process product recovered from other areas. Oils, particulates and oily ballast water have been discharged from the hydrocarbon handling facility at **Port Bonython** (Dainis, 1994; Aquaculture Group - PISA Fisheries, 1996). There may be short term impacts on biota (particularly surface feeders) from oil slicks on the water surface. Periodic oil spills are also another threat from oil handling facilities. The spill of 296 tonnes of bunker oil at **Port Bonython** in 1992, the worst spill in South Australia's maritime history, may have caused short term impact on some species that feed at the surface, and in the upper water column (e.g. Garfish, sea birds), and concerns were raised about potential short-term retardation of growth rates of some economically important fish species in the affected area (Connolly and Jones, 1996). Other impacts included the death and/or total defoliation of 2.3ha of mangroves, with no significant signs of recovery after 2 years (Wardrop *et al.*, 1993; Edyvane, Baker and Seddon, unpublished SARDI data, 1994; Butler, 1995). Although unquantified, the oil from this spill may also have affected populations of mangrove-dwelling invertebrates. **False Bay** has been classified as having high oil strike probability (i.e. 15 - 20%), and **Fitzgerald Bay** as having intermediate probability (Kinhill Stearns, 1987). Other impacts include ongoing contamination of marine biota due to the increased levels of hydrocarbons (in the vicinity of processing, storage and shipping areas), such as increased levels of polycyclic aromatic hydrocarbons (PAH's) in shellfish.
- **Power Stations:** During the mid 1990s, one of the power stations located at Port Augusta produced approximately 40% of South Australia's electricity (Aquaculture Group - PISA Fisheries 1996). There are two power stations in northern Spencer Gulf (Northern and Playford) (EPA, 2001b). The main reported emissions include fly-ash runoff, coal dust, and large volumes of heated seawater (between 1°C and 6°C above the temperature of the receiving water, according to various estimates). The northern power station has discharged, over a long period, into a shallow area of subtidal waters. However, tidal mixing can reduce impacts on the biota in the vicinity of the out falls, but during neap tides the impact might be more localised and severe (Harris and O'Brien, 1998). Dainis (1994) listed the impacts of this discharge as being the death of mangroves in the area, and possible depletion of phytoplankton. Studies by Ainslie *et al.* (1994) showed that seagrasses near the thermal outfall displayed some minor reduction in growth

characteristics, compared with control sites, but that benthic faunal abundance and diversity were apparently unaffected, compared with control sites. Previously, elevated heavy metal contamination near the power station occurred, and was considered to be due to fly ash in the power station effluent (Harbison, 1984). The fly ash ponds at the power station were relocated following reports of mangrove dieback. These areas of dieback have since stabilised, but the cause of dieback adjacent to Hospital Creek during the early 1990s was not clear (Bayard, 1993, cited by Edyvane, 1996a). According to Brown (2001, cited by DEH, 2003a), the discharge from the power station cooling effluent may have other adverse physical and chemical effects on the receiving environment, due to the chlorination of the water, and the velocity of its discharge. The Playford power station reportedly produces 140,000 tonnes of fly ash as waste. Whilst half of this is to be sold, the rest is stored on site, and is expected to increase the height of the disposal area by 3cm each year. The increasing height may make it more difficult to prevent the ash lifting during moderate to high winds. The current system for fly ash treatment in northern Spencer Gulf involves wetting the ash with saltwater and letting it dry so a protective salt crust forms, and this method will also be used for Playford's wastes (Jenkin, 2003). Specific metal pollutants from the two power stations are reported to be arsenic, cadmium, chromium, lead, and mercury, and associated compounds of all of these (EPA statistics, 2002, cited by DEH, 2003a). The annual load of each metal contaminant is in the low kg for both power stations (e.g. ranging from 0.1kg to 16kg from Playford, and 1.9 to 240kg from Northern) (EPA statistics, 2002, cited by DEH, 2003a). McLaren and Wiltshire (1984) noted that the concentrations of heavy metals discharged from the power station are small compared with the heavy industrial plants at Port Pirie and Whyalla. Nitrogen and phosphorus are also released from the power stations at Port Augusta. For example, 6900kg of phosphorus per annum is reportedly released from the Northern power station (EPA statistics, 2002, cited by DEH, 2003a).

- **Railway Facilities:** Reported discharges include oils, detergents, dispersants, and grease inhibitors in fresh water. Reported impacts include death of mangroves near the effluent outfall, and loss of amenity (visual impact) (Dainis, 1994).
- **Proposed Magnesium Plant:** Concern has been expressed by the Spencer Gulf Recreational Fishing Committee about the potential impacts of the proposed magnesium plant near **Port Pirie**, particularly regarding water quality and impact on fish stocks in the area (News Release, SA Gulf Cities, December, 2000). Other issues associated with the building and operation of this plant include potential increased levels of thermal pollution in the area, which might impact upon the seagrass and tidal flat habitats in the area, and physical disturbance of tidal flats during excavation for pipelines (Bryars, 2003). The plant is proposed to smelt 84,000t of metal per annum, with the developed site including a tailings pond and power station. The *coastal and marine environmental issues* (i.e. not including human health issues) that are required to be addressed with the development of the magnesium plant (according to the Major Developments Panel, 2000) include the need to:
 - ♦ Describe the existing terrestrial and marine environmental baseline, including physical characteristics, climatic characteristics, fauna and flora, biological diversity, habitat status and conservation, significant environmental areas and site geology and hydro-geology. The baseline study should include an assessment of the water temperature regime in the Spencer Gulf for the proposed site as part of the description of effects of cooling water discharge and an assessment of the depth and quality of groundwater.
 - ♦ Describe the production facility processes to be provided (including process flow diagrams), showing all gas and solids handling activities, and all emissions, from all processes. This is to be integrated with the mass balance for the Smelter.
 - ♦ Investigate noxious, hazardous or environmentally damaging emissions to the atmosphere, including chlorine, hydrochloric acid, chlorinated hydrocarbons (including but not limited to dioxins, hexachlorobenzene, octachlorostyrene and other persistent organic pollutants), nitrous oxides (NO_x), sulphur oxides (SO_x). The extent of production of these substances (particularly hexachlorobenzene, dioxins and furans) within the plant should be considered when assessing these emissions.
 - ♦ Provide modelling of emissions, taking into account local conditions, and an examination of the extent to which emissions can be contained and managed within statutory limits. The air quality modelling should be carried out using an air dispersion model such as AUSPLUME. In the modelling of emissions, consideration will need to be given to the complex topography and meteorology of the Northern Spencer Gulf.
 - ♦ Identify the likely routes and fate of all emissions, via air, water and soil.
 - ♦ Specifically consider the effects of air emissions on rainwater quality on Weeroona Island.
 - ♦ Investigate odours and dust from the plant and transport activities.
 - ♦ Provide information on risk assessment procedures.
 - ♦ Identify the types of solid waste materials from construction, ore processing, smelting, casting or other

operations, as well as those from maintenance and any other activities. This description should include the chemistry of solid wastes including mass fractions and also address the leachability of components of the waste.

- ◆ Identify the types, processing and disposal of liquid wastes (including sewage).
- ◆ Consider the design of disposal ponds and tailings dams, addressing, at least (a) the water balance (when determining freeboard and sizing of the ponds); (b) the separation distance from the base of the ponds and the underlying ground water; (c) the proposed lining of the base and sides of the ponds; (d) the sources of construction materials for the ponds (including clay liner materials and their geotechnical properties / permeability); (e) the leachate collection systems at the base of the ponds (for solid waste); (f) the proposed capping system for the ponds (to be backed up by appropriate modelling to ensure that infiltration is minimised); (g) the liquefaction potential of the foundation soil under seismic loading and the impact on pond lining integrity; (h) the potential effects of sea level change; and (i) the prevention of adverse environmental impacts with particular reference to ground water, surface water and the marine environment.
- ◆ Identify the long-term risks of and monitoring procedures for pollutant storage, including the liquid and solid waste disposal facilities and the tailing pond(s).
- ◆ Where applicable, discuss the effects of off-site transport, destruction and/or final disposal of polluted materials, particularly materials such as activated carbon used to capture organo-chlorines such as dioxins and furans.
- ◆ Consider the potential for uses, or recycling, of waste products.
- ◆ Discuss the risks of bio-accumulation of toxins in the food chain and the procedures for monitoring impacts of this on flora and fauna where appropriate.
- ◆ Discuss the arrangements for stormwater drainage and management, including consideration of means of collection, storage and, if at all possible, on site treatment for reuse. A proposed surface water monitoring program should be provided.
- ◆ Risk/hazard management should consider the impacts of storm events, and associated stormwater which arises.
- ◆ Develop a comprehensive discussion of water balances in the process and ways in which water can be harvested, recycled/re-used to minimise the requirements for pipeline water.
- ◆ Investigate the potential changes to hydrology (e.g. drainage patterns or groundwater characteristics), including effects from the establishment of evaporation ponds and solid waste disposal pits.
- ◆ Consider the potential for damage to mangroves by hyper-saline groundwater.
- ◆ A groundwater monitoring program, including the location of monitoring bores, will need to be developed. This program will need to consider the location and risks of all evaporation and waste ponds on the site. Consideration of hyper-saline groundwater should occur in pond and tailings disposal design.
- ◆ Identify the significance of the vegetation community that would be cleared or disturbed at the proposed smelter/power station site and the effects on any threatened flora species listed under State and Commonwealth legislation.
- ◆ Describe the effects on coastal wetland, mangrove and seagrass communities.
- ◆ Discuss the potential effects on marine fauna communities of the Spencer Gulf.
- ◆ Discuss the potential effects on any recognised fish nurseries in the region (and on commercial and recreational fish species).
- ◆ Investigate the effects of the use of cooling water (seawater) on the marine environment, including the effects of temperature and increased salinity and the options for locating the intake and outlet for the seawater cooling pipelines, and using sufficient volumes of water to minimise environmental effects.
- ◆ Discuss the potential for fouling by seasonal material from the extensive local seagrass communities, and the means to mitigate this.
- ◆ Describe the effects of the loss of wetland habitat, and disturbance to adjacent habitat, under the Bonn Convention.
- ◆ Provide details of any predicted effects of any water pondage facilities on birds.
- ◆ Investigate the effects on the presence of any threatened fauna species listed under State and Commonwealth legislation.
- ◆ Describe the effects on the fauna habitat value of any vegetation communities that will be affected, with specific reference to the habitat of nationally endangered species.
- ◆ Discuss the potential effects of loss of habitat for water birds in the immediate, and adjacent areas, with

specific reference to the northern hemisphere migratory species listed under the JAMBA and CAMBA agreements between the Government of Australia and the Governments of Japan and the People's Republic of China respectively.

- ♦ Discuss options to minimise the impact of the proposed facility upon native vegetation.
- ♦ Discuss the potential for the introduction or spread of exotic plant or animal species and their management.
- ♦ Consider the effects on weed proliferation.
- ♦ Provide an analysis of greenhouse effects, including potential effects of sea level change on the plant.
- ♦ Identify opportunities and measures that would avoid, minimise and offset greenhouse emissions.
- ♦ Consider the suitability of the project for the 'Greenhouse Challenge' under Commonwealth initiatives.
- ♦ Consider the effects of climate and meteorological factors on structures, facilities and operators.
- ♦ Describe the risk of causing or exacerbating any other environmental problems in the region.
- ♦ Describe mitigation measures and their expected effectiveness.
- ♦ Provide details of rehabilitation of waste disposal facilities.
- ♦ Discuss the rehabilitation of the land following plant closure.
- ♦ Outline the identification, development, management, reporting and documentation of the identified effects and the mitigation measures and their effectiveness on recognised and perceived environmental impacts.

(Major Developments Panel, 2000).

Shipping Issues

Shipping activities are concentrated around **Whyalla, Port Bonython** and **Port Pirie**. A number of modelling studies have been published on oil spill slick trajectories and water-pollutant movements (e.g. Tronson, 1974; Green, 1984; Nunes-Vaz *et al.*, 1990, cited by Harris and O'Brien, 1998). A problem with the negative estuary of Northern Spencer Gulf (in which a net landward flow of surface water is required to offset the seaward flow of dense saline bottom-water), is that circulation acts to transport any pollutants landwards in surface waters towards Port Augusta. This may be an important factor to consider in the context of the fate of discharged, normal-salinity, ballast water (Harris and O'Brien, 1998). Dainis (1994) summarised shipping impacts in the upper Spencer Gulf area according to activity:

- *Entry of Ships*: Results in resuspension of bottom sediments, due to ships entering shallow bays, resulting in turbidity in the water column, siltation and smothering of benthic biota, and release of toxic metal-rich sediments that may adversely affect biotic distribution and function.
- *Loading*: Spillage of metal concentrates into the marine environment may occur, from wharves and stockpiles, and during loading. This can increase the concentration of heavy metals (lead, copper, cadmium, zinc etc) in sediments, and increase the circulation of particulate metal. Other effects include reduction in oxygen levels in water and sediment, suspension of metal-rich matter (causing turbidity and increasing the component of toxic substances in the water column in the short term), smothering of benthic biota, and toxic effects on biotic function. Organic dusts are also released during loading of grain, resulting in turbidity and smothering.
- *Dredging*: Occurs at **Port Pirie**, and at **Whyalla** and **Port Bonython** (Dainis, 1994), mainly to maintain shipping channels, but other dredging events occur periodically, associated with coastal developments. Dredging mobilises silts into suspension, as well as particulate metals, which can accumulate in channel areas in northern Spencer Gulf (Dainis, 1994). Impacts include short-term increased water turbidity (and reduction in light penetration), smothering of benthic flora and fauna, reduction in dissolved oxygen, and suspension of metal-rich sediments, which may be ingested by marine organisms, causing toxic effects on distribution and function of biota. Some of the effects of heavy metal accumulation are discussed above.
- *Spillage*: Spillage of oil and other hydrocarbons, bilge water and other substances (which may accumulate at shorelines and affect biotic distribution, abundance and function). If oil is spilled in large quantities, it may cause acute or (in some cases) longer term impacts on the distribution and abundance of biota in the area. Hydrocarbons from petro-chemical spoilage during shipping operations in **northern Spencer Gulf** (e.g. **Port Pirie, Whyalla** and **Port Bonython**) has been listed as a potential threat to habitats in the area (Bryars, 2003).

Other shipping issues include:

- *Exotic Species in Ballast Water Discharge*: Over the years, ships have discharged ballast water into the

harbours at **Port Pirie** and **Whyalla / Port Bonython**, provided that they follow any voluntary precautions against contaminated ballast water as may be required (Harris and O'Brien, 1998). Ballast water discharge poses the threat of introduction of exotic organisms, including the organisms associated with the development of Harmful Algal Blooms, although the high salinities of northern Spencer Gulf could restrict the establishment of many such species, at least in the uppermost area of the gulf;

- Increased levels of TBT and other organometals, due to shipping operations at **Port Pirie**, **Port Bonython** and **Whyalla**;
- *Hydrocarbon Contamination of Fauna*: For example, increased levels of polycyclic aromatic hydrocarbons (PAH's) in shellfish;
- *Litter* (with impacts including entanglement of marine organisms, and visual pollution);
- *Potential Impacts of Proposed New Shipping Developments*: More recently (2000), concern has been expressed about the potential marine and coastal impacts of the proposed ship-breaking facility at **Whyalla**. Examples of reported community concerns include increased near-shore marine contamination from metals, oils, chemicals, and anti-foulants, and further reclamation of (and damage to) the coastal zone for development.

Sewage and other Nutrient-rich Effluent Discharges

- The main source of nutrient in northern Spencer Gulf is the discharges from sewage treatment works at **Whyalla**, **Port Pirie** and **Port Augusta**. There are also minor sources from industry (e.g. Whyalla steelworks). Sewage effluent contains nutrients such as nitrogen and phosphorus; bacteria and suspended solids, and is released into waters with restricted circulation in northern Spencer Gulf, including tidal creeks and other locations close to the shorelines. Effluent is also released from shack developments along the coast on both sides of northern Spencer Gulf (Aquaculture Group - PISA Fisheries, 1996), including seepage and overflow from septic tanks (see section below, on **Coastal Development**). In the **Port Pirie** area, sewage treatment waste water mainly flows into **Second Creek**, and also in the **Whyalla** area, the sewage effluent drains through a tidal creek.
- In general, the effects of nutrient enrichment in shallow seagrass ecosystems include water turbidity, light reduction, elevated nutrient levels in naturally low-nutrient systems, photosynthetic and respiratory stress for seagrasses, and smothering by nutrient-induced epiphytes and particulate matter (e.g. see Shepherd *et al.*, 1989; Lewis *et al.*, 1998, and the section of this report on **Upper Gulf St Vincent**).
- The impact of effluent-induced nutrient enrichment due to the discharges from **Whyalla**, **Port Pirie** and **Port Augusta** is compounded by the fact that there is restricted circulation in the northern Spencer Gulf region, and discharges in the area are in shallow water (including tidal creeks), close to the shoreline (Dainis, 1994). A number of impacts have been noted from nutrient enrichment in the **Port Pirie** area, including death of seagrass in the gulf waters adjacent to the **Second Creek** outlet (Edyvane, 1996a; Media report, April, 2003). At **Whyalla**, discharges of ammonia nitrogen are reported to have contributed to the loss of 1000ha of seagrass, and the decline of another 1000ha, since 1970 (Harbison and Wiltshire 1993, cited by Lewis *et al.*, 1998), although surveys have shown that some areas of *Posidonia* are now recovering (Wiltshire and Harbison, 1996 and 1997, cited by Lewis *et al.*, 1998).
- According to Dainis (1994), quantities of effluent discharged during the mid 1990s were: 2.5ML / day (with TDS of <2000 mg/L) from **Port Augusta**, 2.7ML / day (TDS approx. 20,000mg/L) from **Port Pirie**, and 4.6ML / day (TDS approx. 5000mg/L) from **Whyalla**. There is some recycling of treated effluent from **Port Augusta** (Dainis, 1994), and improvements have been made in recent years to the **Port Pirie** waste water treatment plant (see section below, on **Impact Management**).
- Around 78% of the effluent from the **Port Augusta West** treatment plant was re-used in 2001-2002, however none of the effluent from the plants at **Port Augusta East**, **Whyalla** or **Port Pirie** was re-used, although there are plans to re-use effluent from the **Whyalla** plant (SA Water, 2002). In 2002, effluent discharges into northern Spencer Gulf waters were as follows (SA Water, 2002):
 - ♦ *BOD*: Pt Augusta West = 7.1t; Pt Augusta East = 20.6t; Pt Pirie = 52.1t, and Whyalla = 48.2t.
 - ♦ *Suspended Solids*: Pt Augusta West = 11.1t; Pt Augusta East = 25.6t; Pt Pirie = 172.6t; and Whyalla = 84.5t.
 - ♦ *Total N*: Pt Augusta West = 5.6t; Pt Augusta East = 22.7t; Pt Pirie = 38.7t, and Whyalla = 58.8t.
 - ♦ *Total P*: Pt Augusta West = 2.0t; Pt Augusta East = 5.1t; Pt Pirie = 9.5t, and Whyalla = 9.5t.
 - ♦ *Annual Effluent Discharge 2001- 2002*: Pt Augusta West = 49.4 ML; Pt Augusta East = 464.9 ML; Pt Pirie = 1,312 ML, and Whyalla = 1334 ML.
- The salinity of waste water from **Port Pirie** (= 23,083 mg/l) is 1 to 2 orders of magnitude above that

released from the other 3 treatment plants in northern Spencer Gulf. The Port Pirie effluent also has by far the highest salinity of any wastewater released from sewage treatment plants in South Australia (see SA Water 2002, WWTP Performance Summary Appendix).

- The solid wastes from sewage treatment in northern Spencer Gulf are stockpiled. In 2002, production of bio-solids were: **Port Augusta East** 54t; **Port Augusta West** 61t; **Port Pirie** 75t, with a stockpile of 4580t (dry); and **Whyalla** 547t (SA Water, 2002).
- septic tank overflows from the shacks and houses between **Point Lowly** and **Port Douglas** have been identified as a potential source of marine pollutants (PIRSA Aquaculture, 2004b).

Diffuse Pollution Sources

- The EPA (1993, cited by Aquaculture Group - PISA Fisheries, 1996) defined the waters which are likely to suffer *continuing diffuse impacts* as: the waters of **False Bay** north-west of a line commencing at **Black Point**, thence generally south westerly to a point on the SSE corner of the spoil ground for **Port Whyalla** outer beacon (E 137°37.65'; S 33°02.45'), and continuing to intersect the coast at high water mark. It is noted that satellite imagery data from 2000-2001 showed that the chlorophyll-a levels in the **Fitzgerald Bay** area were high, at times being more than double the trigger value, according to ANZECC water quality guidelines.

Diffuse pollution sources in the area include:

- *Episodic run-off from rural coastal areas* carrying fresh water, nutrients, silts, fertilisers and pesticides (from agricultural land), which may be exacerbated by land clearance. This mix of substances in fresh water increases near-shore water turbidity, and causes nutrient enrichment, siltation, and also contributes to microalgal blooms and fish kills (Dainis, 1994). Increased level of nutrients caused by diffuse agricultural run-off has been listed as a potential threat to habitats in the northern Spencer Gulf region (Bryars, 2003);
- *Urban and industrial storm water run-off* (e.g. in the **Port Pirie**, **Whyalla** and **Port Augusta** areas), which carries fresh water; nutrients; metals (e.g. lead, arsenic, cyanide, cadmium, chromium, copper, zinc and mercury compounds); sediments; organo-chlorines; hydrocarbons; rubber; acids; caustics; various other industrial and residential organic and inorganic chemicals (some of which are toxic to marine biota, and others of which have a high biochemical oxygen demand); silt; litter, and other products. Apart from turbidity, siltation / sedimentation, nutrient enrichment and contribution to microalgal blooms and fish kills, storm water is considered to kill native plankton and small invertebrates (Dainis, 1994).

Commercial and Recreational Fishing Issues

- In general, impacts in the Northern Spencer Gulf area due to commercial and recreational fishing from major settlements, and recreational fishing from shack sites in Spencer Gulf, include:
 - ♦ depletion of some fish and invertebrate stocks, particularly site-attached and/or aggregative species (a combined impact from commercial and recreational fishing);
 - ♦ disturbance of seagrass beds from boats and boat anchors;
 - ♦ trampling and other physical damage to mudflats and mangroves, in some areas where shore-based fishers and boats in shallow waters operate;
 - ♦ depletion of Razorfish (*Pinna bicolor*) beds (e.g. by trampling; boat damage; over-collecting). Seasonally there are reports to PIRSA's *Fishwatch*, of Razorfish being taken in quantities above recreational bag limits;
 - ♦ loss of benthic fauna, due to damage from boats (in shallow waters) and boat anchors, including natural and artificial reef areas where boats aggregate; and
 - ♦ litter and discarded fishing materials (e.g. plastics, ropes, buoys, nets, oil, garbage) (Dainis, 1994).
- There have been reports to government during the past 5 years, of illegal net fishing at closed areas in northern Spencer Gulf (e.g. **Winninowie / Chinaman Creek**, **Yatala Harbour**, **Port Germein**, **Port Pirie** Creeks).
- The control of illegal fishing occurring in the shallow waters in the vicinity of **Winninowie Conservation Park** has been identified as a required management action of high priority for the area (DEH, 2000a).

Examples of currently fished (and previously fished, in the case of Giant Cuttlefish) species for which there are sustainability issues include the following:

- *Giant Cuttlefish*: During the mid 1990s, and particularly from 1996 to 1998, there was a rapid rise in commercial fishing effort on the spawning aggregations of Giant Cuttlefish in the False Bay - Point Lowly -

Black Point - Fitzgerald Bay area. Total catches for the northern Spencer Gulf area were approximately 69t in 1995/96 and 242t in 1996/97, with the majority of the catch coming from the area of spawning aggregation. The catch figures for the mid-1990s represented a rapid rise from the low tonnage obtained in the preceding years, prior to the development of new markets. Since late 1998 the fishery in the Point Lowly - False Bay - Black Point area has been closed during the spawning season, due to a severe decline in spawning biomass observed in the area. Commercial and recreational fishers are permitted to target cuttlefish outside of the closed area during the spawning season ban. The closure area is described in the section of this document titled **Notes on Current Level of Protection and Management**, and is considered to cover approximately 44% of the rocky reef habitat in the aggregation area (Hall and McGlennon, 1998). The depletion in the number of cuttlefish seasonally aggregating in the area was a consequence of the fishery targeting the large spawning aggregations of many thousands of cuttlefish, with an unknown proportion of these short-lived animals not having the opportunity to spawn before being caught. Apart from the impact in the cuttlefish population, there may be ecological ramifications, because cuttlefish of various sizes form a portion of the diet of Australian Fur Seals, Australian Sea Lions (Gales *et al.*, 1993), Snapper, Yellow-tail Kingfish and other large predatory fish, dolphins and various sea bird species. Hall (1999) provided figures to show that, following the moratorium on fishing in the spawning area, abundance increased in the closed area by 100,000 animals, compared with the previous year in which the spawning aggregation was targeted. However, there are no reliable figures for the size of the spawning stock prior to the rapid and significant rise in catches. Although figures are not available, it has been suggested (Whyalla Sports Divers Club, 2000) that in 2000, based upon regular observations by divers in the area during the 1990s, the biomass at that time represented 10% - 15% of the biomass that was present prior to the rise in commercial fishing, and that the stock had not recovered to a significant extent during the initial closure of 2.5 years (i.e. 1998 - 2000). When the area was first closed to fishing, part of the reported spawning aggregation area (e.g. **Fitzgerald Bay**) was not included in the closed area. The closure has continued to the present (2004), and is further discussed below (see **Notes on Current Level of Protection and Management** for this focus area).

- *Snapper, King George Whiting, and Garfish* are three of the major species caught by commercial and recreational fishers in Northern Spencer Gulf, and Snapper and whiting are also a bycatch from prawn trawling (see Carrick, 1997). All three species are classified as *fully fished* in South Australia (DEHAA and EPA, 1998). Notes on the vulnerability of these species to over-exploitation are outlined below:
- Reviews by McGlennon and Jones (1997) and Fowler (2000) indicated the need for cautious management of *Snapper* stocks, including the spawning aggregations and site-associated large Snapper in **northern Spencer Gulf**. Larger, older Snapper may be important contributors to spawning potential, and larger individuals are targeted at a number of locations (see sections above on **Commercial Fishing** and **Recreational Fishing**). The Snapper stocks in South Australia are characterised by irregular large recruitments, which later sustain the fishery for a number of years after the fish recruit to the fishery. The irregular "good" recruitments of Snapper; the long-lived nature of the fish; and the aggregative nature of large Snapper at a number of sites in Spencer Gulf, requires that the fishery for this species be cautiously managed over the long term.
- Fowler and McGarvey (1997) recommended that there be sufficient escapement of immature *King George Whiting* (particularly the 2 – 3 year old age classes), from heavily fished inshore areas, such as the upper gulfs. This would enable sufficient numbers of King George Whiting to annually replenish the spawning populations of larger whiting further south of the gulfs. McGarvey *et al.* (2000) considered that, because of the nature of population reproduction in the two gulfs, the general risk of relatively rapid decline in the whiting population is higher than average. King George Whiting spawn in very few known locations, and if the spawning stock were to decline enough to significantly affect recruitment, catches would be expected to decline around 3 years later, when the fish spawned from a year class of reduced egg abundance reach legal size. The King George Whiting stock is subject to high levels of fishing and natural mortality. The species is not long lived, and the catch each year is comprised nearly entirely of the newly recruited year class as it comes through. Catch and effort on the younger, newly recruited whiting in Gulf St Vincent are high. McGarvey *et al.* (2000) also recommended additional regulatory measures to protect the spawning stock of King George Whiting.
- Ye (1999) reported that *Garfish* is a fully exploited species in South Australia. Although commercial catch rates have generally been stable since the 1980s, the Garfish stock in S.A. is considered to be fully exploited, according to available biological performance indicators (BPIs). Garfish now mature at a smaller size than was observed 40 years ago, believed to be a response to heavy fishing levels (Ye, 1999; and Ye, cited by Southern Fisheries, 2001). Catch rates are not considered to be a sensitive indicator of stock abundance for schooling species such as Garfish.
- *Yellow-fin Whiting*: Northern Spencer Gulf is a major commercial fishing area for this species. Due to steadily increasing market value of Yellow-fin Whiting since the 1980s, annual commercial catches from

northern Spencer Gulf have been increasing in most years throughout the mid to late 1990s till the present (compared with yields from the mid 1980s to early 1990s). Cautious management of Yellow-fin Whiting fishing is required, considering the following factors (adapted from Ferguson, 1999) (i) older age classes have been found mainly in parts of Spencer Gulf, and in that gulf, fishing in the commercial grounds is considered to be responsible for a reduction in the relative abundance of older age classes; (ii) recruitment and year class strength are highly variable over space and time, likely due to oceanographic factors; (iii) the contraction of the size range in the fishery may indicate smaller numbers of the major egg producers in the population (i.e. the older females), and ultimately a decline in egg production; (iv) fisheries which target young fish are dependent upon continued high annual recruitment levels (and recruitment levels and subsequent year class strength are likely to strongly influence the biomass available to the fishery); and (v) the recreational fishery for yellow-fin whiting is active at a time when these fish are reproductive.

- *Bronze and/or Black Whaler shark*: Caught commercially in northern Spencer Gulf waters and also by recreational fishers, however the extent of recreational fishing in the area is not known for this report. These species may be considered potentially vulnerable, due to relatively slow growth, delayed maturity, viviparous (live bearing) reproduction, and low fecundity (see section 9.2). Both adults and young are caught as part of the fishery in S.A.. The extent of the nursery areas is not well known, and overall there is reportedly little information on the status of both adults and juveniles (Froese and Pauly, 2003). These two species are also fished recreationally in S.A., but figures are not available. Section 9.2 discusses the vulnerability of these species to over-exploitation, due to their life history characteristics.
- *Whiskery Shark*: Caught commercially in small numbers, in northern Spencer Gulf, and also as bycatch in trawling, however no information on trawl bycatch of this species is available. The extent of recreational fishing for this species is not also known for this report. Whiskery Shark was classified as *Lower Risk (Conservation Dependent)* in the IUCN Red List 2000 and 2002, but not included in the 2003 IUCN Red List.

Prawn Trawling Issues

- Prawn trawling occurs in waters deeper than 10m in part of the area described in this table (see **Notes on Social and Economic Values and Uses**). The western king prawn fishery in Spencer Gulf was reported in 1991 to be *fully fished* (Commonwealth of Australia, 1991), and more recently the same status was reported by a South Australian State of the Environment report (DEHAA and EPA, 1998, cited by DEH, 2003a). Prawns are an important food source for various fish species (e.g. young Snapper) and other marine fauna, however the impact of long term prawn trawling yields on the feeding potential and abundance of prawn predators, or on nutrient recycling, is apparently not known in South Australia. There is indisputable evidence that prawn trawling modifies benthic habitat (see Section 9.2), and that bycatch is also an issue (e.g. see below). Prawn trawling issues are discussed in more detail in Section 9.2.
- Bycatch studies (see Carrick, 1997) in the **Point Lowly to Yarraville** area (sampling region No. 1) showed that the catch from tows in February 1996 comprised around 61% western king prawn, 16% various fish species; 20% blue crabs; and 3% cephalopods. In the **Yarraville to Plank Shoal** area (sampling region No. 2), the proportions were 59% Western King Prawn, 27% various fish species; 12% Blue Swimmer Crabs; and 2% cephalopods.
- Most results from the bycatch study were discussed in relation to the entire sampling area (i.e. 4 large sampled regions in Spencer Gulf, collectively extending from the Whyalla area down to Corny Point. According to Carrick (1997), although the proportion of bycatch species to target catch (i.e. the “bycatch ratio”) is low in Spencer Gulf compared with other prawn fisheries in Australia and overseas, a number of impacts were noted, as discussed above in section 9.2.9 on **Franklin Harbour and surrounding coast**. Examples included large bycatch of leatherjacket species, trevally, flounder, Blue Swimmer Crabs, and sponges in some areas, including parts of northern Spencer Gulf.
- Carrick (2003) reported that in 2002, there was a significant decline in prawn biomass density in the Northern Area of the prawn fishery (Whyalla to Wallaroo), compared with the density during 1998 – 2001, however the density in 2002 was reported to be not significantly different from that of the baseline sampling period (1987 and 1988). The decline in biomass density in the Northern Area was difficult to interpret due to differences in sample numbers between the two periods, however it was recommended that exploitation be constrained in the northern area, as a precautionary measure (Carrick, 2003).

Boating

- In general impacts from boat launching and running in shallow intertidal waters include: (i) trampling of saltmarsh, mangroves, intertidal sand and mudflats (e.g. Razorfish beds), and intertidal seagrasses; (ii) scouring of shallow sea floor sediments and benthic biota (including damage to shallow seagrasses); and

(iii) increased turbidity in inshore waters.

- According to DEH (2000a), in the past a “significant number” of small wooden boats were moored in **False Creek** and **Chinaman Creek**. This altered the creek hydrology, slowing the water under boats, creating sandbanks that blocked the entrance to the creeks at low tide, and caused erosion in some tidal creek areas, due to scouring from the boats. Demand for permanent moorings has reduced substantially, wooden boats are becoming less common, and the creeks are not suitable to be used as a marina for yachts. It is considered beneficial for the creek hydrology to discontinue mooring boats in the creeks (DEH 2000a). DEH’s (2000a) management plan for **Winninowie** area stated the need to monitor boat activity in tidal creeks and if necessary, implement procedures to minimise tidal creek erosion caused by such activity.

Issues with Legal and Illegal Artificial Reefs

- Although the construction and/or dumping of artificial reefs may be beneficial to some extent, by providing additional hard substrate for the attachment of biota, and providing shelter, feeding and spawning sites (due to their role as fish attracting devices), there is some concern that the indiscriminant dumping of objects (e.g. car bodies, white goods, scrap metal etc) into northern Spencer Gulf can also have negative effects. Some of these potential impacts include:
 - ♦ increased physical damage to the benthic environment due to both the dumped objects;
 - ♦ increased attraction of boats to the sites, causing concentration of boat anchors in specific artificial reef locations. Increased concentration of boating activity can cause benthic scouring of sediments and biota (e.g. due to anchor damage), and breakage of some types of benthic biota, as well as increased turbidity from boat hulls and motors in shallow waters;
 - ♦ increased impacts on site-attached reef fish populations, which may be attracted to the artificial reefs / dumped objects, and thus become a target for increased fishing levels, because fishers know the exact location of artificial reefs / drops where fish aggregate;
 - ♦ addition of materials that cause metal leachates (Dainis, 1994) and other potentially toxic substances to be released into shallow waters.

Diving

- In general, diving impacts can include physical damage to benthos (from kicking / finning, stepping on attached biota, or from collecting); increased localised sedimentation in sandy / silty areas (which can smother attached benthos); and disturbance to some site-aggregated fish populations. Due to the abundance of attached invertebrates; the prevalence of sandy / silty areas; the collectable molluscs; and the site-aggregated fish and invertebrate populations in Northern Spencer Gulf, diving activities in the region should be monitored, particularly with the increased promotion of the area as a major dive destination.

Aquaculture

- Both shellfish and caged fish farms operate in the northern Spencer Gulf region, and an increase in aquaculture in the region is planned for the 2000s (see information on leases and applications in the section on **Notes on Social and Economic Values and Uses**). During the early 2000s, interest was expressed in expanding the current level of aquaculture in the **Fitzgerald Bay – Backy Point** region, and also developing lease sites for both finfish (e.g. Yellowtail Kingfish) and shellfish in the **Cowled’s Landing** area, around 2km south of the Aquatic Reserve. The benthos in these areas is dominated by sessile invertebrate assemblages, such as soft corals, gorgonian corals, ascidians, sponges, patches of bryozoa, and, in some areas, Razorfish beds. There is potential for the benthos in these areas to be smothered by waste products from aquaculture, or impacted in other ways from nutrient enrichment and also the increase in particulate matter reaching the benthos due to the presence of farms, particularly for caged fish. It is noted that although caged fish aquaculture has been operating in **Fitzgerald Bay** since the 1990s, there appears to have been little monitoring of environmental impacts until recently (early 2000s), and during a recent technical assessment of the site’s potential to support increased levels of aquaculture development, it was reported that the area may already have experienced changes in water quality and community composition, but the specific environmental impacts of caged fish farming in **Fitzgerald Bay** remain unknown. The increased level of nutrients, and increased sedimentation, from caged finfish aquaculture wastes in **Fitzgerald Bay**, has been listed as a potential to habitat in the area (Bryars, 2003). The impacts of shellfish and caged fish aquaculture in general are discussed in section **9.2**.
- It is noted that satellite imagery data from 2000-2001 showed that the chlorophyll-a levels in the **Fitzgerald Bay** area were high, at times being more than double the trigger value for that part of South Australia,

according to ANZECC water quality guidelines. There are nutrient inputs from existing finfish aquaculture leases in the bay, and other nutrient inputs into the area (see section above, on sewage and other nutrient-rich effluent discharges). Government sampling in 2002 also showed that the organic content of the sediments in the area was high. Due to the 'forementioned factors, the potential for harmful algal blooms in the **Fitzgerald Bay** area has been reported as high. This is of concern, considering the increased hectareage of finfish leases proposed for the bay (e.g. see PIRSA Aquaculture, 2004b). In the **Cowled's Landing** area, satellite imagery data from 2000-2001 showed that the area has high to very high chlorophyll-*a* levels, even without the introduction of finfish farms to date (2004). Given the reported chlorophyll-*a* levels at the site, coupled with the relatively low current speeds at Cowled's Landing, the seasonally low flushing rate, and the existence of numerous coastal pollution discharges in the area (see below), there is potential for increased incidence of harmful algal blooms in this area, which could be exacerbated by the increased nutrients from aquaculture developments (particularly caged finfish). Aquaculture developments and their associated wastes also have the potential to lower the levels of dissolved oxygen in the water, which could adversely affect both the benthic sessile and pelagic motile biota. The impacts of shellfish and caged fish aquaculture in general are discussed in section **9.2**.

- Aquaculture Group – PISA Fisheries (1996) reported that aquaculture operations in the northern Spencer Gulf area have the potential to “negatively impact sensitive biological communities” (such as those associated with the wetland complexes in northern Spencer Gulf) “through additional noise, pollution and other disturbances” (Aquaculture Group - PISA Fisheries, 1996).
- Aquaculture Group - PISA Fisheries (1996) stated that mangrove stands, seagrass beds and significant breeding sites for commercially fished species and protected birds, are sensitive to changes and development, and that the impacts of aquaculture on these areas should be considered when assessing aquaculture applications.
- There is some concern that the waters of Far Northern Spencer Gulf are unsuitable for some types of aquaculture activity. For example, Aquaculture Group - PISA Fisheries (1996) stated that in the Paterson Management Zone (in Far Northern Spencer Gulf), licences will not be issued for operations requiring supplementary feeding or of non-native species of oyster, apart from the confines of the intake and outlet pipe channels of the power station. This limitation was made because it was considered undesirable to add further nutrients to the marine environment. The marine environment of Far Northern Spencer Gulf is considered to have a low turnover rate of water, and slow water circulation, which may result in nutrient build up (Harbison and Wiltshire, 1993, cited by Aquaculture Group - PISA Fisheries, 1996). The area is also considered to be a “high stress biological system” due to high salinities and large temperature fluctuations, and additional stresses (such as aquaculture) in an area such as this may have a greater effect on resident organisms than in less stressed areas (Aquaculture Group - PISA Fisheries, 1996).
- *Yellow-tail Kingfish*: Concern has been expressed in recent years about the potential ecological impacts of Yellow-tail Kingfish escaping from farms in Spencer Gulf, including impacts on other fish species in the gulf, and on food supply (e.g. O'Toole, 2002; Grosser, 2003; Office of the Minister for Agriculture, Food and Fisheries, 2003). In the area described in this table, kingfish have escaped from farms at **Fitzgerald Bay**. Bryars (2003) listed as a potential threat in the area, the “stock enhancement” of Yellow-tail Kingfish caused by escapees from caged fish aquaculture operations in **Fitzgerald Bay**. However, it is noted that a recent study of farmed and wild kingfish in northern Spencer Gulf (Fowler et al., 2003) noted significant differences in the diet of escaped farm kingfish compared with wild kingfish: - the farmed kingfish were reported to be incapable of feeding properly, which would suggest limited potential for impacts on other marine species.
- Altered patterns of water movement and sediment movement, caused by the location of the microalgal culture ponds adjacent to **False Bay**, has been listed as a potential threat to mangrove forest in the False Bay area (Bryars, 2003). Permanent inundation caused by the flooding of additional algal culture ponds at False Bay, has been listed as a potential threat to saltmarsh habitat at **False Bay** (Bryars, 2003).

Coastal Development (including those associated with Urban Centres, and Shack Sites)

- In general, a large number of urban centres and shack developments exist along the coast of Spencer Gulf. These areas are often associated with pollution from stormwater and effluent discharges that are released into the marine environment (Aquaculture Group – PISA Fisheries, 1996). Major industrial and urban developments in the area (such as **Whyalla**) have altered the topography and bathymetry of the near-shore area in parts of northern Spencer Gulf, and resulted in extensive reclamation for development. Industrial and urban developments have substantially changed the original coastal configuration (Kinhill Stearns, 1987).
- During the mid 1990s, there were at least 280 shacks located on the western side of the northern gulf (e.g. between **Blanche Harbour** northwards to within 8km of **Port Augusta**), with other smaller shack

developments elsewhere in the region (e.g. **Weeroona Island**, and see section in **Notes on Social and Economic Values and Uses**). These shack sites are considered to be potential contributors to pollution to the northern Spencer Gulf waters. Examples of areas where the increased level of nutrients from septic tank discharge / overflow is considered to be a potential threat to habitats, include **Point Lowly / Port Bonython, False Bay, Murninnie Beach, Cowled's Landing, Fitzgerald Bay, Backy Point, Douglas Point** and **Douglas Point South, Blanche Harbour to Curlew Point, Chinaman Creek and Miranda** (Bryars, 2003). Flood water run-off from surrounding hills and plains may also result in the addition of pollutants (Aquaculture Group - PISA Fisheries, 1996).

- A study undertaken by the Shack Site Freeholding Committee, found that waste water disposal of all shacks in the region (e.g. **Whyalla, Port Pirie, Port Germein** and other coastal areas) was unacceptable to the marine environment (Commonwealth of Australia 1994, cited by Aquaculture Group - PISA Fisheries, 1996).
- Aquaculture Group – PISA Fisheries (1996) stated that mangrove stands, seagrass beds and significant breeding sites for commercially fished species and protected birds, are sensitive to changes such as coastal developments, and that suitable buffer areas should be determined to protect such areas from development.
- Some of the specific issues relating to existence and development of both urban centres and shack sites include: (i) nutrient enrichment due to sewage effluent release (from both seepage/leakage or overflow from septic tanks, and deliberate release); (ii) loss of amenity from litter/garbage in the nearshore and coastal environment; (iii) release of metals into the near-shore environment, from scrap metal and car bodies used as artificial reefs, or dumped in the coastal area; (iv) loss of Razorfish beds at shack development sites (e.g. due to collecting, and trampling); (v) trampling of mangroves and intertidal seagrasses; (vi) release of accumulated metals from sediments, due to sediment disturbance associated with development and consequent physical damage; and (vii) erosion and other damage to intertidal areas from coastal buildings and shacks, and boat launching at developed coastal areas and shack sites (Dainis, 1994).
- Other issues associated with development include impacts on saltmarsh habitat. For example, one impact in the area is the elimination of tidal flows caused by the location of Germein Road, leading out from Port Pirie, which stops tidal flow to some saltmarshes east of **Port Pirie** (Bryars, 2003). Other issues include physical disturbance of saltmarsh due to off-road vehicle use, stock grazing, and illegal rubbish dumping (Bryars, 2003).

Marina Development

- There is a marina at **Whyalla**, and another has been planned for **Port Augusta** (Media report, September, 2003). The potential impacts from the construction and operation of marinas and other boating facilities are discussed in section **9.2**.

Sea Level Rise

- The environment of northern Spencer Gulf may be particularly susceptible to the impacts of sea level rise due to its low lying nature, wide expanses of supratidal and intertidal sediments, and reported level of seismic activity, although the coastal progradation of sediments that has historically occurred due to geological processes, may mitigate the effects to some extent. Harvey *et al.* (1995) undertook a coastal vulnerability assessment of the northern Spencer Gulf area. Considering that habitats in northern Spencer Gulf display a distinct zonation from the supratidal to the deeper central channels areas, it is possible that the distribution of current habitats will change during the coming decades, which should be considered in any future zonation of the northern gulf waters for any purpose (including protected areas / conservation zones; industrial zones; residential zones; aquaculture zones etc).

Other Issues, Potential Threats, and Impacts

Examples include the following:

- In the National Land and Water Resources Audit's assessment of estuaries in South Australia (1999-2001) **Fisherman Creek** (south of Port Pirie) was classified as *Modified*, and described as "moderate to high pressure" (GeoScience Australia, 2001). Assessment criteria included catchment natural cover, land use, catchment hydrology, tidal regime, floodplain, estuary use, pests, weeds, and estuary ecology (Barnett, 2001, cited by DEH, 2003a).
- Soil erosion along coastal cliffs and in sand dune areas (Morelli and de Jong, 1995).
- Much of the inter-tidal boundary of **Winninowie Conservation Park** is unfenced. Sheep are able to enter

the southern portion of the reserve through the unfenced inter-tidal zone, at low tide (DEH, 2000a). Sheep activities include trampling, and grazing on intertidal vegetation. Physical disturbance caused by stock grazing in the **Yatala Harbour to Mambray Creek** area, has also been listed as a perceived threat to habitat in the area (Bryars, 2003).

- **Winninowie Conservation Park:** There are rubbish dumps located near the north-west coastal edge of the Promontory and at the coastal settlement of **Miranda**; however as at 2000 there were current plans to rehabilitate the sites (DEH, 2000a). Physical disturbance caused by illegal rubbish dumping has also been listed as a perceived threat to saltmarsh habitat in the **Point Paterson to Redcliff Point** area (Bryars, 2003).
- Predation upon coastal birds by feral cats and foxes, and rabbit grazing in intertidal and supratidal areas have been reported (Morelli and de Jong, 1995).
- Samphire flats in some areas have been used for racing tracks, and rubbish dumping in some areas of samphire, has also been reported (Morelli and de Jong, 1995). Physical disturbance caused by off-road vehicle use has been listed as a potential threat to tidal flat habitats in the area between **Point Lowly** and **Port Augusta**, and to saltmarsh habitat between **Douglas Point** and **Blanche Harbour** and in **Far Northern Spencer Gulf** (bounded by Curlew Point, Yorkey Crossing and Snapper Point) (Bryars, 2003).
- Altered patterns of water movement and sediment movement caused by (i) a powerline causeway at **Curlew Point**, (ii) a causeway at **Point Paterson**, and (iii) the location of the ash pond at the Port Augusta Power Station, have been listed as potential threats to saltmarsh habitat in **Far northern Spencer Gulf** (bounded by Curlew Point, Yorkie Crossing and Snapper Point) (Bryars, 2003).
- A renewed concern about dredging impacts during coastal development has recently been expressed by the community (e.g. ABC Media report, June 2001).
- Altered patterns of water and sediment movement caused by the location of a weir across upper **Port Pirie River** (Bryars, 2003).
- A species of the tropical pearl oyster *Pinctada* has established in the area and is now considered to be abundant in **upper Spencer Gulf** (S. shepherd, pers. comm., 2004).

Historic Impacts

- Between 1911-1914, a company mined seagrass, *Posidonia australis*, in Northern Spencer Gulf. One extraction site was located in the intertidal zone south of **Redcliff Point** (DEH, 2000a).
- In the 1920's, B.H.A.S. smelters extracted large quantities of shellgrit from coastal dunes in the region, for smelter operations in **Port Pirie**. For example, shellgrit was probably taken from dunes within what is now the **Winninowie Conservation Park** (DEH, 2000a).
- A number of environmentally damaging exploration activities occurred during the 1970s and 1980s at **Redcliff Point** and surrounds, which is now part of the **Winninowie Conservation Park**. Bore holes, borrow pits, test dams and vehicle tracks are still evident in the area, however there is a current plan to rehabilitate these areas (DEH, 2000a).
- The **Port Pirie Uranium Treatment** complex operated between 1955 - 1962, and primarily processed ore from the Radium Hill uranium mine, and stockpiled ore from the Myponga (Wild Dog Hill) uranium mine. Apart from the tailings produced by this process, additional tailings material also came from the processing of rare earth minerals. An area of about 30 acres is covered by tailings, on the tidal flats of northern Spencer Gulf. Over the years, a number of management issues have arisen from the storage of these tailings. Previously, the height of the tailings wall was reported to be insufficient, and failed during the high tides of 1981. The area has now been fenced off and the tailings wall height increased to protect against further high tide events, however there is community concern that the situation at Port Pirie highlights the need for better tailings management.

Notes on Impact Management in Upper Spencer Gulf

The Northern Spencer Gulf Resource Processing Strategy (see Harbison, 1993, and Dainis, 1994) recommended a number of steps to control some of the major impacts in northern Spencer Gulf. Since that time, various environmental improvement programs by industry, government and community have started to address some of these issues. The recommended steps were as follows:

- There should be no further alienation of mangroves or samphire habitats, and any localised removals should be replaced.
- Further dredging of shipping channels or turning basins in seagrass meadows should be avoided, and if necessary, should be undertaken in a manner that minimises the risks of metal mobilisation, and does not cause direct damage to seagrass beds, or indirect damage through siltation.
- Dredging in the contaminated sediments of the Port Pirie shipping channel should be avoided, because metals would continue to be re-mobilised.
- Shipping transport should be avoided above Point Lowly. Port facilities should not be developed adjacent to critical samphire, mangrove, or seagrass habitats.
- Additional marine discharges in northern Spencer Gulf should be avoided or minimal. In particular, there should be no marine discharges in low energy, sedimentary environments (i.e. tidal flats), or in areas adjacent to (or up-drift from) mangrove, samphire, or seagrass communities. All runoff from developments should be treated so that it meets acceptable water quality standards prior to being released into northern Spencer Gulf, and land-based disposal should be investigated where possible.
- No developments (or extensions to existing developments) should be permitted above Lowly Point, where such developments require marine discharges of biological oxygen demand, suspended solids, nutrients, thermal effluent, metals or other toxicants. No additional discharges should be allowed to occur in the Whyalla and Port Pirie areas.
- Existing discharges should be reduced, particularly from BHP and Pasminco smelter, and from the Port Augusta, Port Pirie and Whyalla sewage outfalls, via Environmental Improvement Programs, to meet MEPC guidelines by 2000.
- Discharge of ballast water should not be permitted in the northern Spencer Gulf. During the 1990s, only Port Bonython had facility for bringing ballast ashore, and this was restricted to oil-contaminated ballast.
- Excessive use of agricultural fertilisers should be controlled (*Note that this pertains mainly to Port Broughton area, south of the region discussed in this table*).
- Expansion of shack developments in unserviced areas should be avoided.

Since these recommendations were made during the early 1990s (see Harbison, 1993, and Dainis, 1994), a number of remedial measures have been undertaken, as discussed below. However, work to date in controlling further impacts, and restoring areas that have been subjected to long term pollution, has fallen well short of recommendations. Some of the recent measures to control impacts in northern Spencer Gulf are discussed below:

- In 2001, members of the EPA visited **Port Augusta** and **Whyalla** to better inform themselves of the environmental issues faced by those communities. The EPA members inspected environmental improvements at the Northern and Playford power station, and inspected the **Port Augusta East** sewage effluent outfall maintained by SA Water (EPA, 2001b). In 2001, the EPA met with the **Whyalla** City Council senior management team, **Port Augusta** Council, industry representatives and members of various environment and community groups. Issues that were raised included:
 - ♦ coal and fly ash dust, stack emissions, licensing requirements and discharges to the marine environment from the power station;
 - ♦ options for SA Water effluent reuse in preference to disposal;
 - ♦ provision for waste oil re-use (e.g. on land tracks);
 - ♦ transport of uranium and waste products in northern Spencer Gulf;
 - ♦ waste depot licensing requirements and fee structure; and
 - ♦ "marine habitat" issues (e.g. shacks, foreshore development, mangroves, aquaculture).
- Between 2002 and 2003, Environment Protection Authority conducted an audit of all industry in the **Northern Spencer Gulf** region. The audit by the EPA aimed to identify any problems associated with industrial pollution in the towns of **Whyalla**, **Port Augusta** and **Port Pirie**, and to ensure that licence

conditions are both achievable by industry and acceptable for communities. The audit included extensive on-site inspections of industries, examination of existing licence conditions, and monitoring to determine where the impacts of pollution are occurring. Industrial engineers, marine specialists and air quality investigators were involved with the audit. Some of the sites included in the audit were OneSteel at **Whyalla**, the Santos Hydrocarbon Processing Facility at **Port Bonython**, the Flinders Power Station at **Port Augusta** and the Pasminco operation at **Port Pirie** (Media release, September, 2002).

- At **Port Pirie**, a monitoring program has been undertaken by an environmental consultancy firm (Delta Environmental), to detect ecological changes in saltmarsh creeks resulting from capital improvements to the Port Pirie Wastewater Treatment Plant. In 2001, funding was approved to upgrade the sewage treatment facility, so that leaking clay pipes could be replaced, and treated water could be re-used (Media report, July 2001). Another part of the Plant upgrade during the early 2000s involved the installation of a Sequencing Batch Reactor system, to reduce concentrations and load of nitrogen in the treated wastewater, and to improve dissolved oxygen levels in the tidal creek that receives the sewage treatment effluent (Media release, December, 2002; Media report; April 2003). Other sewage treatment developments in the **Port Pirie** area include the construction of a sanitary effluent treatment plant (SET), to process grey water and sewage prior to creek discharge (Pasminco, 2002).
- There is an environmental improvement program for the smelter at **Port Pirie**, and the plant has reduced the discharges of some pollutants since the 1980s. Some of the improvements during the 1990s have included the identification and ranking of direct and fugitive emissions, and development of an Action Plan; completion of a water management plan; ongoing work to recover sulphur dioxide at the plant; and ongoing work to improve the management of by-products and wastes, including development of disposal strategies for arsenic, and calcium arsenate (Pasminco, 2000). More recent developments have included the construction of a Process Effluent Treatment System (PETS) to reduce the level of heavy metals in discharge water from the smelter. Since early 2002, the PETS system has reportedly resulted in a 60% decrease in lead and zinc concentrations in discharge water; and reduction in levels of selenium, manganese and copper by 90%, 75% and 30%, respectively (Pasminco, 2002). Fugitive emissions from the blast furnace have also been reduced through an on-going emission reduction program (Pasminco, 2002).
- A number of environmental improvements were undertaken during the 1990s at the OneSteel Plant in **Whyalla**, one of which was the creation of a reed bed, to clean a waste effluent stream. Water, which is considered to be a scarce resource in the **Whyalla** area, is used at the steelworks for cooling, cleaning, lubricating, and numerous other purposes. OneSteel has been involved with measures to reduce water consumption, and to treat waste effluent more effectively before it is discharged. Studies over a number of years have identified the effluent from OneSteel's coke ovens as a significant source of organic matter and ammonia. OneSteel has attempted to reduce the levels of organic pollutants (e.g. phenols) and ammonia from its waste water prior to discharge into the gulf, and the use of reed beds is part of that attempt. In soil-based reed bed systems, the effluent to be treated percolates through the biologically active soil and roots of a large bed of reeds, and then drains through a pipe at the base of the bed. The function of the reeds is to pump oxygen into the soil through the roots. Near the roots, there is an aerobic zone and further away, there is an anaerobic zone. Thus, within the soil, a range of processes exist that allow the transformation of environmental contaminant in waste water. Five Australian native reed varieties have been used at the Whyalla reed bed to filter the coke oven waste. After the initial trials, a larger scale (2 hectare) system was constructed during the late 1990s. This involved the adaptation of the plants and biota within the system to pollutants in the wastewater. Ongoing work is occurring to increase the effluent load removed by the reed beds. Currently, in excess of 70% of the ammonia is removed from the treated coke ovens effluent, with 90% or more of other organic and inorganic materials also being removed. The treatment process also allows future recovery of a valuable resource of fresh water for recycling on the plant, and also reduces the impact of wind-blown dust in the area (Environment Australia, 2001c).
- The environmental improvement program of the OneSteel plant at **Whyalla** is also addressing some of the other major issues in addition to coke oven effluent. Examples include separation of process flows and removal of solids and metals using a thickener (Lewis *et al.*, 1998), and dust suppression measures for the fugitive dust (EPA, 2001b). Dust suppression measures at the Pellet Plant include installation of dust collecting systems (for the Screening Plants) and bag houses; covering the unloading point of iron ore from rail wagons into the storage bin at the Pellet Plant; ongoing landscaping of the Steelworks' open areas; coating of raw material stockpiles with recycled paper; regular watering-down of the Steelworks' roads and stockpiles; installation of shade cloth enclosures; and landscaping of around 40,000 m² of

open area stockpiles at the Pellet Plant (OneSteel Media Release, 2001). A waste gas cleaning plant was installed on the Pellet Plant's exit gas stack in November 1998, and this has helped to reduce the emission of dioxins from the plant (Extract from Hansard, Legislative Council, 24th July, 2001).

- The Environment Protection Authority will regulate dust emissions from the Onesteel site at **Whyalla**, by imposing a condition of licence, stipulating that dust measured at a monitoring station in the Walls Street council car park should not exceed the national standard. The National Environment Protection Council's national standard is 50 micrograms PM10 per cubic metre (measured over 24 hours), and not to be exceeded by more than five times a year. Onesteel agreed to submit a report to the EPA in late 2003, outlining how it will manage its operations to ensure that the national standard is achieved at the Walls Street monitoring site by 2008. The EPA may impose additional conditions of licence that require an incremental reduction in dust measured at the Walls Street site, through performance-based improvements at the steelworks. The EPA expects that as a result of Onesteel ultimately achieving the national standard, the amenity of the affected area will also improve (EPA Media Release, 2003).
- Around 78% of the effluent from the **Port Augusta West** sewage treatment plant was re-used in 2001-2002, however none of the effluent from the plants at **Port Augusta East, Whyalla** or **Port Pirie** was re-used, although there are plans to recycle cleaned effluent from the **Whyalla** plant (SA Water, 2002).
- According to Aquaculture Group - PISA Fisheries (1996), the Northern Spencer Gulf Aquaculture Enterprises have been involved with an environmental monitoring program in the **Fitzgerald Bay** area.
- A consultancy firm (Marine Science & Ecology Pty. Ltd) has undertaken marine baseline and monitoring for SANTOS Ltd at **Port Bonython**, including detailed benthic and intertidal surveys of effects of ballast water discharge, and baseline studies in case of oil spills.
- Recycling of various waste products occurs in a number of areas. For example, waste lubricating oil is used as a binding agent for the **Port Augusta** Racing Club race track (EPA, 2001b).
- NRG Flinders is reportedly planning to increase control measures to prevent fly ash from the Playford Power Station at **Port Augusta** becoming airborne (Jenkin, 2003).

9.2.11.11 South-Eastern Spencer Gulf (Spencer Gulf Bioregion)

Coastal Issues

- In parts of the area described in this table, potential threats include the following (from Bryars, 2003):
 - ♦ Increased nutrient levels caused by septic tank overflows in the **Moonta Bay, Port Hughes, Cape Elizabeth, Balgowan, Chinaman Wells and Port Victoria** areas; **Port Rickaby, Parsons Beach**, and the **Point Turton, Burners Beach and Corny Point** areas (Bryars, 2003).
 - ♦ Potential transfer of exotic pest species further south into mid-eastern Spencer Gulf, from vessels docking at Wallaroo; and
 - ♦ Possibility of hydrocarbon and petro-chemical spills, from shipping transport to (and operations in) northern Spencer Gulf.
- Pollutants from mine dumps in the **Moonta** area may affect groundwater quality.
- Red tides of microalgae have been recorded in the **Port Victoria** and **Hardwicke Bay** area. Satellite imagery data has shown that there are also high chlorophyll-a levels in the **Chinaman's Well** and **Port Victoria** areas. There is some concern that the relatively slow current speeds in much of **Hardwicke Bay**, in addition to septic tank overflow from coastal settlements, may further promote the development of harmful algal blooms, particularly in nearshore waters.
- There is potential for erosion of the foreshore around areas developed with shacks. There are numerous shacks / holiday houses situated close to the beach on the **mid-eastern and south-eastern side of Spencer Gulf**.
- **Wardang Island:** According to Australian Heritage Commission (undated), unrestricted access may result in outstanding Pliocene fossil sequences (e.g. *Cerithium potamides*) being subject to denudation by indiscriminate collecting, from tourists visiting the island.

- **Balgowan Sand Dunes:** Previously reported issues include off-road vehicles, rabbits, and sheep causing damage to small and young coastal plants (Australian Heritage Commission, undated).
- The degradation of mangrove and samphire vegetation is reported to be a problem in the **Balgowan** area, and prompted the Balgowan Progress Association to undertake a Coastcare project in 2000, involving the construction of a boardwalk and defined beach access area.
- There has been an issue with destabilisation of sand dunes in the **Port Rickaby** area due to poorly defined beach access, and a recent Coastcare project was undertaken by the Port Rickaby Progress Association to define and stabilise sand dune pathways and revegetate the dune area.
- According to Hamill and Associates (2002) residents and community groups in the **Port Rickaby** area consider “the preservation of the ecology and environment” as very important considerations in any future development plans. Current environmental issues relate to the preservation of the foreshore and sand dunes, and also effluent disposal. Currently there is no common effluent / grey water disposal system in Port Rickaby, and there are environmental issues associated with the close proximity of some facilities to the sea, resulting in effluent near the foreshore. Also, it is reported that the community wants to preserve the current character of the township, rather than having the town become a major tourism destination (Hamill and Associates, 2002).
- Previously, use of trail bikes and dune buggies in the sand dunes of the **Hardwicke Bay** area has been of concern (District Council of Yorke Peninsula, 2002, citing a report from 1982).
- Sheep grazing of the samphire flats at **Peeseey Swamp**, adjacent to Hardwicke Bay, has previously been listed as a threat, and the vegetation fringing the swamp has generally been either cleared or grazed out (Australian Heritage Commission, undated).

Fishing Issues

The status of (and potential risks to) populations of the following species are discussed further in Section 9.2:

- *Abalone:* Shepherd and Rodda (2001) recorded a statistically significant 12 year decline (1987 to 1998) in the yield of Greenlip Abalone from the **Hardwicke Bay** area (Map Codes 22A and 24A), reporting an 87% decrease in yield over that period.
- *King George Whiting, Snapper and Garfish* are caught in the mid-eastern and south-eastern Spencer Gulf area, by both commercial and recreational fishers. All three species are classified as *fully fished* in South Australia (DEHAA and EPA, 1998). South-eastern Spencer Gulf contains a significant commercial and recreational fishery for larger, older King George Whiting that have moved out of the bays further north and closer to shore (see sections above on commercial and recreational fishing). South-eastern Spencer Gulf is also one of several major commercial fishing areas in the State for *Snapper*, and many sites in the area are also popular for recreational fishers. A recent recreational fishing guide reported that undersized Snapper caught by boat fishers in the Hardwicke Bay area are usually dead when returned to water. Larger, older King George Whiting and *Snapper* may be important contributors to spawning potential, and larger individuals of both species are targeted in a number of locations. The Snapper stocks in South Australia are characterised by irregular large recruitments, which later sustain the fishery for a number of years when the fish recruit to the fishery. The irregular “good” recruitments of Snapper; the long-lived nature of the fish; and the aggregative nature of large Snapper at a number of sites in Spencer Gulf, requires that the fishery for this species be cautiously managed over the long term. There are two known spawning locations for King George Whiting in the region (see Fowler and McGarvey, 1997). In recent years, south-eastern Spencer Gulf has been one of several major locations for commercial fishing of King George Whiting, in terms of annual yields. In recent years, there has been concern (e.g. see SA Country Hour media release, 2001) about a possible decrease in the King George Whiting population in Spencer Gulf. Concern has been expressed (e.g. see McGarvey *et al.*, 2000, and references therein) about need to protect the spawning stock of larger whiting, that are fished commercially and recreationally in the areas where they occur. Concern was also expressed about the total catch (which is unquantified, and largely unregulated, to date) from charter boats, particularly the catch of larger King George Whiting that contribute to the spawning stock. McGarvey *et al.* (2000) recommended additional regulatory measures to protect the spawning stock of King George Whiting. Smaller King George Whiting and Snapper are also taken by recreational fishers, and are also caught in the bycatch from prawn trawling. Ye (1999) reported that *Garfish* is a fully exploited species in S.A.. Although commercial catch rates have generally been stable since the 1980s, the Garfish stock in S.A. is considered to be fully exploited, according to available biological performance indicators (BPIs). Garfish now mature at a smaller size than was observed 40 years ago, believed to be a response to heavy fishing levels (Ye, 1999; Southern Fisheries, 2001). Catch rates are not considered to be a sensitive indicator of stock abundance for schooling species such as

Garfish. Notes on the current reported status of King George Whiting, Snapper and Garfish, and potential risks to populations of these species, are discussed in section 9.2.

- Potential vulnerability of other site-attached reef-associated species to population declines, due to fishing activity, including line fishing and spear fishing. Species include Boarfish, Magpie Perch, Dusky Morwong, adult Snapper, Moonlighter, Western Talma, Western Blue Devil, various wrasse species, and Sweep, amongst others. Sea Sweep and Banded Sweep are strongly site-associated (territorial), and therefore vulnerable to localised depletion (e.g. see Rohan *et al.*, 1991). The potential threats to these site-associated reef fish species are discussed in section 9.2.
- Concerns have been expressed (e.g. Bellchambers, 1999) about the possible effect of spear fishing (particularly by indigenous fishers) on reef fish diversity, and abundance of Dusky Morwong, in the **Port Victoria – Rifle Butts Beach** area. Spear fishing along other parts of the coast also (e.g. **Port Rickaby**) has been suggested by divers as a reason for observed low abundance of fish.
- *Yellow-fin Whiting*: Although mid-eastern and south-eastern Spencer Gulf are not the major fishing areas for this species (see section on **Commercial Fishing** for this focus area), cautious management of fishing yellow-fin whiting is required, due to a number of vulnerable characteristics of this species (discussed in section 9.2)
- *School Shark and Gummy Shark*: The species have been fished commercially in the area, but mid-eastern and south-eastern Spencer Gulf are not major fishing areas for School Shark and Gummy Shark, on a State-wide scale. School Shark (Australasian subpopulation) was listed in the IUCN Red List 2003 as *Conservation Dependent*, and previously, Gummy Shark was included in the IUCN Red List 2000 and Red List 2002 as *Conservation Dependent*. The Commonwealth has recently re-regulated the fishery for School and Gummy Shark, in light of the over-fished status of School Shark populations in southern Australia since the early 1990s (see AFFA, 2000b; AFMA, 1999b; AFMA, 2003) and the fully-fished status of Gummy Sharks (AFMA, 2000d). The status of (and potential risks to) School Shark and Gummy Shark populations are discussed further in section 9.2.
- *Whiskery Shark*: Caught commercially in small numbers, in deeper waters of south-eastern Spencer Gulf. No information on trawl bycatch of this species is available. The extent of recreational fishing for this species is not also known for this report. The species was classified as *Lower Risk (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 *Squalus acanthias*. A deeper water species, *S. megalops* (Hutchins and Swainston 2001), has also been recorded in Spencer Gulf (see Carrick, 1997). The status of dogfish species is provided in section 9.2, and an overview of the conservation issues relating to fishing these species in southern Australian waters is provided by Baker (in press).
- *Bronze Whaler and Black Whaler Sharks*: Caught commercially in south-eastern Spencer Gulf waters and also by recreational fishers, however the extent of recreational fishing in the area is not known for this report. These species may be considered potentially vulnerable, due to relatively slow growth, delayed maturity, viviparous (live bearing) reproduction, and low fecundity (see section 9.2). Both adults and young are caught as part of the fishery in S.A.. The extent of the nursery areas is not well known, and overall there is reportedly little information on the status of both adults and juveniles (Froese and Pauly, 2003). Bronze Whaler and Black Whaler were both included in the IUCN Red List 2003 as *near threatened* species. Section 9.2 discusses the vulnerability of these species to over-exploitation, due to their life history characteristics.
- *Ray, Stingray and Stingaree* species: Various “ray” species and related taxa are known to occur in Spencer Gulf (e.g. Southern Eagle Ray; Shovelnose Ray, Southern Fiddler Ray; Short-Tail Torpedo Ray; Black Stingray; Smooth Stingray; Sparsely-Spotted Stingaree and other Stingaree species, White-Spotted Skate, and others). Many ray, stingray and stingaree species in southern Australian waters may be of future conservation concern due to poor knowledge of population sizes, and few or no regulations on their capture in Commonwealth commercial fisheries and State commercial and recreational fisheries. A number of these species are marketed as “ray flaps” in southern Australia. In South Australia, no recreational bag limits have been set for ray, stingray and stingaree species, and these species are not included in regular stock assessments, hence population status is largely unknown for many of these species in South Australia. There is some unconfirmed evidence from fishers, of relatively high numbers of benthic rays being taken by recreational fishers in the more accessible coastal waters in parts of South Australia. Rays are also caught as bycatch in prawn trawlers and commercial fishing nets in S.A.

Aquaculture

- According to S.A. Coast and Marine Atlas (2003), there are 5 intertidal oyster leases in the **Port Victoria / Point Pearce / Wardang Island** area. During the early 2000s, there was interest expressed in expanding aquaculture operations in the area, which resulted in technical assessments of the suitability of sites in the area to support increased shellfish production, as well as finfish in deeper waters (10m – 15m). The potential impacts associated with both shellfish and finfish aquaculture are described in section **9.2**.
- An application for an onshore abalone farm at Island Point on the Point Pearce Peninsula has been approved (Aquaculture Group - PISA Fisheries, 1996; Edyvane, 1999b; S.A. Coast and Marine Atlas, 2001). Such a facility requires an inflow and a discharge pipe into the waters adjacent to the site. The environmental impacts of onshore abalone farming in general are described in section **9.2**.
- During the early 2000s, assessments were also being undertaken to investigate the aquaculture potential of the area **west of Wallaroo** and **north-west of Bird Island**, for both finfish and subtidal shellfish culture. At the time, there were also investigations of the aquaculture potential of the area north of Port Victoria (i.e. off **Balgowan**, to a maximum of 8km seaward into the gulf), and south-east of **Wardang Island**. Also, although **Hardwicke Bay** and **Corny Point** were previously excluded from consideration for aquaculture development (see Aquaculture Group - PISA Fisheries, 1996), technical investigations and site surveys were undertaken during the early 2000s, to investigate the potential of these areas to support both finfish and shellfish aquaculture, including intertidal shellfish culture east of **Corny Point**, and caged finfish (e.g. Yellow-tail Kingfish) in deeper waters of **Harwicke Bay**. The potential impacts of finfish and shellfish culture are discussed in section **9.2**.

Prawn Trawling

- Prawn trawling in the area does not occur in waters less than 10m.
- Although the bycatch ratio in the Spencer Gulf prawn fishery is low (Carrick, 1997; Svane *et al.*, 2000), compared with widely reported high bycatch ratios from tropical waters, the fishery is reported to discard 1000 tonnes of bycatch per year (Svane and Hall, 2000). The effects of prawn trawling on the trophic linkages and food web dynamics of bycatch species; effects on re-suspension and nutrient regeneration, and effects on benthic and pelagic assemblages, have recently been investigated in the Spencer Gulf prawn fishery (see Svane *et al.*, 2000).
- A number of modifications to trawl gear and fishing practices have been made during the past decade, and exclusion devices have been fitted to trawl gear, to reduce the amount of bycatch such as blue crabs, sponges, and sharks and rays in the Spencer Gulf prawn fishery, and to increase the survival of caught and discarded species.
- Information about the impacts of prawn trawling in general are outlined in section **9.2**. During 1991-1996, various studies by Carrick (1997) showed the following results from trawl tows in southern Spencer Gulf:
- Species richness of the bycatch was greater in shallow water than deeper water, and also greater in the southern trawl grounds than the north;
- Fish, sharks and rays dominated the biomass of the total catch from the southern grounds, from South Gutter to Corny Point (i.e. 88% of the catch by weight), due to the heavy weights of large species such as Eagle Rays and stingrays;
- Compared with the northern grounds, the catch of whiting in the southern grounds was low during the sampling period. Whiting caught in prawn trawls are generally smaller than those taken by commercial fishers, and in the southern sampling grounds (from the Southern Gutter to Corny Point area), sand whiting (*Sillago bassensis*) dominated the whiting catch, and had a modal size of around 17cm. The overall catch rate from the Corny Point area was estimated to be around 3.8 whiting per hour during the peak abundance period (May 1992 sampling);
- The biomass of Blue Swimmer Crabs caught in the southern grounds was low compared with the grounds further north;

A number of the results for the entire sampling area also apply to the Southern Grounds. The studies by Carrick (1997) showed the following results for Spencer Gulf in general, including all sampling stations in the northern, middle and southern grounds (direct quotes are in italics). The discussion refers to results from sampling a total of 32 trawl stations in 1996, including northern, middle and southern Spencer Gulf trawl grounds, as well as Carrick's previous studies on whiting, Snapper, flounder and flathead bycatch, during 1991-1992):

- ♦ Significant numbers of some species are caught, most of which are not considered commercially valuable;

- ◆ Around 94 species of fish, shark and ray were caught from 32 trawl tows during the survey period;
- ◆ 15 fish species from 10 families dominated (97%) of the bycatch, such as Sand Trevally (average 38% of catch, or 9008 fish) and Degen's Leatherjacket (average 32%, or 4845 fish), stinkfish species, Southern Silverbelly, southern School Whiting, spiky gurnard, soldier fish, red "mullet", southern Sand Flathead, and slender bullseye;
- ◆ Other numerically dominant species in the bycatch included blue crab, bridled leatherjacket, rough leatherjacket, hardback prawn, Southern Calamari, and toothbrush leatherjacket.
- ◆ Sixteen species of shark, ray and skate were caught from the 32 trawl tows during the 1996 sampling period, including 43 Port Jackson Sharks; 30 Eagle Rays; 25 Black Stingrays; 19 Southern Fiddler Rays, 14 Wide Stingarees, and 11 Dixon's stingarees, amongst other elasmobranchs.
- ◆ Crustaceans (i.e. mainly prawns and Blue Swimmer Crabs) dominated the biomass of the catch in the northern and central trawl stations, but not in the south, where catches of eagle rays and stingrays accounted for a larger proportion of the biomass compared with other areas sampled;
- ◆ Carrick (1997) reported that a "*large significant impact of trawling on small-toothed flounder (a sandy mud/muddy sand habit fish species) was detected, with the fleet having the capacity to reduce local populations by at least 60% over 14 days of intensive fishing*". Carrick (1997) also reported that "*generally, regions more intensively fished had fewer large individuals (of flounder) than areas not fished, and densities of flounder were significantly lower*";
- ◆ Capture of leatherjackets "*was sometimes so high that the efficiency of prawn trawling was substantially affected*";
- ◆ Smaller Snapper, King George Whiting and sand whiting were "*sometimes caught in large quantities by prawn trawls*", although "*there was substantial spatial and inter-annual variation in catches*", and "*there is little evidence that the Spencer Gulf prawn fishery is affecting commercial fisheries for Snapper or whiting*" (Carrick, 1997);
- ◆ "*Whiting numbers were found to decrease with depth, and whiting were most abundant on hard, shallow bottom, in closed areas, or on grounds that received infrequent trawling*" (Carrick, 1997).
- ◆ Tank studies showed that although 83% of Snapper survived trawl tows that ranged from 20 – 40 minutes, only 50% of those fish survived more than 2 hours in holding tanks;
- ◆ Blue Swimmer Crabs and sponges formed a substantial component of the prawn bycatch in some areas. Occasional "*large catches of sponges*" in prawn nets "*suggest that prawn trawls may be modifying the topographic complexity of the sea floor*" (Carrick, 1997). Survival of trawl-captured Blue Swimmer Crabs was consistently high (more than 99%), however 12 – 34% of trawl-caught crabs were damaged (missing claw or leg), which appeared not to affect survival rate during trials in holding tanks. (Note that the number of crabs caught as bycatch has now decreased due to fishery improvements, for example changes to the cod end configuration of prawn nets, which reduces capture of Blue Swimmer Crabs, and use of "crab racks" on the sorting table – see PIRSA, 2003d).
- ◆ "*There is evidence from other studies, and from the species richness of the bycatch in the Spencer Gulf fishery, that the diversity and abundance of fish are greater on topographically complex habitats than on open sand*";

Other Information

- **Wardang Island:** In 1910 the Broken Hill Associated Smelters Ltd took out a lease to enable them to ship away lime sand from Wardang Island as a flux in the smelting operations at Port Pirie. Over a million tonnes of sand were removed between 1910 and 1968. When a more suitable deposit was located at Coffin Bay they shifted their operations to that area (District Council of Yorke Peninsula, 2002).
- **Wardang Island** has been described as "the most degraded of the larger South Australian offshore islands" (Robinson *et al.*, 1996).

9.2.11.12 Western Investigator Strait (including "Toe" of Yorke Peninsula and Northern Kangaroo Island) (Eyre/Gulf St Vincent Bioregions Boundary)

There is a comparatively low level of threat from land-based pollution in this area, due to undeveloped nature

of the coastline.

Coastal Issues

- Four wheel driving occurs on the **Formby Bay** dunes, which may be a concern in terms of dune destabilisation.
- Rubbish is dumped in some areas. For example, a recent clean up by members of the Wanderers four-wheel drive club collected 1000kg of rubbish from the **Gleeson's Landing – Formby Bay** area, including cans, bottles, broken glass, plastics, paper, car parts, other metal, car and truck tyres, and cigarette butts.
- Increased level of nutrients caused by septic tank overflows at **Marion Bay**, is listed as a potential threat to seagrass habitat in the area (Bryars, 2003).

Fishing Issues

Section 9.2 discusses the reported status of, and potential risks to populations of, the following species that are caught in the area:

- *Abalone*: Shepherd and Rodda (2001) recorded a decline (between 1988 and 1998) in the yields of Greenlip Abalone from the south-west Yorke area (Map Code 23), reporting a 48% decrease in yield over that period. Abalone fishing is also popular with some recreational divers in the south-western Yorke Peninsula region. Illegal catch levels are not known for this report, but likely to occur in the area.
- There is potential vulnerability of *reef-associated fish species* to population declines due to fishing activity, including line fishing and spear-fishing. Recreational fishing for a variety of reef fish species occurs in **Investigator Strait** and **North-western Kangaroo Island**, around the **Althorpe Islands**, and along **south-western Yorke Peninsula**, including the **Innes National Park** area and nearshore islands. For example: *Blue-Throated Wrasse* and other wrasse species are caught commercially and recreationally in the region, and, in the past, were targeted by spear-fishers in spear-fishing competitions held during the 1980's at Gleasons Landing (e.g. see Johnson, 1985a). Sub-adult Blue-Throated Wrasse readily take the bait of rock fishers in the **Innes** area, and are regarded as a nuisance species, hence fishers often do not return the wrasse to the water but retain them for bait (Shepherd and Brook, 2002). Surveys of Blue-throated Wrasse (see Shepherd and Brook, 2002) indicate that the mean size of adult Blue-Throated Wrasse is reduced where fishing intensity is high due to the capture of large individuals, whereas large females and males are abundant where there is little or no fishing. Fishing pressure is considered to be intense on south-western Yorke Peninsula (Shepherd and Brook, 2002).
- *Western Blue Groper* are also caught by recreational fishers and charter boats off south-western Yorke Peninsula, and by commercial fishers in deeper waters. Shepherd and Brook (2002) reported much anecdotal information from fishers that Groper down to a size of 10 cm readily take specific baits and that they are taken from time to time by boat fishers, shore fishers and spear-fishers. Juvenile and sub-adult groper (which are a brownish-green colour) are not likely to be recognised as groper by many rock fishers in the area (Shepherd and Brook, 2002), and therefore not returned live to the water. Juvenile and sub-adult groper are also likely to be retained as bait, similar to sub-adults of the Blue-throated Wrasse. Charter boat promotion materials list large Blue Groper as one of the species caught on trips out from the south-western Yorke Peninsula area (however, it is noted that all of Investigator Strait is closed to fishing groper, under the *Fisheries Act 1982*). Large Blue Groper were previously more common in the area (e.g. observed during the 1960s and early 1980s – see evidence cited by Shepherd and Brook, 2002), but abundance has since declined, and fishing pressure is likely to be a primary cause (see Shepherd and Brook, 2002).
- *Harlequin Fish* are present on reefs in the area, and are known to be caught by recreational fishers (e.g. charter boat visits to **Althorpe Islands**). Examples of other reef fish species of conservation concern in the area include *Western Blue Devil*, *Boarfish*, and *Dusky Morwong* (see Section 9.2).
- *Snapper* are caught in the waters off **South-Western Yorke Peninsula, Investigator Strait, North-western Kangaroo Island** and the **Althorpe Islands** area, and the species is classified as *fully fished* in South Australia (DEHAA and EPA, 1998).
- Other species caught in the area that are classified as *fully fished* in South Australia include *King George Whiting* and *Garfish* (DEHAA and EPA, 1998) (see Section 9.2 for information on current population status). Concern has been expressed (e.g. see McGarvey *et al.*, 2000, and references therein) about need to protect the spawning stock of larger whiting, that are fished commercially and recreationally in the areas where they occur. Concern was also expressed about the total catch (which is unquantified, and largely unregulated) from charter boats out from southern Yorke Peninsula, particularly the catch of larger King George Whiting that contribute to the spawning stock. McGarvey *et al.* (2000) recommended

additional regulatory measures to protect the spawning stock of King George Whiting.

- *Ocean Leatherjacket*: In 1998, this species was classified as “fully fished” in South Australia (DEHAA and EPA, 1998).
- *School Shark and Gummy Shark*: The region described in this table has traditionally been one of a number of significant fishing areas in S.A. waters for school and Gummy Shark. School Shark (Australasian subpopulation) was listed in the IUCN Red List 2003 as *Conservation Dependent*, and previously, Gummy Shark was included in the IUCN Red List 2000 and Red List 2002 as *Conservation Dependent*. The Commonwealth has recently re-regulated the fishery for School and Gummy Shark, in light of the *over-fished* status of School Shark populations in southern Australia since the early 1990s (see AFFA, 2000b; AFMA, 1999b; AFMA, 2003) and the *fully-fished* status of Gummy Sharks (AFMA, 2000d). According to AFMA (2002a), there is increasing uncertainty about the size and sustainability of the School Shark population (fished under Commonwealth management). The latest agreed assessment for the School Shark population in the fishery reportedly shows “*extremely low numbers*”. In the 2001 assessment, productivity was estimated to be so low that under some scenarios, the agreed rebuilding of School Shark stocks to the 1996 level (by 2011) would be impossible under any level of Total Allowable Catch (TAC). If productivity is actually as low as the model currently predicts and it remains so, AFMA (2002a) considered that an unacceptably long time frame of 15 years would be required to rebuild the stock. At the 44th meeting of the Southern Shark Fishery Management Advisory Committee (SharkMAC), the committee recognised that the current ambiguities of the School Shark assessment will continue for at least 3-4 years until a time series of fixed station survey data is accumulated. The status of (and potential risks to) School Shark and Gummy Shark populations are discussed further in Section 9.2.
- *Whiskery Shark* are caught in **Southern Yorke / Investigator Strait / North-western Kangaroo Island** waters. The species was classified as *Lower Risk (Conservation Dependent)* in the IUCN Red List 2000 and 2002, but not included in the 2003 IUCN Red List (see Section 9.2 for information on population status).
- *Bronze Whaler*: Caught commercially in the **Southern Yorke / Investigator Strait / North-western Kangaroo Island** area, and also fished recreationally, however the extent of recreational fishing in the area is not known for this report. These species may be considered potentially vulnerable, due to relatively slow growth, delayed maturity, viviparous (live bearing) reproduction, and low fecundity (see section 9.2). Both adults and young are caught as part of the fishery in S.A.. The extent of the nursery areas is not well known, and overall there is reportedly little information on the status of both adults and juveniles (Froese and Pauly, 2003). Bronze Whaler and Black Whaler were both included in the IUCN Red List 2003 as *near threatened* species. Section 9.2 discusses the vulnerability of these species to over-exploitation, due to their life history characteristics.
- *Rock Lobster*: The current status of, and potential risks to, Northern Zone Rock Lobster populations are discussed in Section 9.2. In 2001, low levels of egg production, pre-recruit abundance, and adult biomass were estimated to currently exist in the Northern Zone (a very large fishing area covering waters from the WA border, through to Encounter Bay, and deeper waters south of Kangaroo Island), and reductions in fishable biomass were predicted to occur in the Northern Zone over the next few seasons (Ward *et al.*, 2002). It is also noted that PIRSA receives reports of illegal fishing in the Gleeson’s Landing Rock Lobster sanctuary.
- Commercial and/or recreational harvesting of *specimen shells* in the southern S.A. gulfs region and northern Kangaroo Island includes some species of conservation concern (see Section 9.2).
- Pinnipeds, cetaceans (mainly small cetaceans e.g. dolphins) and fish can become entangled (often fatally) in discarded line and net from fishing activities. Figures are not available for this assessment, but entanglements are known to regularly occur in South Australian waters, according to reports received by S.A. Museum.

Diving

- During the early 1990’s, National Parks and Wildlife Service expressed concern that dive groups made extensive use of the **Innes** area, and that NPWS was not able to properly manage this activity.
- Gorgonian corals in South Australia are considered susceptible to impacts from recreational diving (Environment Australia, 1998a).

Aquaculture

- Part of the **north-western Kangaroo Island** area has been categorised as being suitable for aquaculture development, to a maximum of 260 ha and 1km seaward (see Gilliland, 1996). The potential impacts of

aquaculture are outlined in Section 9.2. Gilliland (1996) mentioned the potential impact of aquaculture upon the high wilderness value of the coastal parks and adjacent areas in the region (e.g. in terms of visual pollution, increased noise, and other impacts associated with farm operation and servicing). Breeding and nesting sites for seabirds have been identified on the north-western coast of Kangaroo Island. According to Gilliland (1996), the operations of an aquaculture development in the vicinity of these sites may impact on the viability of these sites by disturbing adults and young.

Other Issues

- Maher and Clarke (1978, cited by Edyvane, Paxinos and Clarke, 1996) recorded “higher levels of arsenic than expected” in macroalgae collected at **Stenhouse Bay**, and suggested that this might be a result of the long term gypsum mining in the area.
- There are anecdotal reports of some seagrass loss adjacent to settlements in the Southern Yorke region. Possible causes that have been suggested include nutrients from local effluent discharge, and also boat moorings, boat scouring, and anchor damage.

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

Aquaculture Issues

- To date, there are no aquaculture leases in the area due to the remoteness, and exposed and relatively deep nature of the coastal waters in the area. However, the Kangaroo Island Aquaculture Management Plan (Gilliland, 1996) provided for the following development: *North-west Coast*: 60 ha of aquaculture development in the inner Cape Torrens Zone (1km from Cape Torrens Wilderness Protection Area), and 12ha of aquaculture development in the Outer Cape Torrens Zone (part of the area is seaward of the Cape Torrens WPA, to 3 nautical miles). *South-west Coast*: 60 ha of aquaculture development in the inner Hanson Bay Zone (between Flinders Chase National Park and the Cape Bouguer Wilderness Protection Area) and 12ha of aquaculture development in the Outer Hanson Bay Zone (part of the area is seaward of the Cape Bouguer WPA, to 3 nautical miles).
- Aquaculture developments may increase the potential for impacts on the relatively pristine water quality and benthos in the area (see section 9.2 for discussion of the potential impacts of aquaculture developments in general); and there may be potential for interactions with seabirds and marine mammals whose feeding patterns may be disrupted by farms, particularly caged fish farms. Gilliland (1996) considered the potential for impacts upon the high wilderness value of the coastal parks and adjacent areas (in terms of visual pollution, increased noise, and other impacts associated with farm operation and servicing). Breeding and nesting sites for seabirds have been identified on the north-western coast of Kangaroo Island. According to Gilliland (1996), the operations of an aquaculture development in the vicinity of these sites may impact on the viability of these sites by disturbing adults and young.

Fishing Issues

- *Abalone*: Shepherd and Rodda (2001) recorded a decline (from 1988 to 1998) in the yields of Greenlip Abalone from North-east kangaroo Island (Map Code 32, from **Cape Borda** as far east as **Alex Lookout**, which covers most of the **North Coast** of Kangaroo Island), reporting a 50% decrease in yield over that period. Figures were not statistically significant. A decline (from 1979 to 1998) was also recorded for the yields of Greenlip Abalone from **West Bay to Cape du Couedic** (Map Code 26), with a 29% decrease in yield over that period. Figures were not considered statistically significant (Shepherd and Rodda, 2001).

Pilchards: Potential ecosystem impacts of pilchard fishing are discussed in section 9.2, in light of the large (and increasing) pilchard yields from fishing in South Australian waters, and the significance of this species in marine food webs, particularly in the cool water upwelling regions of South Australia

The status of, and potential risks to populations of, the following species are discussed further in Section 9.2.

- *School Shark and Gummy Shark*: The region described in this table has traditionally been one of a number of significant fishing areas in S.A. waters for school and Gummy Shark. School Shark (Australasian subpopulation) was listed in the IUCN Red List 2003 as *Conservation Dependent*, and

previously, Gummy Shark was included in the IUCN Red List 2000 and Red List 2002 as *Conservation Dependent*. The Commonwealth has recently re-regulated the fishery for School and Gummy Shark, in light of the *over-fished* status of School Shark populations in southern Australia since the early 1990s (see AFFA, 2000b; AFMA, 1999b; AFMA, 2003a) and the *fully-fished* status of Gummy Sharks (AFMA, 2000d). According to AFMA (2002a), there is increasing uncertainty about the size and sustainability of the School Shark population (fished under Commonwealth management). The latest agreed assessment for the School Shark population in the fishery reportedly shows “*extremely low numbers*”. In the 2001 assessment, productivity was estimated to be so low that under some scenarios, the agreed rebuilding of School Shark stocks to the 1996 level (by 2011) would be impossible under any level of Total Allowable Catch (TAC). If productivity is actually as low as the model currently predicts and it remains so, AFMA (2002a) considered that an unacceptably long time frame of 15 years would be required to rebuild the stock. At the 44th meeting of the Southern Shark Fishery Management Advisory Committee (SharkMAC), the committee recognised that the current ambiguities of the School Shark assessment will continue for at least 3-4 years until a time series of fixed station survey data is accumulated. The status of (and potential risks to) School Shark and Gummy Shark populations are discussed further in section 9.2.

- *Saw Shark species*: Caught commercially (in small quantities) in deeper waters off south-western Kangaroo Island. 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. Pogonoski *et al.* (2002) recommended conservation status of *Lower Risk, Conservation Dependent* for Australian populations; Australian Society of Fish Biology 2001 list recommended as conservation status: *Lower Risk Conservation Dependent*. The various fisheries catching Saw Shark, and population characteristics of the species, are discussed in section 9.2;
- *Bronze and/or Black Whaler Sharks*: Caught commercially in part of the area described in this table, however the extent of recreational fishing in the area is not known for this report. These species may be considered potentially vulnerable, due to relatively slow growth, delayed maturity, viviparous (live bearing) reproduction, and low fecundity (see section 9.2). Both adults and young are caught as part of the fishery in S.A.. The extent of the nursery areas is not well known, and overall there is reportedly little information on the status of both adults and juveniles (Froese and Pauly, 2003). These two species are also fished recreationally in S.A.. Section 9.2 discusses the vulnerability of these species to over-exploitation, due to the vulnerable characteristics of their life history.
- *Whiskery Shark* are caught commercially in the deeper waters off the coastal area described in this table (e.g. north-western and western Kangaroo Island). The species was classified as *Lower Risk (Conservation Dependent)* in the IUCN Red List 2000 and 2002, but not included in the 2003 IUCN Red List. Pogonoski *et al.* (2002) suggested as conservation status: *Lower Risk, Conservation Dependent* on an Australia-wide basis; Australian Society of Fish Biology 2001 list recommended *Lower Risk, Conservation Dependent* (see section 9.2 for information on fisheries, and population characteristics of Whiskery Shark).
- *Spurdog (Spiny Dogfish)*: IUCN Red List 2003 recorded the conservation status of Spiny Dogfish as *Lower Risk - Near Threatened*. ASFB (2001) suggested the category of *Lower Risk - Least Concern*. Pogonoski *et al.* (2002) suggested as conservation status: *Lower Risk - Least Concern*, on an Australia-wide basis. The species conservation status was reviewed in 2003 by the IUCN Shark Specialist Group, and is still considered to be of conservation concern due to fishing-induced risks to population sustainability. The status of the species, and an overview of the fishery in Australian and New Zealand waters, is provided in section 9.2. The species is caught in Commonwealth fisheries, and also as part of the state waters multi-species scalefish and shark fishery, and is one of the dogfish shark species that also occurs in shallow water (many occur mainly in deep continental shelf and continental slope waters). Spiny dogfish is also caught as bycatch using trawls, long lines and gill nets. In South Australia, dog shark catches are not separated by species, but most refer to Spurdog or Spiny Dogfish (*Squalus acanthias*). In recent years (mid-late 1990s), catches between around 2t and 10t have come from deeper waters south of Kangaroo Island. The species has population and reproductive dynamics that may make it 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; inshore breeding in bays and estuaries; long gestation period; large pregnant females occurring in shallow waters; few young per litter; and schooling behaviour in young – 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).
- *Other Dogfish Shark species*: In addition to spurdog (see above), other dogfish species are caught in southern Kangaroo Island waters, particularly in the deeper Commonwealth-managed waters, but some also in deeper State waters. General information about the fisheries and conservation status of other

dogfish species is discussed in section 9.2.

- *Ocean Leatherjacket*: In 1998, this species was classified as “fully fished” in South Australia (DEHAA and EPA, 1998). No information specific to the vicinity of north-western Kangaroo Island is available, however a regional overview is provided in section 9.2.
- *Western Blue Groper* is commercially fished in deeper waters off western Kangaroo Island. The potential risk to populations of this long-lived, reef-associated species are discussed in section 9.2. Recreational line fishing and spearfishing for Blue Groper is prohibited in northern Kangaroo Island (including all of Investigator Strait). It is noted that charter boats visit south-western Yorke Peninsula, north-western Kangaroo Island and Investigator Strait waters, and at least one of these charter operations promotes the catching of groper (presumably not in the closed area of Investigator Strait).
- *Mixed wrasse species* are fished commercially in the fishing zone in which north-western and western Kangaroo Island are included. At a State level, total catches of Blue-throated Wrasse, Brown-spotted Wrasse and Senator Wrasse have increased from 9 tonnes in 1991/92 to a peak of 47 tonnes in 1998/99. A total of 20 tonnes was taken in South Australian waters in 2000/2001 (Knight *et al.*, 2002). The proportion of this catch that is specific to the deeper waters off western Kangaroo Island is not available for this report. Potential risks to populations of wrasse species, which are strongly site-associated fish, are discussed in section 9.2.
- North-western Kangaroo Island is promoted, as an area where reef fish can be readily caught by recreational fishing vessels that can access the reef areas (e.g. see Sweeney, 1996). *Harlequin fish* are present on reefs off north-western Kangaroo Island / Investigator Strait area. Harlequin fish numbers have been reduced in accessible areas of South Australia due to recreational fishing pressures. Although spear-fishing may not be a threat to Harlequin Fish populations in the northern Kangaroo Island area due to its relative remoteness and low visitor rates, charter boat catches are not monitored, nor are Harlequin Fish population numbers. Examples of other reef fish species of conservation concern in the area include *Western Blue Devil* and *Boarfish* (see section 9.2).
- *King George Whiting* (particularly larger individuals) are also caught in the north-western Kangaroo Island / Investigator Strait area, and are classified as *fully fished* in South Australia (DEHAA and EPA, 1998) (see section 9.2 for information on current population status). Concern has been expressed (e.g. see McGarvey *et al.*, 2000, and references therein) about need to protect the spawning stock of larger whiting, that are fished commercially and recreationally in the areas where they occur. Concern was also expressed about the total catch (which is unquantified, and largely unregulated) from charter boats out from southern Yorke Peninsula / Investigator Strait, particularly the catch of larger King George Whiting that contribute to the spawning stock. McGarvey *et al.* (2000) recommended additional regulatory measures to protect the spawning stock of King George Whiting.
- *Snapper* are caught in the waters off **Investigator Strait** and **north-western Kangaroo Island**, and the species is classified as *fully fished* in South Australia (DEHAA and EPA 1998).
- *Rock Lobster*: The current status of, and potential threats to, Northern Zone Rock Lobster populations are discussed in section 9.2. In 2001, low levels of egg production, pre-recruit abundance, and adult biomass were estimated to currently exist in the Northern Zone (a very large fishing area covering waters from the WA border, through to Encounter Bay, and deeper waters south of Kangaroo Island), and reductions in fishable biomass were predicted to occur in the Northern Zone over the next few seasons (Ward *et al.*, 2002).
- *Blue-Eye (Deep Sea) Trevalla*: Although this is mainly a Commonwealth fishery and most fish are taken from outside State waters, Trevalla are caught adjacent to State waters in this region (see section above, on *Social and Economic Values and Uses*), and are therefore included here. Jones *et al.* (1990) considered Blue-Eye Trevalla to be highly vulnerable to over-exploitation, due to their slow growth and aggregative behaviour (see Williams, 1994). Blue-eye Trevalla appears to be a long-lived species (40 years or more) which matures relatively late in life (8-12 years depending on sex) (AFMA, 2001a). Little is known about the egg and larval stages of Blue-eye Trevalla. Recently in Tasmania, Blue-eye Trevalla of approximately 10cm have been found living in association with large masses of floating kelp. It is believed that as these juveniles reach 50cm they become semi-bottom dwelling. These young fish form schools over hard bottom at depths of around 350m-450m, moving to deeper waters as they grow (DPIWE, 2004). The fishery is mainly a Commonwealth-managed one, with Trevalla taken by the Southern and Eastern Scalefish and Trawl fishery (SESSF), and some of the non-trawl fisheries. The largest catches come from the non-trawl sector. As an example, the 1997 trawl total was 113 t in all Commonwealth waters, with non-trawl landings of around 1038 t (Tasmania =672 t, NSW =200 t, Victoria =86 t and South Australia =80 t). In 1998 and 1999, the agreed Total Allowable Catch was 630 t (100t trawl, 530t non-trawl), with an actual TAC of 763t in 1999 (112 t trawl, 651 t Non-trawl). In 2001, the combined TAC was 676 t (117 t

trawl; 559 t non-trawl), with a catch of 110 t trawl; 478t non-trawl, and 33t discards from trawl fishing. In 2002, the combined TAC increased to 726 t (128 t trawl; 598 t non-trawl), with a catch of 85 t trawl; and 428t non-trawl, and in 2003 the recommended combined TAC was 690t (AFFA website, 2004). Catches in the Commonwealth fishery are mostly comprised of young, immature fish, while larger, mature fish become vulnerable to line fishing when forming seasonal spawning aggregations. Assessment of the fishery is complicated by multiple gear types, gear selectivity, jurisdictional effects and seasonal availability (Tilzey, 1999; AFMA, 2001a). The species is considered to be fully fished (BRR, 1999b), and AFFA (2002b; 2004) recommended that the Blue-eye Trevalla fishery be “carefully monitored”, due to lack of information on population status; concern about the reference points used in the fishery, and lack of an effective stock assessment method. The discarding of Blue-eye Trevalla numbers taken over quota is also of concern in this fishery.

- Deeper waters off south-western Kangaroo Island are part of the Commonwealth’s South East fisheries, which are not discussed in detail here because the fisheries are managed by the Commonwealth. Blue Warehou, Deepwater Flathead, Jackass Morwong, John Dory, Ocean Perch, Orange Roughy, and Redfish are all probably *fully fished* in the South-East Fishery, and 7 other species (Pink Ling, Silver Trevally, Spotted Warehou, Western Gemfish) are of *uncertain status* (Bureau of Rural Sciences, 1999b). The population status of some species taken in the GAB Trawl Fishery is reportedly uncertain. Examples include Deepwater Flathead and Bight Redfish (AFMA, 1999), and the reliability of assessments is low (Bureau of Rural Sciences, 1999c). Some of the aforementioned species occur in deeper waters off Kangaroo Island.
- Apart from pinnipeds (see section below), *cetaceans* (mainly dolphins) and *fish* can become entangled (often fatally) in discarded line and net from fishing activities. Figures are not available for this report, but entanglements are known to regularly occur in South Australian waters, according to reports received by S.A. Museum.

Risks to Pinniped Populations

- In 2003, the Sea Mammal Ecology Group at La Trobe University completed a long-term study of entangled fur seals and sea lions, including those in Kangaroo Island waters. Most entangling material originated from nearby fishing activity. The debris included packing tape, trawl netting, mono-filament gill netting, rope, a beach-washed Rock Lobster pot, fishing line with hooks, a string of burst balloons, rubber o-rings and a strip of car tyre inner-tube. The study found that Australian Sea Lions were most frequently entangled in monofilament gillnet that most likely originated from the shark fishery, which operates in the region where Sea Lions forage - **south and east of Kangaroo Island**. In contrast, New Zealand Fur Seals were most commonly entangled in loops of packing tape and trawl net fragments suspected to be from regional rock lobster and trawl fisheries. According to B. Page (La Trobe University Sea Mammal Ecology Group, cited by Anon., 2003) *“Adult male seals compete vigorously for territories where females give birth and come into oestrus. If a male is hindered by an entanglement and can not build up sufficient energy reserves to fast and fight during the breeding season, he has no chance of competing against other males. Similarly, adult females provision their pups with milk for 10-18 months, and so females alternate foraging trips at sea with periods of suckling their pups ashore. Entangled females immediately abandon their pups when an entanglement makes foraging more difficult, leading to the pups’ starvation. Furthermore, when any seal becomes entangled it continues to grow and the entanglement cuts into its neck, eventually drowning or strangling the seal when the trachea is severed”*. In an article on the results of the forementioned study, Page et al. (2004) reported that the Australian Sea Lion entanglement rate (1.3% in 2002) and the New Zealand Fur Seal entanglement rate (0.9% in 2002) are the third and fourth highest reported for any seal species. Australian Fur Seals are also reported to have some of the highest entanglement rates known. Based on the most recently reported entanglement rates and conservative estimates of subsequent mortality, approximately 1,478 entangled Fur Seals and Sea Lions die in southern Australia each year (Anon, 2003, citing La Trobe University Sea Mammal Ecology Group; Page et al., 2004). According to B. Page (*op. cit.*), if packing tape loops for bait boxes were not disposed of at sea, there would be 300 fewer entangled seals in southern Australia each year.

Risks to Whale Populations

- There may be a potential impact upon food sources for migratory cetaceans, and for populations of pinnipeds, due to deep water trawl fishing (including Commonwealth-managed activities) in southern and western Kangaroo Island waters. Trawl fishing for scalefish and deep water squid species occurs in the area. Southern Kangaroo Island forms part of the Southern Squid Jig Fishery, although it is not a major fishing area on the fishery’s national scale, and most fishing is targeted further south-east, particularly in Victoria and Bass Strait (see Lilly, 2001). Squid and other cephalopods form an important part of the diet

of a number of whale species and also larger sea birds. There was no reliable stock assessment of Arrow Squid (the main species taken in the fishery) up till at least 1999 (Bureau of Rural Sciences, 1999a), despite the fishery having operated for more than a decade. The trawl bycatch of Arrow Squid has been at least as large as the targeted jig catch in recent years, such as 1999 (Bureau of Rural Sciences, 1999a). Bannister *et al.* (1996) recommended an assessment of the possible effect of fishing on food resources for whales (e.g. Sperm Whales), in deep-water areas of likely fisheries importance within EEZ, such as off the southern and western coasts of Kangaroo Island.

- Apart from the fisheries competing with primary food sources for whales, other threats to whales in general include collision with large vessels on shipping lanes beyond edge of continental shelf; disturbance due to seismic operations; net entrapment in deep-sea gill-nets; and pollution, including increasing amounts of plastic debris at sea, and oil spills (Bannister *et al.*, 1996). The extent to which any of these impacts occur in southern and western Kangaroo Island waters is not known for this report (however see section above, on marine debris, in relation to pinniped populations in the area). Butler *et al.* (2002) provided an overview of likely threats to Blue Whales in the Bonney Upwelling area of south-eastern Australia, and some of those threats would also apply to other whale species, including those found in deeper waters off Kangaroo Island (see **Part 1** for examples of whale species in the area).

9.2.11.14 Southern Eyre (Eyre Bioregion)

Aquaculture Issues

- Oyster production has been undertaken in **Coffin Bay** since the 1980s, and the number of leases (and consequent production) increased significantly by the early-mid 2000s. In general, some of the issues associated with oyster farming include competition with native filter feeders, benthic habitat damage, spread of disease, and non-target effects of chemicals for disease control. There is an ongoing monitoring program in Coffin Bay, and the importance of continuing this is noted, particularly in light of the increased production that has occurred since some of the previous environmental impact studies were undertaken (see below).
- A study reported by Madigan and Clarke (1999) on the effect of farmed oysters on native filter feeders in **Coffin Bay**, apparently showed (Figure 9b) that density of *Katelysia* mud cockles at 3 sites at which oysters were grown, was lower than the density of mud cockles at 3 control sites. The differences were consistent over several irregular sampling periods, between 1991 and 1999, and in the later sampling period (1999), it appears from the results (Figure 9b) that no *Katelysia* specimens were recorded in 2 of the 3 sampled areas where oysters are grown, despite having been recorded at those sites at low densities during the early 1990s. Mud Cackle densities were highest at all three of the control sites for which data between 1991 and 1999 were provided (sites A, B, and E), although the density at site E was lower than at sites A (about 115 cockles per 0.063m² in 1999) and B (about 80 cockles per 0.063m² in 1999). During the same study, there appeared to be no detectable trend towards decreased average size of mud cockles at oyster farming sites compared with control sites.
- It is noted that a number of studies (Hone, 1996; Madigan *et al.*, 1999) have reported no significant decreases in seagrass cover due to oyster farming in **Coffin Bay**. No significant differences in vegetation cover between oyster farming sites and control sites could be found. However it is noted that the sampling periods for the two studies were short term (1992 - 1994, and 1994 - 1997). Comparisons were made only within the sampling periods, not between them (i.e. no comparison was made between the 1992 samples and 1997 samples, due to differences in sampling techniques), therefore it would not be possible to determine any changes within that 6 year period. Furthermore, oyster farming was well established in Coffin Bay by the mid 1990s, and no aerial photographs from the 1980s were used to compare changes over decadal periods. A BACI design (Before - After - Control - Impact) sampling could have been used to detect such changes if they have occurred, but data from oyster farming and control sites would be required from both the time of establishment (mid 1980s) as well as the 1990s.
- Physical disturbance to the tidal flats and shallow subtidal areas results from oyster farming operations, due to the presence of structures, and attendance of boats etc. Other issues include lowering of the scenic amenity of the area, and reduction of the wilderness value (PISA Fisheries - Aquaculture Group, 1997).

- South of **Point Longnose**, on the north-western side of **Port Douglas Bay**, there may be some conflict between the position (and potential impacts) of aquaculture leases and the close proximity of the seaward edge of the Coffin Bay National Park.
- Concern has been expressed that the almost enclosed **Kellidie Bay** may not be sufficient (in terms of hydrodynamics / flushing) to support the level of oyster farming that has been permitted in that bay. There is some concern that the assimilative capacity of the bay is being reached.

Coastal Issues

- In the National Land and Water Resources Audit's assessment of estuaries in South Australia (1999-2001), the **Port Douglas / Coffin Bay** area was classified as *Modified* (based mainly on clearance of natural land cover), and described as "under high to very high pressure" (GeoScience Australia, 2001).
- Large areas of **Coffin Bay National Park** are covered by mobile dune fields which pre-date European occupation. Off-road vehicle use and fires have caused localised drift of these dunes in recent times (Australian Heritage Commission, undated). There is ongoing concern about the fragility of these large, unconsolidated dunes on the Coffin Bay Peninsula. Four-wheel driving over the dunes in **Coffin Bay National Park** can destroy small plants and fungal crusts that bind the sand and prevent erosion (DEH, 2000c), thereby damaging the top layer, eroding the soft dunes underneath, and encouraging 4WD access to other areas that are not part of the previously defined tracks (G. Ogle, verbal submission to Environment, Resources and Development Committee, 2001). Concern has also been expressed that increased 4WD vehicle access (for tourism and recreation) to the **Sensation Beach** area, will degrade coastal areas that are being revegetated (G. Ogle, verbal submission to Environment, Resources and Development Committee, 2001).
- "Sand surfing" (sand boarding), a recently introduced recreational activity for tourists, may also damage and destabilise the high dunes of **Coffin Bay**
- Driving on the beach can damage breeding areas and refuges for sea birds (DEH, 2000c). For example, the endangered Hooded Plover lays camouflaged eggs in unprotected scrapes on beaches in the area (e.g. **Seven Mile Beach**, amongst others). Park guides caution visitors to the area against damage to the nests (e.g. by driving as close and possible to the water, and avoiding any driving above high water mark).
- There is potential for erosion of the foreshore around areas developed with shacks and holiday houses. Motorbikes and motor vehicles have caused damage to some of the coast line in **Coffin Bay**.
- Boating activity in **Coffin Bay** may cause an increase in hydrocarbon levels in the shallow tidal flats.
- Algal blooms have occurred periodically in **Coffin Bay** (PISA-Fisheries Aquaculture Group, 1997), and some of these incidences have reportedly caused the mass death of small fish, cockles, and rays in the area. The toxic dinoflagellate *Alexandrium minutum* occurs in Coffin Bay (PIRSA web site, 2003).
- The **islands within Coffin Bay** are extensively modified, due to weed infestations (and consequent reduction in native vegetation); feral animals (which have caused a decline in many native species), and previous guano mining (Australian Heritage Commission, undated).
- Some shallow coastal areas in **Coffin Bay** has been damaged by animal trampling, and by weed infestations. Some swamps in the area have also been damaged by the indiscriminate use of four-wheel drive vehicles (Australian Heritage Commission, undated).
- Other coastal environmental issues in **Coffin Bay** include:
 - ◆ Drainage of coastal swamps in some areas of the bay (e.g. near shacks and houses);
 - ◆ Use of some coastal allotments for dumping / waste disposal;
 - ◆ Liquid waste disposal into the bay;
 - ◆ Potential for seepage from septic tanks;
 - ◆ Physical disturbance to the tidal flats and shallow subtidal area from aquaculture operations;
 - ◆ Physical disturbance to the foreshore and shallow subtidal from shell collecting (e.g. cockles and scallops), and trampling of the coastal fringe by humans and stock.

Fishing Issues

- *Abalone*: Shepherd and Rodda (2001) recorded:
 - ♦ a highly statistically significant 14 year decline (1984 to 1998) in the yields of Greenlip Abalone from the **Frenchman** area, reporting a 98% decrease in yield over that period;
 - ♦ a statistically significant 14 year decline (1984 to 1998) in the yields of Greenlip Abalone from the **Point Sir Isaac to Reef Head** area, reporting at least an 89% decrease in yield over that period;
 - ♦ a highly statistically significant 14 year decline (1984 to 1998) in the yields of Greenlip Abalone from the **Boardinghouse Bay and Point Whidbey** area, reporting a 95% decrease in yield over that period;
 - ♦ a statistically significant long term decline (1979 to 1998) in the yields of Greenlip Abalone from **Misery Bay and Black Rocks** area in **Avoid Bay**, reporting a 95% decrease in yield over that period;
 - ♦ a highly statistically significant long term decline (1979 to 1998) in the yields of Greenlip Abalone from the **Point Avoid** area, reporting at least a 95% decrease in yield over that period;
 - ♦ a statistically significant long term decline (1979 to 1998) in the yields of Greenlip Abalone from the **D'Anville Bay and Liguanea Island**, reporting a 75% decrease in yield over that period; and
 - ♦ a highly statistically significant long term decline (1979 to 1998) in the yields of Greenlip Abalone from the **Fishery Bay** area, reporting a 79% decrease in yield over that period.
- Mayfield *et al.* (2002) reported that reductions in the abundance of adult and juvenile abalone suggest that, with the exception of Thorny Passage, Greenlip Abalone populations in the Western Zone may be declining; and (iii) the catch per unit effort on Greenlip Abalone has declined significantly since 1986, and has been below the long-term average since 1995.

The reported status of, and potential risks to, populations of the following species that are caught in the area, are discussed further in Section **9.2**.

- *School Shark and Gummy Shark*: Caught commercially off southern Eyre Peninsula. School Shark (Australasian subpopulation) was listed in the IUCN Red List 2003 as *Conservation Dependent*, and previously, Gummy Shark was included in the IUCN Red List 2000 and Red List 2002 as *Conservation Dependent*. The Commonwealth has recently re-regulated the fishery for School and Gummy Shark, in light of the *over-fished* status of School Shark populations in southern Australia since the early 1990s (see AFMA, 1999b; AFMA, 2003a) and the *fully-fished* status of Gummy Sharks (AFMA, 2000d). AFMA (2002a) reported that part of the southern Eyre Peninsula area (e.g. **West Point to Cape Wiles**, including **Sleaford Bay**) is one of several sites in South Australia that are important for pregnant female School Sharks and their pups; and that such sites are also important for breeding Gummy Sharks (see section on **Previous and Current MPA / Marine Reserve Nominations**, for information on area closures that were proposed by AFMA in 2002, but rejected in 2003 following consultation with industry). According to AFMA (2002a), there is increasing uncertainty about the size and sustainability of the School Shark population (fished under Commonwealth management). The latest agreed assessment for the School Shark population in the fishery reportedly shows "*extremely low numbers*". In the 2001 assessment, productivity was estimated to be so low that under some scenarios, the agreed rebuilding of School Shark stocks to the 1996 level (by 2011) would be impossible under any level of Total Allowable Catch (TAC). If productivity is actually as low as the model currently predicts and it remains so, AFMA (2002a) considered that an unacceptably long time frame of 15 years would be required to rebuild the stock. At the 44th meeting of the Southern Shark Fishery Management Advisory Committee (SharkMAC), the committee recognised that the current ambiguities of the School Shark assessment will continue for at least 3-4 years until a time series of fixed station survey data is accumulated. SharkMAC recognised that additional measures were required to reduce the potential for targeting the long lived breeding stock as pregnant School Sharks are particularly vulnerable in the sheltered shallow waters of the pupping grounds. SharkMAC recommended the permanent or seasonal closure of 8 selected areas seaward to 3 nautical miles to all takers of shark, and one of these was along southern Eyre Peninsula (i.e. **West Point to Cape Wiles** (including **Sleaford Bay**) (see AFMA, 2002a). The status of (and potential risks to) School and Gummy Shark populations are discussed in section **9.2**.
- *Whiskery Shark*: Caught commercially in deeper waters off southern Eyre Peninsula. The species was classified as *Lower Risk (Conservation Dependent)* in the IUCN Red List 2000 and 2002, but not included in the 2003 IUCN Red List.
- *Pilchards*: Potential ecosystem impacts of pilchard fishing are discussed in section **9.2**, in light of the large (and increasing) pilchard yields from fishing in the southern Eyre region, and the significance of this species in marine food webs, particularly in the cool water upwelling regions of South Australia.
- Various *Wrasse* species (e.g. *Blue-Throated*, and, to a lesser extent, *Brown-Spotted* and *Senator Wrasse*) are fished commercially in waters off Southern Eyre Peninsula. Section **9.2** discusses the status

of, and risks to, populations of these site-associated reef fish species.

- *Ocean Leatherjacket*: This species has been classified as “fully fished” (DEHAA and EPA, 1998) (see section 9.2).
- *Rock Lobster*: Status of Northern Zone Rock Lobster stocks, and also potential ecosystem impacts, are discussed in section 9.2.
- *Southern Bluefin Tuna*: was listed as *Critically Endangered* in the IUCN 2003 Red List. The deeper waters off Southern Eyre Peninsula have traditionally been one of the major fishing areas for this species (see AFMA 2001c and 2002b) and charter boats also target Southern Bluefin Tuna around the offshore islands (McGlasham 2004) will not be discussed here in detail because the Bluefin Tuna fishery and its stocks (migratory across southern Australia and fished by several countries) are managed by the Commonwealth.
- “*Site-associated*” reef fish species: include Boarfish, Magpie Perch, Dusky Morwong, adult Snapper, Redfish, Western Blue Devil, Harlequin Fish, Western Blue Groper, (including large adults to 1m) and various wrasse species. Although the reefs of southern Eyre are mostly inaccessible due to rough sea conditions, some near-shore reefs and offshore islands are accessible by boat, hence the potential for impact from unregulated recreational fishing and the increase in charter boat fishing in recent years. Some reefs can be accessed from the shore which may make reef fish populations in such near-shore areas vulnerable to spear fishing (N.B. spear fishing whilst diving is illegal in S.A.)
- Gastropod molluscs that are important in the shell trade (e.g. Cypraeidae and Volutidae families) are vulnerable to over-exploitation due to low population densities and restricted habitats (Environment Australia, 1998). This issue is further discussed in section 9.2.
- *Bycatch Interactions with Fisheries*: Pinnipeds, cetaceans (mainly small cetaceans such as dolphins), sharks, and fish can become entangled (often fatally) in line and nets from fishing activities, or be caught as bycatch. Figures are not available for this report, but entanglements and bycatch of such species are known to regularly occur in South Australian waters, according to reports received by S.A. Museum and other government organisations. AFMA (2002a), recommended the permanent closure of a number of breeding grounds for School Shark and Gummy Shark in southern Australia (which included part of the southern Eyre Peninsula area, namely **West Point to Cape Wiles**), and considered that such management measures would have the additional advantages of (i) minimising shark fishery interactions with threatened and protected species such as whales, fur seals, sea lions and great white sharks; and (ii) controlling the incidental bycatch of other shark species in the area (e.g. Bronze Whaler, Whiskery and Pencil Shark, Wobbegongs etc.).
- *Mud Cockles and Scallops*: A Mud Cockle population in Coffin Bay has been depleted, considered with high likelihood to be caused by over-fishing during the 1990s (Fowler and Jones, 1997). Previously, the Coffin Bay area also was significant for Scallop fishing, prior to population crash during the 1990s. The Scallop fishery in Coffin Bay was closed in 1999 due to depletion, considered to be caused by a combination of over-fishing (both commercial and recreational), and the effects of ongoing micro-algal blooms in the bay. Prior to the closure there was no bag limit on the commercial catch from Coffin Bay, although a minimum size restriction applied.
- *Sand Crabs*: The fishery is fully exploited. Localised depletion of Sand Crabs in the traditionally fished inshore waters of **Coffin Bay** was reported throughout the mid and late 1990s. Coffin Bay fishers have moved further offshore as populations within the bay have been depleted, and some Coffin Bay fishers have even moved to other parts of the State to maintain their catches and catch rates (Westlake and Jones, 1999).

Other Issues

- The viviparous starfish *Patiriella parvivipara* which has no planktonic larval stage, and narrow habitat limits, is considered vulnerable to pollutants, especially hydrocarbons (Environment Australia 1998a).
- Gorgonian corals in South Australia are considered to be susceptible to impacts from recreational diving (Environment Australia, 1998a).
- Pied Oystercatcher, Hooded Plover (threatened species) and Red-capped Plover (Dotterel) all breed on the beaches of southern Eyre Peninsula in summer. Vehicle movement along beaches used by sea birds for feeding and nesting can cause disturbance, destruction of nests and a higher mortality amongst the young (DEHAA, 1999).
- There are 4WD tours operating along southern beaches of the **Coffin Bay National Park**. Due to the tides, and consequent limited area of beach for driving, vehicles have been known to cut into the sand dunes.

- Staniforth and Richards (2000) reported that, apart from impacts by wave attack and erosion, the historical whaling site in the **Sleaford Bay / Fishery Bay** area is threatened by “obvious amounts of human interference around the site, with bricks being moved around and dug up from the site”.

9.2.11.15 The “Heel” of Yorke Peninsula (Gulf St Vincent Bioregion)

Coastal Effluent

- On the western side of Gulf St Vincent, building activity has reportedly increased between 10 and 25 per cent in coastal towns during the past decade to 2000. Additionally, there are many tourists that visit Yorke Peninsula, and use caravans and campsites. Few regional towns have a common effluent drainage scheme and they generally use septic systems. Shacks, houses and other buildings may be situated on the edge of rivers and creeks, and the coast. This proximity to the water can result in polluted runoff from septic systems flowing untreated into waterways, and causing environmental impacts. Coastal towns such as **Edithburgh, Coobowie, Stansbury**, and Port Vincent do not have a common effluent infrastructure (Senate Inquiry into GSV, evidence presented to Parliament of South Australia, 2000).
- The loss of seagrass adjacent to townships in the area, is possibly due to nutrients from effluent discharge (in combination with **Boating Impacts** as described below) (Edyvane, Paxinos and Clarke, 1996). Bryars (2003) also listed as a potential threat to habitats in the area, the increased level of nutrients from septic tank overflows at **Edithburgh** and **Coobowie**.
- Previously, waste from fish processing being discharged into the sea off **Edithburgh**, has been listed as an impact (EPCSA, 1988 and 1992, cited by Edyvane, 1996a).
- See also section below on **Aquaculture**, for more information about potential effluent impacts.

Boating Issues

- There is reported loss of seagrass adjacent to townships in the area, possibly due to boats mooring in the region (Edyvane *et al.*, 1996), which may cause benthic damage, for example, due to scouring by hulls and anchors. This activity combined with effect of effluent discharge (as described above in the section on **Coastal Effluent**) may be contributing factors in the depletion of seagrass adjacent to townships.

Diving

- There has been some concern expressed by government heritage officials (and some divers) of insufficient protection of historic shipwreck sites and the surrounding benthic environment in the **“Heel” of Yorke Peninsula, Troubridge Shoals and Marion Shoal** area, due to lack of regulation and management of diving activities. Documented evidence is not known for this report.
- Gorgonian corals in South Australia are susceptible to impacts from recreational diving (Environment Australia, 1998). Gorgonian corals are locally common around the **“Heel” of Yorke Peninsula**.

Fishing Issues

The status of, and potential threats to, the following commercial species are discussed further in Section 9.2.

- *Snapper* are caught commercially and recreationally in the waters off southern Yorke Peninsula (see section on **Commercial Fishing**). The species is classified as *fully fished* in South Australia (DEHAA and EPA, 1998). Throughout the 1990s, a decline in the fishery was particularly evident in southern Gulf St Vincent and Investigator Strait (McGlennon and Jones, 1997), and total targetted catch and effort have decreased dramatically since 1983/83, probably due to a lower biomass being available to fishers (Fowler, 2002), however data to 2001 show that catch and effort are now increasing again (see Fowler, 2002). Bryars (2003) also the stock depletion of snapper in the area as a potential threat to habitat.
- Other species caught in the area that are classified as *fully fished* in South Australia include *King George Whiting* and *Garfish* (DEHAA and EPA, 1998).
- Concern has been expressed (e.g. see McGarvey *et al.*, 2000, and references therein) about need to protect the spawning stock of larger whiting, that are fished commercially and recreationally in the areas where they occur. Concern was also expressed about the total catch (which is unquantified, and largely unregulated) from charter boats out from southern Yorke Peninsula, particularly the catch of larger King George Whiting that contribute to the spawning stock. McGarvey *et al.* (2000) recommended additional

regulatory measures to protect the spawning stock of King George Whiting.

- *Western Blue Groper* fishing is prohibited along southern Yorke Peninsula (and throughout Investigator Strait), but minor quantities are caught as commercial bycatch. It not known for this report whether all recreational line fishers and spear-fishers comply with the regulation. Shepherd and Brook (2002) provided information about the potential vulnerability of populations of this species along southern Yorke Peninsula, due to recreational and charter fishing, particularly populations at the “toe” area of Yorke Peninsula, west of the area discussed in this table. Recreational fishers also take juvenile wrasses, presumably including Blue Groper, for use as bait (see Shepherd and Brook, 2002).
- Other site-associated reef fish species found in the area include *Blue-Throated Wrasse* and other wrasse species (also caught by recreational and charter fishers along southern Yorke Peninsula, and the juveniles also taken as bait – see Shepherd and Brook, 2002), Boarfish, Magpie Perch, Dusky Morwong, sweep species, Moonlighter, Western Talma and Western Blue Devil, and populations of these site-attached species may also be vulnerable to decline from recreational fishing (see section 9.2).
- *Whiskery Shark*: caught commercially in small quantities, in deeper waters off **Southern Yorke / Investigator Strait**. The recreational catch is not known for this report. The species was classified as *Lower Risk (Conservation Dependent)* in the IUCN Red List 2000 and 2002, but not included in the 2003 IUCN Red List (see section 9.2).
- *Bronze and Black Whaler Sharks*: These species may be considered potentially vulnerable, due to relatively slow growth, delayed maturity, viviparous (live bearing) reproduction, and low fecundity (see section 9.2). Both adults and young are caught as part of the fishery in S.A.. The extent of the nursery areas is not well known, and overall there is reportedly little information on the status of both adults and juveniles (Froese and Pauly, 2003). The species are also fished recreationally in S.A., but figures are not available. Section 9.2 discusses the vulnerability of these species to over-exploitation, due to the vulnerable characteristics of their life history.
- *School Shark and Gummy Shark*: Shark fishing has been one of the major vertebrate fisheries in this area, in terms of weight yielded (e.g. during the mid-late 1990s, dozens of tonnes per annum were obtained, mainly Gummy Sharks, from southern Yorke Peninsula, although at that time the area was not one of the top 10 of the approximately 44 fishing blocks in S.A., where these shark species have regularly been commercially fished). School Shark (Australasian subpopulation) was listed in the IUCN Red List 2003 as *Conservation Dependent*, and previously, Gummy Shark was included in the IUCN Red List 2000 and Red List 2002 as *Conservation Dependent*. The Commonwealth has recently re-regulated the fishery for School and Gummy Shark, in light of the *over-fished* status of School Shark populations in southern Australia since the early 1990s (see AFFA, 2000b; AFMA, 1999b; AFMA, 2003) and the *fully-fished* status of Gummy Sharks (AFMA, 2000d). AFMA (2002a) reported increasing uncertainty about the size and sustainability of the School Shark population (fished under Commonwealth management). The latest agreed assessment for the School Shark population in the fishery reportedly shows “*extremely low numbers*”. In the 2001 assessment, productivity was estimated to be so low that under some scenarios, the agreed rebuilding of School Shark stocks to the 1996 level (by 2011) would be impossible under any level of Total Allowable Catch (TAC). If productivity is actually as low as the model currently predicts and it remains so, AFMA (2002a) considered that an unacceptably long time frame of 15 years would be required to rebuild the stock. At the 44th meeting of the Southern Shark Fishery Management Advisory Committee (SharkMAC), the committee recognised that the current ambiguities of the School Shark assessment will continue for at least 3-4 years until a time series of fixed station survey data is accumulated.
- *Rock Lobster*: Current stock assessment details, potential risks to the Northern Zone Rock Lobster stocks, and potential ecosystem impacts from Rock Lobster fishing, are discussed in section 9.2. In 2001, low levels of egg production, pre-recruit abundance, and adult biomass were estimated to exist in the Northern Zone (a very large fishing area covering waters from the WA border, through to Encounter Bay, and deeper waters south of Kangaroo Island), and reductions in fishable biomass were predicted to occur in the Northern Zone over the next few seasons (Ward *et al.*, 2002).
- Pinnipeds, cetaceans (mainly small cetaceans such as dolphins) and fish can become entangled (often fatally) in discarded line and net from fishing activities. Figures are not available for this report, but entanglements are known to regularly occur in South Australian waters, according to reports received by South Australian Museum, and other government agencies.

Specimen Collecting

- *Gastropod molluscs*: Specimen shells important in the shell trade occur in the south-western Gulf St Vincent and Investigator Strait areas, such as cowries, volutes and other species, some of which are rare,

and many species of specimen shell are also of conservation concern due to their vulnerable population characteristics, such as limited dispersal, localised and direct reproduction, and specific food requirements found over a limited area (e.g. host sponges, in the case of some *Zoila* and *Notocypraea* species) (see section 9.2). An incomplete list of specimen shell species known 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 to various specimen shell authorities in Australia): *Zoila friendii thersites* (Hump-Backed Cowrie), including black forms; other cowrie species; *Ericusa fulgetra* (Lightning Volute, one of the more commonly observed volute species); *Lyrta mitraeformis*; *Notovoluta kreuslerae* (Kreusler’s Volute), and other volute species (Baker, 2002, and pers. obs., and specimen shell market records, 2001-2002). The potential threats to such species are described in section 9.2.

- Divers in the area have reported illegal harvesting of seahorses (for medicine trade or dried ornaments) in the south-western GSV region, but information has not been verified for this report. Short-headed Seahorse *Hippocampus breviceps* was listed by IUCN Red List 2003 as *Data Deficient*. Southern Pot-Bellied Seahorse *H. bleekeri* was listed as *Lower Risk but Conservation Dependent*, under its previous name (*H. abdominalis*, which now refers only to the NSW population – see Kuitert, 2001).

Aquaculture

- See section on Aquaculture in **Notes on Social and Economic Values and Uses** for details about current and proposed aquaculture development in the region. See Section 9.2 for information on potential impacts of shellfish farming and other forms of aquaculture. Planning S.A. (1997) provided some guidelines for aquaculture, to minimise potential impacts in the region (see section below, titled **Notes on Current and Protection and Management**). Bryars (2003) listed as a potential threat to habitats in the area, the physical disturbance caused by aquaculture operations in **Salt Creek Bay**.

Prawn Trawling

- Occurs in waters deeper than 10m, from Butlers Beach, South and East throughout **Investigator Strait** and **south-western Gulf St Vincent**. Section 9.2 of this report provides more information about the bycatch and other impacts from prawn trawling.
- In the area, deeper beds of *Heterozostera* (now reinstated within the *Zostera* genus) have now been degraded by prawn trawling (Tanner, in prep., cited by Shepherd, pers. comm., 2004). Tanner (2005) described the disappearance of seagrasses from **Investigator Strait**, due to the impact of prawn trawling.

Other

- Bryars (2003) listed as a major threat to **Salt Swamp Creek**, the decreased tidal flows caused by (i) the location of an old causeway inside Salt Swamp Creek, and (ii) the location of a road across the entrance to Salt Swamp Creek.
- Bryars (2003) listed as a potential threat to habitats in the “**Heel**” of **Yorke Peninsula** area, the hydrocarbons from petro-chemical spillage during shipping operations in southern Gulf St Vincent.
- Physical destruction of habitat, sedimentation, and increased turbidity from suspended sediments, all due to land reclamation as part of a proposed port upgrade at **Port Giles**, have been listed as potential threats to habitat in the “**Heel**” of **Yorke Peninsula** area (Bryars, 2003).
- Exotic species introduced from shipping and ballast water exchange at **Port Giles**, as well as organo-metals from the cargo vessels at **Port Giles**, have been listed as potential threats to habitat in the “**Heel**” of **Yorke Peninsula** area (Bryars, 2003).
- Stock depletion of Greenlip Abalone caused by the parasite *Perkinsus* has occurred in the area (Bryars, 2003).

9.2.11.16 Upper Gulf St Vincent (Gulf St Vincent Bioregion)

Numerous physical, chemical, and biological studies on the **Port River-Barker Inlet** system and other parts of the **north-eastern Gulf St Vincent** have occurred during the past three decades. Details of many of the impacts in this area are available in reports associated with the proposed Multi-Function Polis (MFP) development during the late 1980s and early 1990s (e.g. PPK *et al.*, 1992). Many of the current environmental

impacts from multiple point and diffuse sources clearly degrade the environmental values of the area, and without long term remediation works, will continue to do so. Major pollution inputs have included effluent from the Port Adelaide and Bolivar sewage treatment works; outflow from West Lakes to the head of the Port River; discharges from the numerous stormwater drains along the North Arm and other locations; point source discharges from industry; discharges from freshwater drainage points, such as Gawler River, Dry Creek and the Little Para River; and thermal effluent from power production, amongst others (Steffensen, 1988; Thomas *et al.*, 1991; PPK *et al.*, 1992; EPA, 1997b,1997c; Parliament of South Australia, 2000, and references cited in this table). The cumulative effect of these inputs results in water quality which consistently exceeds the recommended national and state criteria for protection of aquatic ecosystems (Kinhill Stearns, 1985b; Kinhill Delphin, 1991; PPK *et al.*, 1992), and the Port River estuary has been described both nationally (Zann, 1995; Zann and Kailola, 1995) and at State level (Rozenbilds, 1991; Edyvane, 1996a) as one of the most polluted regions in South Australia. Existing industrial sites in the Port Adelaide and Outer Harbour areas, and any expansion of industrial activity, have long been recognised as a threat to the ecological functioning of the Barker Inlet system (e.g. Ivanovici, 1984). Current uses of (an in) the river and its surroundings continue to threaten the health of the Port River – Barker Inlet system (EPA, 2003). It is generally agreed amongst marine experts that if all polluting practices ceased now, the historic load of pollutants in the sediments of Barker Inlet is so great that the effects will persist for a long time (P. Harbison, and other evidence presented to Parliament of South Australia, 2000). There is a very high number of known environmental impacts in the region. Some of the main impacts are listed below.

Coastal River and Creek Discharges / Runoff, and Diversions

- The aquatic environment of the water courses draining to northern Gulf St Vincent has been modified through flow regulation, flood mitigation schemes, sand mining, and the input of a range of pollutants, including silt, nutrients, heavy metals and hydrocarbons. The adjacent coastal and marine environment has also been degraded through reclamation of coastal wetlands and the transport of pollutants down creeks and rivers to the sea. Much of the habitat diversity within the aquatic systems of the Adelaide region has been lost through the drainage of wetlands and backwaters, alienation of floodplains, removal of dead trees from channels, altered surface and groundwater flows, and the loss of aquatic vegetation (NAB Catchment Water Management Board, 2001).
- The presence of numerous weirs, dams and reservoirs has further degraded the system by altering flow regimes and acting as barriers to fish migration. Flood mitigation schemes, including dams and 'express' channels have reduced flood peaks and frequency, increased the rate of run-off and reduced aquifer recharge. Clearing of the upper catchments has also increased the rate of run-off, while groundwater extractions have decreased spring fed stream flows in some locations. Low flows are so modified that large reaches of streams are deprived of water for long periods, particularly during summer. The ecological consequences of these changes include the following (NAB Catchment Water Management Board, 2001):
 - ◆ Reduced flows during summer can limit available habitat, leading to reduced biodiversity.
 - ◆ Drought refuges may dry up or water quality may deteriorate to a point where native species disappear and pest species are favoured.
 - ◆ Many biological processes such as spawning or fish migration are associated with the timing and duration of high flows. These flows have changed profoundly.
 - ◆ High flows influence channel form and ensure that sediment and excess vegetation is removed. With reduced frequency and duration of high flows, the diversity of aquatic habitats is not maintained.
 - ◆ Reduced winter/spring flows and construction of levees reduce flooding and impinge on the links between channel, wetland and floodplain. These links are necessary for the life-cycles of many aquatic species and water birds, and their removal will affect stream biological processes.
 - ◆ Flow regulation devices such as reservoirs and weirs are barriers to fish migration. Inability to migrate can have profound implications upon fish breeding and population viability. A recent survey found that fish requiring migrations to and from the sea were only found downstream of the weir near Gawler. Hicks and Sheldon (1999) postulated that the **Gawler** weir and the Yaldara gauging station are acting as significant barriers to fish migration. Levee banks associated with the **Buckland Park** wetland are likely to have restricted migration of fish between the sea and the river system except when major flows reach the mouth of the Gawler River (NAB Catchment Water Management Board, 2001).
- In general, the sources of pollutants in the rivers and creeks of the northern and north-eastern GSV include point sources such as irrigation drainage water; township effluent; urban stormwater runoff; industrial effluent, and intensive animal industries. Diffuse sources of pollution include wash-off material from the floodplains; pollutants from land use; groundwater inflows; excreta from animals; and sediments from gully,

sheet, bed and bank erosion. River and creek discharges add to the problem of excess turbidity. Sedimentation is an ongoing problem in Gulf St Vincent, and contributes to decline of marine vegetation (see sections below).

- **Port Wakefield River** periodically discharges fresh water into the upper gulf, containing agricultural chemicals, silt and town effluent (Berggy, 1996).
- **Clinton Conservation Park:** Water and contaminants from nearby mining might affect coastal and intertidal flora and fauna in the area (Morelli and de Jong, 1995).
- Urban, rural and industrial development of the Northern Adelaide region has degraded water quality in the **Little Para, Dry Creek** and **Gawler River** systems. It is considered that the flow regimes required for a functioning healthy ecosystem throughout the **Little Para** and **Dry Creek** watercourses are not currently being met, in addition to other issues such as the physical structure of the watercourses and lack of habitat diversity (NAB Catchment Water Management Board, 2001).
- Silt, agricultural chemicals and town effluent flow periodically from the **Light** and **Gawler Rivers** into the waters of the upper gulf. The increased level of nutrients caused by agricultural run-off from the **Gawler** and **Light River** catchments, was listed as a potential threat to tidal habitats along north-eastern Gulf St Vincent (Bryars, 2003). Flood events from the **Gawler River, Light River, Salt Creek** and **Thompson Creek** carry freshwater polluted with agricultural chemicals, faecal material, sediments, and other contaminating substances, into the upper gulf waters (Berggy 1996, NAB Catchment Water Management Board 2001). There is a major drain south of the **Gawler River**, which discharges nutrients, particulates, and chemicals into the nearshore marine environment (in the vicinity of the **St Kilda / Chapman Creek** Aquatic Reserve) (Berggy, 1996; Petrusevics *et al.*, 1998). The area also receives some level of pollutants, such as stormwater, industrial and agricultural runoff and sediments, from the **Little Para River** (Phillips and Lawrence 1996; NAB Catchment Water Management Board, 1999; Edyvane, 1999b), although wetlands have recently been constructed to improve the quality of runoff to Barker Inlet through **Dry Creek** and the **Little Para River** (see **Notes on Impact Management** section, below). A study by DEHAA (1999c) concluded that the lower sections of the **Gawler River** are highly degraded, and that provision major wetland / floodplain rehabilitation in this region should be investigated. The **Gawler River** has been classified, in the National Land and Water Resources Audit, as *extensively modified, and under high to very high pressure*, and the **Light River Delta** as *modified, and under high to very high pressure* (see GeoScience Australia, 2001). However, recent legislation initiatives, behavioural changes and the construction of artificial wetlands have the potential to improve downstream water quality along a number of watercourses.
- At **Buckland Park** at the mouth of the Gawler River, the coastal wetlands have been considerably modified by the construction of low levee banks to retain flows from the **Gawler River** to form a brackish wetland. Connections to the sea only occur during major flows (NAB Catchment Water Management Board 2001). Also of potential concern is the reported continual seepage of saline water into **Buckland Park** Lake from nearby salt evaporation ponds (Morelli and de Jong, 1995).
- Widespread runoff from agricultural areas transports sediments and nutrients in the form of fertilisers and faecal matter into the watercourses throughout the rural areas of the catchment. The Helps Road Drain and lower sections of the **Dry Creek** system have minimal or no natural capacity to absorb pollutant loads (NAB Catchment Water Management Board, 2001).
- The diversion of the Torrens River in the early 1900s changed the flow of fresh water into the Port River estuary, and the **West Lakes** development in the 1970s increased seawater movement with a flow-through system, drawing 500 million litres of seawater a day into the **Port River** (EPA, 2003). The West Lakes waterfront residential development is constructed on former reed beds behind the coastal dunes. In the past, the reed beds filtered run-off prior to it reaching the Gulf. Now, after heavy rains, the water in West Lakes is often contaminated to the level where primary contact is not recommended (Parliament of South Australia, 2000).
- **West Lakes** is a source of polluted water entering the **Port River – Barker Inlet** system. The water in West Lakes is influenced by stormwater runoff, and the outflow is often enriched with nutrients, metals, bacteria, and other contaminants (Steffensen, 1988; Thomas *et al.*, 1991).
- The **Barker Inlet – St Kilda System** has been classified, in the National Land and Water Resources Audit, as *extensively modified and under high to very high pressure* (see GeoScience Australia, 2001).

Nutrient Pollution

- Sewage discharge is often described as the major impact in the **Port Adelaide - Barker Inlet** system and surrounds (e.g. Parliament of South Australia 2000, and evidence presented therein). Sewage discharge

has also caused major changes to the mangrove and seagrass habitats of **St Kilda Bay**, since the establishment during the 1960s of the Bolivar effluent outfall to sea, via **Chapman Creek** (see Coleman and Cook, 2003). The wastewater treatment plants at **Bolivar** and **Port Adelaide** have discharged large amounts of nutrients and other pollutants into the **Port River – Barker Inlet** system over a long period, and the soda products factory outfall is also considered to be a significant source of nutrients, such as ammonia (EPA, 2003). Other sources of nutrients include stormwater; runoff from a fertiliser factory; and agricultural waste runoff (e.g. through creeks and drains in the northern part of the gulf).

- Minor contributions of nutrients to northern Gulf St Vincent include septic tank overflows (e.g. at **Price, Port Clinton, Port Parham, Webb Beach, Thompson’s Beach** and **Middle Beach** (Bryars, 2003).
- Nutrient and bacterial enrichment of the estuary has been a problem since the early part of last century. Islington sewage farm previously discharged effluent into **North Arm Creek**, and studies during the 1950s showed that zero dissolved oxygen levels existed at times, due to the effluent (Hodgson, 1959, cited by PPK *et al.*, 1992a).
- Both **Bolivar** and **Port Adelaide** Sewage Treatment Works have contributed nutrients and other contaminants to the system since the middle of the 1900s. During the early 2000s, the **Bolivar** Wastewater Treatment Plant discharged approximately 100 ML/day of secondary-treated effluent into the intertidal region of eastern Gulf St Vincent (SARDI, 2001d). Prior to the recent improvements in waste water re-use (see Notes on Impact Management section below), **Bolivar** contributed approximately 99% of the annual nutrient load (around 3,100 t) and over 80% of all pollutant loads (around 53,000 t) discharged to the Gulf St Vincent from the Northern Adelaide catchments (Fleming and Daniell, 1997, cited by NAB Catchment Management Board, 2001).
- EPA (2002 and 2003) reported that the classification of seven sites in the estuary as “poor quality” in terms of nutrient concentrations, resulted from oxidised nitrogen and ammonia, the main sources being discharges from the Port Adelaide wastewater treatment plant, and outfall from a soda products factory (see **Notes on Impact Management** section, below).
- Prior to the upgrade of the Port Adelaide Waste Water Treatment Plant during the late 1990s and early 2000s, the **Port Adelaide** plant discharged directly into the **Port River**. In addition to being a major point source of nutrient contamination of the estuary over a long period, other concerns with the Port Adelaide treatment plant have included the fact that the plant is an old system, operating in a very low lying area, with many of the pipe systems being below a highly saline water table. Infiltration through leaking joints and other means is considered to have elevated the salinity to above levels that are normally able to be used for irrigation or other reuse purposes. Due to the high salinity, only a small percentage of the effluent was reused prior to the upgrade (Parliament of South Australia, 2000) (see **Notes on Impact Management** section).
- Published water quality criteria from the late 1980s and early 1990s (Kinhill Stearns, 1985b; Kinhill Delphin, 1991) showed that phosphorus levels were four orders of magnitude higher than acceptable levels; and nitrogen levels were at least 10 times higher than the limits set under ANZEC’S and NHMRC’s guidelines for maintenance of aquatic ecosystems. More recent studies (see EPA, 1997b, 2002, 2003) have shown that nutrient pollution is still a significant issue in the Port River – Barker Inlet system.
- Shepherd (1970 and 1989) reported that the deleterious effects of sewage discharge included the depletion of dissolved oxygen, stimulation of eutrophic conditions (proliferation of “nuisance” microalgae and macroalgae, and smothering of local biota), introduction of heavy metals, contamination of fish, shellfish and other marine fauna with pathogens (especially coliform bacteria and enteroviruses). One of the main concerns with nutrient discharge into the nutrient-poor systems. Free-floating microalgae can add to water turbidity, and macroalgae can grow as epiphytes, which attach to leaves and stems. Epiphytic algae can reduce the diffusion of gasses and nutrients to seagrass leaves, shade leaves and thereby reduce photosynthetic activity, and can increase the weight on the seagrass leaves. This additional weight can cause seagrass leaves to break from the stem. Depending on the species, this can lead to irreversible damage or, if the species can re-grow, valuable reserves of energy may be used up in the process (see section on **Seagrass Loss**) (Parliament of South Australia, 2000).
- The high content of nutrients released into the Barker Inlet from the waste water treatment plant effluent, stormwater and other sources, has promoted the growth of macroalgae such as “cabbage weed” (*Ulva*). The plant grows in vast quantities off the shore at **St Kilda** and is washed onto the mangroves and onshore, where it piles up and decomposes (P. Harbison, evidence presented to Parliament of South Australia 2000). Apart from smothering small seagrasses, mangrove seedlings and pneumatophores, the decomposing vegetation causes a chain of impacts. Decomposing *Ulva* has been implicated in directly lowering dissolved oxygen levels due to respiration at night, and biochemical oxygen demand during degradation (Harbison, cited by PPK *et al.*, 1992a). Decomposing *Ulva* also increases the organic content

of the sediments, promoting the production of hydrogen sulphide, which results in oxygen depletion in the system, which can lead to fish kills, particularly at night when oxygen levels are lowest (P. Harbison, evidence presented to Parliament of South Australia, 2000).

- Marina and boating waste has also been identified as a direct source of nutrients to the Port River and Barker Inlet. Very few of the boats have black water facilities and none have grey water holding facilities. Although black water storage facilities may be available on board some boats only one of the marinas in the area has sullage pump out facilities. There is a current project to reduce sewage and wastewater from boats, yachts, marinas and slipways (Office of the Minister for the Environment and Heritage, 2003). (See **Notes on Impact Management** section below).
- Material handling practices on the Port Wharf also contribute to nutrient pollution to the Port Waterways through direct spillage into the waters, runoff and poor management. Cargoes include live sheep exports, bulk fertilizer and grain. Poor management practices at the wharf such as directly washing down or sweeping accumulated material from wharf areas into the river contribute to water quality impairment of the Port River (Office of the Minister for the Environment and Heritage, 2003). (See **Notes on Impact Management** section below).
- An increase in population through coastal building activity (e.g. on the western side of GSV), in addition to use of the coastal towns by tourists (particularly in caravan parks and camping grounds), also contribute to the nutrient pollution of the upper gulf. Few regional towns have a common effluent drainage scheme and they generally use septic systems. Shacks, houses and other buildings may be situated on the edge of rivers and creeks along the coast. This proximity to the water can result in polluted runoff from septic systems flowing untreated into waterways (Senate Inquiry into GSV, Parliament of South Australia, 2000).
- **Magazine Creek** stormwater channel was reported to carry nutrient loads comparable with the upper reaches of the Port River (PPK *et al.*, 1992a), and all major drainage points were reported to carry more than 100 000 faecal coliforms per 100ml of water, according to samples taken following rainfall events (PPK *et al.*, 1992a). Other studies (Thomas *et al.*, 1991) demonstrated total coliform concentrations of up to 1 million cells per 100ml of water, whereas EPA water quality guidelines recommended less than 150 cells per 100ml of water as an acceptable standard. Although the level of effluent piped into the system from the Port Adelaide works has now been reduced, levels of nutrients, metals and faecal bacterial contaminants remain high, because stormwater through creeks and artificial drainage points is also a major contributor of these pollutants (e.g. see Thomas *et al.*, 1991; PPK *et al.*, 1992a, EPA, 1997b).
- Any increase in the discharge of effluents into **Barker Inlet** is recognised as a threat to the system (Morelli and de Jong, 1995; Parliament of South Australia, 2000).
- High levels of nutrients in the system commonly causes a number of impacts, including (i) loss of seagrass (see below) though epiphytic growth and other factors; (ii) stimulation of algal blooms (some of which are toxic, and cause shellfish contamination and fish kills); and (iii) growth of “nuisance” macroalgae, which can smother mangroves and seagrass (EPA, 2003).

Nutrient pollution may also have adverse impacts on faunal species in the Port River - Barker Inlet system. For example:

- A study of nutrient-contaminated sites showed that macrofaunal assemblages surrounding the Bolivar Outfall varied substantially along the resulting pollution gradient. For example, the abundance of both Western King Prawn and the Blue Swimmer Crab progressively increased up to 2 km from the outfall. A decline in water quality adjacent to the outfall was considered likely to explain these changes (SARDI 2001d). At peripheral sites (4-5 km away) species diversity increased. The results of this study suggest that the disposal of effluent has a localised effect on the faunal assemblages surrounding the discharge point (study by R. Marsh, cited by SARDI, 2001d).
- Although the impacts of nutrients on Mud Cocks and other fauna have not been studied specifically in the Barker Inlet system, a study in Princess Royal Harbour in WA showed that populations of two of the same species of Mud Cocks that occur in the Port River – Baker Inlet system (*Katelysia scalarina* and *K. rhytiphora*) significantly declined (to almost zero individuals) in the study area over a 10 year period. Apart from adult mortality, growth rates also considerably slowed over that period, and recruitment of young *Katelysia* was negligible, at levels two orders of magnitude less than observed in 1983-1985. The dramatic declines in abundance of *Katelysia*, which was previously dominant component of the fauna of Princess Royal Harbour, co-occurred with eutrophication, seagrass die-off and macroalgal blooms, and the authors suggested that the environmental problems of the harbour have cascaded through the ecosystem to alter its ability to sustain natural secondary production and ecosystem function (Peterson *et al.*, 1994).

Other Water Quality Issues

- Apart from sewage outfall nutrients (see section above on **Nutrient Pollution**), river and creek flows (which can be point sources for stormwater flows), and diffuse sources of stormwater, are also major contributors to the degradation of water quality in the Port River - Barker Inlet system. Stormwater comes from both point and non-point sources.
- There are four catchment regions that drain into the Port River and environs. Some of the major pollutants from the rivers and creeks that form part of the catchment area, are discussed in the section above, on **Coastal River and Creek Discharges / Runoff and Diversions**. Historical design principals have relied on removing stormwater from the Northern Adelaide Plains area to Gulf St Vincent as rapidly as possible, limiting bio-remediative processes. Whilst this strategy has successfully alleviated flooding on the plains district, it has also accelerated pollution transport to Gulf St Vincent. Many of the creeks draining into Gulf St Vincent have been lined with concrete and diverted to act as conduits for stormwater, to encourage rapid movement of the water to sea and thus reduce flooding risk (Parliament of South Australia, 2000; NAB Catchment Water Management Board, 2001).
- Point sources of water discharge from single locations can also include factories, however the Environment Protection Agency in South Australia does not legally permit any discharge into the stormwater system. Non-point, or diffuse, sources of stormwater, are those where the polluted water is generated across a large area and flows into an outlet from multiple points. There are also numerous stormwater outlets of varying sizes which direct untreated urban runoff to the coast (Parliament of South Australia, 2000). Barker Inlet is a natural sink because of its low topography, very sheltered waters and its orientation which respects the prevailing winds. The "sink status" of the estuary results in it attracting and retaining pollutants (P. Harbison, evidence presented to Parliament of South Australia, 2000).
- Many different organic and inorganic contaminants (including toxic compounds), drain from industrial and municipal stormwater drains and point source outfalls in the Port Adelaide area, into Barker Inlet and the Port River. A number of industries have discharged directly into the Port River-Barker Inlet system over a long period. Surface waters flowing into Barker Inlet area are also contaminated with effluent, heavy metal discharges from industry, road runoff contaminants, oil, grease, and pesticides (PPK *et al.*, 1992). Common contaminants in the system, from a combination of industrial outfalls and stormwater outlets, include nutrients; particulates (e.g. rubber, grain, asbestos, and many others); sediments; organic wastes (animal faeces, leaf litter, lawn clippings, fertilisers); chemicals from industrial effluent and run-off (e.g. soda ash from a salt processing plant, and pollutants from paint factories, sugar refinery, fertiliser factory, and other industries); oil from boats, ships and motor vehicles; chlorine; polychlorinated biphenyls (PCBs); mercury, lead, copper and zinc and other metals; thermal effluent (particularly from the two power stations) and litter (such as plastic bags and bottles, rope, thongs etc) (Hine *et al.*, 1989; Thomas *et al.*, 1991; PPK *et al.*, 1992a and 1992b; Edyvane, 1992, submission to MFP Australia Gillman - Dry Creek Urban Development Proposal Draft EIS; Carey and Kutlaca, Adelaide University, pers. comm., 1993; Harbison, 1997; Petrusevics *et al.*, 1998; Parliament of South Australia, 2000; EPA, 2003).
- Dumping of chemicals, and leachate and litter from landfill sites (see section below on **Landfills**) also add to the water quality impacts.
- Areas of very high salinity reportedly occur in the vicinity of the **Partings** and the upper reaches of **Barker Inlet** resulting from discharge of bitterns (MgCl) from the Penrice Soda plant (GeoScience Australia, 2001).
- Dry Creek and other major urbanised catchments discharge untreated urban stormwater into the Barker Inlet / Port River Estuary (Office of the Minister for the Environment and Heritage 2003). In the Adelaide plains area, untreated stormwater from approximately 770 ha of industrial and residential areas discharges directly into the Barker Inlet estuary and marine environment (Office of the Minister for the Environment and Heritage 2003). Modelled annual average stormwater flow into the estuary is 139 ML per day, and the annual load is calculated to be 50, 702 ML (GeoScience Australia, 2001). Eight major drains have emptied contaminated fresh water into the system over a long period, and a number of other minor discharge points exist. There is now some reuse / recycling of stormwater in the eastern part of the area (e.g. North Arm), following construction of wetland area during the late 1990s (see **Notes on Impact Management** section below). Long-term accumulation of the contents of stormwater in the Barker Inlet system is a major source of contamination. Engineering and Water Supply (1989b) recorded high concentrations and/or loads of dissolved and total nitrogen, phosphorus, copper, chromium, zinc, iron, pesticides, oils and other contaminants in the combined output of eight drains that are associated with the area. Tidal studies by Petrusevics (1986) and S.A. Dept of Fisheries (1989, cited by PPK *et al.*, 1992a) indicated that pollutants that entered the estuary at North Arm could be carried as far as the northern end of Barker Inlet by ebbing tidal currents. There are now major stormwater ponding areas near Magazine Creek and North Arm Creek, but there has long been concern about the release of toxic contents into the Barker Inlet system from the stormwater ponding areas, and from the major drains (e.g. Rosewater Drain near the Port River).

- Stormwater discharge from major drains in the area that empty into the Port River - Barker Inlet system, carry nutrients, heavy metals, industrial and residential chemicals, rural chemicals such as fertilisers and pesticides; sediments; hydrocarbons; organic compounds with high biochemical oxygen demand; toxic organic wastes; pathogenic micro-organisms; and other pollutants. Stormwater / wastewater outlets also result in urban and industrial litter/debris in the Barker Inlet system, such as plastics and rubber, and Barker inlet acts as a trap for debris such as cockle bags, beer cans, fishing line and other rubbish (Thomas *et al.*, 1991; PPK *et al.*, 1992a and 1992b; Carey and Kutlaca, MGCES, pers. comm. 1994; Harbison 1997; CRC for Catchment Hydrology 1997; EPA 1998; Lewis *et al.*, 1998; P. Harbison, verbal submission to Senate Inquiry into Gulf St Vincent, February 2000).
- PCBs and other persistent chlorinated organic compounds occur in the Port River estuary, from stormwater, sewage effluent, and industrial discharges. A 1999 government survey of stormwater drains by the EPA indicated recent PCB contamination of some sites (J. Cugley, verbal submission to Senate Inquiry into Gulf St Vincent, February 2000).
- Water quality studies conducted for the MFP during the early 1990s showed that levels of mercury, cadmium, chromium, copper and lead in the Port Adelaide estuary levels all exceeded those acceptable under EPA and other guidelines for water quality (Thomas *et al.*, 1991). (see section below on **Heavy Metal Pollution**).
- Recent surveys of stormwater drains (e.g. EPA 1997b and 2000) and sediments (EPA 1997c; EPA 2000) showed that elevated heavy metal levels (e.g. of lead, zinc, mercury, copper, amongst others) are still present in some areas (see also J. Cugley, submission to Senate Inquiry into Gulf St Vincent, February 2000). Studies by EPA (see EPA, 2000, 2002) showed that although cadmium concentrations were low in a number of sites sampled, there were “moderate concentrations” of cadmium found in two stormwater drains entering the Port River (EPA, 2000). These results suggested that sediment cadmium concentrations in the Port River are generally low but there is some recent but low-level input of cadmium into the river (EPA, 2002).
- Monitoring of the Port River water conducted by EPA in 1995-1996 (see EPA, 1997b) resulted in the EPA describing the overall water quality as “poor”. The 1997 monitoring indicated that concentrations of nutrients (ammonia) were high at most of the monitored sites; “moderate concentrations” of total phosphorus and nitrogen occurred at many of the sites; water clarity as determined by turbidity measurements was of “moderate quality” at most sites; chlorophyll concentrations (indicative of microalgal presence) were high or moderate at all sites; and heavy metal (particularly copper and lead) concentrations often exceeded guideline concentrations at all sites.
- Published water quality criteria from the late 1980s and early 1990s (Kinhill Stearns, 1985b; Kinhill Delphin 1991) showed faecal coliform bacterial levels up to 700 times higher than acceptable levels for primary contact recreational use of water (under ANZEC’S and NHMRC’s guidelines for maintenance of aquatic ecosystems), and the contamination was particularly evident near drainage sites. High levels of faecal material and faecal organisms have been recorded in a number of areas (PPK *et al.*, 1992a; EPA, 2002 and 2003).
- In a study of water quality between 1995 and 2000, the EPA reported that microbial levels were poor at 6 of 9 tested sites in the Port River – Barker Inlet estuary, due to enterococci and faecal streptococci. Sources may include faecal waste from stormwater, septic tank seepage, boats and sewage outfalls. Discharge from the Port Adelaide wastewater treatment plant is chlorinated, but this does not entirely eliminate bacteria. Since 1995 –96, five sites have declined from good to poor quality in terms of bacterial contamination, which is reported to possibly be due to occasional short term events such as large stormwater discharges (EPA 2002, 2003).
- Excessive water turbidity is also a problem in the area. Sewage discharge and stormwater runoff, industrial discharges, construction and land reclamation work, dredging and storms all increase turbidity in the Port River-Barker Inlet system (Parliament of South Australia, 2000; EPA, 2003).
- A summary of water quality monitoring from 9 sites in the Port River system, between 1995 and 2000 (EPA 2002 and 2003), showed that, in terms of impacts:
 - ◆ Compared to the 1995–96 report, turbidity, copper and total phosphorus levels had improved;
 - ◆ Iron, zinc and faecal coliform levels had not changed;
 - ◆ TK nitrogen, chlorophyll a, faecal streptococci and enterococci levels were worse than when previously sampled.
 - ◆ Copper levels were considered moderate at five sites and poor at four. Given the toxic nature of copper this was highlighted as a concern, although the report stated that “recent trends suggest copper

concentrations are decreasing”.

- ◆ Zinc levels were considered moderate at all sites.
- ◆ Comparisons could not be made for aluminium, cadmium, lead, mercury and ammonia because analytical methodology had changed over the period.
- ◆ Ammonia was poor at seven sites and moderate at two. The high ammonia concentrations, high pH and high temperature of the Penrice outfall were listed as concerns. This combination of factors indicated that ammonia concentrations may be high enough to be toxic near the Penrice outfall. The high ammonia and oxidised nitrogen concentrations are considered to be a significant issue for algae in the Port River, as these forms of nitrogen are highly bio-available. It is likely that these nitrogen concentrations are promoting greater algal growth, and therefore higher chlorophyll concentrations in the Port River. However, environment improvement programs by industry and on-going development of wetlands to treat stormwater are expected to lead to improvements in the nutrient status of the Port River (see **Notes on Impact Management**, below).
- ◆ Chlorophyll a, an indicator of the amount of microalgae in the water, was poor or moderate at all sites, as a result of the high nutrient loading to the Port River. Chlorophyll concentrations have increased at the majority of tested sites since 1995 - 1996.
- ◆ Microbiological ratings were poor at six sites and moderate at three because of faecal streptococci and enterococci. The results reportedly suggested occasional events that reduce microbiological quality for short periods, rather than a consistently high concentration of bacteria.
- In the vicinity of the **Port Adelaide** sewage outfall, the water quality has been classified as *poor* in terms of the quantity of nutrients, heavy metals, chlorophyll (an indicator of microalgal density) and bacteria. Examples of other sampled sites with poor water quality included the northern end of the **Port River**, towards the Outer Harbour channel (high levels of nutrients, heavy metals and chlorophyll); the section of river south of the Penrice outfall (high nutrients, chlorophyll and bacteria); the waters west of **Magazine Creek** drain (high nutrients, heavy metals and chlorophyll levels); **Barker Inlet** waters west of the **Little Para River** drainage (high levels of nutrients, heavy metals, chlorophyll and bacteria); **Barker Inlet** waters between **Dry Creek** and **Torrens Island** (high levels of nutrients, chlorophyll and bacteria). A number of other sampled sites had moderate overall water quality, but had high levels of one type of contaminant (e.g. heavy metals or chlorophyll or bacteria) (EPA, 2002 and 2003).
- The EPA (2003) reported that even if discharges cease, metals and nutrients stored in the sediments, in addition to the historical loss of seagrass and mangroves, will continue to impact on the water quality of the Port River – Barker Inlet (EPA, 2003).

Heavy Metal Pollution

- Sediments (particularly at the margins of the estuary) and water in the Port River – Barker Inlet system, are polluted by heavy metals.
- The metal contamination of the sediments and water of the Port River-Barker Inlet system has been documented in various scientific studies, consultants' reports and government agency monitoring reports. Examples include studies by Harbison 1986a and 1986b; Dillon *et al.*, 1989; and EPA 1997c, 2000, 2002 and 2003. The issue of metal contamination has been considered in numerous management reports and plans during the past decade including: development of an integrated, multi-agency management plan for Barker Inlet during the early - mid 1990s; most of the MFP study reports produced between 1991 and 1994; community monitoring programs, and the current inter-agency Barker Inlet-Port Estuary Committee's (BIPEC) integrated management plan for restoration of the area.
- Industries in the area cause heavy metal pollution, and sewage effluent is also a contributing factor, along with stormwater and urban runoff, which reportedly contains metals from wearing tyres and brakes, and leaking lubricating oil (EPA 2002 and 2003, and references cited above).
- Published water quality criteria from the late 1980s and early 1990s (Kinhill Stearns 1985b; Kinhill Delphin 1991) showed that lead and copper levels were up to two orders of magnitude higher than the level acceptable under ANZEC'S and NHMRC's guidelines for maintenance of aquatic ecosystems. Recent studies by the EPA (see EPA 1997b, 1997c, 2000, 2002, 2003) have shown that metal contamination is still a significant issue in the Port River – Barker Inlet area. During a study of water quality between 1995 and 2000, heavy metal readings were poor at five of 9 sampled sites and moderate at four, particularly due to high copper concentrations and moderately high zinc concentrations (EPA 2002 and 2003). The assessment of the Port River – Barker Inlet estuary under the National Land and Water Resources Audit (see GeoScience Australia, 2001) reported that Port River estuary had elevated levels of copper at all sites and concentrations of lead and zinc regularly exceed guideline concentrations at some sites.

- Contamination of sediments with heavy metals is also a significant issue (e.g. see Harbison 1998a and 1996b and Parliament of South Australia 2000, and section below on **Toxic Soil / Water Interactions**).
- Bio-availability of common heavy metals and metal compounds in South Australian marine environments and consequent contamination of the marine food chain has been considered a cause for concern since the 1980s (e.g. see Thomas, 1981, and McLaren and Wiltshire, 1984).
- Both heavy metals and organo-chlorines have been recorded in fish, crustaceans and other invertebrates, and dolphins in the Port River/Barker Inlet system (e.g. Olsen, 1983; Olsen, 1988; Boxall, 1994; Burzacott, 1997; Bossley and Burzacott, 1999; Bossley, 1999 and 2000; Parliament of South Australia, 2000; EPA, 2000).
- Organo-chlorines are well recognised for their ability to suppress immune function, promote abnormal cell growth, and cause reproductive defects, amongst other toxic effects (e.g. see Cockcroft *et al.*, 1989, cited by Bannister *et al.*, 1996; EPA, 2000).
- Heavy metals also affect marine organisms through acute toxicity, sub-acute toxicity or chronic sub-lethal effects, depending upon the amount and time length of exposure (Boxall, 1994; Hamann, 1994). There are a number of biochemical indicators available to indicate physiological stress in marine organisms (such as fish), due to metal contamination (e.g. see Boxall 1994). Sublethal effects from metal accumulation in marine organisms include a reduced ability to withstand environmental and direct body stresses (i.e. depressed immune response). In marine animals, abnormal changes in growth, fecundity and reproductive success due to metal contamination have been observed. Studies in other gulf waters of South Australia have shown that almost all biota sampled from metal-contaminated areas displayed elevated levels of heavy metals such as cadmium, lead and zinc, and that metal impacts reduced or eliminated 20 of the most common species that occurred in the vicinity of the sampled area (see Ward *et al.*, 1986, cited by Harbison 1993, for results from Spencer Gulf). Furthermore, studies have shown that the structure, species richness and composition of seagrass communities can be affected by high metal content, and all of these measures decreased with increasing contamination levels (Ward and Young 1982). Benthic invertebrates such as molluscs, crustaceans and polychaete worms are particularly susceptible to metal accumulations, ingesting the metal either directly from the water, or from ingesting detritus in the sediment. Several heavy metals that readily attach to fine particulate matter can be readily taken up as food by benthic organisms such as bivalves (Harbison, 1984, 1993). Fish may accumulate metals by consuming benthic invertebrates (Harbison, 1993), and humans may accumulate metals by eating metal-contaminated fish, crustaceans, or molluscs (Harbison, 1993).
- A study during the late 1990s by the Australian Dolphin Research Foundation showed a high mercury level in an examined carcass of a bottlenose dolphin from the Port River system. The source of the mercury is considered to be the sediments in the Port River system. Mercury entering the waterways collects in the sediments and is converted into a toxic form that can be absorbed by invertebrates, and carried through the food chain (ABC Media Report, 1999).
- TBT and associated products are present in the Port River-Barker Inlet system, from shipping and boating. TBT accumulates in marine food chains, and can concentrate in molluscs at levels hundreds of thousands of times higher than surrounding sediment or seawater. The toxic effects of TBT in marine organisms include, amongst others, immuno-suppression, physical deformities, reduced growth rate, reproductive abnormalities in molluscs (including sex change, which has been observed in gastropod molluscs in the Port River – Barker inlet system); death of eggs and larvae in molluscs; reduction in population numbers of molluscs; and inhibition of body organ function in some higher animals (Nias *et al.*, 1993; AMCS and EPA, 1999).

Contaminated Sediments and Associated Impacts

- The accumulation of rotting *Ulva* (i.e. “cabbage weed”, which proliferates due to nutrient pollution), contributes to very high levels of organic matter in sediments, and the sediments in Barker Inlet have an organic content of around 90 per cent (P. Harbison, evidence presented to Parliament of South Australia 2000). The very high organic content in turn results in generation of hydrogen sulphide by bacteria in the anaerobic mud, and leads to depletion of oxygen in the shallow waters of the Inlet, particularly during the night (P. Harbison, evidence presented to Parliament of South Australia, 2000).
- **St Kilda Bay** is considered to be significantly contaminated by hydrogen sulphide, and lacking in oxygen, due to the long term eutrophication of the bay since the 1960s, the destruction of seagrass and mangroves, the proliferation of “nuisance” macroalgae such as *Ulva*, and consequent build-up of decomposing vegetation (Coleman and Cook, 2003). The increased levels of hydrogen sulphide (which are well above ANZECC water quality guideline levels) have also resulted in the bay’s water becoming acidic. Surface “scums” of sulphur bacteria are evident in the bay, and polychaete worms have also proliferated in the

contaminated sediments. In the most contaminated areas, no visible soil fauna is evident at all (Coleman and Cook, 2003). The sediment fauna composition at St Kilda contrasts with that of less contaminated areas, such as Middle Beach, which is dominated by small mussels and cockle species, and other bivalve molluscs (Coleman and Cook, 2003). Similarly, surface dwelling invertebrate composition differs considerably between polluted bays such as **St Kilda** (with few surface-dwelling invertebrates observed) compared with Middle Beach, where crabs and gastropod snails are abundant because sufficient oxygen is available, and sediments are not contaminated by hydrogen sulphide (Coleman and Cook, 2003). Hydrogen sulphide is toxic to a very wide range of coastal and marine flora and fauna, and it is considered that at the biodiversity of the mud flats at **St Kilda** has been reduced to those few species capable of tolerating the extremely high concentrations of hydrogen sulphide (Coleman and Cook, 2003).

- High levels of some heavy metals and metal compounds in marine sediments and biota of the Port River-Barker Inlet estuary. Examples of metals present in the system include mercury, cadmium, zinc, copper, lead and TBT, amongst others, as discussed below. All of these metals and metallic compounds are known to have detrimental effects upon marine biota, as discussed in various sections below.
- Acidic soils and sediments are a significant problem in the area, due to previous swamp drainage, and the resulting acidic conditions promote rapid leaching and transport of nutrients and other pollutants into the estuarine system. (SEA and Harbison, 1989, cited by PPK, 1992b). The area of acid sulphate soils is estimated to be around 12 square km, and acidic drainage water of less than pH 3.5 has been recorded in places (GeoScience Australia, 2001).
- A South Australian Waste Water Management study (1982, cited by Harwood, 1990) found in sediments in the Port Adelaide area (some of which is released into the Barker Inlet system, particularly the North arm area): arsenic, cyanide, acid solutions and acids, caustics, antimony, cadmium, lead, chromium, copper, zinc, mercury compounds, organo-chlorines, and other toxic substances listed under poisons regulations schedules in the Environment Protection Act.
- It was estimated during the early 1990s, as part of proposed Multi-Function Polis developments, that many hundreds of thousands of tonnes of contaminated soil occurs in the Gillman area and surrounds. Soils bordering the Barker Inlet system are known to be significantly contaminated with heavy metals (SA Health Commission 1990; PPK *et al.*, 1992a).
- Biannual monitoring of sediment quality in the Port River estuary (the Port River, Barker inlet, Inner Harbour and Outer Harbour) between December 1995 and November 1996 (EPA 1997c) showed the following, in terms of impacts:
 - ♦ one site (near the Port Adelaide sewage outfall area) had copper concentrations that “could cause frequent adverse effects in marine organisms exposed to the sediment, and concentrations of zinc, lead and cadmium that could occasionally cause adverse effects in marine organisms exposed to the sediment”.
 - ♦ one site (near Magazine Creek drain) had mercury concentrations “significantly above detection limits and high enough to cause frequent adverse effects in marine organisms exposed to the sediment”.
 - ♦ Tributyl tin concentrations were at levels regarded as “moderate at two sites but sediment quality is good at all other sites”.
 - ♦ Chlordane was observed in concentrations “above detection limits at Site 1 (near Port Adelaide sewage outfall) in all replicates during November 1996”.

Toxic Soil / Water Interactions

- Dissolved organic matter, ammonia, phosphorus, soluble iron, arsenic and various other metals can leach from sediments when they are disturbed, and become soluble through the acidic conditions that result from oxidation of the sulphide minerals in the sediments/mud (see Harbison, 1986a and 1986b; PPK *et al.*, 1992b; Harbison, submission to Senate Inquiry into Gulf St Vincent, 2000). Major sources of sediment contamination include the landfill sites in the area, industrial activities, and stormwater. The aforementioned contaminants can seep into the waterways of the **Barker Inlet** system and increase the load of active pollutants in the system. Contaminated acidic and metal-enriched soils in the area may significantly impact the Barker Inlet system if disturbed and oxidised, and the mixing of organic matter from the estuarine mangrove system with metals from the industrial/stormwater outfalls to create highly acidic and toxic products, is considered to be a major problem in this area. Disturbance of contaminated sediments was considered to be a major risk by previous development proposals (e.g. Multi-function Polis, during the early 1990s). Sediment/water interactions on the tidal mudflats during periods of low circulation are considered to be one of the three major effects upon water quality in the area (PPK, 1992a).
- An independent study during the early 1990's, suggested that toxic substances in the land area where

stormwater is ponded, (see points above) were combining with the hyper-saline and acidic groundwater and moving at a rate of up to 10m per year (Coulter, pers. comm., cited by Harwood, 1990).

Thermal Effluent

- **Torrens Island** and **Pelican Point** power stations use estuary water for cooling purposes, and the heated waste water is discharged. Coupled with the **Penrice Soda** outfall, this adds thermal pollution to the estuary (Parliament of South Australia, 2000; EPA, 2003).
- Previous studies in the thermally affected area of Torrens Island Power station, which discharges into Angas Inlet water at eight to nine degrees above the intake water temperature, showed the following impacts:
 - ◆ A reduced infaunal biodiversity, with a cerratulid worm species dominating the benthic fauna in the vicinity of the heat-affected area of Angas Inlet (Zed, 1972).
 - ◆ An opportunistic polychaete dominated the infauna in the thermally affected area, with a low diversity of infauna in the thermally affected area. The impacts on infaunal diversity were not limited to Angas Inlet, with some reduction also noted in North Arm and Barker Inlet (Thomas *et al.*, 1986).
 - ◆ Reduction in biomass of intertidal fauna in response to thermal effluent (ETSA 1986). It has also been hypothesised the low dissolved oxygen levels in the system may also be a contributing factor to the low levels of infaunal species diversity in the area (Fargher Maunsell, 1985, cited by PPK *et al.*, 1992).
 - ◆ A study by Jones *et al.* (1996) implicated the power station effluent as a combined cause (in addition to nutrient effluent and proliferation of *Ulva*) of altered species composition of fish in the Barker Inlet system. The warmer waters can result in higher growth rates, and promote premature movement of some species out of the inner estuary. These latter effects may alter the population structures of these species by increasing their vulnerability to heavy localised fishing intensity, aggregation of natural predators and point-source pollution (Parliament of South Australia, 2000).
- Current concerns include the increase in thermal effluent into the system, from the new Pelican Point power station. There are reported water temperature increases of up to eight degrees Celsius near the discharge point, and the facility is considered inadequate in terms of its facilities to cool heated waste water prior to discharge. Community concerns regarding potential impacts have been echoed in the Senate Inquiry into Gulf St Vincent (Parliament of South Australia, 2000), and concerns were consequently expressed by the Parliament's Environment, Resources and Development Committee. Some of the potential impacts include the following (from M. Bossley, ADRF, pers. comm., 1999; Close, 1999; Close, Conservation Council of South Australia, pers. comm. 1999; CAPP and Port Adelaide Residents Environment Protection Group submissions to Parliament of South Australia, 2000).
 - ◆ increased synergistic effects from existing contaminants in the system, being further mobilised by thermally polluted water;
 - ◆ further changes to fish species composition and abundance in the area;
 - ◆ further changes to infaunal species composition and abundance, which may have food chain effects that affect fish, birds and marine mammals;
 - ◆ further increases in algal species that thrive in warm, nutrient-rich water (e.g. *Ulva*);
 - ◆ death of mud cockles due to the higher water temperatures;
 - ◆ potential effects on distribution and activity of bottlenose dolphins, which heavily utilise the Barker Inlet system;
 - ◆ creation of a hot water "barrier to migration" into the River, which may affect larvae, juvenile fish and other biota entering the estuary;
 - ◆ death of zooplankton and larvae that are ecologically important to the system, due to the large uptake of water from the river for use in cooling. This may be of particular concern during periods of reduced flow, such as ebb tides;
 - ◆ increased incidence of toxic dinoflagellate "red tides" and other harmful phytoplankton that may be stimulated by the altered water conditions. particularly given the proximity of the major shipping channel to the thermal effluent outfall area of the power plant;
 - ◆ further colonisation and proliferation of introduced "opportunistic" species;
 - ◆ ecological impacts on the biota of Pelican Point, which is a bird breeding and feeding area; and
 - ◆ aesthetic impacts.

Combined Impacts (Nutrients, Thermal Effluent, Metals)

- Thermal effluent impacts in the system are exacerbated by nutrient and metal pollutants, causing synergistic effects which may have impacts upon sediment quality, water quality, infauna, marine plants, fish, birds and marine mammals (J. Carey and A. Kutlaca, MGCES, pers. comm., 1993; Jones *et al.*, 1996; M. Bossley, ADRF, pers. comm., 1999; Close, CCSA, pers. comm. 1999):
- Nutrient pollution of the Port River estuary from the Port Adelaide Sewage Treatment Works, coupled with the thermal effluent from the existing power station has caused the following:
 - ♦ regular incidence of toxic microalgal blooms (e.g. *Alexandrium minutum*, amongst others) (Cannon, 1990 and 1991; Hallegraeff, 1995b; Parliament of South Australia, 2000);
 - ♦ proliferation of nuisance macroalgae *Ulva lactuca*, contributed to mangrove dieback, due to smothering of aerial roots and seedlings by *Ulva lactuca* (Connolly, 1986; Edyvane, 1991; Bayard, 1992; Fairhead, 1995);
 - ♦ altered fish species composition, favouring species which have adapted to the warm water conditions (Jones *et al.*, 1996). The nuisance macroalga *Ulva* also provides an additional food source which is utilised by herbivorous and omnivorous fish;
 - ♦ altered invertebrate community composition, with reduction or elimination of populations of several bivalve mollusc and worm species, and increased abundance of previously rare or absent “opportunistic” worm species (Thomas *et al.*, 1986).

Industrial Discharges and Dumping

- Historically the Port Adelaide - Barker Inlet region has been the home of heavy and noxious industries, and it continues to be the main industrial area in Adelaide, where approximately 50% of Adelaide’s industries are located (Torrens Catchment Water Management Board, 2001).
- The high level of industrial activity in the Port Adelaide region includes dozens of industries, many of whose discharges were not regulated for a number of decades, and some of which (as at 2003) are still not adequately regulated. In 1998, there were around 12 licenced discharges (e.g. nutrients, particulates, bitterns, grit, paint) in the Port River area (Petruševics *et al.*, 1998). There are four major catchments which drain into the Port River and environs. Along with stormwater runoff, sewage effluent and the effects of development, the Port River Estuary has been subjected to pollutants from paint factories, chemical dumping, landfill sites, asbestos factories, sugar refineries, ship oil, thermal effluent, mercury, soda ash, chlorine, polychlorinated biphenyls (PCBs) and assorted heavy metals (Gulf St Vincent Senate Inquiry, presented evidence, 2000).
- Both historical and current industrial activity in the area have reduced the natural habitat available, altered water movement and salinity, and increased pollution in the estuary (EPA, 2003)
- Industries whose wastes have been classified as too hazardous to be located in other areas, have been permitted to build in the Gillman area (Harwood, 1990).
- Some of the industries and activities in the area that are considered to have contributed to the cumulative impacts include salt waste (soda) products, chemical factories (e.g. ICI, CIG), sulphuric acid factory (now disused), fertiliser factory, power stations, landfill dumps, a major site for a national waste company, cement works, and fuel depots. Examples of specific industrial activity that has contaminated the Barker Inlet area include the following:
 - ♦ a disused sulphuric acid plant, which has contaminated soil in the LeFevre Peninsula area with high acid levels (A. Kutlaca, Mawson Graduate Centre for Environmental Studies (MGCES), pers. comm., 1994);
 - ♦ a fertiliser factory, which has contributed loads of nitrogen and phosphorus to the system. Amongst the resulting impacts include the increases in the organic content of sediments, which causes hydrogen sulphide production, leading to lowered dissolved oxygen levels, and subsequent fish kills (Harbison, verbal submission to Senate Inquiry into Gulf St Vincent, 2000) ;
 - ♦ PCB contamination from transformers, associated with power station wastes (A. Kutlaca, MGCES, pers. comm. 1994); and
 - ♦ High levels of ammonia, oxidised nitrogen and other nutrients in the **Port River - Barker Inlet** system from industrial waste, and other sources. Interstitial waters in **Angas Inlet** have high concentrations of ammonia close to the margin of the landfill. The concentrations of ammonia found in clean, sandy sediments on the south eastern side of the landfill are considered to be difficult to explain except by movement of groundwater from a source of ammonia, such as the landfill on **Garden Island** (Harbison 1999, and evidence presented to GSV Senate Inquiry, 2000).
 - ♦ Building and maintenance of ships at slipways around the estuary, which pollutes the waters with hydrocarbons, metals, TBT, and assorted chemicals.

- Much of the industry in the Port Adelaide area is not connected to the sewage system but uses septic systems, which are prone to overflow into the surrounding waterways. The industries can also have an impact on the groundwater, which is close to the surface in this area (Parliament of South Australia, 2000).
- During the late 1990s, the Environmental Protection Authority undertook an audit of industries, as well as slipways and other activities/sites associated with boating, in the vicinity of the Port River. According to Cugley (EPA, verbal submission to Senate Inquiry into Gulf St Vincent, February 2000) there was “cause for concern” in some of the findings.
- Parts of the **LeFevre Peninsula** are contaminated with metals, petroleum products, sulphuric acid and other acids, and caustic soda (A. Kutlaca, MGCES, pers. comm., 1994).

Seagrass Loss

- Long term loss of *Posidonia* and *Amphibolis* seagrass species has occurred around areas such as **Port Gawler** and **St Kilda**, and seaward of the **Port Adelaide** area, principally due to excessive nutrients and turbidity from sewage effluent (and previously also sludge) discharged from the sewage treatment works at **Bolivar** and **Port Adelaide** (see section above on **Nutrient Pollution**). Stormwater discharges are also a contributing factor, in terms of nutrients, turbidity and mixed contaminants. Stormwater may cause light reduction at critical times of the year, affecting recruitment of seagrass seedlings (EPA, evidence presented to Parliament of South Australia, 2000). Apart from wastewater discharge, sludge deposits and stormwater discharge, other factors resulting in degradation of seagrass include heavy metals; various pollutants / toxicants; build-up of hydrogen sulphide due to the anoxic conditions created by rotting vegetation in eutrophic areas; increased turbidity from particulate matter from dredging, and dumping of dredge spoil (e.g. off **Outer Harbour**, and previously, in **St Kilda Bay**, during the construction of a boat haven – see Coleman and Cook, 2003); changes in salinity and temperature; road and urban development and increased effluent and road-run off associated with urban growth; and combinations of the above factors (Blackburn 2000; Onkaparinga Catchment Water Management Board, 2002).
- The discharges result in increase in nutrient levels, increased water turbidity, increased growth of both microalgae and macroalgae (including “nuisance” species such as the Cabbage Weed *Ulva*, and a variety of algal epiphytes that attach to seagrasses); reduction in light, and seagrass blades being smothered by nutrient-induced epiphytes, which reduces light penetration and photosynthesis, and also causes breakage of seagrass from the weight of epiphytes (e.g. see Johnson, 1981b; Neverauskas, 1987a, 1987b, 1987c; Shepherd, 1989; Shepherd *et al.*, 1989; Lewis *et al.*, 1998; Parliament of South Australia, 2000). Loss of seagrass creates a cycle of further seagrass loss. As sediments become dislodged and re-suspended when seagrass dies and can no longer bind the substrate, light penetration in other seagrass areas is further reduced. Once sand erosion begins, seagrass is rapidly lost. Severe erosion can result in healthy plants being dislodged and washed ashore. Some of the sediment erosion problems in GSV are due to seagrass losses and the reduced ability of the meadows to bind sediment together (Parliament of South Australia, 2000).
- At least 350 ha of seagrass has been destroyed in the **Port Adelaide** area, since the mid 1960s, with a further 1500ha impacted (Neverauskas, 1987a, 1987b, 1987c, cited by Lewis *et al.*, 1998). Neverauskas considered the seagrass *Posidonia* in the Port River/Barker Inlet system to be extremely vulnerable to impacts from effluent discharge, with low rates of recolonisation. Note that there is now some sign of recolonisation in part of the area, since sludge discharge ceased during the early 1990s (Neverauskas, pers. comm., 2000), and effluent discharges are now also being reduced. The wire weed seagrass *Amphibolis* has also been affected by nutrient inputs into the upper gulf area (Berggy, 1996).
- It has been reported that 25% (DELM 1993, cited by Edyvane, 1996a), of the seagrass in the **St Kilda - Port Gawler** region has been lost due to the impacts of coastal discharges, principally from sewage treatment works. Coleman and Cook (2003) provided photographic examples of the significant changes to seagrass habitat in **St Kilda Bay** that occurred during the 1970s, 1980s and 1990s, principally due to discharge from Bolivar Sewage Treatment Works (and consequent eutrophication of the bay, causing proliferation of nuisance algae and rotting vegetation that smothers seagrass, and build-up of hydrogen sulphide, which is toxic to seagrass). Effluent-induced seagrass loss in the St Kilda area has been exacerbated by dredging and landfill, shoreline constructions, pipeline construction, and other changes to the topographical and hydrological regime of the area. Seagrass no longer occurs close to shore (a seaward retreat of around 250m is evident), and the total area of seagrass in the bay has been reduced. The remaining seagrass now occurs in sparse patches, further from shore (Coleman and Cook, 2003). The Cabbage Weed (*Ulva* sp.) has proliferated in the bay due to the increased nutrients, smothering the benthic environment and further contributing to seagrass loss. Although there have been recent environmental improvements to the treatment facility at Bolivar (see following table), Coleman and Cook (2003) have shown that the decline in seagrass in **St Kilda Bay** is still continuing, with recent areas of seagrass death

recorded in 2000.

- There has also been loss of intertidal seagrasses *Zostera* sp. and *Zostera* (= *Heterozostera*) *tasmanica* from north-eastern Gulf St Vincent. Connolly (1986) estimated that the seagrass loss from a 9km stretch of coast was principally due to the effluent discharged from the sewage treatment works at Bolivar. Excessive growth of *Ulva* sp. stimulated by effluent nutrients may also be partly responsible for seagrass loss, by smothering plants (Connolly, 1986, cited by PPK *et al.*, 1992a).
- Point source sewage outfalls are considered to be a significant source of increased particulates and turbidity, particularly to the offshore areas of Adelaide (Steffensen *et al.*, 1989; Shepherd *et al.*, 1989). Suspended solids (which were released into the system for decades, prior to improvements in effluent discharge standards) attenuate the light and can have the same effect on seagrasses as epiphytes, and suspended solids have been implicated in the decline of seagrasses in the area (Steffensen *et al.*, 1989; Shepherd *et al.*, 1989). In addition to sewage discharges, stormwater, dredging, land reclamation works and changes in land use can also cloud the water, allowing less light to reach seagrasses, thereby decreasing photosynthesis and increasing stress on the plants. Diffuse sources such as stormwater also add to the load of nutrients and various toxicants that can adversely affect seagrasses (Parliament of South Australia, 2000).
- Smothering of seagrass due to sedimentation / siltation from dredging, as well as turbidity from stormwater and other drainage discharges, also contributes to seagrass loss in upper Gulf St Vincent (PPK *et al.*, 1992a; Parliament of South Australia, 2000).
- Seagrass loss also has a negative impact on commercial and recreational fisheries, particularly for the species that rely on seagrass beds for shelter and feeding (Parliament of South Australia, 2000; see also Scott *et al.*, 2000).

Loss of Mangrove Habitats

- Prior to European settlement, much of the coastline north of Adelaide was a tidal swamp, densely colonised by mangroves and samphire. Since the 1890s significant areas of coastal wetland have been lost by the construction of levees with flap gates to exclude tidal flow, resulting in degradation of mangrove forests in the southern section of the estuary. Mangrove and samphire communities have been replaced by terrestrial grasses and shrubs, with swamp vegetation persisting only where leaking gates allow the ingress of some tidal flow. The Penrice salt ponds on the eastern shore of Barker Inlet have alienated a large area of samphire shrubland communities and mangrove woodland bordering tidal creeks (NAB Catchment Water Management Board, 2001).
- The total area of mangroves present in the upper Gulf St Vincent has been substantially reduced from land clearing, land reclamation and construction works, and nutrient pollution. Land clearing and land reclamation started to occur from the 1890s (PPK *et al.*, 1992a). Apart from direct clearing, alienation of mangrove swamps has occurred, so that tidal drainage does not occur, and the mangroves die (EPA, evidence presented to Parliament of South Australia 2000). At the southern end of the estuary within the levees, the mangrove forest was felled early last century, or died due to water restriction from bank construction that began in the late 1800s. Kinhill Stearns (1985a) reported that since 1954, 25% of the area previously occupied by mangroves, has been lost due to land reclamation, development and altered flooding regimes.
- Construction of causeways and embankments to assist early developments such as the **Torrens Island** Power Station, and for flood mitigation, altered the tidal regime and caused the death of mangroves adjacent to the **North Arm**. Construction of levees, embankments, causeways associated with transmission lines, and other control structures, alter the tidal regimes, thereby disrupting the daily wetting/drying cycle of pneumatophores (PPK *et al.*, 1992; Blackburn, 2000; Parliament of South Australia, 2000). The disruptions to tidal movements that have occurred following such constructions has led to mangrove die-back in the **Barker Inlet** region (Morelli and de Jong, 1995; Parliament of South Australia, 2000).
- Reduced tidal flows due to the construction of a levee back at **Mutton Cove** has been listed as a major threat to the mangrove-lined tidal creek habitat in the **Port Adelaide / Barker Inlet** system (Bryars, 2003).
- Apart from direct clearing and alienation of mangrove stands through construction works, increased nutrient levels have affected the mangroves. The rapid growth of Sea Cabbage *Ulva lactuca* / *Ulva rigida* is prompted by excessive nutrients, and the principal sources over a long period have been from **Bolivar** and **Port Adelaide** sewage treatment works. Large drifts of Sea Cabbage, promoted by excess nutrients, prevent or retard the establishment and growth of young mangrove seedlings, and damage established

trees by smothering and eventually deforming and/or killing the pneumatophores (Connolly, 1986; Edyvane, 1991; Fairhead, 1995; CSIRO, 2002). Connolly (1986) and Fairhead (1995) showed that *U. lactuca* appeared to be partly responsible for retardation of mangrove seedlings, and the deformation of mangrove pneumatophores, and in reducing the area available for pneumatophore development. Such effects can reduce plant condition and cause death in some cases. Dead seagrass that banks up can also add to the smothering effect. Mangrove death due to smothering with the green macroalga *Ulva* is considered to be prevalent north of **St Kilda** (Morelli and de Jong, 1995, and see Coleman and Cook, 2003), and this is linked to the increased eutrophication of **St Kilda Bay** since the 1960s, when sewage discharge commenced. The problem of mangrove dieback has also been particularly evident in the **Port Gawler** and **Barker Inlet** area during the 1990s.

- Fotheringham (DENR, pers. comm., cited by Lewis *et al.*, 1998) reported that around 68ha of mangroves have been killed in the region between **St Kilda** and **Port Gawler**, with the greatest loss in the Bolivar area. Mangrove loss began to occur in the Bolivar around 6 years after the establishment of the effluent outfall (Bayard, 1992; Coleman and Cook, 2003); approximately 250ha have been lost since 1956 (Bayard, 1992, cited by Lewis *et al.*, 1998), and a much larger area is in poor health in the region immediately adjacent to the Bolivar outfall (Parliament of South Australia, 2000).
- Landward “buffer zones” for the mangrove area may be inadequate, due to developments behind the mangrove line, continued land subsidence in the LeFevre Peninsula area (partly due to the pumping of groundwater – see ECITA Reference Committee, 2000), and predicted sea level rise. Burton (1982, 1984) recorded landward accretion of mangroves in the **Swan Alley** region, at the rate of up to 17m per year due to land subsidence and changing sedimentation patterns. The landward accretion is partly related to local subsidence which results in a reduction of the slope of the intertidal areas, allowing the widths of mangrove zones to increase (Blackburn, 2000). On **Torrens Island**, mangroves are continuing to invade saltmarsh habitat (Fotheringham, DEP, 1992, unpublished). Edyvane (pers. comm. to PPK, 1992) reported mangrove movement of 2m per year during the early 1990s. The Multi-Function Polis EIS (see PPK, Hassell and CSIRO 1992a and 1992b) recognised the limited area available for mangroves in the event of sea level rise, and provided buffer zones between the mangroves and proposed developments. However, more recently, concern has been expressed that the buffer areas previously set aside, may be developed in future (uncited evidence, presented to Parliament of South Australia, 2000). Mangroves require regular tidal flushing to maintain soil salinities and assist growth, and are intolerant of either permanent inundation, or permanent drying. This characteristic indicates that future water levels in the area will be of critical significance to mangroves. The issue of prevention of the long-term landward progression of mangroves and saltmarsh under conditions of land subsidence and sea level rise, continues to be exacerbated by industrial developments behind the mangroves. Further reclamation of intertidal and supratidal areas for development remains a threat to the saltmarsh and mangrove ecosystem, due to limited space for landward progression.
- Mangroves are under threat from small scale coastal urban developments including boat ramps, marinas and further land reclamation (Parliament of South Australia, 2000).
- A study by De Guia (1992) indicated that the growth rate of mangroves in the area has been inhibited by the effects of thermal discharge from the **Torrens Island** Power Station.
- Heavy metal contamination may also affect mangrove seedling recruitment (PPK *et al.*, 1992a).
- In the **Barker Inlet / St Kilda** area, mangrove death is also caused by boat wash (Morelli and de Jong, 1995). Mangroves seedling in particular may be damaged from boat wash (PPK *et al.*, 1992).
- Seagrass loss may also contribute to mangrove decline. When the seagrass dies, the sediment is destabilised, and under storm conditions movement of sediment (and dead seagrass) inshore can occur, which can suffocate the pneumatophores (Parliament of South Australia, 2000).
- Extensive trampling and damage of mangrove trees has reportedly occurred near **Garden Island** boat ramp (Morelli and de Jong, 1995). There has been some concern expressed by community members of **Port Adelaide** that trampling of mangrove areas in the **Port Adelaide – Barker Inlet** system (by bait diggers and scalefish fishers and other users of the area) may have some impact upon mangroves in the area.
- Loss of mangroves and the subsequent deterioration of the nursery areas for fish and other biota, has been implicated in the growth of the mosquito population in the Barker Inlet Area. The mosquito larvae are a basic unit of the food chain that exists in a mangrove ecosystem. A reduction in the number of fish in the area is reported to have resulted in an increase in the numbers of mosquito larvae, and hence a proliferation of mosquitoes (City of Salisbury, evidence presented to Parliament of South Australia, 2000).
- Concern has been expressed about the impact upon fish and prawn nurseries of the deterioration of the

mangrove areas due to nutrient pollution (evidence presented to Parliament of Australia, 2000).

Loss of Samphire / Saltmarsh Habitat

- Saltmarsh has been degraded and removed due to agricultural, industrial and urban use and developments (Parliament of South Australia, 2000). During the 20th century, the area of samphire saltmarsh in north-eastern Gulf St Vincent was greatly reduced by a combination of industrial and urban developments including salt evaporation pans and waste disposal sites (Brock, 1975; Connolly, 1999). Construction of salt fields has been one of the major causes of the loss of samphire, particularly since the 1950s (Blackburn, 2000).
- The significance of saltmarsh habitat, and its loss in South Australia, has regularly been documented during the past decade (see Shepherd *et al.*, 1989, Steffensen *et al.*, 1989, Kinhill Stearns 1985b, Bucher and Saenger, 1989; Edyvane, 1991; Edyvane, 1996c; Lewis *et al.*, 1998). The loss of samphire saltmarsh is a major problem in the north-eastern GSV area, particularly since there have been few attempts during the past two decades to rehabilitate damaged saltmarsh area. Saltmarshes constitute approximately 376 ha, approximately 13% of the estuary area (Bucher and Saenger, 1989).
- Any further removal of saltmarsh from the system is considered to be detrimental to the ecosystem (PPK, Hassell and CSIRO 1992a, 1992b). Kinhill Stearns (1985b) reported that since 1954, 80% of the samphire saltmarsh area in north-eastern GSV has been lost due to land reclamation and development. Bucher and Saenger (1989) reported that more than 75% of the entire estuary catchment has been cleared of natural vegetation, due to agricultural, industrial and residential development north of Adelaide. Clearing of mangroves, samphires and other vegetation due to port developments was particularly severe in the **Gillman to Wingfield** regions, from the early 1960s onwards (Parliament of South Australia, 2000). A study of the **Bolivar** area revealed that samphire communities have declined from about 200 hectares in 1949 to about 70 hectares in 1997 due to their replacement by mangroves and the prevention of further landward colonisation by Penrice seawalls (Blackburn, 2000). Minor contributions to saltmarsh loss in the St Kilda Bay area include the existence of dredge spoil holding ponds, some of which have been built on the saltmarsh (see Coleman and Cook, 2003).
- There is limited provision for samphire accretion in the event of continued land subsidence, and predicted sea level rise (of up to 1m over 100 years), due to developments adjacent to saltmarsh areas, removal of saltmarsh, and degradation of existing saltmarsh. If mangroves continue to progress landward (see previous section), more of the existing saltmarsh area will be lost.
- During the early 1990s, the **Garden Island** waste disposal facility was identified as a threat to the remaining saltmarsh in that area (Edyvane, 1992, pers comm. to PPK).
- Although the major threat to saltmarsh in general is reclamation (NSW EPA, 2000), remaining areas can also be damaged by off-road vehicles and other recreational use; illegal dumping; grazing (which is particularly detrimental to the succulent species of lower saltmarsh, and also clears areas of the upper saltmarsh, resulting in the invasion of weeds); mining; salt and chemical production; and alteration of drainage regimes to reduce the abundance of insects such as mosquitoes (Connolly and Bass, 1996; Connolly, 1999; NSW Fisheries, 2000, cited by NSW EPA, 2000; DC Mallala Foreshore Advisory Committee and EcoConnect, 2002).
- Damage to samphire habitats due to 4WD, trail bikes and dune buggies; proliferation of access tracks; dumping of car bodies and other rubbish; removal of vegetation; shell grit mining, and agricultural grazing, all have been cited as concerns in a number of areas along north-eastern GSV (including the **Middle Beach to Port Parham** area – see DC Mallala Foreshore Advisory Committee and EcoConnect, 2002).
- There has been some concern expressed by Port Adelaide residents and conservation groups that the remaining estuarine and supratidal samphire area of **Mutton Cove** will be degraded by the existing and future activities and developments on LeFevre Peninsula (J. Emmett, AMCS, pers. comm., 1999).

Loss of Saltwater Tea Tree Habitat

- Since 1954, 100% of the saltwater tea tree community have been lost from the Barker Inlet and Port Estuary area (Kinhill Stearns 1985; Parliament of South Australia 2000). Saltwater *Melaleuca* communities are not common in Gulf St Vincent, nor most other parts of South Australia (Australian Heritage Commission, undated). The loss from the Port River – Barker Inlet area is likely to be permanent.

Algal Blooms and Other Coastal and Marine Pests / Introduced Species

- Most of the approximately 25+ species of introduced marine species that existed in South Australia during

the 1980s and 1990s, have been found in the **Outer Harbour - Port River – Barker Inlet** system. Most marine pests in the area have been introduced through the discharge of ships' ballast water and / or from the external surfaces of the hulls (Parliament of South Australia 2000). Control of ballast water discharge is a difficult problem because many of the methods and chemicals commonly suggested for control are also harmful to the environment (SAFIC, evidence presented to Parliament of South Australia 2000).

- Introduction and settlement of ballast water organisms has occurred in the **Port River / Barker Inlet** area. Some species that have been recorded in the Outer Harbour - Port River - Barker Inlet system are toxic, such as *Alexandrium minutum* (S.A. State of the Environment report, 1998), and form microalgal blooms. Wild mussels from the Port River contaminated by *A. minutum* have contained GTX1–4 (Oshima et al., 1989a, cited by Lehane, 2000) which could have been very toxic to humans, if the mussels were to be consumed. Red tides by the toxic dinoflagellate *A. minutum* were first recognised in the Port River area in 1986 (Hallegraeff et al., 1988). Plankton and cyst surveys in the Port River in 1983 failed to detect *A. minutum* in an area which now has recurrent blooms. This result led to speculation that *A. minutum* could be an introduced species, and genetic studies using ribosomal DNA sequencing have confirmed a close affinity between Australian and Spanish isolates of this species complex (Hallegraeff, 1995b, cited by Parliament of South Australia, 2000 and Lehane, 2000). The **Port River** is one of a few estuaries in Australia that have regularly recurring algal bloom problems (Hallegraeff, 1995b), and *A. minutum* now produces annually recurrent red water blooms during the period September–November (Hallegraeff, 1995b; Parliament of South Australia, 2000). The toxic dinoflagellate *Alexandrium minutum* now blooms for up to nine months of each year in the Port River estuary (Parker and Blackburn, 2000, cited by Coleman and Cook, 2003).
- In addition to ballast water introductions, other reasons why algal bloom species can exist and proliferate include a change in the ratio of nitrogen and phosphorus to silica in coastal marine waters, which can influence the plankton composition. In eutrophic conditions, nitrogen and phosphorus levels increases, and silica levels decrease, because diatoms (which have skeletons of silica, and are one of the basic life forms in marine food chains) stop reproducing, and other plankton types that do not need silicates, start to dominate the system. This can have a significant impacts on marine food webs, including a reduction in the zooplankton communities that eat diatoms, and changes in species dominance in the grazer community, higher up the food chain (Howarth *et al.*, 2000, cited by Coleman and Cook, 2003). Some of the plankton types that proliferate in areas of with high concentrations of nitrogen and phosphorus and low levels of silica, include toxic and nuisance species.
- Effluent from the Port Adelaide sewage treatment works and other point sources of nutrients, has been implicated in providing the nutrients for the red tides of dinoflagellates that occur in spring every year (Parliament of South Australia, 2000).
- A number of other dinoflagellates also occur in the area. The microalgal blooms are stimulated by discharges into the system, and influenced by the tidal regime, temperature stratification in the water column due to thermal effluent, salinity and light levels, and seasonal variability in nitrogen levels (see Cannon, 1990, 1991, 1993). In addition to nutrient inputs from sewage and stormwater, the anaerobic sediments in the Barker Inlet system regularly release nutrients, which stimulate the growth of the microalgae. Toxic microalgal blooms of up to 9 hundred million cells per litre (Cannon, 1991) are responsible for oxygen depletion of the waters, periodic fish kills, contamination of molluscs such as mussels (which can result in paralytic shellfish poisoning in consumers of mussels), and reduction in light available for aquatic plant growth, amongst other impacts. Sixteen blooms involving eight species were recorded in the region over an eight year period (Steffensen, 1988). Dinoflagellate cysts are especially prevalent in the sediments of the Port River (Cannon, 1990, 1991, 1993; Hallegraeff, 1995a and 1995b).
- Microalgal blooms are also an episodic problem in the **Gawler River** (National Land and Water Resources Audit data, see GeoScience Australia, 2001)
- In addition to microalgae, other pests in the **Port River - Barker Inlet** system include those which compete with native species for space and resources, resulting in altered community composition. Examples of introduced animal pests include *Bugula* sp. ("sea moss"); *Cassiopea ndrosia* (tropical jellyfish); New Zealand greenlip mussel (*Perna canaliculus*); European Fan Worm (*Sabella spallanzanii*); the ascidian *Ciona intestinalis*; the European Shore Crab *Carcinus maenas*; the pearl oyster *Pinctada albina sugillata*; and the Oriental grass shrimp *Palaemon macrodactylus* (Berggy, 1996; Furlani, 1996; CSIRO, SARDI Aquatic Sciences and South Australian Museum sources, compiled by MCCN SA; Emmett, AMCS, pers. comm., 2000; Baker, pers. obs., 2000; CSIRO, 2002; University of Adelaide, 2003; Reefwatch, 2003; S. Shepherd, pers. comm., 2004). Some of these species are described in more detail below.
- The Mediterranean Fan Worm, *Sabella spallanzani* (Mediterranean fan worm) has established at North Haven, Outer Harbour and the West Lakes area (City of Port Adelaide Enfield, undated; Reefwatch, 2002), and was first confirmed in the Port Adelaide / West Lakes area in 1986 (Parliament of South Australia,

2000). The species may have already colonised up to 3500 hectares in Gulf St Vincent (CSIRO, 2002). The species is found on a variety of hard substrates (shells, jetty pylons, channel markers, wrecks, rocks, etc.) but can also be found in sand (Reefwatch, 2002). The species is fast growing, and can rapidly cover a large area, forming dense, mono-specific stands that alienate other species. The Mediterranean fan worm reportedly competes with native bivalves and other shellfish for phytoplankton food; changes the marine environment by affecting water circulation, nitrification, invertebrate recruitment, fish breeding, and seagrass beds; and impacts on fishing operations (Joint SCC/SCFA National Taskforce, 1999; Reefwatch, 2002).

- The European Shore Crab is found in a wide variety of habitats, such as on the shore; in rock, mud and sand habitats; in estuaries, seagrass beds and marshes (Reefwatch, 2002). The species is very hardy, able to tolerate extremes of temperature and salinity. In other parts of Australia, a number of studies have shown that *C. maenas* can have a significant impact on native species such as Mud Cockles and other bivalves (see papers in Thresher, 1997). For example, Mackinnon (1997) showed that a large portion of the European shore crab's diet in Tasmania consists of bivalves such as Mud Cockles and small mussels of two species. The study also reported that the crab is capable of consuming vast quantities of the juveniles of various bivalve species over short time periods, and therefore that the European shore crab has the ability to drastically reduce numbers of smaller sized mussels and clams (cockles), and alter bivalve assemblages. Similarly, a study by Walton (1997) showed that juvenile *K. scalarina* (mud cockles) in Tasmania are preyed upon heavily by European shore crabs (particularly by large male crabs), and that the introduced crab species is a more important predator upon juvenile mud cockles than are native crabs and whelks. The study suggested that *Carcinus* may have a very large impact upon the abundance and distribution of *K. scalarina*, and, subsequently, the fishery (Walton, 1997). Both mud cockles and mussels are found in the Port River – Barker Inlet system, and the introduction of the European Shore Crab in this area is therefore of concern regarding populations of these bivalve species. In the Port Adelaide – Barker Inlet area, *C. maenas* has been observed killing native invertebrates such as species of anemone (J. Emmett, AMCS, pers. comm. 2001). *C. maenas* is abundant on intertidal mud flats, which are used by juveniles of the native blue swimmer crab (*Portunus pelagicus*). A recent study concluded that juvenile blue crabs in the northern GSV area may be more vulnerable to predation by the introduced shore crabs than by adults of their own species, and that if shore crabs were to spread outside of their present localised distribution in South Australia they could have substantial negative impacts on Blue Swimmer Crab populations (see SARDI, 2001d).
- The New Zealand green-lipped mussel *Perna canaliculus* has been found in the shipping channel in the **Port Adelaide River**. PIRSA has used a combination of divers and dredges to remove the infestation. Follow-up dive surveys indicated that the pest has not established or spread (Joint SCC/SCFA National Taskforce, 1999).
- During the early 2000s, the invasive macroalga *Caulerpa taxifolia* was recorded in West Lakes and parts of the Port River, such as river bottom in the Jervois Bridge area (SARDI / PIRSA brochure, undated; City of Charles Sturt, 2003). The species grows extremely rapidly, and is capable of covering many hectares of sea floor in a short time. The species can out-compete native seaweed species; displace bottom-dwelling communities and is considered to be a threat to seagrass meadows. Invasions of this species in the Mediterranean have resulted in reduced fish density and a marked decline in coastal fisheries production (SARDI, / PIRSA undated). During the early-mid 2000s, *Caulerpa taxifolia* was eliminated from West Lakes, but remained established in the **Port Adelaide River** (see **Notes on Impact Management** section). Another competitive *Caulerpa* (a strain of *C. racemosa*) has also been found in recent years in the **Port River**, and apparently proliferates in places of high (or enhanced) nutrients (S. Shepherd, pers. comm., 2004).
- A patch of the European Cord Grass *Spartina anglica* has become established near **Port Gawler**, and is considered to have the potential to become a major threat to habitats, if it spreads (Bryars, 2003).

Landfills

- During the late 1990s, Wingfield landfill was accepting around 500, 000 tonnes per annum (tpa) of wastes, and Garden Island around 180, 000 tpa (Planning SA and EPA, 1999). The accumulation of waste, deposited mainly in landfill sites (e.g. **Wingfield** and **Garden Island**), creates large amounts of landfill gas that becomes an environmental pollutant if it is not used as an energy source. The main constituents of landfill gas are methane and carbon dioxide, both of which are major contributors to global warming. According to Falzon (1997, cited by Treloar, 1998) methane from landfill accounts for 13.5 percent of Australia's total emissions, with an estimated 710 000 tonnes of methane being released into the atmosphere annually. With current technology, it is feasible to recover up to 90 percent of the methane from landfill, significantly reducing atmospheric pollution, however landfill gas recovery is currently small

scale in South Australia.

- Mangrove habitat in **St Kilda Bay** has been reduced due to the existence of a landfill / dump for the City of Salisbury, which was established during the 1960s, on the mangroves adjacent to the southern creek (Coleman and Cook, 2003).
- Other issues associated with land fill sites include groundwater contamination from toxic substances released from the site. More than 900 different chemical compounds have been identified from samples taken from the **Wingfield** site (Treloar, 1998).
- Interstitial waters in **Angas Inlet** have high concentrations of ammonia close to the margin of a landfill site. The concentrations of ammonia found in clean, sandy sediments on the south eastern side of the landfill are considered to be caused by movement of groundwater from a source of ammonia, such as the landfill on **Garden Island** (Harbison, 1999, and evidence presented to GSV Senate Inquiry 2000).
- Migration of landfill gas is also an issue. Vegetation can be killed as gas percolates through the soil substrates to the surface. Methane displaces oxygen in the soil, starving the plant roots, and killing the plants. Methane also prevents revegetation of landfill sites until the methane has dispersed from the soil (A. Kutlaca, MGCES, pers. comm., 1994; Haylock, 1996, cited by Treloar, 1998). (see **Notes on Impact Management** section)
- During the late 1990s and early 2000s, community concern has been expressed about new landfills at **Dublin** and **Inkerman** on the north-eastern side of the Gulf (see Parliament of South Australia 2000, and DC Mallala Foreshore Advisory Committee and EcoConnect, 2002). The Dublin landfill site has been approved in the Mallala Council district area, around 3 km south of Dublin, with the first stage development around 6km from the coast (extending to 3km from the coast within 60 years). At Inkerman, one landfill was approved by 2000, with a further four awaiting development applications. The first development at Inkerman is approximately 3.7km from the coast (EPA, evidence presented to Parliament of South Australia 2000). The Parliament's Environment, Resources and Development Committee received a number of submissions, as well as 279 form letters, expressing concerns about these developments (Parliament of South Australia, 2000). The landfills are part replacements for the existing waste repository at **Wingfield** and other landfills that will be closed during the early 2000s.
- Concerns expressed in relation to the **Dublin** and **Inkerman** landfills include the following (from District Council of Mallala; Dublin and Districts Ratepayers Association; Inkerman Proposed Landfill Action Group, evidence presented to Parliament of South Australia, 2000):
 - ◆ Potential for toxins from the waste to leach into the water table and reach the Gulf, thereby impacting ecosystems, including the fish and crustacean nursery and breeding grounds in north-eastern Gulf St Vincent. Gulf St Vincent forms the entire western boundary of the Mallala District Council area, where the Dublin landfill has been approved. The Mallala District Council and residents in the area have been concerned that whilst the outstanding conservation significance of the northern GSV area has been recognised, the dump site is within 4 kilometres of the Gulf, and immediately abuts a Coastal Zone. Mallala District Council and the Dublin and Districts Ratepayers Association, have expressed concern that the Dublin landfill facility breaches standards set for assessing proposals for landfill dumping facilities throughout the State; that landfill cells will be embedded approximately 2 metres beneath the level of the seasonal groundwater table; and that there is potential for waste to enter the groundwater, due to the close proximity of the landfill to both the groundwater table and the GSV coast;
 - ◆ Potential physical and chemical damage to samphire wetlands, which are part of the **Dublin** site;
 - ◆ Potential environmental degradation of the **Inkerman** area, including coastal habitats, the fish breeding and nursery areas, and coastal bird nesting sites. Inkerman is situated 15 km south of Port Wakefield and contains coastal samphire swamplands, mangroves and tidal channels, sand dunes with a high risk drift potential, and has highly saline groundwater. The Inkerman area is also registered by the Soil Board as a high-risk wind erosion area (evidence presented to Parliament of South Australia, 2000). There is concern that because the waters at the top of the Gulf, which move in a circular motion, do not flush readily, any contaminants from the landfills that enter the gulf system, may not be readily flushed and diluted.
 - ◆ Potential for gases from the landfill sites to contaminate the local area;
 - ◆ Potential for water quality in north-eastern Gulf St Vincent to be degraded, which may result in both environmental and industrial / commercial impacts.
 - ◆ Risk of disease transmission from the landfills to the local environment;
 - ◆ Risk of population increases of "opportunistic species" such as silver gulls, and introduced animals such as foxes.

- In terms of environmental impacts, it is noted that the Environmental Protection Authority (evidence presented to Parliament of South Australia, 2000) has stated that, due to the low rainfall in the **Dublin** and **Inkerman** areas, the high evaporation rate, and the design of the lining and leachate collection systems for both new landfill areas, the amount of leachate generated under the proposed operating conditions and following closure and capping, is likely to be minimal. The EPA reported that investigations at both sites indicated that there were no continuous high permeability soil layers that could provide a direct connection to the Gulf. Results of environmental monitoring following construction of the landfills, are not available for this report.

Fish Kills and Invertebrate Contamination

- Dissolved oxygen levels are generally low in the Barker Inlet area, particularly around the North Arm region, due to the high organic content of those sediments (Edyvane and Dalgetty, 1991, unpublished data, cited by PPK *et al.*, 1992b; Harbison, evidence presented to Parliament of South Australia, 2000). Low levels of oxygen in the water directly affect the survival of marine fauna in the region. When the dissolved oxygen concentration reaches its lowest level over a 24 hour period (usually before dawn), large shoals of juvenile fish die from lack of oxygen. The evidence of the fish deaths due to anoxia is not observed during daylight hours, because predators such as silver gulls eat the fish soon after they die (Harbison, evidence presented to Parliament of South Australia, 2000).
- Toxic microalgal blooms are present for up to 10 weeks per year, particularly in the upper reaches of the Port River estuary. Proliferation of macroalgae such as species of *Ulva*, *Cladophora* and *Enteromorpha* is also a periodic problem (National Land and Water Resources Audit – see GeoScience Australia, 2001).
- “Fish kills” have been irregularly reported by fishers in Barker Inlet and the North Arm area for “many years” (PPK *et al.*, 1992). This is considered to be in response to lower levels of dissolved oxygen, particularly in areas where shallow waters overlie sediments that are rich in organic matter, and where excessive growth of “nuisance” macroalgae (e.g. *Ulva lactuca*) or microalgae (including toxic dinoflagellate blooms) occur, due to high nutrient concentrations (Harbison, verbal submission to Senate Inquiry into Gulf St Vincent, February, 2000; EPA, 2003).
- There have been regular episodes during the past decades of mussels and other fauna in the Port River-Barker Inlet estuary being contaminated by a toxin from microalgae, that causes Paralytic Shellfish Poisoning. Microalgal toxin levels are reported to be dangerous from 4 to 6 months per year, especially during spring months, and shellfish contamination in the area is a chronic problem (National Land and Water Resources Audit – see GeoScience Australia, 2001).

Salt Wastes

- There are salt works at **Price** and **Dry Creek**. Alkaline grits and brine from salt works at **Dry Creek** have been dumped over a long period on “spoil grounds” in the shallow waters off the **LeFevre Peninsula**, approximately 2km north-west of Outer Harbour. Some of this highly alkaline waste product, which is rich in magnesium chloride, is now reused as a dust suppressant for roads, but most is still returned to sea via **Barker Inlet**, according to Penrice (2000). There are some reports that the alkaline wastes have degraded the receiving environment over a long period, and that the local soils and water were still contaminated during the mid to late 1990s (J. Carey and A. Kutlaka, MGCES, pers. comm., 1994; Paxinos and Clarke, 1996).
- According to PPK (2000), the waste material from the salt works has “previously been established as being unsuitable for sea disposal”.
- Construction of salt fields has also been identified as a threat to saltmarsh habitat in South Australia, mainly due to reclamation of saltmarsh area (Environment Australia, 1998a).

Dredging and Dredge Spoil

- Dredging in the north-eastern GSV area includes regular dredging of the navigation channel, turning basins and shipping berths. Penrice Soda also dredges the shipping channel. There is occasional dredging to maintain small boat access to St Kilda channel. Also, regular maintenance dredging occurs at commercial marinas at North Haven and Outer Harbour (GeoScience Australia, 2001).
- Dredging has created deep channels for shipping, and extensive areas of vegetation, including saltmarshes, mangroves and seagrass, have been removed (EPA, 2003).
- Dredging in the area (for shoreline developments, and to maintain boating channels in the Port River area) can disturb large volumes of contaminated sediments, resulting in an increased load of chemical pollutants

that are biologically available in the system, as well as increased sedimentation (e.g. causing smothering of benthos and seagrass), and reduction in oxygen levels in the waterways of the system.

- Dumped dredge spoil material from harbour dredging sites contains toxic substances, especially heavy metals and chlorinated hydrocarbons, (J. Carey and A. Kutlaka, MGES, pers. comm., 1994; PPK, 2000).
- The spoil grounds 2km north-west of **Outer Harbour** now contain only scattered patches of seagrass (Clarke, unpublished, cited by Paxinos and Clarke, 1996). There are also spoil grounds seaward of **Ardrossan**, on the north-western side of GSV.
- Although the environmental impacts of dredging were not detailed in a review report by PPK (2000) on options for dredging (2000), the report specified that “*environmental aspects that could require managing throughout any dredging program within the Port River include turbidity, benthic fauna, fish, dolphins, seagrasses and noise*” (PPK, 2000, p. 7).

Hydrocarbon Pollution

- Hydrocarbon pollutants from shipping, boating and associated activities is an issue in the area. This includes small, cumulative sources (e.g. from motor boats, ballast water, bilges, discarded oil containers etc) and larger spills from ships. Two significant oil spills occurred at **Port Adelaide** between 1988 and 1992 (DELM, 1993a).
- In December 1995 2,000 litres of oil was spilled into Angus Inlet when a transformer ruptured (Reynolds, 1998). More than 60 tonnes of bunker oil was spilled into the Port River in February 1998. The oil was spilled from a container ship which was docked at Outer Harbor. Small spills occur regularly. For example, in November 1996 a minor spill from a visiting ship occurred at the inner harbour. In two separate incidents in 1997, boats hit the Outer Harbour breakwater and sank (Reynolds, 1998).
- Hydrocarbon pollution from petro-chemical spillage during shipping operations in **northern Gulf St Vincent**, has been listed as a potential threat to marine and estuarine habitats in the area (Bryars, 2003).

Chemical Spills

- Periodically, there are spills of toxic and persistent chemicals into the Port River - Barker Inlet system. For example, according to Harwood (1990) and Reynolds (1998), 15,000 litres of copper chromium arsenate spilled around Gillman in 1985, and entered the North Arm. Around 100 tonnes of liquid chlorine is reported to have been spilled from an industry at Osborne, in 1986 (Harwood, 1990).

Physical Damage to Habitat and Associated Impacts

- Physical works such as causeway and embankment construction for evaporation ponds is considered to be a “known threat” to the **Port Gawler Conservation Park** area (Ivanovici, 1984).
- Flow in the **Gawler River** is heavily regulated, due mainly to dams, weirs and diversions on its tributaries. The **Little Para River** is regulated by the dam forming Little Para reservoir, while the **Dry Creek** system flows into artificial channels across the Northern Adelaide Plains district (Northern Adelaide and Barossa Catchment Water Management Board, 2001).
- In general, physical impacts regularly cited in the northern and north-eastern Gulf St Vincent area include the following (from PPK *et al.*, 1992b; Carey and Kutlaka, Mawson Graduate Centre for Environmental Studies, pers. comm., 1993; Morelli and de Jong, 1995; Berggy, 1996; J. Emmett, pers. comm., 1999; Harbison, verbal submission to Senate Inquiry into Gulf St Vincent, February 2000; District Council of Mallala Foreshore Advisory Committee and EcoConnect, 2002):
 - ♦ erosion of banks due to powerboats (particularly in areas of mangrove forest, and shallow channels);
 - ♦ erosion of intertidal and shallow subtidal habitats, including loss of seagrass, due to dredging / channel cutting for boat launching;
 - ♦ trampling of mangrove areas by bait collectors and other visitors;
 - ♦ erosion and other damage to saltmarsh, beaches and other habitats in the area, due to cars, 4WD and/or motor bikes;
 - ♦ littering in saltmarsh flats and mudflats and mangroves;
 - ♦ dumping of car bodies and other large objects;
 - ♦ domestic and commercial rubbish dumping, and
 - ♦ grazing by rabbits and English Fallow Deer

- In the weapons testing area, there are reports from a fisheries scientist (Jones, SARDI, pers. comm. cited by M. Bossley, ADRF, pers. comm., 2000) and a commercial fisher who works in the area, of benthic impacts on seagrass beds, such as craters, due to bomb testing. Waters south of Port Wakefield to Sandy Point are part of the Army restricted and danger areas R259E, R259D, and R259A. Physical disturbance due to Army exercises at the Department of Defence Firing Range, has been listed as a potential threat to intertidal and shallow marine habitats in **far northern Gulf St Vincent** (Bryars, 2003).
- There is potential for intertidal and shallow subtidal areas to be damaged, from the launching and use of boats, and associated vehicles used for boat launching (e.g. 4 wheel drives and tractors) (Berggy 1996). Impacts have been noted (Veitch, verbal submission to Senate Inquiry into Gulf St Vincent, February 2000), and examples of damage include sediment disturbance; crushing of mangrove seedlings and pneumatophores; and seagrass scouring /dislodgment and erosion, from boat hulls and propellers.
- Intertidal trampling from recreational activities such as fishing and crabbing, may affect mangrove regeneration (Edyvane, S.A. Department of Fisheries, pers. comm. 1992; Morelli and de Jong, 1995). There is evidence of trampling in a number of areas (e.g. Port Gawler - Berggy, 1996).
- Bait-digging for invertebrates in northern Gulf St Vincent physically damages supratidal, intertidal and shallow subtidal habitats (J. Emmett, AMCS, pers. comm., 2000).
- Destruction of vegetation by off road vehicles and visitors is a recognised threat to the Clinton Conservation Park (Morelli and de Jong, 1995).
- Morelli and de Jong (1995) reported that there had been some degradation of habitat from trail bike riding in the Price area.
- Digging by rabbits has reportedly damaged coastal vegetation at Price (Morelli and de Jong, 1995).

Fishing / Collecting Issues

The status of, and potential threats to, the following species that are caught in the area, are discussed further in Section 9.2.

- *Mud Cockle*: Yields of Mud Cocks escalated in upper Gulf St Vincent during the 1990s, as the fishery developed in response to increased demand. The species has previously been used only for bait but more recently for food, including export to interstate markets (see Fowler and Eglinton, 2002). Fowler and Jones (1997) advocated a cautious management approach to mud cockle fishing in all parts of S.A. (including the upper Gulf St Vincent area), including control of fishing effort, setting of minimum legal sizes, and regular monitoring of stock indicators (Fowler and Jones, 1997). A gear restriction of one harvesting rake per fisher has been introduced (Fowler and Eglinton, 2002). The take by recreational fishers in the northern GSV area has not been quantified. According to Parliament of South Australia (2000), SARDI has previously recommended reducing the take of mud cockle adjacent to **Outer Harbor**. A stock assessment in 2001 (Fowler and Eglinton, 2002) concluded that there was no evidence that would currently cause concern about the status of the stocks in the northern GSV region, however the following points were provided, indicative that mud cockle species have potentially vulnerable population characteristics: (i) between 1999 and 2001 there was a substantial change to the species composition and population structure of mud cockles at Section Bank, believed to be environmentally-driven. One species, *Katelysia rhytiphora* disappeared from the bank, and two other species showed reductions in abundance; (ii) recruitment appears not to be an annual event, and any cohort that does eventuate, must sustain the population (and the fishery) for several years; (iii) mud cockle species are relatively long lived and slow growing. For example, a study of *K. scalarina* at Section Bank showed that the species grew slowly, and individuals were aged up to 10 years; and a Tasmanian study of the same species showed that larger individuals were aged up to 29 years (see Fowler and Eglinton, 2002, and references cited therein).
- *Garfish* are caught in the area, by both commercial and recreational fishers. Although commercial catch rates have generally been stable since the 1980s, the Garfish stock in S.A. is considered to be fully exploited, according to available biological performance indicators (BPIs). Catch rates are not considered to be a sensitive indicator of stock abundance for schooling species such as Garfish. Also, previous assessment of the recreational fishery showed that the current bag and boat limits were inadequate (too high) for conservation purposes (Ye, 2000). Recreational bag and boat limits were reduced in the early 2000s, partly in recognition of the fully fished status of this species.
- *Snapper* are caught in the area. Previously, Snapper were classified nationally as over-fished in Gulf St Vincent (Zann, 1995), and classified as *fully fished* in South Australia (DEHAA and EPA, 1998). Some fisheries researchers and fishers in South Australia agree that the Snapper fishery is over-exploited, due to decline in the number of large (older) high fecundity fish available in the fishery, amongst other indicators,

and the vulnerability of such populations that are subject to sporadic “boom” recruitment episodes. Up until the late 1990s and early 2000s, there were no indications of full recovery of the stock in Gulf St Vincent (Fowler, 2000), which likely declined due to over-fishing and poor recruitment during the 1980s and 1990s. Fowler (2002) attributed long term decreases in hand-line effort (including a halving of the number of fishers targetting Snapper using hand lines in Northern Gulf St Vincent since 1983-84) to a substantial reduction in biomass available to the fishers (Fowler, 2002). Although relatively strong year classes occurred in 3 years during the 1990s, Fowler (2002) concluded that in the absence of a stock rebuilding scheme in Gulf St Vincent, the fishery may continue to operate at a low level, on a depleted stock. However, in 2001/2002, the total catch in Gulf St Vincent was about 51t, 40% higher than the previous year’s catch. The catch from southern and northern Gulf St Vincent was roughly even during that period. According to Fowler et al. (2003), increases in total catch and CPUE since the mid-1990s, “suggest a slow recovery of the fishery in this region”. Despite the increased catches in recent years, it is important to consider the vulnerability of Snapper populations to depletion from over-fishing (see section 9.2), as has already occurred in GSV, and cautious management of the fishery is essential.

- *King George Whiting*: There is evidence to suggest that King George Whiting is fully fished in Gulf St Vincent (e.g. Jones *et al.*, 1990, cited by Lewis *et al.*, 1998; Fowler and McGarvey, 1997). Fowler and McGarvey (1997) recommended that there be sufficient escapement of immature fish (particularly the two to three year old age classes), from heavily fished inshore areas (such as Gulf St Vincent). This would enable sufficient numbers of King George Whiting to annually replenish the spawning populations of larger whiting further south of the gulfs. McGarvey *et al.* (2000) considered that, because of the nature of population reproduction in the two gulfs, the general risk of relatively rapid decline in the whiting population is higher than average. King George Whiting spawn in very few known locations, and if the spawning stock were to decline enough to significantly affect recruitment, catches would be expected to decline around 3 years later, when the fish spawned from a year class of reduced egg abundance reach legal size. The King George Whiting stock is subject to high levels of fishing and natural mortality. The species is not long lived, and the catch in each year is comprised nearly entirely on each newly recruited year class as it comes through. Catch and effort on the younger, newly recruited whiting in Gulf St Vincent are high.
- *Yellow-fin Whiting*: Cautious management of fishing this population may be advised, considering the following factors (adapted from Ferguson, 2000): (i) the fishery in Gulf St Vincent is dominated by young fish (2 year olds), with older age classes found in low abundance. Older age classes have been found mainly in unfished areas, such as limited parts of Spencer Gulf, and in that gulf, fishing in the commercial grounds is considered to be responsible for a reduction in the relative abundance of older age classes; (ii) recruitment and year class strength are highly variable over space and time, likely due to oceanographic factors; (iii) the contraction of the size range in the fishery may indicate smaller numbers of the major egg producers in the population (i.e. the older females), and ultimately a decline in egg production; (iv) fisheries which target young fish are dependent upon continued high annual recruitment levels (and recruitment levels and subsequent year class strength are likely to strongly influence the biomass available to the fishery); (v) due to steadily increasing market value of yellow-fin since the 1980s, annual commercial catches from upper Gulf St Vincent have been increasing in most years throughout the 1990s (compared with yields from the 1980s); and (vi) the recreational fishery for yellow-fin whiting is active at a time when these fish are reproductive.
- *School Shark and Gummy Shark*: Both species are caught commercially in part of the area described in this table. The species are also taken by recreational fishers, but the extent of the fishery in upper GSV is not known for this report. School Shark (Australasian subpopulation) was listed in the IUCN Red List 2003 as Conservation Dependent, and previously, Gummy Shark was included in the IUCN Red List 2000 and Red List 2002 as Conservation Dependent. The Commonwealth has recently re-regulated the fishery for school and Gummy Shark, in light of the over-fished status of School Shark populations in southern Australia since the early 1990s (see AFFA, 2000b; AFMA, 1999b; AFMA, 2003) and the fully-fished status of Gummy Sharks (AFMA, 2000d). The status of (and potential risks to) School Shark and Gummy Shark populations are discussed further in section 9.2.
- *Bronze Whaler Shark*: Whaler sharks are commercially fished in this area. Upper Gulf St Vincent is known amongst the fishing community for its seasonal abundance of Bronze Whaler pups. Young Bronze Whalers are also fished recreationally in South Australia (as both target and bycatch, the latter of which are often killed – according to Winwood (1994), but figures are not available for this report. The extent of recreational fishing in the upper GSV area is not known for this report. Bronze Whaler and Black Whaler were both included in the IUCN Red List 2003 as *near threatened* species. The potential risks to Bronze Whaler and Black Whaler Shark populations are discussed further in section 9.2.
- *Worms*: Bait-digging for tube worms and beach worms and fishing for blood worms in northern Gulf St Vincent may have come ecological impact. Although an assessment of the fishery in 2002 showed that there is no evidence for any decline in the worm fishery since 1983/ 84 (Westlake *et al.*, 2002), there is no

fishery-independent data available to determine the size of the worm populations, or the proportions of the populations that are taken by the fishery. There are no data on the extent of recreational bait-collecting in the area. Also, to date, no studies have been undertaken to determine whether or not the combined commercial and recreational fishery may have impacts on the food chain / food web in this area, and hence the ecological sustainability of the worm fishing industry has not been assessed. Worms are a food source for shallow foraging fish, wading birds, crabs and other worm consumers in the area (e.g. predatory snails). Worms also have other important ecological roles, in terms of sediment processing and nutrient recycling. Another issue related to digging for worms is disturbance of the mudflat and mangrove habitat, through trampling, and sediment mobilisation.

- *Other bait species*: In addition to worm species and mud cockles, uncontrolled harvesting of other invertebrates (such as minor mollusc species) may occur in the area, with similar potential threats (i.e. population impacts and ecological impacts) as those outlined above.
- There have been community reports (e.g. during the late 1990s – early 2000s) to government authorities of increased and illegal fish netting in the upper north-eastern area (**Port Gawler – Port Parham** area). Illegal netting has been identified as a threat in the Baker Inlet area (Morelli and de Jong, 1995).
- There has been anecdotal information of a recent increase in net fishing activity (according to community concerns from the **Middle Beach** area (M. Bossley, pers. comm., 2000).
- Fishing has been identified as a potential threat to the *Zanoni* Historic Shipwreck site (SADF, 1993; AIMA News, 1997). In particular, there have been anecdotal reports from divers during the past decade of Snapper aggregations being regularly targeted at the wreck site (see section above, on conservation concerns regarding Snapper populations).
- There have been ongoing concerns amongst conservation groups, that recreational fishing is permitted in the Barker Inlet system, which is an Aquatic reserve, and an important nursery area for fish and crustaceans. The potential impacts of recreational fishing on dolphins (e.g. boat strikes, entanglements in fishing gear) have also been expressed as a concern (see below).

Risks to Coastal Bird Populations

- Recognised threats to Samphire Thornbill populations in northern Gulf St Vincent include destruction of habitat by trail bikes and cars driving over samphire (widespread in the area); grazing and trampling of habitat by sheep and horses (e.g. there is evidence of samphire degradation by livestock on the Light River floodplain) (Smith, 2002).
- In general, recognised threats to shorebirds in the northern and north-eastern Gulf St Vincent area include: (i) disturbance and destruction of nesting sites (e.g. due to trail bike riding and driving through samphire, on salt pans and along beaches, all of which are nesting habitats for Masked Lapwing and Red-capped Plover); and (ii) disturbance to shorebirds / migratory waders, from boating activity (DC Mallala Foreshore Advisory Committee and EcoConnect, 2002); (iii) persistent disturbance of nesting birds along beaches and other sites, which may increase if north-eastern GSV areas are further developed and inhabited by people. Smith (2002) noted disturbance to roosting flocks in the north-eastern GSV area (e.g. Middle Beach to Port Parham area), due to cars driving on beaches, and also from due to activity by people and dogs. Disturbance of beach nesting sites is considered to be especially pertinent for sharp-tailed Sandpiper (Smith, 2002).
- Plastics, rope, netting and fishing gear can entangle seabirds, or be ingested by them (Parliament of South Australia, 2000).

Risks to Bottlenose Dolphin Populations

- Dolphins in the Barker Inlet / Port River and surrounds have been subjected to pollutants (including mercury contamination), heavy boat traffic, boat strikes, fishing debris entanglements, harassment, stabbings and shootings (Bossley, ADRF, pers. obs.; ABC Media Report, 1999; Government of South Australia, 2002; DEH, 2003c).
- Motor boat activity may cause both acoustic disturbance and physical injury to dolphins in the area.
- Members of the dolphin populations in the Port River-Barker Inlet system are susceptible to deliberate harm by humans (Bossley, ADRF, pers. comm., 2000; DEH, 2003). In recent years there have been reports and findings of dolphins being shot, stabbed and speared (Bossley, pers. comm., cited by City of Port Adelaide – Enfield, 2003).

- Dolphins are also susceptible to injury from floating litter in the Port River - Barker Inlet system, such as fishing line, rope, netting, plastic bags and other plastic waste (Parliament of South Australia 2000). A number of dolphins have been found trapped in marine litter, especially discarded fishing line (Bossley, pers. comm., cited by City of Port Adelaide – Enfield, 2003), or presenting injuries consistent with previous damage due to marine litter.
- There are some anecdotal (and unconfirmed) accounts of dolphin injuries due to bomb testing in the weapons testing area (south of **Port Wakefield to Sandy Point**) (M. Bossley, ADRF, pers. comm., 2000), and there is potential for acoustic impacts on such marine fauna.

Other Issues

- Grain dust enters the marine environment around the **Ardrossan** area (Petruševics *et al.*, 1998), south of the western side of the area discussed in this assessment. Possible impacts include increase turbidity and nutrient input (T. Kildea, pers. comm., 2001). Within that region, spoil grounds for dredged sediment dumping exist in waters 10m deep, between **Ardrossan** and **Tiddy Widdy** beach. There is also a large landfill waste disposal site just above high tide level, at **Ardrossan** (Berggy, 1996).
- **Buckland Park**: The interception of water upstream of the **Gawler River** (now dammed) has reduced flow to the Buckland Park reserve, and is reported to have caused loss of vegetation in breeding and feeding sites (unreferenced, cited by CCSA, 2000), thus reducing habitat quality.
- Exotic fish species such as Goldfish and Mosquito Fish occur in the downstream part of the rivers and streams that enter northern Gulf St Vincent, such as the **Gawler River** (e.g. Hicks and Sheldon, 1999). Exotic fish species compete with native fish species for resources.
- There have been concerns amongst the community in the **Middle Beach** area, about the pumping of seawater used for salt crystallisation, allegedly causing siltation of an access channels in the area (DC Mallala Foreshore Advisory Committee, 2002).
- Rubbish is dumped in the **Price** area and **Clinton Conservation Park** (Morelli and de Jong, 1995), which may result in visual pollution, and potential for reduced habitat quality.
- In the **Clinton** and **Price Conservation Parks** there are weed infestations / exotic plant invasions (Morelli and de Jong, 1995).
- At **Clinton Conservation Park** and **Price**, there has been report of predation upon coastal birds by domestic cats and dogs (and also foxes, at **Price**) (Morelli and de Jong, 1995).
- Illegal shooting has been recorded in the **Price** area (Morelli and de Jong, 1995).
- There have been previous reports (e.g. during the 1980s, cited by DC Yorke Peninsula, 2002) that the **Tiddy Widdy** well (which lies about midway between the beach and the foreshore road amidst the sand hills), was in a state of deterioration, with bottles and tyres thrown into it.
- Continued land subsidence due to both natural instability of the St Kilda Formation sands and clays, and high levels of water extraction for industrial use may, in combination with predicted sea level rise, significantly alter the physical and ecological nature of the entire system in the Baker Inlet region (Burton, 1982a and 1982b; J. Carey and A. Kutlaca, MGCS, pers. comm., 1994).
- Sea level rise is an issue in the area (Morelli 1995), due to the low lying nature of the peninsula. Groundwater extraction may increase the effect of sea level rise in the long term, by contributing to land subsidence.
- Other impacts in the northern and north-eastern Gulf St Vincent region include noise pollution (e.g. motorbikes and powerboats), weed infestation, and grazing by rabbits and other introduced fauna.

Notes on Impact Management in Northern Gulf St Vincent

- It was recommended in 1992 (Edyvane, S.A. Department of Fisheries, pers. comm. to PPK 1992) that baseline, “integrated” ecosystems-based modelling studies should be carried out in the area, and that the current separate assessments of water quality, sediment quality, groundwater, hydrological patterns and biota were inadequate, being based on poor quality, patchy data that were not spatially or temporally

replicated, and did not consider the cumulative or synergistic effects of impacts on the entire system, or consider the relationships between the physical and biological components of the system.

- During the mid 1990s, the MFP (Multi-Function Polis) corporation was involved with a number of remedial works in the **Barker Inlet – Gillman** region and surrounds. Examples included the following (from Parliament of South Australia, 1996):
 - ♦ the development of around 300ha of wetlands, including the Barker Inlet Wetlands, the Range Wetlands and the Magazine Creek Wetlands, and associated desalination projects;
 - ♦ revegetation attempts at **Wingfield**;
 - ♦ measures to prevent further illegal dumping on the **Gillman** site, such as fencing, and providing limited access to certain sensitive areas;
 - ♦ providing areas of mounding covered in dense vegetation to prevent illegal access and dumping in the area;
 - ♦ remediation of the Garden Island dumping site, including revegetation, manufacture of topsoil from waste products, and development of an environmentally-benign capping for the site;
 - ♦ involvement with a catchment management plan for the **Dry Creek** and **Little Para** catchments;
 - ♦ involvement with the multi-disciplinary development of a marine hydraulics model, that analysed the discharges into the Port River area.
- Since the 1990s, a number of pollution control programs have been instigated in this area, involving State and Local governments, community groups, industries and consultants. Harbison (1997) summarised some of these programs, including the EPA's Environmental Improvement Programs (EIPs), such as the plan to reduce nitrogen and phosphorus from wastewater in the area (see details below); Codes of Practice for stormwater discharge; oil spill response procedures; and joint inter-agency State and Commonwealth government programs to reduce ballast water impacts. The Environmental Protection (Water Quality) Policy that has been developed for SA waters is also relevant to activities and impacts in this area.
- In 2000, the Barker Inlet and Port Estuary Committee (BIPEC) began developing an integrated management plan to restore the condition of the Port River estuary, with recommendations for legislative measures to protect the inlet. Some examples of BIPEC involvement during 2003 include:
 - ♦ Continued provision of a Representative Management Committee for the Barker Inlet and Port Estuary environs, and development of an Integrated Action Plan for the area;
 - ♦ Working with the Environment Protection Authority to develop a Water Quality Improvement Plan for the Port Estuary with funding assistance from Environment Australia.
 - ♦ Providing a steering committee for the City of Port Adelaide Enfield's acid sulphate soils project.
 - ♦ Active participation in the Adelaide Dolphin Sanctuary project, the Integration of Natural Resource Management in South Australia, and the development of an Integrated Natural Resource Management Plan for the Mount Lofty Ranges and Greater Adelaide Region.
 - ♦ Working with the Northern Adelaide and Barossa Catchment Water Management Board and participating Council's to review and improve the catchment management aspects of Council Development Plan (BIPEC, 2003).
- According to the EPA (1997 and 2003), a number of initiatives in the Port River – Barker Inlet estuary area should improve water quality over time. These include:
 - ♦ Nutrient reduction and effluent reuse programmes for the sewage treatment works;
 - ♦ Environmental Improvement Programmes being established by industry in the area, to reduce nutrient concentrations and turbidity;
 - ♦ the Environment Protection (Water Quality) Policy, to promote and provide a regulatory framework for reductions in diffuse source pollution in stormwater and streamflow;
 - ♦ on-going development of wetlands to treat stormwater, reducing the amount of nutrients, metals, bacteria and suspended solids entering the Port River.
 - ♦ The continuing development of extensive wetlands by councils, catchment water management boards, and the former MFP, to treat stormwater, which, over time, may help to reduce nutrients, metals, bacteria and suspended solids entering the Port River – Barker Inlet estuary.
 - ♦ These initiatives are designed to reduce nutrient concentrations, turbidity, chlorophyll levels, and reduce "nuisance" algal growth. The improvement programmes may also help to reduce heavy metal

concentrations by removing particulate matter which can adsorb some metals (EPA, 1997 and 2003).

- An Environment Improvement Program (EIP) at the Bolivar Wastewater Treatment Plant was commenced during the late 1990s. The current Environment Improvement Program for the Bolivar plant requires SA Water to implement works to minimise nitrogen compounds discharged to the marine environment, and to reduce odour emissions from the plant (Parliament of South Australia 1999). Aspects of the EIP include:
 - ♦ Construction of a Dissolved Air Flotation Filtration (DAFF) plant to supply recycled water to the Virginia Pipeline Scheme;
 - ♦ An objective to maximise use of recycled water on land via the Virginia Pipeline Scheme, with an initial target reuse goal of about 22,500 megalitres/annum which represents over 50% of the annual plant flow. The long-term potential, dependent upon ASR storage potential, is re-use of around 70% or more of all Bolivar effluent (NAB catchment Management Board, 2001).
 - ♦ Provision of a program for nutrient reduction and odour control to be implemented in accordance with the government's commitment and the community's expectations for improvement; and
 - ♦ Research into aquifer storage and recovery (ASR), which could provide further opportunity to reduce the amount of recycled water discharged to Gulf St Vincent, subject to technical and economic feasibility, community acceptance and the summer demand for stored irrigation water (Parliament of South Australia, 1999; SA Water, 2002 and 2003).
- One of the projects in the Bolivar EIP (see above) included construction of an activated sludge plant and ancillary works, to achieve compliance with the legislative requirements of the Environment Protection Act 1993 (Parliament of South Australia, 1999). The sludge plant project aimed to replace the existing biological filtration treatment process (which has contributed over 50% of the odour from the existing plant) with a new activated sludge plant, and also collect and treat odorous gases from other areas of the plant. Apart from reducing odour level, the project aimed to reduce the impacts of treated wastewater discharge to the marine environment, by reducing the pollutant load on the existing maturation lagoons, and reducing nutrient concentration in the final effluent (Parliament of South Australia, 1999). Other aspects of the Bolivar EIP include construction of sludge thickening facilities to improve sludge digestion performance and to control the odour emissions from the sludge lagoons; construction of gas separators and flares to remove gases from the digested sludge transfer mains and reduce the volume of odorous gas discharged at the sludge lagoon inlets, and associated works including modifications to the grit removal process, settling tanks (clarifiers) and construction of a new primary pump station (Parliament of South Australia, 1999).
- By 2001, a new plant had been built at Bolivar to improve process and reduce odours (SA Water, 2001), and work on a new waste-water treatment plant had commenced, as part of a large scale plan to control the discharge of treated and chlorinated waste-water into upper Gulf St Vincent and the Port River. Under the plan, all waste-water will be diverted from existing plants to the new plant through a new pipeline, and an existing pipeline. The Port Adelaide Wastewater Treatment Plant, due for closure in 2005, will have all wastewater diverted by pipeline to the new treatment facility at Bolivar. Upon completion of the new Bolivar facilities, approximately 30% of Port Adelaide's waste-water will be pumped from the plant to growers on the northern plains, through the Virginia pipeline scheme, and no wastewater will be discharged into the Port River. The new plant at Bolivar will include tertiary stage treatment for removal of nutrients (particularly nitrogen), and desalination of high salinity wastewater (SA Water, undated; Anon, 2000d).
- In January 2002, the sewage received at the Queensbury pumping station was diverted to Bolivar. The Queensbury Diversion, low salinity flow from the Port Adelaide WWTP to Bolivar helps to maximise wastewater reuse from the north-western suburbs sewer drainage area (SA Water, 2002). The diversion to Bolivar has reduced the flow of wastewater to the Port River by around 30%. The remaining flow will be diverted to Bolivar before 2005. This will reduce turbidity, nutrients, algal problems and microbiological contamination (EPA, 2003).
- Penrice Soda Products commissioned a settling pond system in April 2001. Initial monitoring shows suspended solids have been reduced by about 95%. Penrice is also developing an environment improvement program to reduce the discharge of ammonia in its wastewater (EPA, 2003).
- In 2003, a consultancy report on restoration options for **St Kilda Bay** was prepared for the St Kilda Progress Association (see Coleman and Cook, 2003). Recommendations included re-instating the historic drainage channels in the bay; and methods were suggested for reducing nutrient pollution from Bolivar treatment works, and from septic tanks.
- A number of catchment restoration works were co-ordinated during the late 1990s by The Northern Adelaide and Barossa Catchment Water Management Board (Media Release, October 1999). The works

program develops partnerships between local government, industry, primary producers and the community. Examples of projects include:

- ◆ *Little Para Outfall Wetland System*: the construction of a linear wetland system along the Little Para River, to filter water before it discharges into Barker Inlet. The project aims to improve water quality, provide new recreational opportunities, improve habitat and biodiversity and maintain flood protection. Treatment of polluted stormwater by this wetland will also help to protect the adjoining mangrove ecosystem.
 - ◆ *Dry Creek Stream Rehabilitation*: a project aimed at stabilising and restoring the creek bed and banks, improving water quality, and increasing local vegetation and habitat. The project aimed to restore the eroded channel, which was contributing to excessive silt loads in the watercourse.
 - ◆ *Dry Creek Management Study*: A project to assess flooding issues, prioritise works and identify sites for future wetland development in the Dry Creek catchment area.
 - ◆ *Waterloo Corner Groundwater Investigation*: A project to investigate the problem of increasing salinity in the groundwater around Waterloo Corner.
 - ◆ *North Para Riparian Zone Restoration*: The project includes erosion control works along the North Para River, fencing to keep stock out of the watercourse, replanting with native plants and assisting landholders with property management plans.
 - ◆ *St Kilda Stormwater Management Study*;
 - ◆ Review of Gawler River floodplain management; and
 - ◆ Water quality sampling and data review.
- A number of other initiatives during recent years, which have contributed to improving the water quality in catchments that drain into the Port River – Barker Inlet and St Kilda areas, include:
 - ◆ the employment of Stormwater Pollution Prevention Officers, to educate businesses, the community and Council in issues regarding stormwater pollution;
 - ◆ the employment of Catchment Project Officers, to co-ordinate efforts by Catchment Boards and local governments in the preservation and enhancement of riverine environments in the northern Adelaide plains area;
 - ◆ the Our Patch Program, whose officers work with community and schools to develop projects to improve habitat quality and biodiversity across the catchment; and
 - ◆ the Waterwatch program, which encourages the community to manage water in their region.
 - According to the NAB catchment Water Management Board (2001), there are limited water quality data available for the streams of the Northern Adelaide Plains area. The Waterwatch program has a broad network of monitoring locations, but the program is young and has not yet collected sufficient data. Quality control procedures currently being developed will engender greater confidence in the collected data. Conclusions drawn from this data need to be treated cautiously as spatial or temporal correlation of water quality parameters with flows and storm events is impractical with such a small database. The data already captured is useful only for assessment of indicative trends in areas with no other data sources.
 - In 2002, the Environment Protection Authority conducted an audit of industries in Port Adelaide, including all businesses between the Port River and Victoria Road on the western side, and the Port River and the Grand Trunkway on the eastern side. The audit was undertaken in response to growing community concern over the water quality of the Port River, and in recognition of the fact that the decline in Port River water quality is manifested by seagrass loss, red tides, major water discolouration and fish kills. The audit involved inspections of industries to ensure compliance with the Environment Protection Act; checks to identify industrial sources of water pollution, and examination of environmental management practices. The EPA endeavours to work with industry to promote best practice and cleaner production techniques, and encourage companies to invest in innovative techniques for pollution prevention, wastewater reuse and water conservation. Furthermore, there is provision under the Environment Protection Act for Environment Protection Orders (EPOs) to be issued, in cases where industries are found to be negligent in not complying with the Act (EPA Media Release, 2002).
 - In 2003, Commonwealth and State funding was announced for a number of water quality projects in Adelaide's Port River Estuary and Barker Inlet (Office of the Minister for the Environment and Heritage, 2003). The interim projects for South Australia have been developed to assist the implementation of existing Water Quality Improvement plans, and address significant nutrient sources in the Port Waterways catchment. Examples of projects include:

- ♦ *Marina and Boating Management in the Port Waterways:* A project undertaken by the EPA, with the aim of reducing sewage and wastewater discharges from boats, yachts, marinas and slipways into the Port River-Barker Inlet system. The project includes an audit of current practice, and development of viable options to dispose of waste and wastewater from boats, marinas and slipways in a responsible manner. A Code of Practice is being developed, to provide guidelines for best environmental management practice for managing vessel and marina wastes in inland waters. The Code is being developed in consultation with the relevant industries, owners and users of the marinas, vessels and slipways. The Water Quality Environment Protection Policy (EPP) is being amended to include marine waters affected by vessel waste.
- ♦ *Development of a Code of Practice for Material Handling Practices on the Port Wharf:* A project run by the EPA, aiming to reduce material discharges from spillage and runoff, by auditing current material handling practices and developing and implementing a statutory code of practice to prevent nutrient discharges from these sources. The code will be supported by enforcement and compliance procedures. Environment protection regulations will be amended to include material handling practices.
- ♦ *Load-based Pollution Control Licensing in Adelaide's Port Waterways catchment:* An EPA project, which aims to reform licensing arrangements for point sources in the Port Waterways catchment. Load-based licensing (LBL) can ensure industries licensed under the SA Environment Protection Act discharge pollutants in accordance with the load allocations determined under the proposed Water Quality Improvement Plan. The project will develop an LBL framework and apply it to all premises within the Port Waterways Catchment. The project will determine pollutant load allocations for licensed discharge points, develop a set of draft regulations in consultation with licensees, amend the regulations to accommodate a load based licensing system, and build processes for executing the load based licensing system.
- ♦ *A Statutory Nutrient Offsets Program for the Port Waterways Catchment:* A EPA project, which aims to establish a pollution offset program and nutrient trading system within the Port Waterways catchment. A nutrient offsets program would allow existing or new polluters to compensate for their impacts on water quality. Compensation could occur through direct rehabilitation of other pollution sources in the catchment, or through contributions to a central rehabilitation fund. This enables participants to fulfil their nutrient control obligations on a catchment-wide basis, where existing controls cannot be met on-site. The project will develop a framework for establishing a nutrient offsets program, develop a set of draft regulations in consultation with licensees, amend regulations to accommodate a nutrient offset scheme, and build processes for executing the nutrient offset program.
- ♦ *Water Quality Monitoring For Execution and Review of the Water Quality Improvement Plan:* An EPA project, in which a Water Quality Improvement Plan (WQIP) is being developed for the Port Waterways. The plan includes measures to manage pollution sources. The program is designed to address the range of monitoring issues required for nutrient load management (including program design and objectives, field sampling, laboratory analysis, community based monitoring, data analysis and interpretation, and public reporting). The project will also involve upgrading several water quality and flow monitoring sites and equipment and developing reporting protocols for measuring the success of management actions. A key element of the WQIP is implementation of a formal water quality monitoring program, consistent with the requirements of the National Water Quality Management Strategy. The program aims to track nutrient (nitrogen and phosphorus) load changes, resulting from the implementation of projects and actions described in the WQIP. Establishing a comprehensive monitoring program and infrastructure will allow Governments and the community to evaluate the effectiveness of catchment management, and assess whether nutrient load and environmental flow targets set under the WQIP are being achieved.
- ♦ *City of Port Adelaide Enfield - Urban Stormwater Master Plan:* A project managed by the City of Port Adelaide Enfield, to develop a number of Urban Stormwater Master Plans (USMP) for sub-catchments in the Port Adelaide Enfield catchment. A USMP is a vehicle that provides the specific requirements for urban stormwater management in an existing council area. The project will develop criteria and techniques for determining how activities in the Port Adelaide Enfield Catchment affect water quality, how those activities can be managed, and how the environmental values of waters in the Port River Estuary and Barker Inlet can be protected. The criteria and techniques will be incorporated into the USMPs for a number of sub-catchments in the Port Adelaide Enfield Catchment. The USMPs can be used to implement changes to existing Development Plans if the Plans are limiting the environmental management of urban stormwater.
- ♦ *Burton West Wetlands Project:* A project managed by City of Salisbury, which aims to construct a treatment basin and wetland, to reduce the gross pollutant load to Barker Inlet. The proposed wetlands will reduce the phosphate, nitrates, sediments and heavy metals in the stormwater through a natural treatment process, before it enters the Barker Inlet. It is estimated that sediment loads, nitrogen and

phosphorus will be reduced by at least 50%.

- ◆ *Review and Amendment of Council Development Plans - Northern Adelaide and Barossa Catchment Management Board:* The project will review the Development Plans of participating Councils in the Northern Adelaide and Barossa catchment, and identify changes that could be implemented through a Planning Amendment Report. The project will examine how current development plans impact on catchment health, and how these plans can be modified to remove or minimise such impacts. The project will address issues such as watercourse rehabilitation and protection, water affecting activities, land capability, land management, stormwater management and wastewater treatment and use within the catchment. An amendment to the Development Plans of catchment Councils dealing with catchment water management issues, is required, to advance the process of water reform associated with new developments within the catchment area (Office of the Minister for the Environment and Heritage, 2003).
- ◆ *Gross Pollutant Trap on Dry Creek and Rising Main to South Terrace Reserve Wetland:* A project managed by the City of Salisbury, aiming to construct a major in-stream trap for gross pollutants and sediments on Dry Creek, to capture a large portion of the pollutants currently discharging to Barker Inlet. The project also aims to design and construct a rising main to draw water from a new sediment basin directly in front of the GPT and pump it to the existing South Terrace Wetlands. The wetlands are expected to result in reductions in phosphorus and nitrogen loads of 60-70%. Sediment and heavy metal loads are expected to be reduced by around 90-95%.
- A number of Coast and Clean Seas projects have been undertaken in the Port Adelaide area during the early 2000s. The "Port River Urban Stormwater Improvement Program" aims to contribute to improved water quality, by developing a number of integrated strategies and installing pollution reduction devices to reduce discharge of polluted stormwater to the Port Adelaide estuary. This project also has a public awareness-raising component. The "Industry Reducing its Impacts on the Port River Estuary" project addresses the issue of degradation of wetlands in the Port River – Barker Inlet system, due to concentrated industrial development, uncontrolled land-filling and liquid waste disposal. The project is designed for industry to work with the three spheres of government, and research organisations, on an industry sector and precinct basis. The co-operative project aims to identifying industrial sources of pollution, and implement cost effective management practices, including cleaner production and reuse techniques. The City of Port Adelaide Enfield has lead the project, which aims to reduce and treat stormwater runoff and effluent before it reaches the Estuary. New riparian filter strips on public lands and new treatment infrastructure in public stormwater drains, are designed to will complement the project actions by industry (Commonwealth of Australia, 2003).
- In September 2001, the Commonwealth (Office of the Minister for the Environment and Heritage, 2001) announced a suite of projects to divert stormwater and other wastewater into newly constructed wetlands, and also for industrial re-use, thereby reducing polluted water flows into the Port River - Barker Inlet system. The major project under this scheme is the Parafields Partnerships Urban Stormwater initiative. Part of the program includes the Parafield Urban Stormwater Harvesting Project, to divert untreated stormwater that has previously flowed into Barker Inlet, to a reed bed treatment and storage complex at the Parafield Airport. The recycled and treated stormwater will be used by local industries, and surplus treated stormwater will be injected into underground aquifers for extraction during dry periods.
- The Little Para River Industry Partnership Program (see Australian Government Department of the Environment and Heritage, 2003a) aims to reduce runoff from local industries reaching the Little Para River and Barker Inlet. The local stormwater catchment, including runoff from a car manufacturing plant at Elizabeth, currently drains into the Little Para River, which flows into Barker Inlet. The runoff is high in nutrients and pollutants. An example of one project under this program is the "harvesting" of stormwater from the industrial site, for diversion into Kaurna Park wetlands for cleansing. It will then be piped back to the site to meet non-potable processing and irrigation requirements. Water surplus to immediate requirements will be pumped into the Aquifer Storage and Recovery system for later extraction and various uses during the drier summer periods (Australian Government Department of the Environment and Heritage, 2003).
- The Virginia Horticulture Water Reuse Project aims to improve the horticultural industry's management of stormwater and wastewater, and to reduce the use of bore water; and a project to reduce the use the water demand of plant nurseries, by recycling stormwater and wastewater using innovative treatment techniques (Office of the Minister for the Environment and Heritage, 2001).
- The Port Adelaide-Enfield Council, the Torrens Catchment Water Management Board (CWMB) and Business SA have been involved (during the early 2000s) with a works program to reduce the levels of some pollutants currently affecting the Port River and Barker Inlet area. For example, the "Street Smart River Clean" - North West Adelaide Stormwater Pollution Prevention Project has been undertaken between local industries, the Torrens CWMB, and the Cities of Charles Sturt, Port Adelaide Enfield and

Prospect. The catchment area for the project also includes the Port River and environs (West Lakes, the Port River, Barker Inlet and north-eastern Gulf St Vincent). The project aimed to encourage businesses and industries to minimise stormwater pollution, through 'Best Practice Environmental Management' (e.g. onsite pollution prevention, cleaner production, water and wastewater minimisation, and waste management) (Torrens Catchment Water Management Board, 2001).

- Other stormwater cleaning projects include the Stormwater Smart Project, a partnership between the Northern Adelaide and Barossa Catchment Water Management Board and the Cities of Playford, Salisbury and Tea Tree Gully. The project aims to reduce the level of pollution entering the stormwater system and impacting on water quality in watercourses including **Little Para River, Dry Creek, Barker Inlet** and the coastal environment. The project also aims to raise awareness and increase knowledge on stormwater issues amongst commercial and industrial operators and local government, and to develop strategies to prevent pollution of waterways, in order to avoid practices that lead to pollution entering waterways via the stormwater system (City of Salisbury, undated).
- During the early 2000s, the community in the area of the Mallala District (particularly the **Middle Beach to Port Parham** area, including **Light River Delta**) have been involved with foreshore restoration works, fencing, weeding and coastal re-vegetation, rubbish removal, signage to reduce proliferation of unmanaged access tracks, and other restoration activities. A community and visitor education program was also undertaken, to highlight the ecological, social and commercial values of the area, and the environmental impacts that need to be addressed (see DC Mallala Foreshore Advisory Committee and EcoConnect, 2002).
- During the late 1990s, there was a potential joint project between community, council and Torrens Catchment Management Board to restore the ecological integrity of **Mutton Cove**, through mangrove replanting, and alteration to the existing tidal flushing by installation of a culvert, and another outlet into the River. This was proposed to meet the flooding regime required by mangroves in the area, and to improve the area for juvenile fish, wading birds and other marine and coastal biota (J. Emmett, AMCS, pers. comm., 2000).
- In the early 2000s, the Port River Clean Project (PRCP) was initiated by The School of Fish organisation and the Torrens Catchment Water Management Board. School groups, fishing clubs and other volunteer groups participate (often weekly) in the collection of debris in the Port River area, both on the shore and in the water. The clean-up area encompasses the train bridge at the top end of the Port River, to Snapper Point, including the North Arm area to the Torrens Island Bridge. The PRCP is designed to reduce the amount of floating debris and gross pollutants in the Port River Estuary each year. Objectives of the debris collection project include: improving the quality of water and habitat in the area; reducing the incidence of entanglements by dolphins and birds in floating debris; minimising amenity loss; increasing recreational potential; and creating a safer and more pleasant boating environment. There are strong marine conservation and community awareness aspects to the project. The PRCP aims to promote a more positive perception of the Port River, and to promote the responsibilities of those using the Port River system. The program's co-ordinating bodies form partnerships with community groups, clubs and schools (RHBS Multimedia Productions, 2003).
- In the early 2000s, the *Caulerpa taxifolia* infestation in the West Lakes - Port River area was being treated. A widespread information / education program was undertaken soon after the discovery, to help minimise the spread of this invasive strain of macroalgae. Examples of methods used include covering the beds of *C. taxifolia* in some areas, to kill the plants; and suction dredging to remove plants. In the **Port River**, an area of 22,000 square metres was dredged, and approximately 414 tonnes of sediment and *C. taxifolia* were removed from the river (City of Charles Sturt, 2003). Various physical and chemical methods were trialled, and by 2004, the species had been eliminated from **West Lakes**, but remained established in the **Port River** (S. Shepherd, pers. comm., 2004). Other introduced pests which are the subject of control / removal programs include the competitive alga *Caulerpa racemosa*, and the pearl oyster *Pinctada albina sugillata* (S. Shepherd, pers. comm., 2004).
- In 1998, the EPA produced guidelines for major solid waste land fills in South Australia, and a Landfill Audit was undertaken in 2000. The **Wingfield** and **Garden Island** landfill sites are due for closure in 2004, following decisions about stormwater management, waste management, and final capping (EPA, 2001). The State government is investigating future use of the **Wingfield** site following closure, including future industrial development, resource recovery, and green waste processing. A closure plan for **Garden Island** includes recovery of landfill gas; long term monitoring of ground water and surface water, and rehabilitation of the landscape for planned recreational use (Planning SA and EPA, 2001).

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

Bay of Shoals – Western Cove - Nepean Bay - American River - Eastern Cove

Coastal Discharges and Runoff

- There has been considerable loss of seagrass in the **Nepean Bay** catchment (around 2700 hectares, according to Hale, 1997, and Gray, 2000), including **Western Cove**. Epiphytic algae are smothering remaining seagrass in parts of the Western Cove area (Gray, 2000). There are a number of government, industry and community based monitoring programs in the **Nepean Bay** catchment area, that have been operating since the late 1990's. Edyvane (1997), Flaherty (1997b) and Gray (2000) reported possible causes for the decline. High nutrient loads and sediments, particularly from the **Cygnnet River** and surface runoff, as well as saline seepage from land clearing have been identified as potential causes of current elevated nutrient levels and seagrass loss in **Western Cove** area. Bryars (2003) also included as a potential threat to habitats in the area: the increased level of nutrients, turbidity and/or sedimentation caused by agricultural run-off from the **Cygnnet River**, and from a catchment in the south-west corner of **Bay of Shoals**. Diffuse agricultural runoff in the **Western Cove** area may also be a threat to habitats. Richards (2001) reported that causes being investigated include "nutrient-loaded groundwater discharging into the town storm water and effluent water and into the bay". Hale (1997) and Flaherty (1997b) discussed concerns about the existing and more recent developments (i.e. STED scheme) for sewage treatment facilities in the **Kingscote** area, and their relation to the Cygnnet River / Nepean Bay system.
- Potential threats considered to have changed the value of the **Cygnnet River** system for coastal birds and other coastal biota include salinisation and siltation (from further clearing of the catchment area) (Australian Heritage Commission, undated).
- Gilliland (1996) reported that there is potential marine pollution associated with townships such as **Kingscote**, and that several other pollution sources in the **Western Cove** area include the effluent ponds associated with the **Kingscote** common effluent disposal system, and a disused rubbish dump site. There are effluent ponds at **Brownlow**, and the increased nutrient levels caused by effluent leakage from the ponds, and also from septic tank overflows in the **Nepean Bay** settlement, and at **American River, Island Beach** and **Baudin Beach**, are considered to be a potential threat to habitats in those areas (Bryars, 2003). According to the Kangaroo Island Coastal Protection District Study Report (Edwards, 1987) cited by Edyvane (1999b), the golf course, effluent ponds, and rubbish dump located north of **Cygnnet River** have caused "extensive modification of the catchment area", however details were not provided.
- The increased level of nutrients caused by stormwater in the **Kingscote** area (e.g. there is an outfall near the **Kingscote** yacht club) is considered to be a localised habitat threat (Edwards, 1987, cited by Edyvane, 1999b; Bryars, 2003). There is also a fish processing plant at **Kingscote**, which may cause an increased level of nutrients in the area (Bryars, 2003).
- There is sewage and other effluent pollution in **Eastern Cove** and **American River**, from sewage outfall pipes and runoff (e.g. sewage outlets along the foreshore north of **Pelican Point**, and at **American River**, from hotels, motels and residential development). Concern about effluent disposal in the area has been documented since at least the 1980s (see Edwards, 1987). Flaherty (1998) reported that the effluent discharges at American River had resulted in contamination of shellfish. Two licensed sewage outfalls at **American River** are used for stormwater runoff, rather than sewage, according to Gilliland (1996). In 1998, the State Government's Environment, Resources and Development Committee recommended that the effluent outfall problem at American River be resolved as a matter of urgency.
- There have been impacts resulting from the proliferation of subdivisions that have occurred on the banks of **Eastern Cove** during the past decade (e.g. untreated effluent disposal). Benthic sampling in 1994 showed that 50% of the seagrass was dead at **Newland Bay** and **Rocky Point** (near **Island Beach**) and covered with filamentous epiphytes. A number of government, industry and community-based monitoring programs have been occurring since the mid 1990s in the **Nepean Bay** catchment. There is anecdotal evidence to suggest contamination of local molluscs in this area, due to effluent impacts (M. McKelvey, pers. comm., 1999).
- There has been some loss of seagrass from the eastern part of the **Nepean Bay** area (e.g. **Eastern Cove** and **American River**), however, the loss has been more pronounced during the 1990s in the western part (see above, for **Western Cove**, and report by Edyvane, 1997).

Aquaculture

- From North Cape, to the waters south of Busby Islet Conservation Park (i.e. including much of the Bay of Shoals), the area has been classified in the Bay of Shoals Aquaculture Zone as being suitable for aquaculture development (both research and development, and commercial, subject to EIA). Deeper waters seaward of the Bay of Shoals and Western Cove have also been classified as suitable for aquaculture, as part of the Nepean Bay Aquaculture Zone (Gilliland, 1996), with the exception of an exclusion zone around the navigation channel. Provision was also made for leases adjacent to Nepean Bay Conservation Park (including both existing and yet to be approved lease sites). The waters forming a block between Ballast Head, Point Morrison and Kangaroo Head were classified by PIRSA (Gilliland, 1996) as part of the Eastern Cove Aquaculture Zone as being suitable for shellfish farming, subject to EIA if the potential lease is to be positioned over seagrass. (Note that reef occurs in much of the eastern part of this area, north of American River). Provision was also made for aquaculture development in a small zone south of Ballast Head. An area between Penneshaw and Cuttlefish Bay was also zoned for a maximum of 200 ha of shellfish long-line culture (Gilliland, 1996), however no leases have been approved to date. Details of the aquaculture zoning, including the reported provision, under a future review of aquaculture, to increase the area allotted for aquaculture in 1996, are listed in **Notes on Social and Economic Values and Uses**.
- The area designated by PIRSA for aquaculture development on north-eastern Kangaroo Island includes seagrass habitat, sand habitat and near-shore reef. Some of the areas designated for aquaculture are also in the vicinity of coastal conservation reserves, and other significant features (e.g. breeding and feeding areas for coastal and sea birds). A summary of the leases approved to date is included in the section **Notes on Social and Economic Values and Uses**.
- In general, issues associated with shellfish farming include benthic enrichment, silt accumulation, deoxygenating of benthic surface and interstitial waters; increased sulphide concentrations and other physical and chemical changes to the benthos due to organic enrichment, including changes to benthic species composition; decreased water quality in the vicinity of the farm; competition of farmed mussels with wild biota for water-borne food sources (known as “nutrient stripping”); and aesthetic impacts (see section 9.2). Farmed mussels in the north-eastern Kangaroo Island area have reportedly settled and proliferated in adjacent areas outside the farms (e.g. in the vicinity of the **American River Aquatic Reserve**). Raptis and Sons (1998) provided examples of escaped mussel spat in this area. The potential impacts of shellfish farming in general (including oysters and mussels) are discussed in section 9.2.
- Previously, in 1996, there was concern expressed by local community, conservation representatives and scientists about the potential for fin-fish farming in the north-eastern Kangaroo Island area. A fin-fish farming application received by government during the mid 1990s was rejected. Ecological concerns about the proposed development included potential impacts on dolphins (though net entanglement), disturbance to breeding bird populations along the coast, decreased water quality, benthic damage, disturbance to pinniped populations (which are attracted to fin-fish farms, for feeding), and nutrient enrichment of the waters, which may cause impact on the reef systems of north-eastern Kangaroo Island, where water quality is currently very high. It was reported (T. Flaherty, MCCN, 1996, pers. comm.) that the proposed aquaculture site was within the foraging range of the significant Sea Lion population at the Pages, which are known to visit the north-eastern Kangaroo Island area. A number of potential social impacts were also noted, but are not discussed here under environmental impacts. In 2000, concerns were again expressed by local council and community (see (ABC Country Hour Media Report, October, 2000) about the potential provision for fin-fish farming on Kangaroo Island under the recent Aquaculture Act in South Australia, and the possibility of such development applications not being subject to full environmental and social impact assessment procedures prior to approval.
- Gilliland (1996) considered that aquaculture development may “compromise the integrity” of designated conservation areas, through additional pollution, noise and disturbance associated with aquaculture operations. Examples of such conservation areas include **Busby Islet, Beatrice Islet, Pelican Lagoon, and Nepean Bay Conservation Parks** as well as the **American River Aquatic Reserve**. A number of other areas were listed by Gilliland (1996) as being environmentally significant and vulnerable to impacts from any aquaculture development in the vicinity. These areas include the **Bay of Shoals** and the western section of **Western Cove**. Gilliland (1996) reported that the shallow water and the possibility of low water exchange in the **Bay of Shoals** makes it susceptible to pollution. The features of such areas which Gilliland considered may be affected by aquaculture development included fish nursery areas, breeding and feeding sites for coastal and marine birds, representative coastal vegetation types, wetlands of national importance and sites listed under international treaty for their role as migratory bird habitat. Gilliland (1996) considered that development in the proximity of designated conservation areas might impact on their conservation value, including reduction of visual amenity, potential pollution problems and disturbance of breeding

colonies through operations of a development. However, despite the recognition of the significance of these areas in PIRSA's (1996) Kangaroo Island Aquaculture Management Plan (Gilliland, 1996), aquaculture development has proceeded in the northern **Bay of Shoals** area (i.e. three longline leases for shellfish were approved in 1997, according to S.A. Coast and Marine Atlas, 2001), and in the vicinity of the **Nepean Bay Conservation Park** (10 approvals for near-shore shellfish culture since 1990).

- Physical disturbance caused by oyster aquaculture operations in the **Morrison Beach – Redbanks** region is considered to be a potential threat to local habitats in the region (Bryars, 2003).
- Other details of threats posed by aquaculture in the north-eastern Kangaroo Island region, according to Gilliland (1996), include:
- Other details of threats posed by aquaculture in the north-eastern Kangaroo Island region, according to Gilliland (1996), include:
 - ♦ potential disturbance of seabird (reported to be Peregrine Falcon, White-bellied Sea Eagle and Little Penguin) breeding sites and/or colonies in the area between **Kangaroo Head** and **Cape Willoughby** (**Penneshaw** Policy Area);
 - ♦ poorly sited aquaculture developments which, if permitted to occur, may impact on the scenic amenity of the coastal environment.

Recreational Impacts

- The increased use of jet ski and motorboats / speed boats in the **American River** area (including boating in Pelican Lagoon) is of concern, considering that the use of such craft in estuarine environments, has impacts that are well recognised and documented at state, national and international levels (see section 9.2). In particular, the benthos (including shallow seagrass beds in fine sand/muddy areas, and shallow beds of macroalgae) can easily be damaged, which has numerous adverse ramifications for the ecology of the area.
- Physical disturbance from motor boats mooring in the **Kingscote** area, is reported to be a perceived threat to habitats in the area (Bryars, 2003).
- Noise from both motor boats and jet skis is also an issue, considering the value of this refuge area for birds (including migratory species), fish, dolphins, and other coastal and marine fauna. The damage that motor boats can do was recognised as a threat, when the area was listed at both State and National levels as a *Wetland of Importance* (see Morelli and De Jong, 1995, and ANCA, 1996).
- Some of the potential impacts upon shallow water habitat (e.g. inner **Bay of Shoals**, **Nepean Bay**, **American River** and **Pelican Lagoon**) from recreational boats are discussed in detail in Section 9.2, and include benthic scouring and seagrass loss, due to boat hulls in shallow water and benthic impact from boat propellers and anchors; increased water turbidity; hydrocarbon contamination; transfer and spread of marine pest species; noise pollution impacts on coastal and marine fauna; and potential threats to populations of site-attached pipefish, and other potentially threatened species in the seagrass system, such as blennies (Kuitert, pers. comm. to T. Flaherty, MCCN, 1995; Pogonoski *et al.*, 2002). Sheltered estuarine environments are particularly susceptible to pollution associated with recreational boating.
- Previously, sponge communities occurred in the entrance channel areas of **American River / Pelican Lagoon**. These would appear to be more typical of those found in deeper waters, and their occurrence in Pelican Lagoon was probably indicative of poor light penetration, (and visibility) due to natural turbidity, and the presence of strong currents which are important in feeding. Over a two year period in 1993-5 these sponges declined significantly, and this was concurrent with the operation of a tour-boat visiting the location to allow passengers to view the sponge gardens (J. Lavers pers. comm. to T. Flaherty, MCCN, 1995). Activities which result in disturbance of sediments can adversely effect sponges and other filter-feeding animals by increasing amounts of suspended inorganic particles in the water, impairing their feeding. The growth of new sponges can also be affected by increased sedimentation (Kinhill, 1987, cited by Flaherty, MCCN, 2002).
- A 66-berth marina was proposed (in 2002) for **American River**, between the existing wharf and the boat ramp, and in 2003 was the subject of a referral under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. There are a number of both potential and likely impacts associated with the building and operation of a boating marina in the estuarine environment of American River. The ecological values of the area are discussed in another section of this report, and the social and historical values are discussed above. Current and ongoing concerns with a proposed marina, and any increase in boating activity in the area, include:
 - ♦ Unsuitability of a marina facility in the regionally important, sheltered tidal habitat of American River, which has been recognised nationally as a *Wetland of National Importance*. Such calm-water estuarine

environments are uncommon on both Kangaroo Island and the adjacent Southern Fleurieu Peninsula, as well as in South Australia as a whole. It is well recognised at State, national and international levels that estuarine and lagoon wetland environments are very sensitive to disturbance from human activities, including power boating (see Section 9.2). Pollard (1993) provided a good overview of the need to prevent environmentally damaging activities from occurring in estuarine areas. The limited number of estuarine wetlands in South Australia means that the few remaining undisturbed wetlands are of great importance to fish stocks and other regional populations and migratory species of wildlife (T. Flaherty, MCCN, pers. comm., 2002). The development of a marina at American River is not in keeping with the South Australian government's current Strategy for the protection and management of Wetlands

- ◆ Unsuitability of a marina facility in close proximity to (i.e. within 1km of) the *American River Aquatic Reserve*, a significant refuge, nursery and feeding area for fish, elasmobranchs and crustaceans (including commercially and recreationally important species), and habitat for marine mammals, including regular feeding area for bottlenose dolphins. There is a need to restrict development activities that may disturb seagrass beds in estuarine areas, especially at the times when fish larval settlement occurs (Larkum *et al.*, 1989, cited by T. Flaherty, MCCN, pers. comm., 2002).
- ◆ Unsuitability of a marina facility in close proximity to the *Pelican Lagoon Conservation Park*, a regionally and nationally significant shallow, quiet-water estuarine habitat that adjoins the American River Aquatic Reserve. Unsuitability of a marine development in the vicinity of habitat for species listed under the Commonwealth's *Environment Protection and Biodiversity Conservation Act 1999*.
- ◆ Unsuitability of a marine development in the vicinity of habitat for species listed under international agreements for migratory birds (American River wetland provides habitat for 16 water bird species listed under the Japan-Australia Migratory Bird Agreement (JAMBA) and 17 listed under the China-Australia Migratory Bird Agreement (CAMBA). For many wading bird species, including international migratory species, the American River system is an important feeding and roosting area, and also a breeding area for some of those species. Boating and marina activities have the potential to disturb such activities.
- ◆ Unsuitability of a marine development in the vicinity of habitat for other species of conservation concern (such as site-associated small, endemic fish species of very limited distribution and specific habitat requirements). For some of the site-associated, less mobile species, American River and Pelican Lagoon represent a significant, permanently used and regionally "unique" habitat, and the estuarine system is an important refuge area for others. Power boating has the potential to significantly impact populations small, strongly-site associated fish species (Glover, 1979; Kuitert, 1995, pers. comm. to T. Flaherty, MCCN; Kuitert, 1996). Damage to this habitat through increased human activity and disturbance may impact populations of such species, which do not have provision to re-locate to other sites.
- ◆ Concern about increased boating traffic (including power boats to 35m) in parts of the river system where boating traffic has previously been minimal, due to the existing American River Aquatic Reserve and Pelican Lagoon Conservation Park. Potential impacts on the ecology of the system due to increased boat traffic include effects on water quality, substrate quality, benthic flora and fauna, fish, wading birds, and marine mammals. Of particular concern is the likelihood of increased boating traffic in the sensitive Pelican Lagoon area, a shallow, quiet-water habitat of State and National significance. Boating in shallow lagoon environments can cause serious environmental damage (see Section 9.2). The benthic habitat of the American River and Pelican Lagoon system (including shallow seagrass beds, sponge communities, stands of macroalgae and shell beds) can easily be damaged. Loss of seagrass is possible by direct physical damage due to propellers, jet propulsion, anchors, and benthic scouring by hulls; and indirectly over time, due to light reduction from increased water turbidity, and smothering by sediment plumes. Seagrass loss has significant ecological impacts, and a number of seagrass species (particularly species of *Posidonia*) do not readily regenerate. Other impacts linked to increased boating traffic include erosion of shorelines, from boat wash/waves. The damage that motor boats can do was recognised as a threat to the area, when it was listed at both State and National levels as a *Wetland of Importance* – i.e. "*Motor boats cause water disturbance, and silting of seagrass and algae meadows*" (see Morelli and De Jong, 1995, and ANCA, 1996).
- ◆ Lack of sillage / waste containment facilities in many yachts / boats, and possibility of increased amount of sewage, waste water, and rubbish entering the estuary. The possibility of effluent entering Pelican Lagoon is of particular concern. There are also issues relating to sewage disposal from associated onshore amenities, and stormwater run-off from impermeable surfaces such as the car park and onshore facilities. The impacts of sewage in the American River system is already of concern (M. McKelvey, pers. comm., 1999), and any increase in the discharge of sewage or related products would be a further detriment to the system, particularly to shellfish populations, which may be affected by bacteria, viruses and protozoan parasites related to sewage contamination;
- ◆ Potential for oil and fuel spills (and consequent contamination of the river and estuary with hydrocarbons) from a re-fuelling facility associated with the development;

- ♦ Increased risk of disease transfer to the river system, through discharge of vessel wastes, which may affect both local indigenous fauna, and cultured shellfish species;
- ♦ Increased risk of introduction and transfer of marine pest species (a threat which was recognised when the area was listed as a *Wetland of National Importance* – see Morelli and De Jong, 1995 and ANCA, 1996). Not only may introduced marine pests impact upon local indigenous estuarine fauna, but may also affect shellfish species cultured in the area (T. Flaherty, MCCN, pers. comm.). Examples of species include microalgae that can bloom, deoxygenating and discolouring the water, and also cause serious health problems, such as Paralytic Shellfish Poisoning (i.e. PSP) for humans who consume contaminated shellfish. In South Australia, at least two species of introduced dinoflagellates have been recorded from state waters: the toxic dinoflagellate, *Alexandrium minutum* and *A. tamarense*, with at least two other species suspected to occur (Flaherty, pers. comm., uncited reference). The introduction and spread of *A. minutum* in South Australia has been directly linked with shipping, including recreational craft, and the introduction and spread of *A. minutum* is of major concern to the oyster industry. The toxic dinoflagellate *Alexandrium minutum* has been recorded at **American River** (South Australian SOE Report, 1998). Other marine pests that have the potential to become established in the area include the European shore crab *Carcinus maenus*, and the European Fan Worm *Sabella spallanzanii*, the latter of which has become established in a number of Adelaide metropolitan areas where boating activity is high (e.g. North Haven and West Lakes) and is easily spread from the area of initial establishment (e.g. *Sabella spallanzanii* has now spread along the metropolitan area to at least Noarlunga). Pest species of marine plants can also easily be transferred by recreational boats.
- ♦ Possibility of increased amounts of anti-fouling paints such as TBT entering and accumulating in American River. TBT accumulates in marine food chains, and can concentrate in molluscs at levels hundreds of thousands of times higher than surrounding sediment or seawater. The toxic effects of TBT in marine organisms include, amongst others, immuno-suppression, physical deformities, reduced growth rate, reproductive abnormalities in molluscs (including sex change); death of eggs and larvae in molluscs; reduction in population numbers of molluscs; and inhibition of body organ function in some higher animals (Nias *et al.*, 1993; AMCS and EPA, 1999). Of particular concern is the ability of TBT to accumulate in estuaries, with long-lasting impacts, particularly on shellfish. Any increase in TBT may affect both native biota in the area, as well as cultured shellfish species;
- ♦ Possibility of mobilisation of sediment / silt due to construction and maintenance dredging, with potential impacts on water quality (e.g. increased turbidity) and benthic flora and fauna, particularly smothering of seagrass beds and feeding grounds for wading birds. Benthic smothering is a well recognised impact of dredging (see Section 9.2). Considering that current flows are strong in the area, it is possible that dredging would be required on an ongoing basis;
- ♦ Increased noise from motor boats, considering the value of this relatively quiet refuge area for birds (including migratory species), fish, dolphins, and other coastal and marine fauna. Noise and increased boating activity can disturb nesting and foraging coastal bird species including those listed under International Migratory Bird Treaties JAMBA and CAMBA, and species listed as vulnerable under Commonwealth and State legislation (e.g. Hooded Plover).
- ♦ Due to increased boat traffic, possible interference with the use of the area by marine mammals such as bottlenose dolphins (for which American River and Eastern Cove are feeding and nursery areas), Australian sea lions, and Pygmy Right Whales (the latter of which are infrequent visitors, however American River is one of the new areas in southern Australia where this species is found inshore. Issues include potential increase in boat strikes; acoustic pollution; and boats' interference with marine mammal travel / feeding routes.
- ♦ Increased wave action from the movement of boats, with potential impacts on habitat, including feeding grounds such as mud flats.
- ♦ Increase in artificial light (e.g. marina lighting at night for both moored and moving boats), which has a potential to disturb some fauna in the area.
- ♦ Concern about cumulative physical, chemical and biological impacts, and the fact that environmental assessment of potential developments such as marinas are site –specific, and ignore the ecological functioning and interactions that occur in estuarine systems;
- ♦ Potential social impact due to increased noise and activity in the area, which may conflict with the current and historic recognition (and promotion) of the area as a quiet, peaceful holiday destination. Many locals and tourists place value on the quiet nature of the area.
- ♦ Residents in the **American River** area have also expressed concern about rubbish and chemical spills in the area.

Fishing Issues

- Potential threat to population of large *King George Whiting*, in deeper waters out of Western Cove and Nepean Bay. These larger, older whiting are likely to be part of the spawning population, although scientists have not observed spawning activity within the area described in this table. Large whiting, being both a popular and relatively valuable coastal fish, have become increasingly coveted by commercial, recreational and charter boat fishers during the past decade. More than 10 years ago, this species was classified as *fully fished* in South Australian waters (1988 State of the Environment Report for South Australia) and the status remained unchanged a decade later (DEHAA and EPA, 1998). The apparent status of King George Whiting, which may be considered for this report as a fished species of conservation concern in some parts of South Australia, is discussed in more detail in section 9.2.

In addition to King George Whiting, other fished species in the north-eastern Kangaroo Island area, which may be of conservation concern at local and/or regional scales, according to available information, include

- *Garfish*: Ye (1999) reported that Garfish is a fully exploited species in S.A. (see section 9.2)
- a spawning population of *Elephant Fish / Shark*, which seasonally visit the north-eastern Kangaroo island bay areas, such as American River (see **Ecological Criteria** section);
- Site-associated edible reef fish species (e.g. *Blue Groper* and other *wrasse species*, *Harlequin Fish*) – of particular concern are the large mature individuals of Western Blue Groper and Harlequin Fish that are fished by charter boats which depart from north-east Kangaroo Island, and also the likelihood of juvenile groper being fished in American River and other shallow waters in north-east Kangaroo Island; and
- *Sand Crabs*: There have been community concerns that recreational fishing regulations are inadequate to protect populations of this species, and that large numbers are taken in some areas.

Notes on the apparent status of these species populations in S.A., according to various data sources, are provided in section 9.2.

- In recent years, there have been irregular reports to government of illegal line and net fishing (for both scalefish and sharks) in **American River** and **Pelican Lagoon** protected areas.
- Potential impacts upon shallow water habitat (e.g. inner **Bay of Shoals**, **Nepean Bay**, **American River** and **Pelican Lagoon**) from fishing boat. Boating in shallow waters can result in benthic scouring and seagrass loss, due to boat hulls in shallow water and benthic impact from boat propellers and anchors (see Section 9.2). Other potential boating-induced impacts include increased water turbidity, hydrocarbon contamination, transfer and spread of marine pest species, and potential threats to populations of site-attached pipefish, and other potentially threatened species in the seagrass system, such as blennies (R. Kuitert, pers. comm. to T. Flaherty, MCCN, 1995; Pogonoski *et al.*, 2002).

Site-Associated Species of Conservation Concern

- *Fish*: There are a number of strongly site-associated fish species of restricted habitat, that are found on north-eastern Kangaroo Island. For example, Eelblenny *Peronedys anguillaris*, may be vulnerable to disturbance such as power boating in shallow seagrass beds, other forms of habitat degradation, and pollution. Other strongly site-associated fish species known from the area include Verco's Pipefish *Vanacampus vercoi*, (suggested conservation status: *Lower Risk - Near Threatened* by Pogonoski *et al.*, 2002 and Australian Society of Fish Biology, 2001); and the two more widely distributed species Long-Snout Pipefish *Vanacampus poecilolaemus* and Deep-Body Pipefish *Kaupus costatus*, both found in other parts of South Australia and southern Australia. Tourism impact has long been considered a threat to Kangaroo Island's fish fauna. For example, according to Glover (1979): "*because of the island's developing tourism, there is a growing threat to this fauna - due to increasing recreational fishing and spoilage of the aquatic environment arising from other human activities such as power boating*" and "*measures to minimise the potential threat to this vulnerable fauna should be considered*" (Glover, 1979). In 1995, fish authority Rudie Kuitert stated that populations of less abundant pipefish species (such as those listed above) are vulnerable to disturbance from boating activities and other impacts on shallow seagrass beds (Kuitert, pers. comm. to T. Flaherty, MCCN, 1995). Pogonoski *et al.* (2002) suggested that pollution and habitat degradation may be a threat to Eelblenny populations, due also to its apparent very restricted distribution. Protected bays associated with seagrass habitats appear critical to the survival of Eelblenny (Pogonoski *et al.*, 2002). Pogonoski *et al.* (2002) recommended protection of habitats in areas where this species is known to occur, and investigation of the biology and accurate distributional range of this species, to determine its susceptibility to threats such as pollution and habitat degradation. Kuitert (1996a) considered that pollution is a threat to this species. Apart from the potential threats above, the species has a restricted distribution, and members of the Clinidae (the family to which *Peronedys* belongs) are viviparous, and

therefore have low dispersability, a characteristic that can increase vulnerability to processes causing population decline. Kelleher *et al.* (1996) mentioned that this characteristic of breeding live young accounts for much of the endemicity in this group of fish in southern Australia. Similarly, the endemic Spotted Snake Blenny *Ophiclinops pardalis* also has a restricted distribution, is a viviparous species of low dispersability. *O. pardalis* has a restricted and specific habitat, and is dependent upon the litter layer of seagrass beds. A number of other site-associated small fish species known from north-eastern Kangaroo Island (see Baker, in press, and references therein).

- **Specimen Shells:** Occur on reef, sponge and sand areas, such as those in waters off parts of the Dudley Peninsula. Some of the specimen shells in South Australia are of conservation concern because molluscs which have direct development of young are particularly vulnerable to over-exploitation and population decline (see Ponder and Grayson, 1998). Volutes as a group have particularly vulnerable population dynamics, as do the southern Australian cowries (species of *Zoila* and *Notocypraea*) and some of the *Conus* species (e.g. *Conus anemone*), which have direct development of young and no planktonic larval phase, and therefore limited dispersal, and geographically distinct sub-populations and varieties, with little mixing. Such characteristics makes populations of these species with limited dispersal vulnerable to over-collecting. Geographically distinct populations of species of *Zoila* and *Notocypraea*, *Conus* and volutes (e.g. *Amoria*, *Ericusa*, *Notovoluta* and other volute genera) often have distinctive colours and patterns, and some of the “varieties” or “sub-forms” are uncommon or rare, and are highly sought after by collectors. It is recognised that species with small extent of occurrence (i.e. narrow geographic range) can be vulnerable to localised extinction from local impacts (IUCN, 1994; Jones and Kaly, 1994, cited by O’Hara and Barmby, 2000). Furthermore, some shell species in the shell trade have specialised feeding habits and therefore also have restricted habitats (e.g. some of the *Zoila* and *Notocypraea* rely on host sponges). This feature makes such species more vulnerable than those with more generalised feeding requirements. Specimen shells are discussed further in section 9.2.

Other Issues

- Threats which have been considered to potentially change the value of the **Cygnnet River** system for coastal birds and other coastal biota include damage to wetland vegetation and shorelines by stock, off road vehicle use, dumping of rubbish, oil spills and inadequately controlled fishing levels (Australian Heritage Commission, undated).
- In the **American River / Pelican Lagoon** area, decreased tidal flow has occurred due to the location of Hog Bay road in the south-western corner of Pelican Lagoon. This restricts water from reaching a small area of saltmarsh on the southern side of the road, and the decreased tidal flow is considered to be a potential threat to saltmarsh habitat in that area (Bryars, 2003).
- Decreased freshwater flows caused by abstraction from the **Deep Creek** catchment (near **Baudin Beach**, in **Eastern Cove**), and increased levels of nutrients caused by agricultural runoff from this catchment area, may be a potential threat to the estuarine habitat of **Deep Creek** (in **Eastern Cove**) (Bryars, 2003).
- The toxic dinoflagellate *Alexandrium minutum* has been recorded at **American River**, Penneshaw, **Ballast Head** and **Kingscote** (SA SOE Report, 1998).
- There are previous coastal developments in the **Kingscote** area, whose past and present impacts are not known for this report. Examples include the breakwater east of the **Bluff** (approximately 80m long); the old basalt quarry at Kingscote, and Kingscote wharf (unreferenced, cited by Edyvane, 1999b).
- Bryars (2003) reported that the proposed upgrade of port facilities in the **Kingscote** area may be a threat to local habitat, in terms of physical disturbance and destruction.
- Little Penguins on the **Kingscote** foreshore are subject to attacks by dogs. There was an incident in 2002 in which 30 penguins were estimated to have been affected (National Parks and Wildlife South Australia, 2002b).
- A shipping facility is located at **Ballast Head (Eastern Cove)**, in connection with the previous mining industry for gypsum (Edyvane, 1999b), but the impacts of this facility are not known for this report, other than the existence of toxic dinoflagellate (see above), and anecdotal reports of coastal run-off from a slag heap, remaining from the previous gypsum mining industry. The facility is occasionally used by boats to tend nearby aquaculture leases.
- A community-based monitoring program in the area during the late 1990s showed that following the **Penneshaw** breakwater construction, sand was eroded from a local area and re-deposited elsewhere. Sedimentation (over marine plants) occurred, the height of the sea floor rose, and current flow was altered on the leeward side of the reef with a buildup of drifting macroalgae across sessile animal assemblages, at depths of 9m and deeper (KI-AMCS, 2000).

- Loss of freshwater soaks in the **Pelican Lagoon** area, which has reduced the breeding productivity for a number of waterfowl reliant on fresh water incursions into the marine waters of the lagoon (T. Flaherty, MCCN, pers. comm. 2002).
- **Busby and Beatrice Islets (Bay of Shoals area)**: Trail bike riding on the islets and surrounding mudflats has been considered to be a threat to the habitat in the region (Australian Heritage Commission, undated). Other disturbances and threats identified by Morelli and de Jong (1995) include purported depletion of stock from fishing (and collecting), pollution (e.g. oil spills and rubbish dumping), and erosion of stabilised areas by pedestrians and boat activity. Reported factors which may change the value of the area for coastal birds and other biota include inadequately controlled fishing levels, pollution (oil spills and rubbish dumping) of rubbish, introduction of or increase in competitive and predatory exotic species (e.g. starlings, rats) (Australian Heritage Commission, undated; Morelli and de Jong, 1995).

Dudley Peninsula

Coastal Issues

- Increased level of nutrients in developed areas, due to septic tank overflows (e.g. **Penneshaw** area) (Bryars, 2003).
- Increased turbidity and increased sedimentation caused by the Kangaroo Island ferry operation at Penneshaw (Bryars, 2003).
- Ongoing impacts from the breakwater at **Penneshaw**, affecting the benthic environment, including reef communities. Impacts of the Penneshaw breakwater have been monitored by community and government divers, as part of a *Coastcare* project (e.g. see KI-AMCS, 2000).

Diving

- Potential for damage to attached invertebrate benthos from dive boat anchors. Brittle fauna such as bryozoa and soft fauna such as sponges may be particularly susceptible to damage, a factor which has been considered in the recent National Mooring Program (see Environment Australia, 2001).
- There is increasing local, national and international interest in dive tourism in this area, with potential for localised damage to the invertebrate-dominated assemblages and other benthos (e.g. due to anchor damage and other impacts from boats and recreation activities), if dive tourism increases in the area during the 2000s, and is not adequately managed. The need to protect reef communities in the area through increased management of activities was highlighted in a recent community submission to government regarding the north-eastern Kangaroo island area (KI-AMCS, 2000).
- Gorgonian corals in South Australia are susceptible to impacts from recreational diving (Environment Australia, 1998a).

Fishing

- Potential for damage to attached invertebrate benthos from fishing boat anchors. Brittle fauna such as bryozoa and soft fauna such as sponges may be particularly susceptible to damage, a factor which has been considered in the recent National Mooring Program (see Environment Australia, 2001).
- Shepherd and Rodda (2001) recorded a statistically significant 10 year decline (between 1988 to 1998) in the yields of Greenlip Abalone from the False Cape to Cape Coutts area (Map Code 31A, 31B, 31C), reporting a 90% decrease in yield over that period.
- Gastropod molluscs that are important in the shell trade (e.g. Cypraeidae and Volutidae families) are vulnerable to over-exploitation due to low population densities and restricted habitats (Environment Australia 1998). Some of the specimen shells in South Australia are of conservation concern because molluscs which have direct development of young are particularly vulnerable to over-exploitation and population decline (see Ponder and Grayson, 1998). Volutes as a group have particularly vulnerable population dynamics, as do the southern Australian cowries (e.g. species of *Zoila* and *Notocypraea*) and some of the *Conus* species (e.g. *Conus anemone*), which have direct development of young and no planktonic larval phase, and therefore limited dispersal, and geographically distinct sub-populations and varieties, with little mixing. Such characteristics makes populations of these species with limited dispersal

vulnerable to over-collecting. Geographically distinct populations of species of cowries (e.g. *Zoila* and *Notocypraea*), cone shells (*Conus*) and volutes (e.g. *Amoria*, *Ericusa*, *Notovoluta* and other volute genera) often have distinctive colours and patterns, and some of the “varieties” or “sub-forms” are uncommon or rare, and are highly sought after by collectors. It is recognised that species with small extent of occurrence (i.e. narrow geographic range) can be vulnerable to localised extinction from local impacts (IUCN, 1994, Jones and Kaly, 1994, cited by O’Hara and Barby, 2000). Furthermore, some shell species in the shell trade have specialised feeding habits and therefore also have restricted habitats (e.g. some of the *Zoila* and *Notocypraea* rely on host sponges). This feature makes such species more vulnerable than those with more generalised feeding requirements. Specimen shells are discussed further in section 9.2.

- Potential vulnerability of “site-attached” reef-associated species to population declines due to fishing activity, including line and spearfishing. Species include Blue Groper, Blue-throated Wrasse and other wrasse species, Boarfish species, Magpie Perch, Dusky Morwong, adult Snapper, Moonlighter, Western Talma, and Western Blue Devil, amongst others.
- Commercially and/or recreationally significant species that are caught in the area, and may be of potential conservation concern, according to various data sources on stock status, include the following (see section 9.2 and the section on **Fishing Issues** in other tables of this report, for more detailed discussion of the status of these species populations in S.A., according to some available data sources:
 - ♦ *School Shark and Gummy Shark*: The School Shark (Australasian subpopulation) was listed in the IUCN Red List 2003 as *Conservation Dependent*, and previously, Gummy Shark was included in the IUCN Red List 2000 and Red List 2002 as *Conservation Dependent*. Australian Society for Fish Biology (2001) also listed School Shark as *Lower Risk, Conservation Dependent*;
 - ♦ other *Shark* species (see list in table on **Ecological Values** for this area);
 - ♦ *Snapper*: are classified nationally as over-fished in Gulf St Vincent (Zann, 1995), and classified as fully fished in South Australia (DEHAA and EPA, 1998). Some fisheries researchers and fishers in South Australia agree that the Snapper fishery is over-exploited, due to decline in the number of large (older) high fecundity fish available in the fishery, amongst other indicators, and the vulnerability of such populations that are subject to sporadic “boom” recruitment episodes.
 - ♦ *King George Whiting* (of particular concern in the north-eastern Kangaroo Island area is the capture of large mature whiting that may otherwise contribute significantly to the spawning potential); and
 - ♦ Site-associated edible reef fish species (e.g. *Western Blue Groper* and other wrasse species, *Harlequin Fish*). Of particular concern are the large mature individuals of groper and harlequin that are fished by charter boats which depart from **north-east Kangaroo Island**, and also the likelihood of juvenile groper being fished in **American River** and other shallow waters in north-east Kangaroo Island.

Other Issues

- The toxic dinoflagellate *Alexandrium minutum* has been recorded at **Penneshaw** and Ballast Head (SA State of the Environment Report, 1998).
- Greenlip abalone stocks in the Dudley Peninsula area have reportedly been depleted by the disease *Perkinsus* (Bryars, 2003)

Southern Fleurieu (from Aldinga Bay - Yankalilla Bay - Second Valley - Rapid Bay - Cape Jervis - to Newland Head)

Coastal Discharges and Sedimentation

- Sedimentation, amongst other impacts of diffuse-source, land-based outflows, is a continuing problem on the eastern side of Gulf St Vincent. There are numerous impacts of sedimentation, such as decreased water quality, smothering of benthic organisms, and effects upon both the flora (e.g. reduced recruitment rates) and attached fauna on macroalgae-dominated reefs. In general, sedimentation in S.A. gulfs is due to combined sources, including particulates from storm water, river catchment outflows, dredging operations, sand and limestone mining, and other sources (mainly land-based runoff) associated with coastal vegetation clearing, coastal developments such as cliff and shore housing, marina development and other sources of sediment mobilisation. (Environment Protection Council of South Australia, 1992; Jones and Edyvane, 1996; Cheshire et al., 1999; Grady and Brook, 2000).
- Previously the operation of the limestone quarry at Rapid Bay (1942 – 1981) is reported to have

caused sedimentation effects in the local area, due to the mining and crushing operations, dumping of the “fines” on the beach and in the nearshore area, and spillage during loading. Effects reported by the local community include water turbidity, and smothering of seagrass, reef and associated benthic biota, from re-suspension of the limestone fines over a long period. Limestone operations in the area were scaled down in 1988, ship-loading facilities have been dismantled, and the jetty is no longer used for loading. However, substantial reserves remain, within the 200m – 300m thick lens of grey, white and brown medium to coarse-grained, banded marble (PIRSA, 1999c).

- There is agricultural runoff (farm chemicals, as well as sediments) onto reef and seagrass areas in a number of areas in the **Southern Fleurieu** region. For example, agricultural runoff and sedimentation onto seagrass and reef areas in the **Aldinga** area (Environment Protection Council of South Australia, 1992, cited by Edyvane, 1996a).
- Nutrients and other pollutants (e.g. agricultural chemicals, sediments etc) flow from the **Yankalilla, Bungala and Myponga Rivers** and from **Waitpinga Creek**, into the near-shore area (DENR map, cited by Edyvane, 1996b; Bryars, 2003), and increased the level of nutrients has been listed as a perceived threat to the estuarine habitats in these areas (Bryars, 2003). The point source pollution from the **Bungala River** was the subject of a community program of impact monitoring during the mid 1990s.
- Community submissions received by government during 1991, described land-based impacts in the southern Fleurieu area (e.g. **Lady Bay - Carrickalinga - Normanville - Second Valley**) as including: declining quality of the near-shore reef and seagrass ecosystems due to land clearing and coastal development, farming and grazing (causing pollution of local estuaries from agricultural runoff including sediments, herbicides and pesticides, cattle wastes, dairy runoff at **Second Valley**) and human wastes (e.g. effluent overflow at **Second Valley**) (Schiansky, pers. comm. to S.A. Department of Fisheries, 1991). One report suggested that pollutants from river outlets in the area has resulted in reduced variety of macroalgae, in the shallow waters near river outlets, and siltation of near-shore reefs, resulting in reduced diversity of reef biota, and less abundant fish in local areas (Christie, pers. comm. to S.A. Department of Fisheries, 1991).
- Increased levels of nutrients caused by septic tank overflows at **Carrickalinga, Second Valley and Rapid Bay**, has been listed as potential threat to nearshore habitats in those areas (Bryars, 2003).
- Decreased freshwater flows caused by abstraction from the **Waitpinga Creek** catchment, has been listed as a potential threat to nearshore habitat in that area (Bryars, 2003).

Coastal Development (Sub-Divisions, Marina etc)

- Potential impacts from marina in the Wirinna area. General impacts of marinas include:
 - ♦ hydrocarbon pollution; TBT contamination of sediments and biota; physical damage to benthos, such as seagrass destruction and increased sedimentation from channel dredging and maintenance; anchor damage and boat hull scouring; and exotic species introductions (Harvey, 1993; Edyvane, 1995e; Emmett, 1997; O'Leary, 1999). There is anecdotal evidence of disturbance to Southern Calamari habitat due to construction in the area (Grady and Brook, 2000). Information about other impacts specifically associated to the Wirinna marina area is not available for this assessment.
 - ♦ Land clearing and coastal soil disturbance associated with coastal development (e.g. housing sub-divisions) contributes to sedimentation in the near-shore **Southern Fleurieu** marine environment (e.g. **Carrickalinga / Lady Bay / Rapid Bay / Normanville** area and other coastal areas of increasing sub-division) (Grady and Brook, 2000). Amongst other contents, stormwater contains sediments from coastal developments. Stormwater runoff occurs from urbanised and rural areas, particularly those undergoing building site clearance (Caton, 1997, cited by Brook, 2000). Community submissions received by government during 1991 described impacts in the southern Fleurieu area (e.g. **Lady Bay - Carrickalinga - Normanville - Second Valley**) as including impacts upon near-shore environment due to coastal subdivisions and marina (e.g. Wells, pers. comm. to S.A. Department of Fisheries, 1991).

Fishing / Spear-fishing / Collecting

- Tanner (2005) described the disappearance of seagrasses from **Investigator Strait**, and of Hammer Oyster beds in **south-eastern Gulf St Vincent**, due to the impact of prawn trawling.
- There has been an apparent fishing-induced collapse of a Greenlip Abalone population in the **Backstairs Passage** area (e.g. **Cape Jervis**). The population, which was monitored over a 20+ year period, showed strong spatial contraction. It is noted that in this area, catches declined from more than 10 tonnes per annum to less than 500kg per annum over a 25 year period (Shepherd and Rodda, 2001; Shepherd et al.,

2001; S. Shepherd, pers. comm., 2004).

- Shepherd and Rodda (2001) recorded a long term decline (between 1984 and 1998) in the yields of Greenlip Abalone from the **Backstairs Passage** area (Map Code 25A), reporting a 76% decrease in yield over that period, compared with the original production (although the figures were not statistically significant). The low levels of Greenlip Abalone catch during the late 1990s (approximately 1t or less per annum) in the aggregated area from **Cape Jervis** to **Encounter Bay** were considerably lower than yields between 1979 to 1989, during which per annum yields of between 4.4t and approx. 12.5t were recorded in eight of those years. It is noted that during the 1960s, Greenlip Abalone populations extended along the south coast from **Cape Jervis** to **Middleton**. Notable populations included those from **Middleton** to **Port Elliott**, **West Island** and **Tunkalilla**. These populations are now virtually extinct (Shepherd and Brown, 1993; Shepherd, pers. comm., 2004)
- Anecdotal reports (recreational diver's observations over 20 year period) of decline in size and abundance of Abalone in the **Second Valley** area, between the early 1970s and the early 1990s. Also, in 1991, there was an anecdotal report by an officer of the National Parks and Wildlife Service, of depletion of abalone in the **Deep Creek** area (see also evidence above, in previous section).

Commercially and/or recreationally significant species that are caught in the **Southern Fleurieu** and/or **Backstairs** area and may be of potential conservation concern, either locally or regionally, according to various data sources on stock status, include:

- *School Shark and Gummy Shark*: The School Shark (Australasian subpopulation) was listed in the IUCN Red List 2003 as *Conservation Dependent*, and previously, Gummy Shark was included in the IUCN Red List 2000 and Red List 2002 as *Conservation Dependent*; Australian Society for Fish Biology (2001) also listed School Shark as *Lower Risk, Conservation Dependent*;
- *Common Saw Shark*: 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. Pogonoski *et al.* (2002) recommended conservation status of *Lower Risk, Conservation Dependent*; Australian Society of Fish Biology 2001 list recommended *Lower Risk Conservation Dependent*;
- *Whiskery Shark*: Classified as *Lower Risk (Conservation Dependent)* in the IUCN Red List 2000 and 2002, but not included in the 2003 IUCN Red List. Pogonoski *et al.* (2002) suggested as conservation status: *Lower Risk, Conservation Dependent* on an Australia-wide basis; Australian Society of Fish Biology 2001 list recommended *Lower Risk, Conservation Dependent*
- *Snapper*: Jones *et al.* (1990) and Rohan *et al.* (1991) noted long-term regional declines in the Snapper fishery for Gulf St Vincent. The fishery for Snapper in southern Gulf St Vincent declined significantly during the 1980s, and had not recovered by the late 1990s, which prompted the call for a "rebuilding strategy" (PIRSA, 2000). Stock depletion of Snapper caused by over-fishing, was listed as a potential threat in the **southern Fleurieu** area (Bryars, 2003). During the past decade, the decline in the fishery was particularly evident in **southern Gulf St Vincent** and **Investigator Strait** (McGlennon and Jones, 1997). The decline in catches was been partly attributed to a series of poor year classes (i.e. low levels of recruitment) (see McGlennon *et al.*, 2000 for an example of variability in recruitment strength), possibly exacerbated by the higher levels of effort (and numbers of fishers) targeting Snapper during that time, compared with the present. In 2000, a report on the stock of Snapper in northern Gulf St Vincent, showed that there were no obvious signs of recovery from the crash in catches that occurred in the mid to late 1980s (Fowler, 2000), however the stock assessment report in 2002 (Fowler, 2002) showed that both average catches and catch rates per fisher are starting to increase, particularly in the hand-line sector, due to the substantial decrease in total effort (and number of fishers targetting Snapper) that has occurred over the past decade, following the population depletion in the early 1990s, which resulted in a "lower biomass being available to fishers".
- *Garfish*: Classed as being fully exploited in South Australia – see DEHAA and EPA, 1998; Ye, 1999);
- Some edible reef fish species (e.g. *Western Blue Groper*, *Blue-Throated Wrasse*, and *other wrasse* species; *Dusky Morwong*, amongst others) have been over-fished, by both line fishers and spear-fishers. There is a ban on the taking of Western Blue Groper from Gulf St Vincent, however there are few measures in place to protect other reef fish species, other than a spear-fishing ban in the Second Valley area. Bryars (2003) also reported the stock depletion of reef fish species in the **Southern Fleurieu** area, due to over-fishing;
- *Southern Calamari*: There have been fishing-induced localised depletions of inshore stock along the **Southern Fleurieu** – see Triantafillos, 2000) and
- *Abalone*: There has been long term localised depletion due to over-fishing along the **Southern Fleurieu** (S. Shepherd, per. comm., 2000). Stock depletion of abalone caused by over-fishing, has been listed as a

potential threat in the **Southern Fleurieu** area (Bryars, 2003).

- Notes on the apparent status of these species populations, at local and regional scales, according to some available data sources, are provided in section **9.2**.
- Site-associated reef fish species are susceptible to population declines due to fishing activity, including line and spearfishing (**Lady Bay, Carrickalinga, Haycock Point, Second Valley, Rapid Bay**). Species include Blue Groper, Blue-throated Wrasse and other wrasse species, Boarfish, Magpie Perch, Dusky Morwong, Western Blue Devil, Harlequin Fish, amongst others. Notes on the apparent status of some of these species populations in S.A. are provided in section **9.2**. Some of the fish species that dominated the catches in spearfishing competitions during the 1980s in the **Cape Jervis** area included Magpie Perch, red "mullet", Blue-throated Wrasse, horseshoe leatherjacket, sea sweep, long-snout Boarfish (Johnson 1985a and 1985b). Ottway *et al.* (1980) discussed the decline of near-shore reef fish in the southern Fleurieu area and recommended increased protection. Public submissions received by government during the early 1990s also expressed concern about the impacts of spearfishing on reef fish populations at **Haycock Point (Carrickalinga)** and **Second Valley**, including the spearing of juvenile Western Blue Groper at the latter site (Muirhead, pers. comm. to S.A. Department of Fisheries, 1991). More recently, there have been further anecdotal reports of fishing-induced decline in abundance of species such as Dusky Morwong in the area, including reports from spear-fishers.
- There are important spawning areas for Southern Calamari, in the **Southern Fleurieu** region, such as the **Myponga** and **Second Valley** areas. Triantafillos (1997) recommended that spawning populations should not be over-fished, because of the possibility of recruitment over-fishing; and because calamari is an annual species, characterised by high inter-annual recruitment variability, a cautious approach to management should be adopted.
- There are unpublished reports from divers that fishing debris (fishing line, hooks, discarded bait, plastic) and recreational debris (cans, bottles, plastics) etc at **Rapid Bay** jetty may also be a potential impact on seadragons in that area.
- During the 1990s, there were periodic reports to government every year, of illegal netting and line fishing (for scalefish, calamari, and sharks) from boats, and spearfishing in Aldinga Aquatic Reserve. Also irregular reports of discarded sharks and rays in the **Aldinga** area (bycatch from line fishing for scalefish). Concern about illegal fishing within the **Aldinga Aquatic Reserve** was recorded as long ago as 1980 (see Ottway *et al.*, 1980).
- There were reports to government during the 1990s of illegal intertidal collecting from the platform reef at **Aldinga**. Collecting from intertidal reefs is now prohibited in South Australia (see PIRSA, 1996).
- There is potential for reduced food supply for cetaceans and pinnipeds, due to fishing activity. Heavy harvesting of squid and fish species as yield and bycatch may adversely affect some cetaceans, especially those species or populations restricted to inshore habitats (such as some dolphin populations) (ANCA, 1996).
- Community submissions received by government during 1991 (Muirhead; Wells; Schiansky; Schultz; Christie; all pers. comm. to S.A. Department of Fisheries), described impacts in the southern Fleurieu area (e.g. **Lady Bay – Carrickalinga - Normanville - Second Valley**) as including the following:
 - ♦ long term depletion of reef fish throughout the area due to spearfishing;
 - ♦ bycatch from prawn trawling further offshore, and purported seasonal depletion of local fish populations;
 - ♦ localised over-fishing of both target and non-target species by commercial and recreational fishers;
 - ♦ fishing of juveniles and non-edible fish species; and
 - ♦ shell collecting, and recreational diving for lobster (e.g. **Carrickalinga, Haycock Point**), including juvenile lobster, which were reported to previously have been abundant in some areas such as **Lady Bay**.
- *Specimen Shells*: Occur in reef and sand areas, such as those in waters off parts of **Southern Fleurieu**. Some of the specimen shells in South Australia are of conservation concern because molluscs which have direct development of young are particularly vulnerable to over-exploitation and population decline (see Ponder and Grayson 1998). Volutes as a group have particularly vulnerable population dynamics, as do the southern Australian cowries (e.g. species of *Zoila* and *Notocypraea*) and some of the *Conus* species (e.g. *Conus anemone*), which have direct development of young and no planktonic larval phase, and therefore limited dispersal, and geographically distinct sub-populations and varieties, with little mixing. Such characteristics makes populations of these species with limited dispersal vulnerable to over-collecting. Geographically distinct populations of species of cowries (*Zoila* and *Notocypraea*), cone shells (*Conus*) and

volute (e.g. *Amoria*, *Ericusa*, *Notovoluta* and other volute genera) often have distinctive colours and patterns, and some of the “varieties” or “sub-forms” are uncommon or rare, and are highly sought after by collectors. It is recognised that species with small extent of occurrence (i.e. narrow geographic range) can be vulnerable to localised extinction from local impacts (IUCN, 1994; Jones and Kaly, 1994, cited by O’Hara and Barmby, 2000). Furthermore, some shell species in the shell trade have specialised feeding habits and therefore also have restricted habitats (e.g. some of the *Zoila* and *Notocypraea* rely on host sponges). This feature makes such species more vulnerable than those with more generalised feeding requirements. Specimen shells are discussed further in section 9.2.

- Both licenced and illegal removal of seadragons from their habitat occurs in S.A., however the impacts upon population structure and abundance are not known.

Diving

- Potential impacts on local seadragon populations from unregulated dive practices (including prodding and handling of seadragons and disturbance of resting seadragons for viewing by dive groups etc). This is being addressed by government and community groups via a Diving Code of Conduct, released during the early 2000s.
- Potential local impacts (e.g. physical damage to benthos, such as attached reef invertebrates, due to anchoring and other activities associated with diving) if dive tourism increases in the area during the 2000s. The general potential for habitat damage if SCUBA diving is not effectively managed was mentioned in a recent report on the southern Fleurieu region (see Brook, 2000).

Aquaculture

- PIRSA’s Gulf St Vincent / Fleurieu Management Plan (Berggy, 1996) provided for aquaculture development in the area, including 30 ha in the West Fleurieu Management Zone, and 60ha in the Rapid Bay area (see **Notes on Social and Economic Values and Uses** for details of location). No leases have been approved, although applications were received by government during the 1990s. The potential impacts of fin-fish and shellfish farming in general are discussed in section 9.2.

Other Issues

- Anecdotal reports from divers, of anchor damage from boats visiting **Aldinga Reef**.
- Previous sand mining in the northern section of **Normanville** has reportedly destroyed vegetation in the dune area, making the area vulnerable to erosion, and development of blow-outs. The dunes are considered to be an “essential sand supply” for maintaining the beaches in the area. The dunes are also subject to further erosion from foot traffic (Australian Heritage Commission, undated).
- Potential for reef damage and altered species composition from oil spills, carried southwards from Port Stanvac (e.g. in June 1999, a spill of 270 000 litres reached **Aldinga Bay** area).
- Perceived threats to habitats of the **Yankalilla, Bungala and Myponga Rivers** include the decreased fresh water flow caused by abstraction from the catchments of these rivers (particularly by the Myponga Reservoir, in the case of the Myponga River), and the altered patterns of freshwater flow caused by the Myponga Reservoir (Bryars, 2003).
- Increased turbidity and increased sedimentation caused by the period dredging of the ferry harbour at **Cape Jervis**, and also due to the regular operation of the Kangaroo Island ferry in that area, was listed as a potential threat to nearshore habitat at **Cape Jervis** (Bryars, 2003).
- In addition to direct littering of the beach, urban litter is delivered to the **Southern Fleurieu** coast via stormwater drains and rivers (Lewis, 1996, cited by Brook, 2000).
- There is anecdotal evidence from a public submission to government, of coastal Aboriginal Heritage sites along the **Southern Fleurieu** being destroyed through lack of awareness and protection (Wells, pers. comm. to S.A. Department of Fisheries, 1991).
- Community submissions were received by government during 1991 (Schiansky; Wells; Christie; all pers. comm. to S.A. Department of Fisheries) described impacts in the southern Fleurieu area (e.g. **Lady Bay - Carrickalinga - Normanville - Second Valley**) as including:
 - ♦ foreshore erosion and dune blow-outs due to recreational activities such as horse riding and motorbike riding and walking;
 - ♦ other damage to coastal areas and biota from weeds, pets and people;
 - ♦ reduced water quality in estuarine areas due to littering (plastics, car tyres, and assorted garbage),

including litter pollution both from marine activities (fishing) and from estuarine catchment areas that deliver litter such as plastic bags to the near-shore marine environment;

- ♦ disturbance to breeding populations of coastal birds.

Backstairs Passage and Pages Islands

Fishing

- There may be some potential for impact due to shark berleying, as part of cage viewing tourism activity, and shark fishing activity. Previously, PIRSA's discussion paper Management of the Great White Shark in South Australia (Presser, 1995) proposed that the boundaries of the Pages Islands Conservation Park be extended seawards. In that report, DENR (i.e. DEH) proposed to exclude berleying for an annual period of 5 months, during the pupping season, to prevent what the Department perceived to be potential for increased mortality of sea lion pups due to increased numbers of sharks, attracted by the berleying operations. At present there is a three nautical mile marine extension gazetted for the Pages Islands, but there has been no known berleying to occur within the vicinity of the Pages for the past two years (K. Twyford pers comm., 2000).
- Shark netting close to breeding and haul out locations, and baiting the water to attract sharks, has recognised impacts (e.g. disturbance of breeding) on pinniped populations (Gales, 1990). Disturbance to breeding colonies from boating activity may also occur.
- Pinnipeds (e.g. Sea Lions), cetaceans (mainly small cetaceans - dolphins) and fish can become entangled (often fatally) in discarded line and net from fishing activities. Figures are not available for this assessment, but entanglements are known to regularly occur in South Australian waters, according to reports received by S.A. Museum.
- Other than entanglements, there may be some potential for fishing activities around the Pages to have other impacts upon pinniped, cetacean and shark populations (e.g. competition for food sources; deliberate harm from shooting, harassment etc).

Commercially and/or recreationally significant species that are caught in the **Backstairs Passage and Pages Islands** area, and may be of potential conservation concern, according to various data sources on stock status, include the following (see section 9.2 for more detailed discussion):

- *School Shark and Gummy Shark*: The School Shark (Australasian subpopulation) was listed in the IUCN Red List 2003 as *Conservation Dependent*, and previously, Gummy Shark was included in the IUCN Red List 2000 and Red List 2002 as *Conservation Dependent*. The Australian Society for Fish Biology (2001) also listed School Shark as *Lower Risk, Conservation Dependent*. School Shark is classified as over-fished in southern Australia, and Gummy Shark as fully fished (see references by AFMA, this report);
- *Saw Sharks*: There are two species in South Australian waters. 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. Pogonoski *et al.* (2002) recommended conservation status of *Lower Risk, Conservation Dependent*; Australian Society of Fish Biology 2001 list recommended *Lower Risk Conservation Dependent*, for Common Saw Shark.
- *Whiskery Shark*: Classified as *Lower Risk (Conservation Dependent)* in the IUCN Red List 2000 and 2002, but not included in the 2003 IUCN Red List. Pogonoski *et al.* (2002) suggested as conservation status: *Lower Risk, Conservation Dependent* on an Australia-wide basis; Australian Society of Fish Biology 2001 list recommended *Lower Risk, Conservation Dependent*.
- *Bronze Whaler and/or Black Whaler*: Whaler sharks (including aggregations of juveniles) are actively fished in various parts of SA, including the Backstairs and Encounter Bay area, by commercial (and sometimes recreational) fishers. Bronze Whaler and Black Whaler were both included in the IUCN Red List 2003 as *near threatened* species. Section 9.2 discusses the vulnerable population characteristics of these species.
- *Snapper*: Jones *et al.* (1990) and Rohan *et al.* (1991) noted long-term regional declines in the Snapper fishery for Gulf St Vincent. The fishery for Snapper in southern Gulf St Vincent declined significantly during the 1980s, and had not recovered by the late 1990s, which prompted the call for a "rebuilding strategy" (PIRSA, 2000). The decline in the fishery was particularly evident in **southern Gulf St Vincent and Investigator Strait** (McGlennon and Jones, 1997). The decline in catches was been partly attributed to a series of poor year classes (i.e. low levels of recruitment) (see McGlennon *et al.*, 2000 for an example of variability in recruitment strength), possibly exacerbated by the higher levels of effort (and numbers of fishers) targeting Snapper during that time, compared with the present. In the 2000 stock assessment of

Snapper in northern Gulf St Vincent, there were no obvious signs of recovery from the crash in catches that occurred in the mid to late 1980s (Fowler, 2000), however the stock assessment report in 2002 (Fowler 2002) showed that both average catches and catch rates per fisher are starting to increase, particularly in the hand-line sector, due to the substantial decrease in total effort (and number of fishers targeting Snapper) that has occurred over the past decade, following the population depletion in the early 1990s, which resulted in a “lower biomass being available to fishers”.

- Some edible reef fish species (e.g. *Western Blue Groper*, *Blue-Throated Wrasse*, and other wrasse species). Notes on the apparent status of these species populations in S.A., according to various data sources, are provided in section 9.2.
- There is potential for reduced food supply for cetaceans and pinnipeds, due to fishing activity. Heavy harvesting of fisheries species that are also prey species for marine mammals, may adversely affect some cetaceans (Banister *et al.*, 1996).

The section above which outlines impacts in the **Southern Fleurieu area (Aldinga Bay - Yankalilla Bay - Second Valley - Rapid Bay - Cape Jervis - to Newland Head)** discusses the long term decline in Greenlip Abalone yields from the **Backstairs Passage** area.

Aquaculture

- PIRSA's Gulf St Vincent / Fleurieu Management Plan (Berggy 1996) provided for aquaculture development in the area, including 50ha in the **Investigator Strait / Backstairs Passage** Management Zone (see **Notes on Social and Economic Values and Uses** for details of location). No leases have been approved to date. Aquaculture development within the vicinity of pinniped colonies is recognised as a threat to foraging ability, the lives of individual animals (death through entanglement and drowning, and deliberate harm), and breeding success. Other potential impacts include disturbance to breeding and feeding colonies of seabirds. The Pages Islands (Backstairs Passage) supports the most important breeding colony of Australian sea lions in the world. The potential impacts of fin-fish farming in general are discussed in section 9.2.

Sea Lion Pup Mortality

- Rowley (2001) and CSIRO (2000b) reported that mortality rates for sea lion pups at the Pages Islands have been high in recent years (e.g. around 55% in the 1995/96 breeding season which was considered a “failed season”, and relatively high percentage mortality (compared with some other colonies in South Australia) also in the ensuing years of the late 1990s, to the present. The reasons for the high pup mortality are alarming, given the small global population size for this species. Factors (both natural and anthropogenic) that may be related to the recent high death rates are currently being investigated by CSIRO's Wildlife and Ecology section (P. Shaughnessy).

Encounter Bay

Coastal Discharges / Effluent / Sedimentation

- The **Hindmarsh** and **Inman Rivers** are the principal point sources of marine pollution in the Encounter Bay area. The **Inman River** also discharges sewage into the bay (Baker and Edyvane, 1996; Australian Heritage Commission, undated; SA Water, 2002). The Victor Harbor Wastewater Treatment Plant delivers secondary treated effluent to the Inman River five kilometres above the estuary. Studies reported by Camp Scott Furphy Pty Ltd (1992) and Lewis (1996), cited by the Australian Heritage Commission (2000) showed that comparatively high pollution episodes occur in the estuaries of both the Inman and the Hindmarsh Rivers. The Victor Harbor Waste Water Treatment Plant discharged the following into the aquatic environment in 2002 (see SA Water, 2002):
 - ◆ Total nitrogen: 51.82t
 - ◆ Total phosphorus: 2.4t
 - ◆ Suspended solids: 36.7t
 - ◆ Biochemical oxygen demand: 21.37t
- Treated effluent: 916.9ML (8% is currently recycled). A new wastewater treatment plant is being developed in the Victor Harbor area, and treated water will be stored in the disused Hindmarsh Valley reservoir for re-

use as a land-based resource (SA Water, 2002).

- Both the **Hindmarsh** and **Inman** Rivers receive what are reported to be “large amounts” of stormwater runoff from Victor Harbor. Apart from runoff through the two estuaries, stormwater runoff (containing a variety of both organic and inorganic materials, including toxic substances) occurs at other points around **Encounter Bay**, particularly from developed areas. Nutrients and other pollutants from sewage and stormwater outlets can cause eutrophication, increased turbidity, smothering and other effects which result in benthic habitat degradation (Baker and Edyvane, 1996, cited by Australian Heritage Commission, 2000). Bryars (2003) listed the increased level of nutrients, increased turbidity and increased sedimentation caused by stormwater in the Victor Harbor area, as a potential threat to estuarine habitats of the **Hindmarsh** and **Inman** rivers, and also to sheltered beach habitat and subtidal sand habitats in the **Victor Harbor** area and other parts of **Encounter Bay**.
- **Watson Gap** is also a point source of pollution in the area (Baker and Edyvane, 1996), and sewage is discharged from **Port Elliot**.
- Some runoff of silt and farming chemicals also occurs, transported by local streams and rivers into Encounter Bay (with potential to periodically cause turbidity, benthic smothering, and chemical contamination of water, sediments and biota). In general, chlorinated hydrocarbons from agricultural biocide runoff are considered to be especially damaging to marine mammals, whose enzyme systems cannot degrade such chemicals, which consequently accumulate in organs, tissues and milk, which can cause debilitating (and sometimes lethal) effects (Bannister *et al.*, 1996). However, such potential effects have not been studied in the Encounter Bay area.
- Turbid river water discharging from the Murray is occasionally swept westward to Encounter Bay after a period of strong southerly winds (mainly from September to November) (Shepherd and Womersley, 1970). Discharge from the River Murray is considered to be a water quality issue in the area (Petrusevics *et al.*, 1998)

Coastal Developments

- During the mid 1990s, a proposal at Victor Harbor for a boat ramp (also including a breakwater, small marina and a car park, according to CCSA, 2000) was considered by Cheshire and Miller (1998) to potentially result in loss of 1ha of dense seagrass, and to potentially impact a further 5ha-10ha of habitat in the vicinity. Loss of seagrass in the area was expected to result in reduced “ecosystem integrity” due to changes in the local ecosystem function, and increased sedimentation. CCSA (2000) reported potential visual impact of the development upon the beachfront.
- Increasing urban development in the Victor Harbor area (Halstead, 1987; Baker and Edyvane, 1996; Berggy, 1996) may increase potential impacts in the Encounter Bay area, especially on the western side of the bay. Several new sub-divisions have been developed during the past decade, to serve new residents (e.g. Encounter Bay is becoming increasingly popular for retirees). The increasing popularity of the Encounter Bay region for tourists/holiday-makers during the past decade may also increase marine impacts (including many of those outlined above). Examples of potential impacts include increased nutrient and other chemical runoff, increasing water turbidity, and increased physical damage to near-shore habitats.
- Berggy (1996) listed foreshore effects from the rapid (and increasing) development of **Victor Harbor, Port Elliot, Middleton** and **Goolwa** as being litter, erosion, effluent and stormwater pollution.
- There has been a marina proposal for **Encounter Bay**, and the physical disturbance and habitat destruction that would occur during construction, as well as the altered patterns of water and sediment movement that would result from the marina, have been listed as potential threats to nearshore habitats in the area (Bryars, 2003).

Intertidal Collecting and Trampling / Subtidal Collecting

- Shell collecting and harvesting of intertidal fauna was a popular activity during the 1980's. For example, Kings Beach previously supported a variety of crustaceans, molluscs, sea stars, sea cucumbers, sea anemones and other benthic organisms, and has suffered substantial decline in the number of intertidal invertebrates, particularly sea cucumbers and sea stars (J. Orbach pers comm., cited by Baker and Edyvane, 1996). Intertidal collecting can be intensive in some areas. In Halstead's (1987) study, 58% of all intertidal collecting in the Encounter Bay area occurred in only 3% of the study area. Although signs were erected by Fisheries Officers and the Victor Harbor Council in 1987, prohibiting the collection of organisms from the intertidal area, the collecting continued until at least the 1990s (Baker and Edyvane, 1996). Intertidal harvesting from the shoreline out to 2m is now banned on all rocky shores in South Australia (PIRSA, 1996). Trampling of reef biota also occurs, by people walking in the intertidal area.

Boating / Jet Skiing

- Jet ski activity in Encounter Bay, particularly around some of the islands has been a concern (Coxon, pers. comm. 1999), and became an increasingly popular activity during the 1990s. Jet skis are responsible for potential acoustic impacts on marine fauna (such as marine mammals, which are sensitive to acoustic disturbance), and other potential impacts such as disturbance of bird populations (including nesting sites), hydrocarbon pollution, bank erosion, and benthic scouring in shallow water, amongst other impacts (Tiarnlund *et al.*, 1993; Krueer, 1994; Sargent *et al.*, 1995; Klarin, Oregon Ocean Coastal Management Program, pers. comm., 1998; Burger, 1998; Bluewater Network, 1998)
- Motor boat activity may also be a potential source of acoustic and physical disturbance to whales and other marine mammals, and control measures to prevent boat crowding, motor revving and fast manoeuvring (and therefore potential disturbance) must be maintained in the Encounter Bay area (ANCA report, Bannister *et al.*, 1996, cited by Baker and Edyvane, 1996).
- Acoustic disturbance can cause stress, disorientation, physical harm, and/or abandonment of feeding, calving, nursery or migration areas, and has been highlighted as a major threat to the recovery of cetacean populations in Australian waters (Bannister *et al.*, 1996).
- Physical disturbance due to boat anchoring in **Encounter Bay** has been listed as a potential threat to seagrass habitats in the area (Bryars, 2003).

Fishing

- “Site-attached” reef fish species are vulnerable to population declines due to fishing activity, including line and spearfishing. Species include wrasse species, Boarfish, Magpie Perch, Dusky Morwong, adult Snapper, Moonlighter, Western Talma, Western Blue Devil, Western Blue Groper (e.g. caught around Granite Island) and Harlequin Fish, amongst others. Notes on the apparent status of some of these species populations in S.A. are provided in section 9.2. Some of the fish species that dominated the catches in spearfishing competitions during the 1980s in the **Victor Harbor** area included Sea Sweep, Banded Morwong (not common in S.A.), Magpie Perch, Long-snout Boarfish, Blue Morwong, Blue-throated Wrasse, zebrafish, and Dusky Morwong (Johnson, 1985a and 1985b).

Commercial species that are caught in the area, and may be of potential conservation concern at local and/or regional scales, according to various data sources on stock status, include:

- *School and Gummy Shark*: The School Shark (Australasian subpopulation) was listed in the IUCN Red List 2003 as *Conservation Dependent*, and previously, Gummy Shark was included in the IUCN Red List 2000 and Red List 2002 as *Conservation Dependent*. Australian Society for Fish Biology (2001) also listed School Shark as *Lower Risk, Conservation Dependent*;
- *Common Saw Shark*: Fished commercially in small quantities (e.g. less than 1 tonne per annum, during the mid to late 1990s) in the deeper waters of the Encounter Bay and Murray Mouth area. 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. Pogonoski *et al.* (2002) recommended conservation status of *Lower Risk, Conservation Dependent*; Australian Society of Fish Biology 2001 list recommended *Lower Risk Conservation Dependent*;
- *Whiskery Shark*: Classified as *Lower Risk (Conservation Dependent)* in the IUCN Red List 2000 and 2002, but not included in the 2003 IUCN Red List. Pogonoski *et al.* (2002) suggested as conservation status: *Lower Risk, Conservation Dependent* on an Australia-wide basis; Australian Society of Fish Biology 2001 list recommended *Lower Risk, Conservation Dependent*
- *Bronze Whaler and Black Whaler*: Whaler sharks (including aggregations of juveniles) are actively fished in various parts of SA, including the Backstairs and Encounter Bay area, by commercial fishers (and sometimes recreational fishers – see below). Bronze Whaler and Black Whaler were both included in the IUCN Red List 2003 as *near threatened* species. Section 9.2 discusses the vulnerable population characteristics of these species
- Some site-associated reef fish species (e.g. *Western Blue Groper, Blue-Throated Wrasse, and other wrasse species; Morwong species; Boarfish species*), which are easily targeted in the area, and may be over-fished. Bryars (2003) listed stock depletion of reef fish caused by overfishing, as a perceived threat in the **King Head to Middleton Point** area of **Encounter Bay**;
- *Mulloway* (see information below, for Murray Mouth region)

Details on the apparent status of some of these species populations in S.A. are provided in section 9.2.

- There have been periodic reports to government during the past several years, of illegal fishing for scalefish, Rock Lobster and shark in the Encounter Bay area, including fishing within the West Island Aquatic Reserve, and net fishing in areas closed to nets. For example, there have been periodic reports to government during the 1990s, of illegal fishing for abalone within and adjacent to the West Island Aquatic Reserve. Illegal fishing for abalone was considered to be one of the two major factors (the other being oceanographically induced recruitment failure) responsible for the population decline of Greenlip Abalone at West Island (Shepherd and Brown, 1993). Illegal pot fishing for Rock Lobster also occurs in Encounter Bay area (Baker, pers. obs.; Kildea, pers. obs.; PIRSA Compliance Unit records)
- Discarded plastic (bait box covers, bags, ropes etc) and other fishing debris (nets, lines, hooks) is a potential impact in the area, and may particularly affect marine mammals, which may become entangled, or ingest plastic bags. Potential effects include reduced foraging ability and drowning in some cases. Seals and sea lions are particularly vulnerable, and seals entangled in netting and other debris have been observed in Encounter Bay. Sharks and large fish may also ingest or become entangled in plastic. It is likely that those seals with net tangled around their heads and necks, observed around islands in South Australia, represent only a small proportion of those which die out at sea from entanglement (Gales, 1990). According to Gales (1990), drowning of marine mammals in lobster pots is also considered possible.
- Shark netting close to breeding and haul out locations, and baiting the water to attract sharks, have recognised impacts (e.g. disturbance of breeding) on pinniped populations (Gales, 1990). This is a potential impact in the vicinity of Encounter Bay and deeper waters.
- A survey in 1986-87 of 46 marine activities in Encounter Bay (Halstead 1987, cited by Baker and Edyvane, 1996) showed that the area used most intensively was that adjacent to Rosetta Head, and that net fishing, lobster potting and rod and line fishing were considered to have the greatest "impact". Netting for Mulloway and shark still occurs in Encounter Bay, and there is some swing netting from the beaches (C. Halstead, DEH, pers. comm. 2003)
- Recreational fishers report catching aggregations of juvenile Bronze Whalers in the **Encounter Bay** and **Granite Island** area. There are currently no controls over fishing small sharks, which have not yet become reproductive, which may be a sustainability issue at a local scale. There are inadequate controls over the capture of benthic sharks (e.g. Port Jackson) and rays in the area, which are also targeted and caught (in multiple quantities, in some cases) by some recreational fishers. FishInternet Australia (2001) listed examples of recent fishing reports for the area.

Other Impacts and Threats

- Reported environmental impacts of whale watching in busy years (according to Madigan 1995) have included some damage to some of the "soft" sites along the coast (**Goolwa and Bashams Beach, Fisherman's Bay, Sandy Bay, The Chicken Run, Boomer Beach, Watson's Gap and Waitpinga Beach**).
- **Hindmarsh and Inman Rivers:** Australian Heritage Commission (undated) reported that the estuaries are exposed to various impacts from recreational activities, but these were unspecified.
- Previously, potential damage to penguins from netting activity and oil slicks had been noted, as well as vandalism of rookery areas (NPWS 1987, cited by Halstead 1987). During the 1990s, the Encounter Bay penguin populations were considered to be under pressure from habitat disturbance, feral animals, netting and possibly diminishing food resources (C. Halstead, DENR, 1994, pers. comm., cited by Baker and Edyvane, 1996). Intentional disturbance to penguins and rookeries on Granite Island was noted by National Parks and Wildlife officers to occur as recently as the late 1990s.
- Terns which breed on West Island are under pressure from habitat modifications due to changes in island vegetation during the past few decades, and increased silver gull numbers (C. Halstead, DENR, 1994, pers. comm., cited by Baker and Edyvane, 1996).
- The beach and dune areas of **Waitpinga** and **Parsons** beaches have previously been described as being under "constant and intensive threat from beach-goers" (Australian Heritage Commission, 1977). Indiscriminant camping and general use of fore dunes at Waitpinga Beach has destroyed vegetation, making the dunes susceptible to erosion, which causes blowouts and loss of beach sand in the area.
- According to Bourman (1974 and 1979, cited by Baker and Edyvane, 1996), **Middleton Beach**, and **Tunkalilla Beach** are sites of rapid erosion due to scalloping and collapse following undercutting. Whilst much of the erosion is caused by natural processes such as the tectonic subsidence of the Murray Basin

and storm episodes, the erosion has apparently been exacerbated by land clearing and runoff from the pastoral land of the lower Fleurieu, which has increased the "gullying" of the soft alluvial cliff materials. Rapid coastal erosion was initiated at **Middleton** at around the beginning of the 20th century, and a major portion of the beach has now been lost - since 1910, the shoreline has moved about 200m inland on Middleton Beach.

- Trampling, erosion and littering of coastal areas by visitors, and damage to geologically significant coastal sites (Baker and Edyvane, 1996).

Murray Mouth / Goolwa / Sir Richard Peninsula

Impacts and suggested management actions are discussed in detail in the report by Edyvane, Carvalho, Evans, Fotheringham, Kinloch, and McGlennon (1996), and more recently the implications of the closure of the Murray Mouth have been discussed in a report by the Murray Darling Basin Commission and Department of Land, Water and Biodiversity (2002). Edyvane *et al.* (1996) considered that lack of an integrated ecosystem approach to management was identified as a major issue threatening the conservation values of the Lower Murray. Owen (1999) also provided a brief overview of threats in the Lower Murray area, and threats are also discussed in detail in the draft and final Management Plan for the Coorong and Lower Lakes Ramsar sites (produced in 1999 and 2000 respectively).

Combined Impacts of Altered Estuarine Dynamics

- The five barrages (Goolwa-632m long, Mundoo-792m long, Boundary Creek-244m long, Ewe Island-2271m long and Tauwitschere-3658m long) constructed across the tidal channels of the lower Murray lakes, separate lakes Alexandrina and Albert from the Coorong, and have resulted in permanent freshwater conditions in the lakes. Consequently, the Murray Mouth estuary, which is reported to have once been an area of almost 75,000 hectares, is now reduced to the area embracing the Murray Mouth and the Coorong lagoons (Bourman and Barnett, 1995, cited by Edyvane *et al.*, 1996). The altered pattern of freshwater flow caused by the Murray River locks and the Goolwa Barrage, is considered to be a major threat to habitat in the Murray Mouth area (Edyvane *et al.*, 1996; Bryars, 2003).
- The construction of the barrages near the mouth in 1930-1940s, as well as the system of locks and weirs upstream and the large extraction of water for agricultural and other uses, has dramatically altered the influence of the River Murray on the Murray Mouth estuary. The barrage system has been described as the most significant impact ever to occur to the Murray Mouth estuary (Pierce, 1995). The quantity of water diverted from the Murray River system has increased over the decades, with at least two-thirds of the water that would originally reach the sea now being used (Thomson, 1995, cited by Edyvane *et al.*, 1996). According to a more recent estimate, the upstream extraction of water from the system is now as high as 73% of the natural flow (Paton, pers. comm. to ABC, 2002). The Murray Mouth estuary is reported to have been around 953.5 square kilometres prior to barrage construction and only 110.5 square kilometres remains as estuarine habitat (Pierce, 1995).
- Some of the combined impacts of altered flow regime since the middle of last century, principally due to construction of 5 barrages within the vicinity of the Murray Mouth, and the increased extraction of water from the system, include the following. At least 12 reports and papers on the effects of reduced flow have been written since 1980. Author details for these reports are provided in Edyvane *et al.* (1996), and the Murray Darling Basin Commission and DWLB in SA produced a more recent (2002) summary of the effects of reduced flow. In summary, the altered flow regime due to water control and over-use, has resulted in the following impacts, some of which are major (Morelli and de Jong, 1995, Edyvane *et al.*, 1996; MDBC and DWLB, 2002; Paton, pers. comm. to ABC, 2002; Bryars, 2003):
 - ◆ Reduced estuarine function,
 - ◆ reduced outflows of river water (due to water abstraction, locks, and barrages) and reduction of associated nutrients and fine sediments from the river flows, that are important in the ecology of the Murray Mouth and Coorong system;
 - ◆ increased salinity, due to lack of freshwater flows from the River Murray;
 - ◆ increased sedimentation caused by lack of freshwater flows;
 - ◆ increased input of marine sand in the Murray Mouth area (resulting in decreased tidal flows, and periodic closure);
 - ◆ a barrier between marine and freshwater;

- ◆ reduced fish passage,;
 - ◆ artificially high and stable water levels,
 - ◆ wetland and habitat loss, and
 - ◆ shore erosion
- The reduced flow rate and creation of artificially stable water levels has impacts on the entire estuarine area, including disruption to estuarine conditions and function, reduced water quality, and changes to the population dynamics, distribution and abundance of flora and fauna associated with the Murray Mouth. There has been a reduction in the amount of estuarine water in the system, as well as freshwater (see below).
 - A reduction in the amount of fresh water entering the system from the Murray has altered the ecological functioning of the Murray Mouth area, and is considered to be a major threat to habitats in the area (Edyvane *et al.*, 1996; Bryars, 2003). Fresh water is important for the maintenance of estuarine conditions, riparian vegetation, water quality and estuarine fish abundance, migration, reproduction and health (Edyvane *et al.*, 1996), and water-bird ecology. The persistence of artificial salinities for long periods has significant impact on the biological values of the area. Although estuaries may be characterised by low species diversity of many taxonomic groups, Edyvane *et al.* (1996) also stated that the species diversity of the Murray Mouth estuary is likely to have been considerably affected by artificial flow manipulations.
 - Long term changes to the dynamics of estuarine vegetation communities (Edyvane *et al.*, 1996) has occurred, with little consideration for optimal flow requirements for persistence of estuarine vegetation. Altered flow regime (including reduced flow, and significant changes to salinity levels and flood cycles over space and time) has resulted in long term changes in the species composition, distribution and abundance of riparian, estuarine and saltmarsh vegetation. Changing sedimentation patterns within the estuary have also caused significant habitat changes to wetland communities particularly in the vicinity of the Murray Mouth. For example, the expanding flood tide delta has resulted in the loss of sedge communities but has created new habitat for saltmarsh communities (Edyvane *et al.*, 1996). The effects of altered flow regime on estuarine flora have also been exacerbated by grazing (see below).
 - Interruption to the natural cycles of flushing has also affected the ecology of the area. For example, discharge from Lake Alexandrina generally occurs during moderate to high flow in the River Murray. During these times, the water tends to have higher turbidity, greater nutrient loads and lower salinity than during periods of low flow (Steffensen 1995, cited by Australian Heritage Commission, undated). The gradual desalinisation of the lakes since barrages were constructed near the Murray Mouth to keep the Lakes fresh during low river flows, and maintain a stable water level, has allowed an invasion of Water Couch *Paspalum distichum* along the lake shores. Irrigation practices on Narrung Peninsula and south of Meningie may be the origin of a similar but less obvious effect on parts of the northern lagoon of the Coorong (Eckert pers. comm., cited by Morelli and de Jong, 1995).
 - Periodic closure of the Murray Mouth due to sand and sediment build-up has occurred, which would be flushed more regularly to sea under more natural conditions (i.e. without the level of artificial flow manipulation, which now occurs). Reduced river flows have resulted in the accumulation of sediments within the estuary and the formation of a large flood tide delta (i.e. Bird Island), which can lead to the closure of the mouth (Edyvane *et al.*, 1996). The mouth's width has also been reduced, and is related to the tidal prism, i.e. "the volume of water which passes through the inlet over a half tidal cycle" (MMAC, 1987, cited by Edyvane *et al.*, 1996). The barrages, when closed, reduce the tidal prism by around 90% of its original pre-barrage size (Harvey, 1995). Modelling studies conducted by Chappell (1991, cited by Edyvane *et al.*, 1996) demonstrated that littoral drift is affected by a reduction in the tidal prism, which can lead to a closure of the Mouth. Apart from some of the ecological effects on the inside habitats in the system (see points above and below), build up of sand at the Murray Mouth reduces the opportunity for periodic replenishment of sand on the outside Peninsula, which would occur under more natural flow conditions (Fotheringham, pers. comm., 2000). The reduction of sand movement back out to the coastal area can exacerbate erosion in the northern Coorong Peninsula area (Fotheringham, pers. comm, 2000). The Murray Mouth closed over again in 2002, and required emergency dredging.
 - Around 3000 extra gigalitres of River Murray water are required to flow, to reinstate more normal estuarine functioning at the South Australian end of the system (Hill, S.A. Environment minister, pers. comm. to ABC 2002).
 - In 2001, D. Paton, (bird researcher from Adelaide University) expressed concern about plans to cut a drain through the Coorong lagoon to clear water from agricultural lands in the upper South-East, which may dilute the hypersaline South Lagoon system within 5 to 10 years, converting it to an estuarine system similar to

the Murray Mouth, and threatening the continued existence of biota that thrive in highly saline conditions, such as *Ruppia* weed, and some species of fish that have managed to adapt to the highly saline conditions. South East Catchment Water Management Board (2001) also mentioned the draining of the upper South-East into the Coorong as a likely impact on the biodiversity of the southern Coorong. There may be other ecological repercussions up the food chain (e.g. the hardyhead, a fish which may be affected by diluted salinity, is an important food source for hoary-headed grebes and fairy terns, and the South Lagoon reportedly has the largest population of fairy terns in Australia. Paton also considered that changes to the salinity of the system may make the area more attractive to predatory fish which eat the hardyheads, thus potentially affecting populations of fish-eating birds. Revegetation rather than draining, was suggested as a measure to prevent potential impacts.

Impacts on Fish

- The irregular pulses of freshwater reaching the mouth, in addition to the reduced flow, have disrupted the estuarine function of the area for fish and invertebrates. Pierce (1995) considered that policy to hold the Lakes system at an approximately stable level will further restrict the ability to emulate natural flow conditions reaching the estuarine part of the system, and such natural flow conditions are required for estuarine species life cycles. Pierce (1995) reported that many fish and other fauna of the Murray Mouth system follow the freshwater/saltwater interface, and may move many kilometres per day to stay within that salinity range. A number of major estuarine fish in the Murray Mouth area (**Mulloway, Black Bream, Greenback Flounder, Congolli** and others) require access to either continuous or (in the case of black bream) natural pulse flows of fresh water and/or brackish water at critical stages of their life cycle (e.g. spawning, recruitment, and/or adult migration). The altered flow of the River Murray has interrupted the life cycles of these species, particularly affecting estuarine fish reproduction, migration, growth, condition and abundance. Examples include:
- The effects upon reproduction and recruitment of **Black Bream** and **Greenback Flounder**, which is artificially limited because daily and seasonal flows are non-synchronous with flows to which the fish have evolved to respond (Pierce, 1995). For example, barrage outflows triggering reproductive behaviour in black bream may cease suddenly (within 1 day), rather than over a period of days or weeks, which causes the fish to cease reproductive effort.
- Population levels of **Mulloway** are also considered to be now reduced, principally due to altered flow regime (and the consequent effects upon Mulloway population dynamics) and over-fishing (both commercial and recreational) (Chapter 4.4 in Edyvane *et al.*, 1996, and PIRSA 1999b). A regular flow of water out of the Murray Mouth is considered important to ensure sufficient spawning to maintain recruitment. The diminished flow of the River Murray water has led to a decline in the abundance of Mulloway (PIRSA, 1999b).
- **Congolli** must move from freshwater to brackish and back again to complete the life cycle, and barrage construction has therefore hindered the timing and passage of this life cycle event.
- Other impacts associated with flow manipulation, solutions to which have been addressed by research (see Pierce 1995), include inhibition of fish passage up the Murray due to the restrictions of barrages, yet upstream passage is required by species such as black bream, Mulloway and flounder. Apart from the freshening of the Lakes and restriction of fish passage into the area, the reduction of water flow at the seaward end has created more saline conditions in parts of the lower Coorong, particularly the southern end, which has also adversely affected the population dynamics of estuarine fish species, and other species such as yellow-eyed mullet (Edyvane *et al.*, 1996). According to Edyvane *et al.* (1996), there is lack of detailed information on the effects of Murray River manipulation upon the spawning, recruitment, feeding and nursery requirements of estuarine fish species, particularly, the passage of eggs, larvae and juvenile fish into the Murray Mouth estuary, and further work is required to determine how best to manage water flows to reduce some of the current impacts on estuarine fish population dynamics. Pierce (1995) stated that management of the system required an understanding of its dynamic nature, and a return to more natural flow conditions through the barrages.
- Related to the reduced flow from river manipulation and water extraction, closure of the Murray Mouth may have a significant effect on the estuarine, lake and river fish populations and fisheries in the Coorong area, due to increased salinity; stagnation of water due to the low flow rates and volumes; promotion of algal blooms, and interference with the life history processes of fish species, particularly those which require both fresh and salt water (and normal flow conditions) to carry out their life processes.
- Higham, Hammer and Geddes (2002) considered that species likely to be most affected (due to an interrupted life cycle) by closure of the Murray Mouth include the following: Climbing Galaxias (*Galaxias brevipinnis*); Common Galaxias (*Galaxias maculatus*); Pouched Lamprey; (*Geotria australis*); Short-headed Lamprey (*Mordacia mordax*); Short-finned Eel (*Anguilla australis*); the endangered Estuary Perch

(*Macquaria colonorum*), which may no longer occur in the area; Congolli or Tupong (*Pseudaphritis urvillii*); Jumping Mullet (*Liza argentea*); Yellow-Eye Mullet (*Aldrichetta forsteri*); Garfish (*Hyporhamphus regularis regularis*); Mulloway (*Argyrosomus japonicus*); Sea Mullet (*Mugil cephalus*).

- Secondary impacts of the closure of the Murray Mouth can include increased salinity, reduced food availability, increased frequency of predator-prey interactions (due to the 'concentration' of residents in smaller wetland areas), increased risk of algal blooms (toxicity and/or eutrophication), and reduced dissolved oxygen levels.
- Higham, Hammer and Geddes (2002) considered that fish species that will be indirectly affected by Murray Mouth closure due to degraded water quality and salinity impacts include: Black Bream (*Acanthopagrus butcheri*); Bridled Goby (*Arenigobius bifrenatus*); Small-Mouthed Hardyhead (*Atherinosoma microstoma*); Tamar River Goby (*Favonigobius tamarensis*); Swan River Goby (*Pseudogobius olorum*, *Pseudogobius* sp. 9); Greenback Flounder (*Rhombosolea tapirina*); Lagoon Goby (*Tasmanogobius lasti*); Flathead Gudgeon (*Philypnodon grandiceps*).
- The authors considered that the Small-Mouthed Hardyhead (*Atherinosoma microstoma*) is very important ecologically as a major prey species for many birds and predatory fishes including Mulloway (Molsher *et al.*, 1994; Hall 1984), and that if the Coorong population was depleted (for example, fish kills arising from low oxygen levels), the effect could be disastrous for the ecology of the region (Higham *et al.*, 2002).

Impacts on Birds

- Numbers of migratory (and other) waterbirds in the **Murray Mouth** area have declined in number since the 1960s (CCSA Media Release, August 2001; Paton 2002; ABC, 2002). Carpenter (1995, citing Parker *et al.* 1979 and 1985, Paton *et al.*, 1989, and Carpenter pers. obs.) reported declining numbers of Masked Lapwing (plover), Black-fronted Plover, Eastern Curlew, Musk Duck, Latham's Snipe, Australasian Grebe, four species of cormorant (Great, Pied, Little Black and Little Pied), Little Egret, Straw-necked Ibis, Royal Spoonbill, Yellow-billed Spoonbill, Dusky Moorhen, Purple Swamphen, Whiskered Tern and Fairy Tern. Some of these species of declining status are recognised as rare and/or threatened (see other sections of this document). Paton (2002) showed the numbers of various species of small and large migratory wading birds, and endemic wading birds, that have declined in the Murray Mouth area between 1982 and 2001. The total decline in numbers in small wading birds, for example, is very significant (e.g. from 250,000 recorded in one part of the estuarine area in the 1960s, down to less than 15,000 for the whole estuarine area in 2001). Although Red-Necked Stint (*Calidris ruficollis*) is a migratory species, and utilises a number of habitats along the migratory path, the dramatic decline in the number of Red-Necked Stints in the Murray Mouth area *is difficult to attribute to factors outside of the Coorong / Murray Mouth area*, and is of sufficient magnitude to be of international concern, utilising IUCN threatened species criteria (Paton, 2002). *Reductions in flows of freshwater into the estuarine area are likely to lead to reductions in the quantity and quality of estuarine habitats in the vicinity of the Murray Mouth and this ongoing loss of habitat and habitat quality could contribute to the decline of these birds* (Paton, 2002).

Changes that are likely to have affected the number of migratory waders over the long term include:

- ♦ Long term reduction in water flow (only 12% of estuarine area remains, according to Pierce, 1995, cited by Paton, 2002);
- ♦ Reduction in available feeding area for waders, due to the smaller volumes and spatial extent of water;
- ♦ Lack of gradual transition between fresh and salt water, leading to more abrupt changes in salinity, and lack of normal estuarine salinities for extended periods;
- ♦ Silting up of the Murray Mouth and the channels inside the Murray mouth;
- ♦ An inflow of coarse marine sands into the Murray Mouth area. When coarse marine sand are deposited on the estuarine sediments, the conditions are no longer conducive to the growth of small estuarine invertebrates. For example, coarse sediments or sediments with high sand content are known to reduce the growth rates, survival and abundance of invertebrates in other estuaries (Quammen, 1982; Wanink and Zwarts, 1993, both cited by Paton, 2002). Paton *et al.* (2000) reported lower abundances of benthic invertebrates in sediments with a high proportion of coarse sand compared to the numbers found in fine sediments where invertebrate densities were as much as four times higher. The increase in coarse sand at the Mouth, and the reduction in invertebrates, also affects the feeding potential of some small-beaked wading bird species, which pick up coarse sand particles instead of small invertebrates (Quammen, 1982, cited by Paton, 2002, and Paton, pers. comm. to ABC, 2002); and
- ♦ Lack of regular flooding and siltation events from peak river flows, which are important in maintaining both prey abundance and availability for wading birds, and foraging area.

- The lack of flow, and the build-up of coarse marine sands at the Mouth and inside the channels, reduces the height and width of the tidal flux, which drastically reduces the available tidal habitat area in which wading birds can forage. The tidal flux has reduced from around 50cm to less than 10cm, and now occurs over a much smaller area, which particularly affects those bird species that, in normal estuarine conditions, forage over a wide area according to water depth variations linked to the tidal cycle (Paton 2002, and Paton, pers. comm. to ABC, 2002). The 'formentioned changes to the system, and a number of other impacts upon waders due to the reduced volume, frequency, duration and area of flow, are discussed in Paton (2002).
- Carpenter (1995) reported the following concerns regarding bird populations in the **Murray Mouth** area:
 - ◆ need to maintain diversity and available area of wetlands in the region (which are suffering from numerous impacts);
 - ◆ disturbance by recreational and urban uses during summer, when resident bird species are breeding and migratory species are present, especially the open mudflat areas subject to tides;
 - ◆ inconsistent use of sites by breeding colonies (e.g. Salt Lagoon Island), possibly due to human interference;
 - ◆ cattle grazing damage wetland vegetation and disturb substrate;
 - ◆ European carp may degrade water plant communities, resulting in less available prey for waterbirds;
 - ◆ low breeding rate for waterfowl, which is related to both availability of nesting sites and seasonal flooding/drying events (indicating disturbance to the cycles in the system);
 - ◆ conflict between waterbirds and agriculture (e.g. grazing of irrigated crops and pastures by Cape Barren geese and black swans).
- An emergency dredging operation was required in 2002 to reopen the Murray Mouth, which had silted up due to reduced outward flow of river water, and inward flow of coarse marine sands. Bird researchers have observed a steady decline in migratory wading birds during the past 20 years, particularly the species that use the shorelines. According to Paton (Adelaide University zoologist, cited by ABC, 2002): *"probably in the 1980s there were 50,000 to 60,000 waders using the area. And the last five or so years when we've been (surveying the area), it's been consistently between around 5,000 and 15,000. So it has dropped substantially. When looked at historical records, the estuarine areas near the Murray mouth were up to 250,000 small waders going there, now in just that region, the top 20 kilometres of the Coorong, it's probably more like 5,000 to 10,000. So that's like a twenty-fold reduction in numbers"*.
- Paton (2002) summarised the significance of the impact of Coorong and Murray Mouth changes on wading birds as follows: *"There is sufficient evidence to show that under the current management regime the estuarine habitats are declining in area and quality, particularly as habitat for migratory waders. The lack of adequate flows of water to the Mouth of the River Murray will continue to erode the estuarine habitats of the region. Coincident with this, the abundances of migratory waders have declined substantially over the last 30 to 40 years. Based on changes in abundances of one species, the Red-necked Stint, the magnitude of the changes in the last 20 years alone is sufficient for the species to be classified as Endangered for the region under IUCN (2000) criteria. Continuing to allow these estuarine habitats to deteriorate contravenes Australia's obligations under a series of international agreements, including the Ramsar Convention, JAMBA and CAMBA. Our knowledge of natural systems remains severely limited, and this impedes management decisions, but we do know that complete closure of the Murray Mouth will exacerbate the degradation"* (Paton, 2002).

Impacts on Invertebrates

- Changes in the salinity, flow rates and volume of water reaching the mouth can impact upon the invertebrate populations. A reduction in water flow also reduces amount of fine river sediment and nutrients that reach the mouth and are distributed through the estuarine area. These changes to the system also affect invertebrates in the Murray Mouth estuary, which are an important part of secondary production in the system, and are significant food sources for many bird and fish species. The fact that peak flows no longer occur, and therefore nutrients and fine sediments are no longer discharged into the nearshore area, is also likely to affect invertebrate populations in the near shore marine area. Examples of impacts on invertebrates include the fact that:
 - Reduced water flow has resulted in a build-up of coarse marine sand at the Murray Mouth. When coarse marine sands are deposited on the finer estuarine sediments, the conditions are no longer conducive to the growth of small estuarine invertebrates (Paton, pers. comm. to ABC, 2002; Murray Darling Basin

Commission and DWLB, 2002).

- On the seaward side of the Murray Mouth, it has been suggested that the diatom *Asterionella* sp. is the major food source for the Goolwa Cockle *Donax (Plebidonax) deltoides* (King, 1976, cited by Murray-Jones and Johnson 2003), which reaches high abundances on the high energy dissipative beaches of the Goolwa – Coorong area. Blooms of *Asterionella* are common on Goolwa Beach (McLachlan and Hesp, 1984, cited by Murray-Jones and Johnson, 2003), and it is thought that River Murray outflows underpin primary production of phytoplankton in the area, particularly *Asterionella* sp. (McLachlan and Hesp 1984, cited by Murray-Jones and Johnson, 2003). Therefore, it is possible that the significantly reduced flows of River Murray water out of the Murray Mouth may affect the production of *Asterionella*, and therefore reduce the major food source for *Donax*, which may in turn affect *Donax* populations;
- Apart from reduced flow of water, nutrients and sediments that are important in the life cycles of the estuarine invertebrates, impacts of the closure of the Murray Mouth can also include increased salinity, reduced food availability, increased frequency of predator-prey interactions (due to the ‘concentration’ of residents in smaller wetland areas), increased risk of algal blooms (toxicity and/or eutrophication), and reduced dissolved oxygen levels. Macro-invertebrates that complete their entire lifecycle within the estuary/lagoon will be affected by these changes to the system (Higham, Hammer and Geddes 2002).

Land-Based Impacts

- Impacts from land-based activities, such as urban development, grazing, agriculture / improved pasture development, land clearance, waste disposal and agricultural and other runoff. These impacts include the following (see Edyvane *et al.*, 1996 and Bryars, 2003):
- Reduced water quality due to diffuse sources (nutrients, agricultural fertilisers, herbicides and pesticides; sediments from land clearing; faecal wastes, and other runoff from grazing activities and pastures; heavy metals, and other diffuse source pollution (from shack and housing development and marina operation);
- Reduced water quality due to point sources (e.g. septic tank overflows from **Hindmarsh Island** and at various point along the **Coorong**; sewage discharge from **Goolwa**; and waste disposal);
- Eutrophication of Lakes Albert and Alexandrina, primarily due to farming activity and runoff, which has affected the lakes system, and periodically affects the Murray Mouth when flows of eutrophic water are released. According to Edyvane *et al.* (1996), the increase of nutrients, mainly phosphorus, entering the waterways of the Murray-Darling Basin is predominantly from (upstream sources such as) sewage treatment plants, agricultural and recreational activities, urban stormwater drains, drainage water from irrigated dairy pastures and effluent from holiday shacks. Such sources of nutrients create optimal conditions for algal blooms, particularly during periods of low river water flow and calm, warm weather (Edyvane *et al.*, 1996). The increased level of nutrients caused by agricultural run-off from the Murray River catchment area, is considered to be a major threat to habitats in the **Murray Mouth** area (Bryars, 2003).
- Long-term changes in the distribution and abundance of riparian, estuarine and saltmarsh vegetation, due to altered flow regimes (see above) as well as overgrazing by stock, amongst other causes. Grazing, occurs on **Mundoo, Long, Tauwitchere, Reedy and Ewe Islands**. These impacts have entailed a loss of riparian vegetation (which protects shorelines, as well as providing essential habitat for biota in the area) due to erosion, building and trampling. Grazing has caused ongoing degradation of the wetlands in the **Lower Murray, Lakes, Coorong and Murray Mouth** estuary (Edyvane *et al.*, 1996). Cattle and horses graze the northern and southern coasts of **Hindmarsh Island** and the eastern spit, sheep and cattle feed and sleep in, and around, the inland lakes, and fishers trample the shore by **Bird Island** (Renfrey *et al.*, 1989, cited by Edyvane *et al.*, 1996).
- Saltmarsh vegetation along the channels around **Hindmarsh Island** has also been disturbed by grazing (Baker and Edyvane, 1996). Worst affected wetland sites in the Murray Mouth area include the **Mundoo Channel** and an inland lake on the north coast. Five other sites along this coast are also severely damaged as are two salt lakes (Renfrey *et al.*, 1989, cited by Edyvane *et al.*, 1996). The main damage to wetlands at these sites is reportedly due to the activities of cattle and horses. Old grazing land does show improvement in other areas (i.e. north coast) and Edyvane *et al.* (1996) considered that these heavily damaged sites might improve if the grazing pressure was removed. The south coast and most of the **Mundoo Channel** area registered only a moderate level of disturbance (Renfrey *et al.*, 1989, cited by Edyvane *et al.*, 1996). Bryars (2003) listed physical disturbance of saltmarsh by stock grazing as a “perceived threat” to habitats in the **Murray Mouth** area. Apart from stock, grazing by rabbits is also considered to have a significant impact on the wetland communities. Edyvane *et al.* (1996) reported that, along the western shoreline, supratidal communities are well grazed by rabbits. Along the eastern shoreline the plant communities are subject to heavy grazing and trampling by cattle particularly on **Mundoo, Ewe and Tauwitcherie** islands. Wetland communities subject to heavy grazing have been significantly altered Edyvane *et al.* (1996) reported that

the greatest impact has been to the supratidal communities where palatable species such as *Atriplex paludosa* have been severely reduced by browsing. Edyvane *et al.* (1996) stated that the communities would not survive in the long term if grazing continues. An example provided by Edyvane *et al.* (1996) of a partially degraded area that may recover if grazing activity were to cease, was the *Halosarcia indica* community on **Ewe Island**.

- Eutrophication of the Murray Mouth estuary, characterised by high levels of “nuisance” macroalgae that proliferate in high nutrient conditions, such as *Enteromorpha*, *Rhizoclonium* and *Gracilaria*, particularly in the sheltered channels of the Mundoo channel, as well as Boundary Creek. One of the main sources of eutrophication in the area was reported to be cattle faeces in runoff from grazing areas, and eutrophication of the estuary was considered to affect sedimentary processes and aquatic biota, including the establishment / re-establishment of benthic flora associated with the estuary in previous non-eutrophic conditions.
- Increased incidence of microalgal blooms, including toxic species. The incidence of blooms in Lake Alexandrina is of particular concern, and this also has implications for the Murray Mouth region. *Anabaena* and *Nodularia* are the main bloom genera recorded over time. Edyvane *et al.* (1996) reported that the major cause of microalgal blooms may be inadequate flow management and water pollution from upstream from land-based sources and boats.

Recreation / Tourism Issues

- The Murray Mouth Estuary is close to an area of rapid population growth and urban development. Recreational and tourism use of the Estuary is increasing, with evidence of a growing conflict between recreational activities and conservation values (Edyvane and Carvalho 1995, cited by Australian Heritage Commission, undated). Edyvane *et al.* (1996) considered that visitor and tourism impacts to the region are likely to increase following increases in chartered cruises and adventure wilderness hire operations, the increase in residential marinas (e.g. **Hindmarsh Island**), the increase and upgrading of boat ramps, private launching and mooring, the general population increase in the area, and also resulting from improved access to Hindmarsh Island. There is also the potential for both large hovercraft and houseboat operations in the region.
- Residential and tourism developments are often in close proximity to wetland areas of high conservation value. Apart from damage to habitat in the vicinity, there are also potential problems associated with flooding and waste disposal (Edyvane *et al.*, 1996).
- Increased motor boating activity and vehicular access due to the growth in recreation / tourism was considered to be a threat to riparian and subtidal wetlands, and to associated waterfowl and their habitats (Edyvane *et al.*, 1996). An example is the destruction of banks and associated vegetation around parts of Hindmarsh Island to create boat moorings and access routes to shallow waters (J. Baker, pers. obs., 2001).
- In general, impacts from power-boating, jet skiing and skiing activity, including hydrocarbon pollution (since fuel consumption by jet skis is high, and fuel burning is inefficient), benthic scouring (e.g. impacts on seagrasses have been observed in other countries); water turbidity; bank erosion and consequent damage to aquatic vegetation, and acoustic disturbance to fauna (e.g. nesting waterbirds in the **Goolwa** area may be affected). Impacts of jet skiing in general are discussed by Tiarnlund *et al.*, 1993; Kruer, 1994; Sargent *et al.*, 1995; Burger, 1998; Blue Water Network, 1998). Owen (1999) mentioned jet skiing as an impact of major public concern in the **Lower Murray** area. Australian Heritage Commission (undated) reported that disturbance of water-bird habitat by motorised craft (boats, jet skis) has been recognised as an impact in the Murray Mouth - Coorong region.
- Edyvane *et al.* (1996) considered that wave erosion from the boat wash of jet skis, powerboats and cruise tour operators in the Murray Mouth region is likely to have major effects on both the emergent and submerged aquatic flora in the region. Much of the Lower Murray estuary is characterised by shallow mudflats and channels, fringed with riparian vegetation and hence, the habitats are particularly susceptible to wave erosion from boating activity. The north coast of Hindmarsh Island is characterised by a wave cut terrace and the high turbidity readings recorded in the region (generally above 60 NTU) probably reflect erosion caused by wave action, which may be increased by boating activity, especially speed boats (Renfrey *et al.*, 1989). Renfrey *et al.* (1989) recorded very high levels of turbidity at a site used for mooring boats.
- Threats and impacts from terrestrial motor vehicle activity (e.g. 4WDs, cars, trailers), include physical disturbance of dune and beach nesting bird species and their nests, damage to vegetation in intertidal and supratidal habitats (including saltmarsh and tidal flats), and acoustic disturbance (e.g. of bird populations in the Murray Mouth and Sir Richard Peninsula area) (Morelli and de Jong, 1995; Bryars, 2003). The physical disturbance from vehicle use in the surf beach areas of **Middleton** and **Goolwa**, is a potential threat to

habitat in that area (Bryars, 2003).

- Potential for increased impacts on water quality, supratidal, intertidal and subtidal habitat distribution and quality, estuarine functioning, and wildlife population dynamics (e.g. waterbirds and coastal birds) from the increasing residential and recreation / tourism development in the area (marina development and associated increase in boat mooring and boating activities, housing development, dredging and artificial lake construction, increased residential population and visitor numbers and activities etc). **Hindmarsh Island** is one example of an area undergoing rapid residential and recreational expansion.
- Degradation of sand dune plant communities also occurs, due to off road vehicles and campers, boating and water-skiing (Brown, pers. comm., 1995, cited by Morelli and de Jong, 1995).
- Coastal developments, such as shacks, are reported to have “considerable impacts on landscape and scenic values” (Edyvane *et al.*, 1996).
- **Sir Richard Peninsula:** The use of four-wheel drive vehicles away from designated roads and tracks has also caused trampling of coastal vegetation, soil compaction and erosion of sand dunes (National Parks & Wildlife Service 1990) and vehicles travelling along the ocean beach are detrimental to the nesting success of the vulnerable Hooded Plover (Buick and Paton, 1989). Erosion of the Sir Richard Peninsula has been exacerbated in the past by vehicle use on the dunes, which interferes with berm and foreshore development (Heyligers, 1981, cited by Baker and Edyvane, 1996). The Management Plan for the park aims to rationalise vehicle movement within the park by restricting vehicles to designated roads and tracks and by closing the northern part of the ocean beach to vehicles during the time that plovers breed (National Parks and Wildlife Service, 1990, cited by Australian Heritage Commission, undated).
- Trampling and other damage to wetland vegetation and other estuarine areas occurs, due to vehicles and foot traffic (Edyvane *et al.*, 1996).

Fishing Issues

Commercial marine species that are caught in the area, and may be of potential conservation concern, according to various data sources on stock status, include:

- *Mulloway*, which have been affected by both the severe modification of estuarine habitat (see above) and high fishing levels over the long term;
- *Greenback Flounder*: Bryars (2003) listed stock depletion of this species, caused by overfishing, as a potential threat in the **Murray Mouth** area.
- *School Shark and Gummy Shark*: The School Shark (Australasian subpopulation) was listed in the IUCN Red List 2003 as *Conservation Dependent*, and previously, Gummy Shark was included in the IUCN Red List 2000 and Red List 2002 as *Conservation Dependent*. Both species are of conservation concern in southern Australia – see section 9.2);
- *Saw Shark*: which is fished commercially in small quantities (i.e. less than 1 tonne per annum, in some recent years) in the deeper waters of the Encounter Bay and Murray Mouth area. 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. Details on the apparent status of some of these species populations in S.A. are provided in Section 9.2.
- There is insufficient information about the impacts of the increasing levels of recreational fishing in the Murray Mouth estuary (Edyvane *et al.*, 1996). Owen (1999) considered that recreational netting was an issue of conservation concern in the Goolwa Channel area.
- Fishers trample the shore at **Bird Island**, according to Renfrey *et al.* (1989, cited by Edyvane *et al.*, 1996). Edyvane *et al.* (1996) also stated that trampling and track formation by recreational fishermen gaining access to the shoreline is having a significant impact on the extensive saltmarsh community at the southern tip of **Hindmarsh Island** (e.g. Section 601 of the Island).

Summaries of Other Impacts

Morelli (1995) listed other major impacts and threats to the **Murray Mouth** area as being:

- potential salinisation associated with regional land clearance and drainage schemes;
- weed invasion;
- presence of feral animals;
- stabilisation of the lakes water levels by the barrage structures, which allows prolonged wind- induced seiches >1.2 m, and wave erosions >30 m inland along some sections of the shores of both lakes is a

problem (Eckert, pers. comm. 1995, cited by Morelli and de Jong, 1995);

- toxic microalga blooms (e.g. a 1995 toxic bloom of Cyanophyta algae in Lake Alexandrina resulted in water-carting for stock, and for human consumption in the nearby town of Strathalbyn (Eckert pers. comm., 1995).
- more frequent closure of the Murray Mouth and an increase in salinisation.
- the Hindmarsh Island bridge, a 2000 (approx.) berth marina and a housing development on Hindmarsh Island were also listed as threats (Brown, pers. comm. 1995, cited by Morelli and de Jong, 1995).
- **Mundoo Island and surrounding area:** The following information is from the *Register of the National Estate* listing for Mundoo Islands (Australian Heritage Commission, undated). In some areas, recreational fishing activities have denuded the shores of vegetation (Renfrey *et al.*, 1989). People visiting the area may disturb the local bird population (Paton *et al.*, 1989). Cattle and horse grazing is damaging the vegetation in some areas, (Renfrey *et al.*, 1989), and increasing shore erosion. Shore erosion is a threat to the maintenance of conservation values in the area, and causes other than grazing include loss of riparian vegetation and the artificially high and stable level of Lake Alexandrina (Jensen, 1995). A number of weed species occur on the islands and in the channels, particularly the less saline areas (Renfrey *et al.*, 1989).
- Threatened aquatic plants, such as *Vallisneria spiralis* and *Ceratophyllum demersum*, are prone to impacts from vessel traffic and boat moorings, trampling and grazing by cattle, and collection for aquariums (Edyvane *et al.*, 1996).
- **Hooded Plover:** DNRE Victoria (1992) summarised threats to the nationally vulnerable Hooded Plover, a species that occurs on ocean beaches in southern Australia, including the Coorong, and nests in depressions in the sand. The species was listed under Schedule 2 of the *Flora and Fauna Guarantee Act 1988 (Threatened)*, and is of conservation concern at national level (see Garnett and Crowley, 2000). Summary of status from DNRE Victoria (1992): Since European settlement the range of the Hooded Plover in eastern Australia has declined. Even where it still occurs this species is now less abundant than formerly (Bransbury, 1983; Blakers *et al.*, 1984). Breeding success is very low to extremely low on beaches frequently visited by people and dogs. In general, threats to the species in southern Australia include disturbance by humans and domestic dogs, walkers and horse riders; nest and egg destruction by off-road vehicles; feral predators; and destruction of nest sites through flood or storm damage (see Schultz and Bamford, 1987; Buick and Paton, 1989). In Victoria, the introduced Sea Spurge *Euphorbia paralias* may also affect the nest sites of the Hooded Plovers on breeding beaches (Schultz, pers. obs.). Plovers are most vulnerable to disturbance during the breeding period (Schultz, 1989). The incubation period (about 30 days) is the longest of any Australian member of the genus *Charadrius*. The young do not fly for at least three weeks, so each clutch is vulnerable for nearly two months. The nesting seasons extends from August to February, which includes the time of peak use by holidaymakers and surf fishers. The Hooded Plover's habit of leaving a nest site if people approach and usually not returning until people have left the area has an important influence on breeding success. While the parent is absent the eggs or chicks are vulnerable to predators such as gulls (*Larus* spp.), and foxes (which has been a threat to Coorong populations prior to fox control programs) and to extremes of temperature. The destruction of nests by off-road vehicles-a major factor in South Australia (Buick and Paton, 1989). For example, it has been estimated that up to 87% of all nests in the Coorong region were run over by off-road vehicles during the incubation period in the 1985-86 breeding season (Buick and Paton, 1989). In general, the Hooded Plover is increasingly threatened by the rising levels of public use of ocean beaches, associated with a larger human population, further residential and resort development along the coast, increasing outdoor recreation, and an increasing desire by many people to seek out remote areas. In its final recommendations, the Scientific Advisory Committee determined that the Hooded Plover is: *significantly prone to future threats which are likely to result in extinction; and very rare in terms of abundance and distribution*. The conservation requirements of the Hooded Plover should be considered in plans for coastal areas; also, measures that reduce human disturbance and protect breeding sites will enhance the breeding success of other shorebirds-such as the Pied Oystercatcher (*Haematopus longirostris*) and Red-capped Plover (*Charadrius ruficapillus*) (Schultz, DNRE report, 1992).
- The European shore crab (*Carcinus maenus*) was reported six kilometres south-east of Tauwitchere barrage (Zeidler 1988, cited by Edyvane *et al.*, 1996). The crab is described as an aggressive and non-selective predator of molluscs and other invertebrates, and the potential for changes to the Coorong ecosystem due to this crab have been noted by Edyvane *et al.* (1996).
- There are at least eight exotic fish species within the Lower Murray, Lakes and Coorong estuary (see chapter by McGlennon, in Edyvane *et al.*, 1996). Apart from increasing water turbidity, physically altering habitat, and competing with native fish for food, habitat and other resources, exotic species such as European Carp, are known to have impacts on aquatic vegetation, such as destroying the root systems,

including threatened plants such as *Vallisneria spiralis*. Carp and other exotics may also affect waterfowl habitat, and the recruitment success of some native fish species (Edyvane *et al.*, 1996).

- Purported reduction in diversity of estuarine fauna, including aquatic invertebrates (Edyvane *et al.*, 1996), from combined sources (i.e. altered flow regime, increased freshwater input, turbidity, runoff, and various other physical and chemical impacts on the system).
- There is a small colony of feral *Avicennia* mangrove (planted) in the Murray Mouth area, which might compete with local vegetation if permitted to expand (Edyvane *et al.*, 1996).
- Contaminants other than those listed in this section, that reportedly affect Lake Alexandrina and possibly also the Murray estuary include mercury lost from treatment of gold ore in northern Victoria, and other trace metals such as cadmium, lead, zinc and copper (Edyvane *et al.*, 1996).

9.2.11.18 Upper South-East (Coorong/Otway Bioregions Boundary)

A general overview of environmental issues in the South-East was provided by Master Plan *et al.* (1999), including issues related to tourism / recreation; aquaculture; commercial and recreational fishing; port and marina development; drainage out-falls and other marine and coastal pollution; coastal development; conservation and biodiversity in the coastal area; and cultural heritage. These and other specific issues relating to the **Upper South-East** are outlined below.

Coastal Discharges / Effluent Issues

- There have been reports of significant seagrass die-back in **Lacepede Bay** (Kingston to Cape Jaffa). Causes that have been suggested include agricultural drain effluent (from the SE Drainage Scheme) and/or nutrient enrichment due to sewage discharge from adjacent townships, and/or freshwater inputs from the drainage network and stormwater. There are three effluent drains with outlets into Lacepede Bay. The Draft South East Catchment Water Management Plan (2002b) listed the drains as Kingston Main Drain, Blackford Drain, and Wongolina Drain. The die-back problem has been recorded since at least 1982 (SE Coast Protection District Study Report) and has been mentioned in a recent coastal management strategy for the South-East (Master Plan *et al.*, 1999 and 2000).
- There are nearshore impacts from three major land-clearing drains on **Lacepede Bay**. Drains in the South East discharge high nutrient loads from fertilisers and animal wastes, agricultural chemicals such as pesticides, and other contaminants such as zinc and silver (e.g. from the **Blackford Drain** and **Drain L**) into the near-shore marine environment, as well as periodic large volumes of fresh water (Master Plan *et al.*, 1999 and 2000). Peak concentrations of pesticides and other agricultural chemicals are likely to enter the near-shore environment of the upper South-East following application during periods in which surface runoff is high (Hodder *et al.*, 1980). There is also another discharge drain north of this region, at Henry Creek, which is approximately 20km North of the Granites (Petrusevics *et al.*, 1998). Bryars (2003) also listed the increased level of nutrients from agricultural run-off via **Blackford, Kingston Main and Butchers Gap Drains**, as being a threat to seagrass and sand habitats in **Lacepede Bay**.
- Treated sewage effluent is reported to be discharged from the **Kingston** and **Robe** areas (Master Plan *et al.*, 1999), however it is noted that these towns have a STED (Septic Tank Effluent Drainage) scheme established for the collection, treatment and disposal of wastes (Master Plan *et al.*, 2000). Increased nutrients from septic tank overflows at **Cape Jaffa, Boatswain Point, Little Dip** and **Nora Creina**, has been listed as a potential threat to nearshore habitats in these areas (Bryars, 2003). Shacks in the coastal area also contribute to coastal effluent loads (Master Plan *et al.*, 1999).
- Freshwater inputs and contaminants (e.g. agricultural chemicals and animal wastes) from stormwater drains have been identified as a community concern in the upper South-East (Master Plan *et al.*, 1999).
- A dump is located near the shore, north of **Kingston** (Gilliland, 1996).
- There are fish processors operating in the **Kingston** area (e.g. **Cape Jaffa**). Wastes from fish processing plant at **Robe** enter the marine environment. Fish wastes from both processors, and from recreational fishing activities, have been identified as a concern in the South East (Master Plan *et al.*, 1999), due to the lack of waste disposal and fish cleaning facilities adjacent to popular fishing locations. Bryars (2003) also listed the increased level of nutrients from fish processing at **Cape Jaffa** as a threat to habitats in that area.

- There are likely to be long term effects on Guichen Bay's ecosystems, due to drain outlets at **Boatswains Point** (northern Guichen Bay) and **Long Beach** (southern Guichen Bay). Drains in the South East discharge high nutrient loads from fertilisers and animal wastes, and other contaminants into the nearshore marine environment (UEPG 1982; Edyvane *et al.*, 1996; Master Plan *et al.*, 1999). Bryars (2003) also listed the increased level of nutrients from agricultural runoff via Drain L as a threat to habitats in the **Robe** area (e.g. **Robe Lakes**).
- Groundwater in the upper South-East is contains excessive nitrates and other contaminants, which can pollute the coastal marine zone (Master Plan *et al.*, 1999).
- There are discharges from sundry processing in the **Robe** area (Petrusevics *et al.*, 1998).
- The impacts of drainage schemes on the local ecology of the area, and the importance of maintaining (uncontaminated) freshwater outflows to the coast, have been listed as issues in the South-East (Master Plan *et al.*, 1999).
- Bryars (2003) listed the increased freshwater flows into **Maria Creek**, via the South East Drainage Scheme, as a potential threat to habitat in that area.
- The South East Catchment Water Management Board (2002b) mentioned the following impacts in the coastal and estuarine areas south of **Kingston**: decline in unconfined aquifer groundwater levels; changes to the coastal freshwater/seawater interface, decline in spring discharge to the marine environment, and in the volume of water reaching coastal lakes. Associated with these impacts have been changes in land use, that have reduced recharge to groundwater aquifers; altered runoff patterns and reduced volume of runoff; low rainfall reducing recharge to the aquifers; historical water allocation policy impacts; over-allocation and extraction in some areas; lack of knowledge of actual volumes extracted; inability to measure water extracted; and inadequacy of technical information to support policy development (SECWMB, 2002b).

Aquaculture Issues

- There are existing aquaculture leases (e.g. Atlantic Salmon and Ocean Trout) in **Lacepede Bay**. Permitted species endorsed on the current licences also include Yellow-tail Kingfish. The environmental impacts of caged fish farming are discussed in section 9.2. Bryars (2003) listed the increased level of nutrients and sedimentation from sea cage aquaculture near **Cape Jaffa**, as being a threat to seagrass meadows in **Lacepede Bay**. In a recent policy document for the area, PIRSA Aquaculture (2004a) also recognised the need to restrict stocking densities of finfish in cages in inner **Lacepede Bay**, to reduce the likelihood of build-up of nutrients and sediments in shallow waters, in the vicinity of seagrass beds. Aquaculture expansion in the inner part of southern Lacepede Bay would be "controlled via incremental tonnage increases linked to environmental monitoring results for both the Historical Cape Jaffa and Inner Kingston Zones" (PIRSA Aquaculture, 2004a).
- Potential environmental impacts due to caged fish culture (see section 9.2) have been recognised by government agencies, researchers, and conservation bodies, both nationally and at State level. The Parliament's ERD Committee (1998) inquiry into aquaculture, discussed in detail some of the impacts of finfish farming in South Australia. A number of actual and potential impacts of finfish farming in S.A., many of which may apply in the Upper South-East, are discussed below.
- *Sea bird* populations, including oceanic migrants; penguins and other breeding populations of native bird species, may be at risk from caged fish operations. Little Penguin populations exist at a number of sites in the Upper South-East, and island-dwelling penguins regularly leave nesting areas to fish at sea. Numerous other seabird species frequent the Upper South-East area, including species of Cormorant, Petrel, Tern, Prion, Albatross, and others (see part 1, on **Ecological Values**). The Commonwealth's Senate Inquiry into Marine and Coastal Pollution (1997) and the Commonwealth's 1995 State of the Marine Environment Report both highlighted as a major issue: the culling of natural predators such as seabirds, involved with caged fish aquaculture operations. Sea birds are attracted to the small fish species that are used as feed for the caged fish, as well as the small fish species that visit the farms for feeding. Birds attracted to the farms may become entangled, and/or habituated to feeding at the farm sites, thus disrupting the natural food web dynamics of which sea birds are part. The attraction of penguins and other seabirds to pelletised foods (which may have feeding attractants added), should also be considered. Bird species known to frequent other fish farms in the state (e.g. in the Port Lincoln area) include Penguins, species of Cormorant, Silver Gulls, Giant Petrels, and other Petrel species (D. Pemberton, Tasmanian National Parks Service, 1996, cited by T. Flaherty, MCCN, pers. comm., 2002), and all of these bird species also occur in the South-East of S.A. Some of these species become entangled in fish farms, or become apparent 'pest species', (e.g. cormorants, silver gulls). Increases in local populations of silver gulls in relation to fish farming practices have been reported in other parts of S.A. (e.g. Port Lincoln area), and such increases may impact on the breeding of other seabirds such as species of tern and cormorant. Silver gulls are a major predator of

cormorant chicks and eggs (Robinson *et al.*, 1996), and seagulls can displace local bird populations by preying on eggs and chicks, and at some sites may also cause disturbance to migratory shorebirds. Furthermore, adult black cormorants go to sea to fish and bring back food for the nest, whilst the other parent tends the nest (Robinson *et al.*, 1996), hence there is potential for impact upon these populations (particularly the food supply to the young nestlings), if the fishing parents are attracted to fin fish cages to feed, and are entangled or otherwise damaged / killed. Concern has also been expressed about the attraction of large numbers of Silver Gulls to finfish farms, which may increase the risk of transferring parasites and diseases between production sites and waste disposal areas (Pemberton, 1996, cited by T. Flaherty, MCCN, pers. comm., 2002). Introduction and transfer of diseases could impact populations of penguins and other seabirds populations, as well as the fish in the farms.

- *Pinnipeds* are attracted to caged fish farms and have been known to be injured or killed in other parts of South Australia (Pemberton, 1996; Kemper and Gibbs, 1997 and 2000; SA Museum records, cited by MCCN, undated). Although pinnipeds eat a variety of food sources (squid, octopus, fish, some crustaceans) there is evidence that pinnipeds are attracted to finfish cages to feed on the fish that are associated with the cages, and both entanglements and deaths of New Zealand Fur Seals and Australian Sea Lions have occurred in other parts of South Australia (see Kemper and Gibbs, 1997 and 2000). There is also concern that acoustic deterrent devices used in the caged fish industry in South Australia may have impacts on sea lions and fur seals. There are concerns that such devices can damage seal hearing and lead to deafness. Disabled animals may be more inclined to further habituate fish farms, as their hunting skills may be impaired. Experience overseas and in Tasmania suggests that seals will eventually become habituated, continuing stock losses (T. Flaherty, MCCN, pers. comm., 2002). It has been demonstrated in Tasmania that the number of incidents between farms and seals increases with the proximity of those farms to haul-out sites (Pemberton and Shaughnessy, 1993, cited by Flaherty, pers. comm., 2002).
- *Dolphins*: There is evidence that dolphins are attracted to finfish cages, and in other parts of South Australia, both entanglements and deliberate killings have occurred (Kemper and Gibbs, 1997 and 2000; SA Museum records, cited by MCCN, undated). Both Common Dolphins and Bottlenose Dolphins are known to be involved in current entanglement problems in the Port Lincoln area (Kemper and Gibbs 1997 and 2000), and both species also occur in the Upper South-East. The Commonwealth's Senate Inquiry into Marine and Coastal Pollution (October 1997) and the Commonwealth's 1995 State of the Marine Environment Report both highlighted as a major issue, the "culling" of natural predators such as pinnipeds, involved with caged fish aquaculture operations.
- *Whales* are occasionally observed close to the coast in the Upper South-East waters. Whales may become entangled in fish farm nets, although the occurrence is infrequent, compared with other marine mammals, and sharks).
- *Acoustic Harassment*: There is potential for dolphins (and also whales) to be affected by acoustic harassment devices, which are used on many finfish farms. Internationally, experts in aquaculture impacts (see SECRU, 2002), have recognised that current acoustic deterrents methods to reduce net damage and consequent fish farm escapes, may exclude whales and dolphins from a much larger area than the vicinity of the farms, owing to their great sensitivity to underwater acoustic noise (SECRU, 2002). Although there is no research available on this issue in S.A., there is evidence from overseas research showing that Acoustic Harassment Devices (AHDs) can have impacts on the sonar of whales, thus disrupting whale travel patterns (e.g. Morton and Symonds, 2002). Some of the methods that are being trialled in fish farms in South Australia to reduce pinniped attack, namely acoustic harassment Devices (AHD's) and acoustic deterrent devices (ADD's), may in the long term also impact whale and dolphin populations in areas where fish farms and cetaceans coincide. There is also concern about the possibility of acoustic equipment driving dolphins, whales, and other marine mammals out of sheltered bays, which have been used as resting, feeding or calving and nursery areas. Noise pollution has been identified as a threat to bottlenose dolphin populations (T. Flaherty, MCCN, pers. comm., 2002). The long-term concern for dolphin populations from aquaculture is that as more fish farms become established around the coast they may displace local marine mammals. Some researchers fear that sonic devices to reduce entanglements could result in avoidance of large areas of the coastline used by species such as Southern Right Whales.
- Various *shark* species are also attracted to caged fish farms. Although there is little formally documented evidence, there is abundant other evidence (e.g. articles, media reports, community statements etc) of white pointer sharks, Bronze Whalers, and other shark species interacting with finfish cages in other areas of South Australia, resulting in entanglements and in some cases intentional killing of the sharks. The Draft Recovery Plan for Great White Sharks (Environment Australia, 2000) noted that the targeted killing of "nuisance" white sharks entering cages or harassing stock during capture and transport, has been reported by several commercial fishers, but that the number of white sharks (a legally protected species) that continue to be taken intentionally (and illegally) by people, is unknown. A related issue is the potential for sharks to become 'habituated' to feeding at or near finfish farm cages, which may have a number of both

ecological and social impacts. The aggregation of sharks in areas where caged fish are kept may interrupt natural movement / travel patterns and feeding patterns, particularly for oceanic species.

- *Wild fish* may be attracted to feed at fish farms, thus disrupting natural feeding processes. Wild fish may also be adversely affected by the decreased quality of water and damage to benthic habitat that is consequent to fish farming operations. Also of concern for wild fish species would be increased incidence of algal blooms, and potential for blooms of toxic species that exist at low levels prior to added nutrients and other changes to the system. Damage to benthic habitat, such as reduced plant cover, increased densities and abundance of “opportunistic” species such as worms that thrive in altered conditions, and increased bottom sediment and pollutants such as hydrogen sulphide and ammonia, could affect fish which feed in the benthic environment (e.g. those that feed on marine plants, or the epifauna and epiflora attached to plants, or those that feed in the sediment).
- *Invertebrates*: Although baseline surveys of invertebrate composition and abundance are inadequate for the upper South-East area, there may be potential for damage to benthic invertebrate communities if aquaculture proliferates in the region, due to build up of organic wastes, and alteration of the physical and chemical composition of the sediment associated with fish farming. Benthic macro-invertebrates are known to be affected by organic waste from fish farms, particularly below the pens (Johnsen *et al.*, 1993, Ye *et al.*, 1991). Smothering of invertebrates by farm waste (e.g. sediment, faeces etc) can also occur.
- *Yellow-tail Kingfish*: Concern has been expressed in recent years about the potential ecological impacts of Yellow-tail Kingfish escaping from farms in S.A., including impacts on other fish species in the gulf, and on food supply (e.g. O’Toole, 2002; Grosser, 2003; Office of the Minister for Fisheries, 2003). Thousands of farmed kingfish have escaped from farms in Spencer Gulf (see PIRSA Aquaculture Public Register, 2003). Although Kingfish are not currently farmed in the upper South-East, there is provision for that to occur, through current licence endorsements (e.g. Atlantic Salmon, Ocean Trout, and Yellow-tail Kingfish – see PIRSA, 2003a). However, it is noted that a recent study of farmed and wild kingfish in northern Spencer Gulf (Fowler *et al.*, 2003) noted significant differences in the diet of escaped farm kingfish compared with wild kingfish: - the farmed kingfish were reported to be incapable of feeding properly, which would suggest limited potential for impacts on other marine species.
- The Commonwealth’s Senate Inquiry into Marine and Coastal Pollution (1997) and State of the Marine Environment Report (1995) both highlighted as a major issue, waste production from aquaculture, leading to local increases in nutrients and excessive algal growth. In South Australia, concern has been expressed by the Parliament’s ERD Committee (2000) about “the lack of control that the EPA has over an industry which is a heavy polluter of the environment. The Committee believes that finfish farming should be put into Schedule 1 of the Environment Protection Act” (ERD Committee 2000, p. 22). The impacts of organic fish farming wastes on benthic environments in general are discussed in section 9.2. however, it is noted that to date, investigations in the **Cape Jaffa / Lacedpede Bay** area (based on the visual assessment of seagrass standing crop, leaf density, and epiphyte load, and the presence of sediments on seagrass), have reported that “there was no evidence to suggest that any eutrophication or sedimentation was occurring” (Bryars, 2002, cited by PIRSA Aquaculture, 2004a). Reasons for this likely include the fact that in Lacedpede Bay, fish are fed a pellet diet, which reduces food wastage, and therefore reduces the likelihood of buildup of uneaten food, wastes and consequent nutrients. Also, the area adjacent to Cape Jaffa experiences strong wind-driven currents, moderate tidal currents, and swell (Sinclair Knight Merz, 2000; Bryars, 2002), factors which would help to quickly dissipate any feed or faecal wastes from the cages (Bryars, 2002). It is noted, however, that the seagrass investigation was reported to be limited in scope and further investigation was recommended (Bryars, 2002, cited by PIRSA Aquaculture, 2004).
- Caged fish farming is associated with increased incidence of *algal blooms*, and potential for blooms of toxic species that existed at low levels prior to added nutrients and other changes to the system (see section 9.2).
- Potential damage to benthic habitat, such as reduced plant and sessile animal cover, increased densities and abundance of “opportunistic” species, and increased bottom sediment and pollutants such as hydrogen sulphide and ammonia, could affect fauna which feed in the benthic environment (e.g. on marine plants, or the epifauna and epiflora attached to them, or in the sediment) (see section 9.2, and references cited therein). *However, it is noted that none of these impacts has yet been reported for the upper South-East* (see Bryars, 2002; PIRSA, 2004a).
- There is an issue with scouring of the benthic habitat by the mooring apparatus for sea cages in the **Cape Jaffa / Lacedpede Bay** area. Engineering improvements to reduce this impact were recommended in a report by Bryars (2002).
- Use, storage and disposal of chemicals may have some impact on fish, invertebrates, marine plants, and the bacteria and other micro-organisms in benthic sediment. Although chemical use in South Australian

aquaculture is low, common chemicals used in aquaculture generally include pesticides and herbicides, anti-fouling chemicals on farm nets (which may contain toxic copper or tin compounds), petroleum products, and antibacterial, antibiotic and cleaning/disinfectant products.

- Other potential impacts include rubbish and debris from caged fish farm operation and servicing (which can entangle sea lions, dolphins, and sea birds – see section above on **Fishing Issues**).

Marina Development Issues

- A marina has been proposed for the **Cape Jaffa** area. The Cape Jaffa Anchorage Marina proposal involves the development of a multi-component, multi-use commercial and residential marina facility, and associated waterfront residential development, on land located immediately east of the Cape Jaffa township (Planning SA, 2003b). The Cape Jaffa proposal was declared a Major Development in December 2002, therefore there is provision for full assessment of the possible impacts of the marina development on the surrounding environment (Planning S.A., 2003a). In general, some of the environmental issues associated with marina and boating facilities include:
 - ◆ Alteration and damage to coastal and marine habitats due to construction;
 - ◆ Interruption to natural patterns of water circulation in the harbour / bay in which the facility is developed
 - ◆ Potential scouring of nearshore seafloor and damage to benthos;
 - ◆ Transfer of pest species;
 - ◆ Declines in water quality and benthic quality, due to increased sediment mobilisation;
 - ◆ Increased hydrocarbon levels from discharge of oily wastes such as bilge water and from fuel use / leakage;
 - ◆ Chemical contamination of sediments and biota from TBT and other anti-foulants; and
 - ◆ Increased nutrient loads (e.g. from septic discharge), other effluent and garbage associated with marina activities.
- For the **Cape Jaffa** development, significant *environmental issues* identified by the Major Developments Panel (Planning SA, 2003b) for the purposes of public consultation, prior to the formulation of Guidelines and determination of the appropriate level of assessment, include the following (*N.B. social and economic issues are not included in this table, which outlines coastal and marine environmental issues, however the significant social and economic issues that require attention during the assessment phase for the marina proposal, are also detailed in Planning SA, 2003b*):

Groundwater:

- ◆ The effect of constructing channels and basins on groundwater quality and movement.
- ◆ Stormwater and wastewater management and the potential impact on groundwater.
- ◆ Groundwater investigations undertaken on the site or in the locality of the site.
- ◆ The likely effects on marine organisms and seagrass, given groundwater flow out to sea is likely to increase, potentially reducing the salinity and increasing nutrients and pollutants, especially heavy metals.
- ◆ Management systems to control the quality and quantity of outflow from the marina, given that it is likely to become a sump for groundwater or high freshwater flows that may affect marine organisms.
- ◆ The impact on land, of the off-site depression of the water table, and the extent of groundwater depression.
- ◆ Seasonal variations of groundwater level and impact on marina design and offsite operations.
- ◆ Impact of housing and the commercial fishing base on groundwater quality.
- ◆ Measures to be taken to protect and monitor groundwater resources.
- ◆ The known existing groundwater environmental conditions.

Coastal Issues:

- ◆ The visual effect of the construction of the breakwater into the bay at Cape Jaffa.
- ◆ Effects on visual amenity and landscape quality, including effects of structures (breakwaters, earthworks, power lines) and impact on the coastal environment, and visual effect of development in the locality generally.
- ◆ Effect of the breakwater and entrance channel construction on seagrass and sand movement on the coast and outline management and rehabilitation measures.

- ◆ The effect of removing swing moorings from the Rock Lobster sanctuary and off the seagrass bed, including details of the programs for removal of the swing moorings.
- ◆ The effect of the development on native biota, including impacts on coastal and marine flora and fauna.
- ◆ The measures to protect dunes and beach areas during and after construction.
- ◆ Requirement for sea level rise policies, and how these will be addressed by the development.

Environmental Management Issues:

- ◆ Frequency of dredging, and potential impacts of silt mobilisation on the water column.
- ◆ Procedures to prevent and manage pollution spills or sewage leaks.
- ◆ The sewage disposal and rubbish collection systems for the commercial and recreational boats.
- ◆ The effects of boating traffic and “people pressure” on the surrounding environment.
- ◆ The disposal of dredged or excavated material.
- ◆ Dry-dock management methods for careening, and interception of pollutants such as hull scrapings.
- ◆ Methods for bunding hazardous materials in storage areas.
- ◆ Measures for preventing / managing coastal weed introductions, and marine pests (both plant and animal).
- ◆ Investigations required to include in an environmental management plan.
- ◆ Risk assessment for potential exacerbation of environmental problems in the locality, and mitigation methods, including assessment of their expected effectiveness.

Water Issues:

- ◆ The impact of developing a wastewater treatment system to which the existing development can connect.
- ◆ The connection to water supply for the development proposal, including information on the quantity of potable water required.
- ◆ Opportunities for recycling wastewater.
- ◆ Ways in which mains water use can be minimised or supplemented.
- ◆ Measures proposed to protect and maintain suitable water quality in waterways and flushing basins.
- ◆ Stormwater and sewage management measures.

Other Issues:

- ◆ Transport and storage for construction materials, to minimise effects on the local amenity.
- ◆ Measures to control dust, vibration, noise, stormwater and groundwater and other emissions during construction.
- ◆ Flood mitigation strategies for prevention of flooding, and operation of canals and flushing basins.
- ◆ Measures to monitor impacts during and after construction.
- ◆ Requirements for consistency with State and Commonwealth legislation, and initiatives relating to conservation or protection of the biological environment.

Fishing Issues

- Discarded plastic, fishing line, and other fishing-associated litter have been identified as concerns in the South East (Master Plan *et al.*, 1999). The Rock Lobster industry has an environmental management plan to reduce such impacts from that industry.
- Fish wastes from both processors and recreational fishing activities have been identified as a concern in the beach and nearshore environments of the South East (Master Plan *et al.*, 1999), due to the lack of waste disposal facilities and fish cleaning facilities adjacent to popular fishing locations.
- Litter from fishing activities (bait boxes, fishing line, netting etc), and the need to improve fishing waste disposal facilities (Master Plan *et al.*, 1999).

The documented population status of the following species that are caught in the area, is discussed further in section 9.2. For these species, various population risks and sustainability issues have been recognised, either regionally or nationally.

- *School Shark and Gummy Shark*: The region described in this table has traditionally been one of a number of significant fishing areas in S.A. waters for school and Gummy Shark. School Shark (Australasian subpopulation) was listed in the IUCN Red List 2003 as *Conservation Dependent*, and previously, Gummy Shark was included in the IUCN Red List 2000 and Red List 2002 as *Conservation Dependent*. The Commonwealth has recently re-regulated the fishery for School and Gummy Shark, in light of the over-fished status of School Shark populations in southern Australia since the early 1990s (see AFFA, 2000b; AFMA, 1999b; AFMA, 2003a and b) and the fully-fished status of Gummy Sharks (AFMA 2000d). According to AFMA (2002a), there is increasing uncertainty about the size and sustainability of the School Shark population (fished under Commonwealth management). The latest agreed assessment for the School Shark population in the fishery reportedly shows “extremely low numbers”. In the 2001 assessment, productivity was estimated to be so low that under some scenarios, the agreed rebuilding of School Shark stocks to the 1996 level (by 2011) would be impossible under any level of Total Allowable Catch (TAC). If productivity is actually as low as the model currently predicts and it remains so, AFMA (2002a) considered that an unacceptably long time frame of 15 years would be required to rebuild the stock. At the 44th meeting of the Southern Shark Fishery Management Advisory Committee (SharkMAC), the committee recognised that the current ambiguities of the School Shark assessment will continue for at least 3-4 years until a time series of fixed station survey data is accumulated. The status of (and potential risks to) School Shark and Gummy Shark populations are discussed further in section 9.2.
- *Snapper* are caught commercially and recreationally, and *Garfish* are caught recreationally, in the Upper South-East, although in minor quantities on a State-wide scale. Both species are classified as “fully fished” in South Australia (DEHAA and EPA, 1998). Current status of (and threats to) populations of these species are discussed in section 9.2.
- *Mulloway* are caught commercially, recreationally and as part of the bycatch of the shark fishery in the upper South-East. The species has population characteristics that may make it vulnerable to over-exploitation, as discussed in section 9.2.
- *Western Blue Groper* is caught commercially and recreationally in the area. The potential risk to populations of this long-lived, reef-associated species are discussed in section 9.2.
- *Various Wrasse species* are fished commercially in deeper waters of the region, and as bycatch. Wrasse species and other site-associated reef fish species are also caught by recreational fishers. Wrasse species have characteristics that make them vulnerable to over-exploitation. Potential risks to populations of wrasses and other reef-fish species are discussed in section 9.2.
- *Ocean Leatherjacket*: This species has been classified as “fully fished” in S.A. (DEHAA and EPA, 1998).
- *Saw Shark species*: Caught commercially (in small quantities) in deeper waters south and west of the Coorong, and west of Cape Jaffa. 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. Pogonoski *et al.* (2002) recommended conservation status of *Lower Risk, Conservation Dependent* for Australian populations; Australian Society of Fish Biology (2001) recommended as conservation status: *Lower Risk Conservation Dependent*. The various fisheries catching saw shark, and population characteristics of the species, are discussed in section 9.2;
- *Elephant Fish / Shark*: is caught commercially as a minor species in the upper South-East (North and West of Cape Jaffa), and also as a bycatch and targeted catch in Commonwealth fisheries. The conservation status of elephant fish in general, and potential risks to populations of this species, are discussed in section 9.2.
- *Blue-Eye (Deep Sea) Trevalla*: Although this is mainly a Commonwealth fishery and most fish are taken from outside State waters, Trevalla are caught adjacent to State waters in this region (see section above, on *Social and Economic Values and Uses*), and are therefore included here. Jones *et al.* (1990) considered Blue-Eye Trevalla to be highly vulnerable to over-exploitation, due to their slow growth and aggregative behaviour (see Williams, 1994). Blue-eye Trevalla appears to be a long-lived species (40 years or more) which matures relatively late in life (8-12 years depending on sex) (AFMA, 2001a). Little is known about the egg and larval stages of Blue-eye Trevalla. Recently in Tasmania, Blue-eye Trevalla of approximately 10cm have been found living in association with large masses of floating kelp. It is believed that as these juveniles reach 50cm they become semi-bottom dwelling. These young fish form schools over hard bottom at depths of around 350m-450m, moving to deeper waters as they grow (DPIWE, 2004). The fishery is mainly a Commonwealth-managed one, with Trevalla taken by the Southern and Eastern Scalefish and Trawl fishery (SESSF), and some of the non-trawl fisheries. The largest catches come from the non-trawl sector. As an example, the 1997 trawl total was 113 t in all Commonwealth waters, with non-trawl landings of around 1038 t (Tasmania =672 t, NSW =200 t, Victoria =86 t and South Australia =80 t). In 1998 and

1999, the agreed Total Allowable Catch was 630 t (100t trawl, 530t non-trawl), with an actual TAC of 763t in 1999 (112 t trawl, 651 t Non-trawl). In 2001, the combined TAC was 676 t (117 t trawl; 559 t non-trawl), with a catch of 110 t trawl; 478t non-trawl, and 33t discards from trawl fishing. In 2002, the combined TAC increased to 726 t (128 t trawl; 598 t non-trawl), with a catch of 85 t trawl; and 428t non-trawl, and in 2003 the recommended combined TAC was 690t (AFFA website, 2004). Catches in the Commonwealth fishery are mostly comprised of young, immature fish, while larger, mature fish become vulnerable to line fishing when forming seasonal spawning aggregations. Assessment of the fishery is complicated by multiple gear types, gear selectivity, jurisdictional effects and seasonal availability (Tilzey, 1999; AFMA, 2001a). The species is considered to be fully fished (BRR, 1999b), and AFFA (2002b; 2004) recommended that the Blue-eye Trevalla fishery be “carefully monitored”, due to lack of information on population status; concern about the reference points used in the fishery, and lack of an effective stock assessment method. The discarding of Blue-eye Trevalla numbers taken over quota is also of concern in this fishery.

- *Rock Lobster*: major yields are taken from the region. Current indicators of status of Rock Lobster stocks, and ecological issues, are discussed in section 9.2.
- *Blacklip Abalone*: major yields are taken from the region. Issues relating to abalone fishing are discussed in more detail in section 9.2.
- Issues associated with the deeper water Commonwealth-managed fisheries, such as interactions with protected species, bycatch, and depleted stock levels of some species, are not discussed here, because the issues are under Commonwealth jurisdiction (e.g. see AFMA 2003). However, it is noted here that according to AFFA (2002), some of the species found in the area discussed here, (upper South-East South Australia) are over-fished (e.g. Blue Warehou, and Redfish), or *fully fished* (e.g. Blue Grenadier, Jackass Morwong, and Ocean Perch) and the status of others is uncertain (e.g. Blue-eye Trevalla, Pink Ling, Silver Trevally, Spotted Warehou).

Tourism and Recreation Issues

In general, issues identified include the following (see Master Plan *et al.*, 1999):

- 4WD and motorbike activity on beaches, and near dune areas;
- the need to protect sensitive coastal areas from human impacts (foot and vehicle traffic etc), and reduce the number of unplanned access tracks (which can degrade coastal vegetation, and spread weeds etc);
- recreational waste / litter (tyres, cans, bottles, plastics) on beaches and/or in the nearshore environment; and
- potential impacts of jet ski use (see section 9.2).

Beach Wrack Harvesting Issues

- The potential ecosystem impacts of continued harvesting of seagrass and macroalgae (including long term effects and potential expansion of the industry). Seagrass and macroalgal beach wrack deposits have significant ecological values (see Kinloch, 1998; Master Plan *et al.*, 1999; Baker, 2000, Appendix 2, and Jones, undated, for summaries), and also protect the foreshore from erosion, and assist in the formation of sand dunes. During the early 2000s, there were 5 operators in the Kingston and Beachport area, and increasing demand for new approvals to harvest beach wrack. Community submissions to a Coastal Management Plan for the South-East (see Master Plan *et al.*, 1999), identified beach wrack harvesting as a potential impact on the ecological functioning of the near-shore marine environment of the upper South-East, including feeding habitat for waders / sea birds . PIRSA's 1998 Draft Management Plan (see Kinloch, 1998) provided a series of recommendations to ensure that the practice is “sustainable”.

Risks to Bird Species Populations

- *Orange-bellied Parrots*: In general, loss of coastal samphire and dune areas due to coastal clearing and development, threatens Orange-bellied Parrots, which utilise such areas as feeding habitat (Master Plan *et al.*, 2000). Only 100 - 200 individuals remain in the wild, with habitat destruction being one of the greatest threats to their existence (NPWSA, 2000b). These parrots nest and breed in Tasmania during summer, then over-winter in south-east Australia, from southern Gippsland in Victoria to Lake Alexandrina in S.A. There are at least 15 plants upon which this species feeds (Croft *et al.*, 1999, cited by NPWSA, 2000b), including the introduced Sea Rocket (*Cakile maritima*). Orange-bellied Parrots have also been recorded in beach wrack kelp in the intertidal area; however it is not known for this report whether beach wrack harvesting would have an impact on the Orange-bellied Parrot population in south-eastern S.A.. Master Plan *et al.*

(2000) mentioned beach wrack as habitat for the food plants used by this bird species. Foxes and cats in the area are also a threat to the Orange-bellied Parrot (Stephenson, 1991, cited by Australian Heritage Commission, undated).

- **Risks to Hooded Plover: Little Dip Conservation Park** is considered to be a significant area for Hooded Plovers in the south-east of South Australia (i.e. south of the Coorong area – see **Area 15**), although concern has been expressed about the amount of disturbance experienced there, particularly when birds are breeding. For example, in the past, vehicles have caused disturbance to dunes and to breeding hooded plovers on the beaches (Bransbury, 1988 and undated), although this no longer occurs because vehicles are now banned from the beach. Predation by foxes is a major factor influencing the breeding success of Hooded Plover (L. Best, DEH, pers. comm., 2003).
- **Baudin Rocks (Godfrey Islands)** are periodically visited by anglers and boat visitors and in the past, this has sometimes led to vandalism and destruction of nests and nestlings (Bonnin, 1968, cited by Australian Heritage Commission, undated). Little Penguins breed at Baudin Rocks, but there appeared to have been some reduction in their numbers during the 1970s and early 80s. In 1922 hundreds of nests were recorded, but only seven nests were found in 1982 (Australian Heritage Commission, undated). The reason for the decline is not known for this report (but see point above, about human impacts on nesting sites).
- The introduced boxthorn (*Lycium ferocissimum*) occurs on the south islet of **Baudin Rocks** (Natural Resources Group, 1994). While it may provide some bird species with nesting sites, any expansion of this vegetation will be detrimental to other coastal bird species that require open areas to breed (e.g. Crested Tern) (Australian Heritage Commission, undated). Feral pigeons occur in large numbers and breed on the islands. Control activities were undertaken by the National Parks and Wildlife Service in 1982 and 1983, with support from the South East Field and Game Association (Natural Resources Group, 1994). Feral pigeons may lead to a reduction in numbers of some native birds through competition for nesting sites (Bonnin, 1982, cited by Australian Heritage Commission, undated).
- **Risks to Australasian Gannet and Black-Faced Cormorant populations:** In 2002, the Commonwealth considered the proposed demolition of the disused lighthouse platform at Margaret Brock Reef to be a Referred Action for public comment, under the *EPBC Act 1999*. The environmental significance of the structure relates to its role as a nesting habitat for birds, particularly Australasian Gannet, which is a listed species under the Act. The platform area reportedly provides habitat for approximately 1.7 % of the Australian population and 0.5% of the world population of Australasian gannets. Since breeding was first observed, the colony has reportedly increased in recent years to approximately 170 breeding pairs. Black-Faced Cormorants are also reported to nest on the collapsed remnants of the working platform beneath the main platform (approximately jetty level) (SARFAC, 2003, citing a 2003 Referral Notice under the Commonwealth's *EPBC Act 1999*; ABC Media reports January, 2003; Sneath, 2003).
- Drainage schemes are reported to have an impact on food sources for Australian Pelicans in the upper South-East (Master Plan *et al.*, 1999). Stormwater ponding / holding areas may also have an impact on bird life (Master Plan *et al.*, 1999), by reducing freshwater flows to the coast and altering the ecology of the area.

Whale Protection Issues

- Butler *et al.* (2002) identified potential risks to aggregations of blue whales in the south-eastern area of SA and western Victoria. Blue whales have been recorded as far north as the **Robe / Cape Jaffa** area (see Gill, 2002 and Butler *et al.*, 2002). The authors produced a matrix of potential impacts upon blue whales in the Bonney Coast region, such as marine debris from a variety of sources; noise pollution from a variety of sources; diffuse chemical pollution from several sources, and global warming (which may affect krill distribution and abundance). According to the authors, "*Of particular concern in the Bonney Upwelling are: changes to the upwelling (e.g. through global warming), collisions with vessels, and noise pollution. While there is little evidence of significant current impacts — the regions' fisheries mainly use low-risk gears, offshore oil and gas exploration is still in the exploration stage although potential gas production fields have recently been identified, there is no krill fishery, and no current reports of collisions with whales — we concluded that any new industries and/or increases in activity by existing users will have to be assessed on a case-by-case basis regarding their impact on the Blue Whales*" (Butler *et al.*, 2002, page 5).
- Harassment by potential whale-watching or research operations is also considered to be a potential threat. Butler *et al.* (2002, p. 55) provided the following summary of the possible effects of noise on whales along the Bonney Coast: "*In the specific case of the Bonney Upwelling, seismic airguns may elicit behavioural changes in blue whales in the tens of km, and probably avoidance at 3-20 km (McCauley and Duncan 2001). The noise from shipping may produce localised displacement of whales to several km from the vessel; whale avoidance due to drilling noise was estimated to be negligible while rig tenders were shut down or idle, and to within perhaps 2.25 km when a rig tender was victualling at the rig (McCauley and Duncan 2001). Miller et al. (2000) report that male Humpback Whales lengthen their song patterns*

significantly when they are exposed to LFA sonar transmissions, presumably to compensate for acoustic interference. While McDonald *et al.* (1995) did not observe changes in Blue Whale movements and calling patterns when they were subjected to air-gun or shipping noise, Wiggins *et al.* (2001) noted that Blue Whales vary the intensity of their sound production level in response to varying ambient noise levels. Behavioural changes may come at an energetic cost that cannot be estimated; thus, it should be kept in mind that many long-term impacts of noise cannot be assessed within the limits of our current knowledge (S. Dolman pers. comm.). McCauley and Duncan (2001) concluded in their study that it was considered prudent to evaluate each proposed activity on a case-by-case basis, since the risk factor will vary for different activities at different times and of different scales.

Petroleum Exploration Issues

- The offshore petroleum exploration license that exists for the region between Cape Jaffa to Nora Creina may present some risk. Potential examples include hydrocarbon spills and leaks (Master Plan *et al.*, 1999); contamination of water, sediment and benthos around drill sites; and acoustic pollution. A number of exploration wells have been drilled in offshore areas within the region (see Master Plan *et al.*, 1999, and Butler *et al.*, 2002).

Shipping Issues

- Ocean-based litter and other wastes from shipping has been identified as an issue in the South-East (Master Plan *et al.*, 1999). International shipping may also pose risks in terms of spillage of oil and hazardous chemicals, and introduction and transfer of pest marine species.

Other Issues

- Vessel mooring in **Lacepede Bay** area is considered to have contributed to scouring of seagrass beds (PIRSA Aquaculture, 2004a).
- There are issues relating to management of oil, bilge water and other boating wastes, and refuelling practices of fishing boats (Master Plan *et al.*, 1999).
- The increased turbidity and sedimentation caused by intermittent dredging operations at the **Lake Butler** Boat Haven, has been listed as a potential threat to habitat in the area (Bryars, 2003).
- In the coastal zone, the degradation of native vegetation, and proliferation of weeds such as Box Thorn and other species, have been identified as issues in the South-East (Master Plan *et al.*, 1999).

9.2.11.19 Lower South East (Otway Bioregion)

Effluent and Water Quality Issues

- Previously, raw sewage effluent was discharged from **Finger Point (Blanche Bay)**. During the 1980s, E&WS recorded localised impacts on the marine biota within 500m of the discharge pipe at Finger Point. Shepherd (1979) reported that the deleterious effects of sewage discharge included depletion of dissolved oxygen; stimulation of eutrophic conditions (resulting in proliferation of “nuisance” microalgae and macroalgae and smothering of local biota); introduction of heavy metals; and contamination of fish, shellfish and other marine fauna with pathogens (especially coliform bacteria and entero-viruses). The sewage was discharged in a raw state prior to the mid-1990s, when treatment began at the waste-water treatment plant. Sewage is now treated to secondary stage at the wastewater treatment plant, and processes therein now contain solid “sludge” waste (which is currently stock-piled for later use as a land fertiliser), and reduce nitrogen to what are reported to be “relatively low levels” (SA Water, 2002). However, impacts in the nearshore marine waters are still possible from effluent discharge. The Finger Point Waste Water Treatment Plant discharged the following into the near-shore marine environment in 2002 (see SA Water, 2002): Total nitrogen: 11.36t; Total phosphorus: 16.1t; Suspended solids: 11.9t; Biochemical oxygen demand: 3.77t; and Treated effluent: 1813 ML (effluent is not recycled).
- Discharges from effluent drains and stormwater drains into the nearshore marine environment have been identified by the local communities in the South East as an environmental concern, due to the inputs of freshwater, high nutrient loads and chemicals from agricultural land (South East Coastal Management

Strategy – see Master Plan *et al.*, 2000).

- Increased levels of nutrients due to agricultural run-off from catchments such as **Chess Creek, Jerusalem Creek, Deep Creek / Baddenoch Main Drain, Eight Mile Creek, Ellards Creek, Milstead Main Drain, Hitchcock Main Drain** and various unnamed drains, have been identified as a potential threat to habitats in the lower south east (e.g. between Cape Northumberland and the Victorian border). Nutrients are also released into the nearshore environment from diffuse agricultural run-off (Bryars, 2003).
- High nitrate levels present in the groundwater system are considered to potentially contribute to elevated nitrate levels in the nearshore marine environment in the South East, through offshore seepage and beach springs (Master Plan *et al.*, 2000).
- According to a map provided in a South East Coastal Management Strategy report (Master Plan *et al.*, 2000), there are at least eight artificial drains (part of the South East Drainage Scheme) that empty to the sea east of **Port MacDonnell**, between the Port and **Green Point**. For example, extensive draining of farm land occurs in the **Pick's Swamp** area (Jones, Coastcare, undated). There is, therefore, potential for cumulative, ongoing impacts from the regular discharges of freshwater, nutrient loads from agricultural run-off, organic and inorganic rural chemicals (e.g. from farms) and sediments entering the lower South East marine environment via these drains. Modified creek outlets for drainage, such as **Eight Mile Creek** and **Ellards Creek**, may also contribute additional nutrients to the system (see section below, on Estuarine Impacts).
- Wastes from fish processing works are discharged into the marine environment at **Cape Northumberland** and **Port MacDonnell**. Fish wastes from both processors and recreational fishing activities have been identified as a concern in the South East (Master Plan *et al.*, 1999), due to the lack of waste disposal facilities and fish cleaning facilities adjacent to popular fishing locations.
- Septic tank overflows in some parts of the South East (e.g. **Cape Douglas**, and between **Riddoch Bay** and **Brown Bay**) may be a potential threat to nearshore habitats in the area (Bryars, 2003).
- There are existing and potential impacts reported in the area due to port operations at **Port MacDonnell** (e.g. water quality issues associated with oily wastes, fuel spills, solid wastes and chemicals; inadequate water circulation at Port MacDonnell; introduced species from ballast water - see *Other Issues* section). All of these issues have been raised by the local community in relation to existing ports, and port development in the South East (Master Plan *et al.*, 2000). Lack of appropriate waste management facilities at ports, declining water quality, refuelling practices, potential habitat impacts during both construction and operation of ports, and introduced pests, all have been identified as concerns in the South East ports. A new boating facility development is proposed for Port MacDonnell (Master Plan *et al.*, 2000).
- In the **Piccaninnie Ponds** area and surrounds, landholders use chemical sprays and fertilisers in close proximity to the ponds (Morelli and de Jong, 1995).
- In the **Piccaninnie Ponds** area, groundwater pollution and rising nutrient levels have been listed as threats (Morelli and de Jong, 1995).
- There is beach litter in some areas (e.g. **Umpherstone Bay, Middle Point, Finger Point, Pebble Point**), particularly plastics and toilet refuse, due to sewage outfall and other drainage points (see Jones 2000a and Jones, undated).

Estuarine Impacts

- The impacts of drainage schemes on the local ecology of the area, and the importance of maintaining (uncontaminated) freshwater outflows to the coast, have been listed as issues in the South East (Master Plan *et al.*, 1999).
- The South East CWMB (2002b) mentioned the following impacts in the coastal and estuarine areas of the lower south-east (e.g. **Eight Mile Creek, Ewen's** and **Piccaninnie Ponds**): decline in unconfined aquifer groundwater levels; changes to the coastal freshwater / seawater interface; decline in spring discharge to the marine environment, and in the volume of water reaching coastal lakes. Associated with these impacts have been changes in land use, that have reduced recharge to groundwater aquifers and altered runoff patterns and reduced volume of runoff. Bryars (2003) also considered water abstraction from the adjacent groundwater and catchment feeding the springs in the **Deep Creek** and **Piccaninnie Ponds** areas, to be a perceived threat to habitat in that area, due to decreased fresh water flow. Additional problems include low rainfall reducing recharge to the aquifers; historical water allocation policy impacts; over-allocation and extraction in some areas; lack of knowledge of actual volumes extracted; inability to measure water extracted; and inadequacy of technical information to support policy development (SECWMB, 2002b).
- **Lower South East:** Major changes have occurred in the region, resulting in the overall reduction of swamp

habitat and water levels (Hammer, 2002). **Ewen's Ponds** is reduced in volume compared to its original state. Also, there is now no evidence of the diverse and lush 'eight mile swamp' to which that area was originally referred. Extensive land clearance and drainage following solid settlement, has isolated spring features, with those remaining now being under threat, with possible reduction in groundwater expression (e.g. spring pools, wet tea tree heath). The main implication is reduced swamp habitat and reduced connectivity between locations. Historically, **Eight Mile Creek** was the only natural exit of the coastal springs in the area until drains to lead blind creeks from springs to the sea were created following 1937 (Eardley, 1943, cited by Hammer, 2002). For example, Deep Creek previously ran along a coastal dune and connected with **Eight Mile Creek**. In the Piccaninnie Ponds area, an artificial drain was installed to sea during approximately the same period (Morelli and de Jong, 1995). Such major changes to drainage patterns alters the ecology of the entire wetland system. Apart from changes in species distribution and abundance of riparian and swampland vegetation, and other impacts on wetland flora, severing this tie between creeks will in time reduce gene flow and recolonisation of Variegated Pygmy Perch and other fish species (Hammer, 2002). Similarly the change in flow direction for the **Piccaninnie System** (Robinson and Rowberry, 1983, cited by Hammer, 2002), may have alienated habitat and altered flow conditions, thus exterminating local populations and severing aquatic links with the **Glenelg River**. Such details can frame projects that seek to reinstate aspects of historic condition (e.g. spring pool enhancement at Jerusalem Creek) (Hammer, 2002). Recent dredging in the area has also resulted in siltation and damage to aquatic vegetation.

- **Eight Mile Creek:** In addition to reduced flow and spring isolation (see above), a number of other impacts have previously been identified for the Eight Mile Creek area, but most of these are not specific to the marine environment. Those which may have limited relevance to the adjacent marine area include the following, which were specified as impacts in the mid 1990's: (i) increased levels of nutrients, and escapement of trout *Salmo gairdneri*, from an adjacent trout farm into **Third Pond** and **Eight Mile Creek** (which drains to the sea); and (ii) groundwater pollution and rising nutrient levels, and increased effluent inflow from a trout farm into **Eight Mile Creek** (Morelli and de Jong, 1995; Bryars, 2003).
- **Piccaninnie Ponds area:** The water level at Piccaninnie Ponds has declined in recent years and is believed to have caused the loss of aquatic macrophytes (URS, 2000). In addition to reduced and diverted flow of **Ellards Creek** (see above) number of other impacts have been identified for the **Piccaninnie Ponds** area, but most of these are not specific to the marine environment. Those that may have some relevance to the adjacent marine area include discharge from the artificial drain installed to the sea during the middle part of last century. Also, landholders in the surrounding area use chemical sprays and fertilisers in close proximity to the ponds, and some of this drains to the sea. Groundwater pollution and rising nutrient levels are also of concern in this area (Morelli and de Jong, 1995).
- The Increased level of nutrients caused by polluted groundwater seepage in the **Ewens Ponds / Eight Mile Creek**, and **Piccaninnie Ponds / Ellards Creek** area, is considered to be a potential threat to nearshore habitats in the area (Bryars, 2003).
- Hammond's Drain at **Port MacDonnell** has reduced flow, resulting in the outlet being blocked by sand and seaweed (K. Jones, Coastcare, undated).
- URS Australia (1999), in a report prepared for the South East Catchment Water Management Board, recommended that priority be given to investigating the presence, composition and physical environment of karst ecosystems of the South East, to provide an informed basis on which to allocate water. Also recommended was research into the influence of groundwater discharge on marine ecosystems and its importance in sustaining those ecosystems, also to provide a basis to allocate water. The report considered that the impact of water extraction on coastal ecosystems may be greater than on inland ecosystems, and an assessment was recommended of the acceptable level of impact of current and future groundwater extraction on coastal ecosystems (URS Australia, 1999).
- In February 2001, the exotic fish species Carp (*Cyprinus carpio*) was discovered upstream in part of the **Glenelg River**. Carp is declared a noxious species in Victoria. There has been an eradication program in place, involving catchment management authorities, Fisheries Victoria, and the Department of Natural Resources and Environment. The eradication program, which has entailed placement of screens, and surveys and fishing of Carp, has attempted to limit the spread of the species into the lower Glenelg River. A research consultancy firm has also been engaged to investigate and report on various management options for Carp in the Glenelg River Basin.
- Parks, Flora and Fauna Division of DNRE (1995) listed declining water quality in the Glenelg River as a potential threat to the **Glenelg River Estuary**.

Aquaculture Issues

- An on-shore abalone aquaculture facility has been approved at **Douglas Point** (the headland north-west of Middle Point) (Development Assessment Commission, 2002), which would discharge to sea from a pipe leading from the **Douglas Point Conservation Park** area. It is a requirement of the development that an environmental monitoring program be implemented, with the results verified by an independent third party. The monitoring program must include a thorough initial survey of the impact site and a reference site, and seabed where intake/outlet pipes are to be located, prior to construction commencing. An environmental authorisation (licence) from the Environment Protection Authority must be in place before operation commences. Conditions of licence require that the operator undertake an independently verified monitoring program in accordance with the *Environment Protection (Marine) Policy 1994*, with reports to the licensing authority at regular intervals. Identification of any environmental harm (as described in the *Environment Protection (Marine) Policy 1994*) will be mitigated by reducing nutrient loads entering the marine environment from the aquaculture farm towards a zero level in the following way: *if monitoring shows that a significant change has occurred in the receiving environment as a result of the activity, the proponent shall amend site activities and/or infrastructure to improve the quality of the discharge water. Amendments in site activities and/or infrastructure shall continue until the monitoring shows that the activity is not having a significant effect on the receiving environment.*
- The monitoring program for the Abalone aquaculture facility at **Douglas Point** was reported to require the following: *Water flow and quality monitoring sufficient to provide a clear understanding of the effect the development has on the quality of the water used. The monitoring to show the change in concentrations and where relevant, mass loadings of nutrients and other relevant criteria under the Environment Protection (Marine) Policy 1994.* While the final design of the monitoring program must be site specific, the following were recommended by the Development Assessment Commission (2002) to be included in the program:
 - ♦ an initial survey of the area;
 - ♦ benthic monitoring that compares the relative abundance of relevant organisms within and outside of a 50 metre radius of the discharge and that of reference site(s);
 - ♦ monitoring of epiphyte growth on artificial substrates within and outside of a 50 metre radius of the discharge and that of reference site(s);
 - ♦ Seasonal changes to be taken into account;
 - ♦ Monitoring of the intake and discharge pipes and anchoring systems for scour;
 - ♦ Monitoring to include sufficient sampling to allow a probability level of 0.05 (5%) to determine whether an observed change is significant.
 - ♦ The activity will be expected to operate such that there is no increase in nutrient concentration in the discharge water as compared to the inlet water.
 - ♦ A Contingency Plan for the use of chemicals on-site is to be developed.
 - ♦ Any use of chemicals on organisms farmed at the site must be in accordance with the *Fisheries (Exotic Fish, Fish Farming and Fish Diseases) Regulations 1984*.
 - ♦ A licence may be refused where the applicant has failed to comply with any conditions of development approval imposed at the direction of the Environment Protection Authority.
 - ♦ The applicant must comply with Section 50 of the Fisheries Act, 1982, which states that growers must prevent the escape of farmed fish. If a serious disease outbreak is detected or suspected then PISA Fisheries must be notified immediately.
 - ♦ All wastes generated during the treatment of organisms, including dead stock, must be disposed of in accordance with the requirements of the local Public and Environmental Health Officer, and the requirements of the *Environment Protection Act 1993* (disposal to a licensed waste facility is preferable to on site disposal).

The potential impacts of land-based abalone farms in general, are discussed in section 9.2.

Beachwrack Harvesting Issues

- There is increasing demand for new approvals to harvest beachwrack in the South-East. Beachwrack deposits are high in some areas e.g. **Middle Point, Umpherstone Bay, Port MacDonnell, Racecourse Bay, Riddoch Bay** (large quantities particularly in winter and spring), **Danger Point, Feast Bay, Green Point, Pick's Swamp**, and **Victorian border**, according to K. Jones (Coastcare, undated). Macroalgal and seagrass beach wrack deposits have significant ecological values in terms of nutrient recycling and contribution to near-shore foodwebs, amongst other ecological values (see PIRSA, 1998, and Baker, 2000, Appendix 2, for summaries), and also protect the foreshore from erosion, and assist in the formation of

sand dunes. Community submissions summarised in the South East Draft Strategic Management Plan (Master Plan *et al.*, 1999), identified beachwrack harvesting as a potential impact on the ecological functioning of the near-shore marine environment of the South East. PIRSA's 1998 Draft Management Plan has provided a series of recommendations to guide sustainable practice.

Fishing Issues

The reported status of, and potential threats to, the following species that are fished commercially (some also recreationally) in the region, are discussed further in section 9.2.

- *School Shark and Gummy Shark*: Fished commercially in the region, and Gummy Shark are also fished recreationally in waters off some of the ports and bays. School Shark (Australasian subpopulation) was listed in the IUCN Red List 2003 as *Conservation Dependent*, and previously, Gummy Shark was included in the IUCN Red List 2000 and Red List 2002 as *Conservation Dependent*. The Commonwealth has recently re-regulated the fishery for School and Gummy shark, in light of the over-fished status of school Shark populations in southern Australia since the early 1990s (see AFFA, 2000b; AFMA 1999b; AFMA, 2003a, 2003b) and the fully-fished status of Gummy Sharks (AFMA, 2000d). The status of (and potential risks to) School Shark and Gummy Shark populations are discussed further in section 9.2.
- *Elephant Fish ("Shark")*: Caught commercially and recreationally in the area. Concerns about elephant fish populations are discussed in section 9.2.
- *Saw Sharks* are fished commercially in deeper waters between Nene Valley and the Victorian border. 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.
- *Various wrasse species* occur in the area, and are commercially fished in waters south of Nene Valley. Wrasse species are also vulnerable to recreational line fishing, however near-shore populations may be less prone to decline from spear-fishing compared with those in some other parts of South Australia, because most of the near-shore reefs are not accessible in the lower South East area, due to adverse sea conditions.
- *Ocean Leatherjacket*: At a State-wide scale, the species was classified as "fully fished" in 1998 (DEHAA and EPA, 1998).
- *Mulloway* are caught commercially, recreationally (e.g. Glenelg River area) and as part of the bycatch of the shark fishery in the South East. The species has population characteristics that may make it vulnerable to over-exploitation, as discussed in section 9.2.
- *Blue-Eye (Deep Sea) Trevalla*: Although this is mainly a Commonwealth fishery and most fish are taken from outside State waters, Trevalla are caught adjacent to State waters in this region (see section above, on *Social and Economic Values and Uses*), and are therefore included here. Jones et al. (1990) considered Blue-Eye Trevalla to be highly vulnerable to over-exploitation, due to their slow growth and aggregative behaviour (see Williams, 1994). Blue-eye Trevalla appears to be a long-lived species (40 years or more) which matures relatively late in life (8-12 years depending on sex) (AFMA, 2001a). Little is known about the egg and larval stages of Blue-eye Trevalla. Recently in Tasmania, Blue-eye Trevalla of approximately 10cm have been found living in association with large masses of floating kelp. It is believed that as these juveniles reach 50cm they become semi-bottom dwelling. These young fish form schools over hard bottom at depths of around 350m-450m, moving to deeper waters as they grow (DPIWE, 2004). The fishery is mainly a Commonwealth-managed one, with Trevalla taken by the Southern and Eastern Scalefish and Trawl fishery (SESSF), and some of the non-trawl fisheries. The largest catches come from the non-trawl sector. As an example, the 1997 trawl total was 113 t in all Commonwealth waters, with non-trawl landings of around 1038 t (Tasmania =672 t, NSW =200 t, Victoria =86 t and South Australia =80 t). In 1998 and 1999, the agreed Total Allowable Catch was 630 t (100t trawl, 530t non-trawl), with an actual TAC of 763t in 1999 (112 t trawl, 651 t Non-trawl). In 2001, the combined TAC was 676 t (117 t trawl; 559 t non-trawl), with a catch of 110 t trawl; 478t non-trawl, and 33t discards from trawl fishing. In 2002, the combined TAC increased to 726 t (128 t trawl; 598 t non-trawl), with a catch of 85 t trawl; and 428t non-trawl, and in 2003 the recommended combined TAC was 690t (AFFA website, 2004). Catches in the Commonwealth fishery are mostly comprised of young, immature fish, while larger, mature fish become vulnerable to line fishing when forming seasonal spawning aggregations. Assessment of the fishery is complicated by multiple gear types, gear selectivity, jurisdictional effects and seasonal availability (Tilzey, 1999; AFMA, 2001a). The species is considered to be fully fished (BRR, 1999b), and AFFA (2002b; 2004) recommended that the Blue-eye Trevalla fishery be "carefully monitored", due to lack of information on population status; concern about the reference points used in the fishery, and lack of an effective stock assessment method. The discarding of Blue-eye Trevalla numbers taken over quota is also of concern in this fishery.

- *Luderick*: Associated with both the marine and estuarine areas of the lower South-East. Luderick is mainly an eastern states species, and is infrequently / rarely found in South Australia (Hutchins and Swainston, 1986; Australian Museum, 2002k), which is at the end of the range (Kuitert, 1996a). Luderick are 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 SA), and considered vulnerable to nearshore impacts due to their estuarine association.
- *Southern Rock Lobster*: Potential for ecosystem impacts from long term fishing (see section 9.2).
- *Blacklip abalone*. Although there is currently no evidence of over-exploitation in the southern zone fishery (see Mayfield *et al.*, 2002), however it is noted that stock status for many blacklip populations has not been as thoroughly researched as has that for greenlip (see section 9.2). There is a possibility that long term fishing on highly abundant herbivores such as abalone may have some ecosystem impacts, but any potential ecosystem impacts of heavy fishing of abalone have not been researched in South Australia.
- Abalone poaching has been noted at **Douglas Point** and **Middle Point**. Abalone “offences” (unspecified) and taking of undersized lobsters by recreational divers have also been noted at **Finger Point** and **Pleasant Cove** (K. Jones, Coastcare, undated).
- A number of specimen shells of conservation concern in are found in the lower south-east, such as *Umbilia hesitata*. Illegal collecting for the specimen shell market may be an issue in parts of the **lower South East**.
- There is a lobster shell disposal site at **Cape Northumberland**, which is reported to have an impact on the aesthetics of the area (Fairfax Publishing – F2, 2000).
- Apart from fish processing wastes (see **Effluent and Water Quality Issues**, above), fishery-related pollutants / impacts such as plastics from offshore fishing, as well as fishing line and fish offal, as listed as issues in the South-East (Master Plan *et al.*, 1999).
- Issues associated with the deeper water Commonwealth-managed fisheries, such as interactions with protected species, bycatch, and depleted stock levels of some species, are not discussed here, because the issues are under Commonwealth jurisdiction (e.g. see AFMA, 2003). However, it is noted here that according to AFFA (2002a and 2002b), some of the species found in the area discussed here, (lower south-east South Australia) are *over-fished* (e.g. Blue Warehou – for which catch and catch rate have been consistently declining in the Commonwealth-managed fishery in south-eastern Australia, and redfish), or *fully fished* (e.g. Blue Grenadier, Jackass Morwong, and Ocean Perch) and the status of others is uncertain (e.g. Blue-eye Trevalla, Pink Ling, Silver Trevally, Spotted Warehou). AFFA (2002b) recommended that the Blue-eye Trevalla fishery be “carefully monitored”.

Potential Threats to Estuarine Fish Populations

- A number of regionally uncommon fish species associated with the creek outlets and other drainage channels are present in the area (*Short-Finned Eel*, *Wide-Mouthed Lamprey* and *Short-Headed Lamprey* (Glover, 1983; Lloyd and Balla, 1986; Hallam and Thurgate, 1992), or have previously been present (*Australian Grayling* – Glover, 1983; Hallam and Thurgate, 1992; M. Hammer, Adelaide University, pers. comm., 2003). Such species are dependent upon both freshwater and marine habitats at stages in the life cycle. All of these species have vulnerable population characteristics, and are species of conservation concern in South Australia (see section 9.2, and Baker, in press).

Tourism and Recreation Issues

Examples include the following:

- 4WD and motorbike activity on beaches, and near dunes and other sensitive areas (Master Plan *et al.*, 1999 and Jones, undated);
- The need to protect sensitive coastal areas from human impacts (foot and vehicle traffic etc), and reduce the number of unplanned access tracks (which can degrade coastal vegetation, and spread weeds etc) (Master Plan *et al.*, 1999 and Jones, undated);
- Recreational waste / litter (tyres, cans, bottles and plastics) on beaches and/or in the nearshore environment (Master Plan *et al.*, 1999 and Jones, undated);
- The *Tenterden* historic shipwreck has been blasted by amateur divers seeking relics (Stone, undated).
- Excessive recreational snorkelling and cave diving has caused disturbance to the aquatic and riparian plant communities in the **Ewens Ponds** and **Piccaninnie Ponds** areas (Morelli and de Jong, 1995). Bryars (2003) also included as a perceived threat in the **Ewens Ponds / Eight Mile Creek** and **Piccaninnie Ponds / Ellards Creek** areas, physical disturbance caused by recreational divers

Boating and Marina Development Issues

- A new 60-berth boating facility / marina development is proposed for **Port MacDonnell** (Master Plan *et al.*, 1999 and 2000; Halstead Management Services, 2001a). The area currently contains a breakwater, a slipway and a mooring area for vessels. The potential impacts of boating facilities / marinas in general, include
 - ♦ interruption to natural patterns of water circulation in the harbour / bay in which the facility is developed;
 - ♦ potential for scouring of nearshore seafloor and damage to benthos;
 - ♦ transfer of pest species (N.B. the potentially toxic dinoflagellate species *Alexandrium tamarense* has been recorded offshore from Port MacDonnell – see Furlani, 1996; DEHAA and EPA, 1998);
 - ♦ declines in water quality and benthic habitat quality, due to increased sediment mobilisation;
 - ♦ increased hydrocarbon levels from discharge of oily wastes such as bilge water and from fuel use and leakage;
 - ♦ chemical contamination of sediments and biota from TBT and other anti-foulants, and
 - ♦ increased loads of effluent and garbage associated with port activities.

The potential impacts of marina and boating activities are discussed more fully in section 9.2.

Shipping Issues

- Ocean-based litter and other wastes from shipping has been identified as an issue in the South-East (Master Plan *et al.*, 1999; Jones, Coastcare, undated). Examples of litter in the lower South-east include packing timbers and foreign plastic and glass bottles (Jones, Coastcare, undated).
- International shipping may also pose risks in terms of spillage of oil and hazardous chemicals. For example, the potential for fuel spills being transported from offshore vessels to the nearshore zone through tidal movement, has been identified as a potential concern in the South East (Master Plan *et al.*, 1999). Shipping also poses a risk in terms of introduction and transfer of pest marine species.

Petroleum Exploration Issues

- There are potential future impacts of the offshore petroleum exploration license that currently exists for the region between Millicent and **Port MacDonnell**. A number of exploration wells have been drilled in offshore areas within the region (Master Plan *et al.*, 1999). Potential examples include hydrocarbon spills and leaks (Master Plan *et al.*, 1999); contamination of water, sediment and benthos around drill sites; and acoustic pollution (see below, and section 9.2, for information on acoustic harassment of whales). A number of exploration wells have been drilled in offshore areas within the region (see Master Plan *et al.*, 1999, and Butler *et al.*, 2002).

Risks to Coastal Bird Populations

- The *nationally endangered* Orange-bellied Parrot has been recorded in the **Douglas Point Conservation Park**. Only 100 to 200 individuals remain in the wild, with habitat destruction being one of the greatest threats to their existence (NPWSA, 2000b). These parrots nest and breed in Tasmania during summer then over-winter in south-east mainland Australia, from southern Gippsland in Victoria to Lake Alexandrina in South Australia. There are at least 15 plants upon which this species feeds (Croft *et al.*, 1999, cited by NPWSA, 2000b). Of these, beaded glasswort (*Sarcocornia quinqueflora*) and biddy biddy (*Acaena novae-zelandiae*) are found in the Park. The patch of beaded glasswort has been fenced off to prevent damage by vehicles (NPWSA, 2000b).
- The breeding population of Little Penguin at **Cape Northumberland**, which represents one of only two breeding sites in the South East of South Australia for this species, is considered to be under threat from dogs and foxes (Robinson *et al.*, 1996).
- Foxes and feral cats prey on coastal birds in the **Lower South-East** (K. Jones, Coastcare, undated).
- Parks, Flora and Fauna Division of DNRE (1995) listed as a main threat in the **Glenelg River Estuary** area, disturbance (by recreational activity) to beach-nesting birds and birds roosting in the estuary (especially at the river mouth), by recreational activity.

Risks to Whale Populations

- Butler *et al.* (2002) identified potential threats to aggregations of blue whales in the south-eastern area of SA and western Victoria. The authors produced a matrix of potential impacts upon blue whales in the Bonney Coast region, such as marine debris from a variety of sources; noise pollution from a variety of sources; diffuse chemical pollution from several sources, and global warming (which may affect krill distribution and abundance). According to the authors, “Of particular concern in the Bonney Upwelling are: changes to the upwelling (e.g. through global warming), collisions with vessels, and noise pollution. While there is little evidence of significant current impacts — the regions’ fisheries mainly use low-risk gears, offshore oil and gas exploration is still in the exploration stage although potential gas production fields have recently been identified, there is no krill fishery, and no current reports of collisions with whales — we concluded that any new industries and/or increases in activity by existing users will have to be assessed on a case-by-case basis regarding their impact on the Blue Whales” (Butler *et al.*, 2002, page 5).
- Butler *et al.* (2002, p. 55) provided the following summary of the possible effects of noise on whales along the Bonney Coast: In the specific case of the Bonney Upwelling, seismic airguns may elicit behavioural changes in blue whales in the tens of km, and probably avoidance at 3-20 km (McCauley and Duncan 2001). The noise from shipping may produce localised displacement of whales to several km from the vessel; whale avoidance due to drilling noise was estimated to be negligible while rig tenders were shut down or idle, and to within perhaps 2.25 km when a rig tender was victualing at the rig (McCauley and Duncan 2001). Miller *et al.* (2000) report that male Humpback Whales lengthen their song patterns significantly when they are exposed to LFA sonar transmissions, presumably to compensate for acoustic interference. While McDonald *et al.* (1995) did not observe changes in Blue Whale movements and calling patterns when they were subjected to air-gun or shipping noise, Wiggins *et al.* (2001) noted that Blue Whales vary the intensity of their sound production level in response to varying ambient noise levels. Behavioural changes may come at an energetic cost that cannot be estimated; thus, it should be kept in mind that many long-term impacts of noise cannot be assessed within the limits of our current knowledge (S. Dolman pers. comm.). McCauley and Duncan (2001) concluded in their study that it was considered prudent to evaluate each proposed activity on a case-by-case basis, since the risk factor will vary for different activities at different times and of different scales.
- Butler *et al.* (2002) also considered harassment by potential whale-watching or research operations, to be a potential threat.

Other Issues

- Problems identified at a number of coastal areas of the lower South-East, such as **Douglas Point** and **Finger Point**, include one or more of the following: feral cats, foxes, and introduced pest plants. Also, cattle wander onto the fore-dunes and beach near **Pick’s Swamp** and **Discovery Bay**, resulting in destruction of dune vegetation, damage to dune slopes through trampling, spreading of weed species, and manure on beaches (K. Jones, Coastcare, undated).
- A landfill operation / dump is located close to the **Port MacDonnell** coast (Master Plan *et al.*, 2000), however information about any potential near-shore marine impacts (e.g. from seepage) is not available for this report.
- There are large quantities of plastic wastes on some beaches, in areas such as **Middle Point**, and in that area, such wastes have been attributed to sewage out-falls such as **Finger Point**). Plastic bags on beaches at **Pleasant Cove** are associated with the town dump (Jones, undated).
- The scenic headland in the **Pleasant Cove / Cape Northumberland** area is considered to be threatened by coastal housing development (K. Jones, Coastcare, undated).
- Decline of remnant coastal vegetation such as Swamp Gum and other species of conservation concern (including rare species), is considered an issue in the **Port MacDonnell** area (Jones, Coastcare, undated).
- Siltation of the fishing harbour inside the **Port MacDonnell** breakwater occurs (Jones, Coastcare, undated). The increased turbidity and sedimentation from intermittent dredging operations in the **Port Macdonnell** area, are reported to be a potential threat to the local nearshore habitats (Bryars, 2003).
- Giant kelp is a species susceptible to a number of small-scale and large-scale impacts. Information specific to giant kelp abundance in south-eastern South Australia is not available, but it is noteworthy that beds of giant kelp in Tasmania have allegedly declined considerably in extent (see DPIWE Kelp Watch web site, 2001, and Edyvane, 2003).
- Disturbance to Aboriginal heritage sites in the **Douglas Point** area has been recorded (NPWSA, 2000b).