Marine & Estuarine Fishes of Conservation Concern in the Adelaide and Mount Lofty Ranges Natural Resources Management region

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Executive Summary

The tables below list the marine and estuarine fishes of principal conservation concern within the Adelaide and Mt Lofty Ranges Natural Resources Management region. These species, and threatening processes, are discussed in the accompanying report.

The report also provides a summary of **Priority Actions**, i.e. recommendations to assist knowledge of these species; also to improve protection of their habitats, and to manage and mitigate activities that may pose a threat. These include:

- Fish Surveys
- Habitat Impact Studies
- Long Term Habitat Protection and Restoration Programs
- Bycatch Monitoring
- Marine Protected Areas Research and Monitoring
- Increased Governmental Involvement in Marine Threatened Species Issues
- Fisheries Research and Management
- Recreational Fishing Regulations and Monitoring
- Monitoring of Southern Australian Aquarium Trade (Legal and Illegal)
- Research Support for South Australian Museum
- Public Awareness of Potentially Threatened Species
- Awareness and Assessment of the Impacts of Climate Change

A full list of fish species of potential conservation concern in the AMLRNRM region is provided in the **Appendix**.

Small, Benthic Marine Fishes in Seagrass and Reef Habitats
Syngnathids: Southern Pygmy Pipehorse, Verco's Pipefish, Red Pipefish, Southern Gulf Pipefish, Gales Pipefish, Javelin Pipefish, Deep-bodied Pipefish
Clinidae: Particularly Spotted Snake-blenny and Eel-blenny
Crested Threefin / Crested Triplefin
Clingfishes (see **Overview** and **Appendix** for examples of the less common species)
Scarlet Cardinalfish and Southern Cardinalfish

Uncommon Reef Species
White-nose Pigfish
Warty Handfish and Australian Handfish
Rough Anglerfish, Bougainville's Anglerfish, Rodless Anglerfish / Cryptic Anglerfish, Glover's Anglerfish, Sponge Anglerfish, Spinycoat Anglerfish / Mitchell's Anglerfish, Glauert's Anglerfish

Prowfishes: Whiskered Prowfish, Red Indianfish, Warty Prowfish
Red Velvetfish
Slender Blindfish and Southern Pygmy Blindfish

Benthic Sand-Dwelling Species
Sculptured Seamoth
Gurnards (see **Overview** and **Appendix**)
Flounders (see **Overview** and **Appendix**, and Flimsy Flounder is of particular note)
Southern Sole and Dusky-banded Sole

Estuarine Species
Pouched Lamprey and Short-headed Lamprey
Estuary Perch
Congolli
Estuary Catfish
Black Bream
Estuarine Gobies: Pale Mangrove Goby and Frayed-fin Goby / Krefft's Goby
Short-snout Hardyhead and Pikehead Hardyhead
River Garfish
Southern Tongue Sole
(possibly) Bandfish

Reef Fish Species – Commercially and/or Recreationally Significant
Western Blue Groper
Blue-throated Wrasse and other large Wrasses
Harlequin Fish
Rock Ling
Boarfishes (see **Overview** and **Appendix**)
Banded Sweep
Western Blue Devil
Black-banded Seaperch
Knifejaw
Southern Blue Morwong

Mixed Habitat Fish Species – Commercially and/or Recreationally Significant
King George whiting
Pink Snapper
Mulloway
Southern Sea Garfish
Silver Trevally
Yellowfin Whiting
Dusky Morwong
Luderick
Flatheads
Leatherjackets
Gurnard Perches and Scorpionfishes

Sharks
School Shark
Bronze Whaler and Black Whaler
White Shark
Dogfishes (White-spotted Spurdog and Piked Spurdog)
Smooth Hammerhead
Spotted Wobbegong, Ornate and Large Ornate Wobbegong, and Cobbler Carpetshark
Whiskery Shark

Others
Rays, Stingray, Skates & Stingarees (of particular note: Coastal Stingaree and “Magpie Fiddler Ray”)
Elephant Fish

Marine & Estuarine Fishes of Conservation Concern in the AMLRNRM region

Section 1 of this report discusses a number of potentially threatened bony and cartilaginous fish species in the AMLRNRM region, in groups according to fish type and habitat type. Section 2 provides a summary of recommendations to assist knowledge of these species; also to improve protection of their habitats, and to manage and mitigate activities that may pose a threat.

1. Species Overviews

Small, Benthic Marine Fishes in Seagrass and Reef Habitats

Syngnathids: Since January 2006, fishes in the Syngnathidae (seadragons, pipefish, pipehorses) have been formally protected in S.A., under the *Fisheries (General) Variation Regulations 2006* of the *South Australian Fisheries Act 1982*. Some consider formal protection will reduce potential threats such as collecting, which governmental decision-makers and community groups have long perceived to be a threat to syngnathids, despite no substantial evidence that illegal collecting of any syngnathid species in S.A. has occurred since the tightening of export regulations (under Commonwealth law) and development of syngnathid aquaculture during the 1990s (e.g. Martin-Smith and Vincent, 2006). The numbers collected legally under permit were considered during the early-mid 1990s to be a concern, but are not known to be at present. Of greater threat to these fishes, which have limited mobility and strong site association, may be habitat degradation. Of the 26 or 27 species that are found within the AMLRNRM region (**Appendix**, plus 5 common species not listed here), protection of habitat may be particularly important for apparently uncommon syngnathids, for which few S.A. records are known, such as:

- Southern Pygmy Pipehorse: a small, highly camouflaged pipehorse found on macroalgae-covered reefs in S.A. and possibly southern W.A., and known mostly from old museum records. Some locations in the vicinity of the AMLRNRM region where the species has previously been recorded include Cape Jervis, and a site 10km east-south-east of Troubridge Island, in south-western GSV (S.A. Museum data, cited in Baker, 2007);
- Red Pipefish, a well-camouflaged pipefish for which there is only one record known from eastern GSV (data by R. Charles, 2002, cited in Baker, 2006b), a small number from northern Kangaroo Island, and very few from other parts of S.A. or other southern Australian States. The species is small, cryptic in red macroalgae, and is not likely to be observed unless targeted searches are made (Baker, 2006b); and
- Verco's Pipefish: An inshore, endemic pipefish known to date only from the central S.A. coast, particularly Spencer Gulf, southern GSV, and Kangaroo I. (Waite and Hail, 1921; Glover, 1979; Paxton et al., 1989; Dawson, in Gomon et al., 1994; Kuiter, 2000; B. McDonald, unpubl. data, 2001; K. Smith, unpubl. data, 2003; Australian Museum record; S.A. Museum records, cited in Baker, 2006b). The species has not been recorded to date from within the AMLRNRM, but regions in the vicinity include south-western GSV / southern Yorke Peninsula (e.g. Edithburgh and Stansbury) and north-eastern Kangaroo I., including Pelican Lagoon, the type locality (but possibly atypical habitat – Browne, 2004) , where it was previously recorded as being locally common (Kuiter, 1996a). Within the currently known geographic range, the species has been recorded in tide pools, tidal channels, shallow subtidal macroalgae and *Zostera* seagrass, and rubble bottom habitat. Little is known of the relative abundance, full depth range and biology of this species, and it is possible that the rare recording and poor knowledge of Verco's Pipefish is due mainly to the lack of targeted surveys in the specific (and possibly less accessible) micro-habitats utilised by this species (Browne, 2004, and pers. comm., 2005, cited by Baker, 2006b). Nevertheless, given the possible endemic status of this species, coupled with it's nearshore distribution, habitat degradation is a potential threat to the survival of Verco's Pipefish (Pogonoski et al., 2002), and examples may include dredging and channel

development, other coastal developments, and power boating in shallow waters where the species is present. The biology and population ecology of this species should be investigated to determine its specific susceptibility to impacts from habitat degradation (Pogonoski et al., 2002).

Also of note is the Southern Gulf Pipefish "*Stigmatopora narinosus*" (Browne and Smith, in press), a South Australian endemic - previously confused with *S. olivacea* Castelnau 1872 (Kuiter, 2000), the latter of which is a junior synonym of *S. argus* (M. Gomon, Museum of Victoria, pers. comm. 2007). Southern Gulf Pipefish is closely related to the common *S. nigra*, and has been recently re-described by Brown and Smith (in review). This species may be common in some parts of the known range (GSV and Spencer Gulf), and divers have observed large aggregations in some areas (see Baker, 2007 for summary). It appears to be restricted to moderately sheltered, shallow, open water habitats, probably between 1-5m deep, in mixed habitats of brown macroalgae and rubble/rock substrate within seagrass; also small patches of seagrass (*Zostera* and *Posidonia*) in sand, amongst stands of brown macroalgae (Kuiter, 2003; R. Browne, pers. comm., 2005, cited in Baker, 2006b; Browne and Smith, in review). The preferred habitat is restricted, and only occurs along limited sections of the species' known range (GSV and Spencer Gulf) (Browne and Smith, in review, cited by Baker, 2006b).

A number of other syngnathids that dwell in coastal fringing reefs (including rubble reefs) and mixed reef / seagrass habitats are known from very few specimens, and their apparent uncommonness may be an artefact of the lack of specific survey effort in the shallow subtidal (to ~ 20m) habitats where these species reside. Examples include Gales Pipefish, a small (to 6cm) species that ranges from central S.A. coast to the central W.A. coast, and the Javelin Pipefish, widespread along Australia's south coast, but known from very few records, with only two published records from the AMLRNRM region, and very few in other parts of South Australia (see Baker, 2006b and 2007 for summary).

Habitat decline is considered to be one of the main threats to nearshore populations of syngnathids (e.g. Vincent 1996, cited in CITES, 2002; Kuiter, 2000, 2003a; Department of Fisheries W.A., 2004), and endemic species of limited geographic range, and found in inshore habitats, may be particularly susceptible to the impacts of habitat degradation. A number of syngnathids rely upon shallow subtidal seagrass beds or macroalgae- dominated reefs, and degradation of such environments reduces available habitat in which life processes can be carried out. Degradation of nearshore habitats is especially prevalent in highly urbanised areas such the metropolitan coast of GSV (see **Priority Actions** below). Recent studies by R. Browne (pers. comm., 2003) and K. Smith indicate that although the Deep-bodied Pipefish *Kaupus costatus* can survive in harsh, physically disturbed environments, its abundance depends on the presence of fine, shallow-water *Zostera* seagrass, in which it is normally found. Such seagrass provides critically important habitat for this pipefish species (Browne, 2004, cited by Baker, 2006b). Examples of locations in the AMLRNRM region and surrounds where the species has been recorded include Port Gawler to Middle Beach; Outer Harbour and Port River - Barker Inlet system; lower Fleurieu locations such as Cape Jervis; and Kangaroo I. (e.g. the Investigator Strait / north coast area; the north-eastern bays, and American River) (Glover, 1979; Jones et al., 1996; Kuiter, 1996b and 2000; Fairhead et al., 2002b; R. Browne, MLSSA, pers. comm., 2003; Tanner et al., 2003; Australian Museum records; S.A. Museum records, Museum of Victoria records, cited in Baker, 2006b). In areas where *K. costatus* is present, any processes that destroy shallow subtidal seagrass beds, may adversely affect the populations in those areas.

Even without the compounding effect of habitat damage, populations of some syngnathids may exhibit a high degree of fragmentation due to the patchy nature of suitable habitat, and the limited ability of syngnathids to disperse away from habitat "patches". Additionally, it has been shown that seahorses, for example, have specific microhabitat preferences, occupying only the edges of particular habitat types (e.g. seagrass / sand or reef / sand interfaces); thus, large areas of seemingly suitable habitat are unoccupied (Vincent, 1996, cited in CITES, 2002).

Clinids: There are numerous species of snake-blennies and weedfishes (Clinidae) in S.A. (Baker, 2007, and **Appendix** below, for a list of the more threatened, currently known taxa). Most are found over a narrow depth range in nearshore waters. All are benthic, strongly site-associated, viviparous (live-bearing) fishes with low dispersive ability, characteristics that can increase vulnerability to processes causing population decline. Some clinids are common in

nearshore seagrass beds and macroalgae-covered reefs; others are known from very few records. These species may be susceptible to population declines from physical disturbance to habitat and siltation from dredging, channel development, boating in shallow waters; also sediment- and effluent-induced dieback of macroalgae and seagrasses etc), but specific data are lacking (Baker, 2007). Of note here within the clinid group are Spotted Snake-Blenny, which may be a South Australian endemic, and the Eel-blenny, which also has a restricted geographic range, found mainly in the gulfs region of S.A., with isolated records from eastern Great Australian Bight (GAB) and southern W.A. (Baker, 2007)

Crested Threefin / Crested Triplefin: A number of triplefin species are commonly known within S.A., and some are apparently abundant and widely distributed (Baker, 2007). However, the potentially vulnerable population characteristics of the whole group is noted here, such as are strong site association; the guarding of benthic eggs in a "nest"; and use of shallow coastal habitats that may be subjected to localised impacts (Baker, 2007). Of the triplefins, the Crested Threefin is of particular conservation interest because it may be endemic within this State[1]. However, this reef-associated species has been commonly recorded, and appears not to be rare within the known range. Processes that impact upon the extent, quality and cover of nearshore reefs may adversely affect populations of site-associated nearshore reef fishes such as Crested Threefin, but there are no specific data.

Clingfishes: There are numerous species of clingfish in S.A., some very common, others rarely recorded, and almost all species are shared with one or more other southern Australian States (see Baker, 2007). Only one endemic clingfish is known to date from S.A., an unnamed species known from a single record, collected in the eastern GAB (B. Hutchins, W.A. Museum, pers. comm., 2007). Clingfishes are strongly site-associated with nearshore seagrass beds (and, in some cases, macroalgae-covered reefs), and therefore any processes with degrade the quality of coastal seagrass beds and reefs may have an impact on these species. Clingfish are members of a family with characteristics that may increase their vulnerability to impact, such as strong site association; habitat specificity; parental care of eggs and young at the "nesting" site; poor swimming ability, and low dispersal ability (Baker, 2007).

Cardinalfishes: *Vincentia* cardinalfishes are benthic, mouth-brooding species with site-specific reproduction, found mainly in shallow subtidal seagrass beds and/or nearshore reefs; all of these characteristics may increase the vulnerability of such species to localised impacts. Scarlet Cardinalfish and southern Cardinalfish may be part of the bycatch in prawn trawl fisheries, but no risk assessments have been undertaken, and data are lacking. Southern cardinalfish is a minor part of the bycatch in the Blue Crab Fishery (Svane and Hooper, 2004; Currie and Hooper, 2006). Little is known of the relative abundance, biology and population dynamics of these species.

Uncommon Reef Species

The White-nose Pigfish: A slow-moving, sedentary species with a prominent snout, which is used to probe for benthic invertebrates. The species is found in S.A. and W.A., in rubble bottoms and on various types of reefs on the continental shelf. It was first recorded in 1917 and 1920 from a beach at Glenelg. The species has rarely been found in S.A., with the few other examples including 3km north of Wirrina (1987), Spencer Gulf (several specimens collected from Tiparra in 1975), and Kangaroo I. (Waite, 1922; Glover, 1979, and S.A. Museum records, cited in Baker, 2007). The species is rarely recorded in lobster pots in W.A., but has not been recorded in lobster bycatch monitoring programs in S.A. (see Baker, 2007, for summary).

Handfishes: Currently there are two handfishes known from S.A., the Australian Handfish and the Warty Handfish. Unlike the endangered Tasmanian handfishes, the two currently known

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[1] Due to its apparent endemic status, it may qualify for listing internationally (e.g. under IUCN), but is unlikely to qualify for listing as Rare within South Australian legislation (Baker, 2007).

species in S.A. have broad depth ranges across the continental shelf, to at least 200m. However, all handfishes are susceptible to population decline, because the adults and juveniles of these small benthic fishes are largely sedentary (and hence vulnerable to site-specific impacts); handfishes generally have small, distinct and measurable populations over small ranges; they have low fecundity; they rely upon benthic structures for nesting; they have a high degree of parental care of the eggs, fully formed young at hatching (i.e. no larval phase), and poor dispersal capability. Handfishes are slow to expand their range and colonise new areas (Bryant and Jackson, 1999; Pogonoski et al., 2002; Commonwealth of Australia, 2004, cited by Baker, 2007). Southern GSV is the type locality of the Warty Handfish (SA Museum record, 1905; McCulloch and Waite, 1918), but there are no verified records to date of Australian Handfish from within the AMLRNRM region, although it is known from other parts of this State. Given the lack of knowledge of distribution, relative abundance and habitat requirements of handfishes in S.A., it is important that handfish specimens recorded in this State be correctly identified. For example, a specimen collected at Section Bank during a environmental impact survey for a dredge program, was incorrectly identified as the endangered endemic Tasmanian species *B. hirsutus*, which is not known to occur in South Australia.

Anglerfishes: Of the 10 anglerfishes currently known from S.A., most occur in GSV, including one (Tasselled Anglerfish *Rhycherus filamentosus*) for which GSV is the type locality. Some anglerfishes are common in parts of GSV, including the reef-dwelling Prickly Anglerfish and Smooth Anglerfish, the latter often observed below jetties, and in boulder reefs. Others are uncommon, such as Bougainville's Anglerfish, Glover's Anglerfish, Spinycoat Anglerfish, and the rare and very well camouflaged Glauert's Anglerfish, the latter of which has been recorded off Kangaroo I., and also within the eastern GAB, but not yet within GSV. A number of these species are rare in fish collections and known from few specimens, with most S.A. records collected during the early 20th century. Although some of the anglerfishes have a broad distribution across the continental shelf (e.g. Rodless Anglerfish, and Glauert's Anglerfish), others have a very restricted depth range (e.g. Bougainville's Anglerfish, and Sponge Anglerfish), being found on nearshore subtidal reefs (and possibly other hard structures), or in shallow water sponge beds. Such restricted habitat range can increase the vulnerability of populations to site-specific coastal impacts, including degradation of natural reefs, artificial reefs and under-jetty habitats, and sponge beds. Shallow water temperate anglerfishes in general are potentially vulnerable to population decline, due to their strong site association, low fecundity, benthic reproduction and (probably) restricted dispersal ability. A number of anglerfishes are part of the bycatch in prawn trawls, and rock lobster pots in S.A., but data are lacking on the frequency of capture in both of these fisheries. In southern Australia, some temperate anglerfishes are sought-after in the specialist aquarium trade, which may cause localised population depletion, but there is very little information on the source of specimens from southern Australia that appear in the trade.

Prowfishes: Three species of wedge-shaped, laterally compressed, scaleless prowfishes occur in S.A. (Warty Prowfish, Whiskered Prowfish, and Red Indianfish), including the AMLRNRM region. Like a number of species discussed above, prowfishes are of conservation concern due to their benthic existence, strong habitat association, low densities per habitat area, slow movements, and probable localised reproduction; all being characteristics that increase the vulnerability of populations to decline from habitat impacts. Although broadly distributed, Whiskered Prowfish is very uncommonly recorded. Metropolitan GSV is the type locality for that species, and the gulf has been subject to extensive habitat modification and degradation during the past century since the type specimens were collected. The species may also be susceptible to capture in benthic trawls, and rock lobster pots (see Baker, 2007, for examples), but data are inadequate. Similarly, the Red Indianfish has been very uncommonly recorded in S.A., which is the eastern edge of the western part of its disjunct distribution. Red Indianfish is found in upper continental shelf waters (~10m – 80m), usually in the vicinity of sponges, which it closely matches in appearance, and any processes which degrade such sponge habitat where this species resides, may adversely affect populations. The more common and broadly distributed southern Australian species Warty Prowfish exists in similar habitats to the Red Indianfish (macroalgae-covered reefs and sponge beds), but has an even narrower depth range (~2m – 25m). Warty Prowfish is a minor bycatch in nearshore fisheries such as rock lobster, but there are no species-specific data for South Australia.

Red Velvetfish: This species is broadly distributed across southern Australia (N.S.W. to W.A.) and also has a broad geographical range within S.A. (from the GAB to the South East). Nevertheless, it is of conservation concern, as a benthic, strongly site-associated reef fish, found in low densities in kelp and other reef habitats, over a relatively narrow depth range on the upper continental shelf. These characteristics may increase the vulnerability of populations to site-specific impacts, particularly decline in cover of critical habitat. Although populations have not been monitored in S.A. to date, it is noted that in Tasmania, there has been a significant decline in sightings of this species over a 15 year period in a protected (unfished) area, likely due to reduction in kelp cover, a critical habitat (G. Edgar, University of Tasmania, pers. comm., 2006, cited by Baker, 2007). Although there is some knowledge of the geographic distribution of this species in S.A., there is little information about the relative abundance. Within the AMLRNRM region and surrounds, the species has been recorded in eastern Investigator Strait; metropolitan GSV; northern and north-eastern Kangaroo I.; and Encounter Bay (Baker, 2007, and references therein). Red Velvetfish is slow-moving and easily caught, which makes populations potentially vulnerable to exploitation. In Tasmania, it is part of a developing aquarium trade in temperate fishes, and if such interest spread to S.A., then it is important that any collection be closely monitored and controlled. There are records of the species as bycatch in some commercial fisheries (including S.A.), and it is also taken incidentally by anglers and spear fishers. Other than in Tasmania, catches of this species are not monitored or controlled.

Blindfishes: Slender Blindfish, a south-western species (WA to central SA coast) for which north-eastern Kangaroo I. is the type locality, appears to be common in the gulfs region, and has been recorded at a number of locations within the AMLRNRM region (see Baker, 2007 for summary). Another blindfish known from the gulfs region of S.A., the Southern Pygmy Blindfish *Dinematichthys* sp., also occurs in Victoria and W.A., and appears to be an undescribed species (Nielsen, pers. comm. to M. Gomon, Museum of Victoria, 2006, cited in Baker, 2007). Members of this family of small fishes are viviparous (bear live young), and therefore reproduce at a local, site-associated level. Blindfishes are presumed to have low fecundity and low dispersal ability, and these characteristics can increase the vulnerability of populations to processes that cause decline. Both species are found in shallow waters habitats (less than 25m), particularly reefs, but the latter also occurs in estuaries.

For all of these reef-dwelling species, their benthic association and sedentary, slow-moving nature may increase their vulnerability to site-specific impacts. Also, there is very little information for these species on the distribution within S.A., the full depth range, habitat requirements, relative abundance or rarity over the range, biology (particularly growth, longevity, and reproduction), population dynamics, ecology, or the specific nature and extent of threatening processes (see **Priority Actions**).

Benthic Sand-Dwelling Species

Sculptured Seamoth: This is one of the more unusual sand-dwelling species found in the AMLRNRM region. It has a broad geographic range across southern Australia, but may be of conservation concern because it is a benthic, site-associated, seasonally aggregating species of limited mobility. It generally occurs in low densities; has high social structuring, including pair bonding and monogamous mating, and these characteristics can increase the vulnerability of such species to over-exploitation and population decline. Little is known of the distribution or relative abundance in S.A., where it is part of the bycatch in prawn trawlers, including GSV (S.A. Museum data, Museum of Victoria data, cited in Baker, 2007). Trawling may be a threatening process for Sculptured Seamoth populations in some areas. The trawl bycatch of this species is poorly quantified, yet much of the known depth range and habitat type of this species are within trawlable area. Degradation of inshore sand and seagrass habitats by various agents may adversely affect populations of Sculptured Seamoth (Pogonoski et al., 2002), but there are no species-specific data.

Gurnards: The gurnards found in the AMLRNMR region are listed in the **Appendix** Most are found over sand and rubble substrate (including sand near reefs), some in estuaries, but most in continental shelf waters. Although most have a broad range across the shelf, they are site-associated benthic species that are vulnerable to capture in benthic trawls and other gear. Some species are caught in large quantities in Commonwealth-managed trawl fisheries, and are considered to be at high risk of population impacts (see Baker, 2007 and references therein). Of greater relevance within the AMLRNRM is the prawn trawl bycatch, which is large for some species, but not well quantified in GSV (see Priority Actions). The gurnards are not a major recreational species, with about 3,424 specimes recorded as being caught by S.A. fishers during a 12-moht survey (2000/01) (Henry and Lyle, 2003). There is little information on distribution and relative abundance of gurnard species over the range (including S.A.), and on the biology, population dynamics and ecology.

Flounders: The AMLRNRM region and surrounds are rich in flounder species (e.g. Baker, 2007, and sub-set in the **Appendix** below). For some flounder species, S.A. is at the edge of the geographic range, and some of the species have been recorded over a narrow depth range in upper continental shelf waters. Benthic fishes such as flounders generally have limited mobility, more site-specific reproduction than most pelagic species, and limited opportunity for population dispersal, all of which can increase the vulnerability of populations to decline. Of particular note within S.A. is the apparently endemic Flimsy Flounder, found to date over a narrow depth range, from very few areas, in eastern GAB and Investigator Strait, mainly in prawn trawl bycatch (S.A. Museum records, 1981 and 1982, identified by M. Arai, 1995, cited by R. Foster, pers. comm., 2006). In S.A., much of the commercial flounder catch comprises Greenback Flounder (*Rhombosolea tapirina*) in the Lakes and Coorong fishery, not discussed here. Flounder species are also caught, in lower numbers, in the Marine Scalefish Fishery, with examples within the AMLRNRM and surrounds including northern GSV, and the bays of north-eastern Kangaroo I.. In S.A., one of the main commercial fishing-induced sources of mortality of flounders (other than Greenback), may be due to by-capture in prawn trawl fisheries, and localised population impacts are likely (see Carrick, 1997, and Baker, 2007 for recent summary). Flounder bycatch is very minor in other fisheries, such as the Blue Crab Fishery (e.g. Svane and Hooper, 2004; Currie and Hooper, 2006). About 3,000 flounders and soles (combined) are taken per annum by recreational fishers in S.A. (Henry and Lyle, 2003). For recreational fishers in S.A., there is a daily bag limit of 20 flounder (all species) and a boat limit of 60. There is no legal minimum size in S.A. (PIRSA, 2006). Other than fishing, pollution may be an issue for these species. There are no specific studies on pollution impacts on flounders in Australia, but it is noted that in the northern hemisphere, sub-lethal effects of sewage and industrial pollutants, and others (such as tri-butyl tin from ship and boat anti-foulants) have been recorded, including changes in body chemistry, and reproductive impairment in flounders (e.g. CSTEE, 1999; WWF, 1999, cited by Baker, 2007).

Soles: Southern Sole and Dusky-banded Sole are both south-western species, which may have a limited geographic distribution within S.A.. Both are found in sandy habitats in the gulfs region, and both have a narrow small depth range, and may thus be vulnerable to nearshore impacts. These two species are part of the bycatch in prawn trawlers in the gulfs region of S.A. (e.g. Carrick, 1997, cited in Baker, 2007), but species-specific data for GSV are lacking. Very little is known of the relative abundance, biology, and population dynamics of these soles.

Estuarine Species

Lampreys: Pouched Lamprey and Short-headed Lamprey are not commonly recorded in S.A., and there is little information on the current distribution or abundance. The former has not been recorded during a number of recent surveys in areas where it would be expected to occur, and there are few recent records of the latter, compared with its historical distribution (see Baker, 2007 for summary). The number of permanent creeks and rivers in S.A. that open to the coast is small, and suitable habitat is thus limited in spatial extent. Lampreys rely upon specific habitat of limited distribution, for spawning – i.e. both species reportedly requires permanent creek / river headwaters in good ecological health to complete its life cycle, and significant reduction in the quality of estuarine and freshwater habitat has occurred across the central and south eastern coasts of S.A. during the 20th century. Within the AMLRNRM and surrounds,

reductions in the quality and extent of the riverine and stream habitat that is used for spawning and other stages of the life cycle, have occurred in areas such as the Adelaide Plains and the River Murray. Many of the waterways in S.A. into which these lampreys previously migrated, are subject to barriers such as weirs, dams and diversions, and many such rivers and streams have also suffer reduced flow due to excess water extraction, as well as increased pollution levels from a variety of sources over the past few decades. Barrage opening and freshwater flows are important for maintaining the life cycle of lampreys (MDBC, 2003). Lampreys must overcome both natural and human-made obstacles in order to migrate upstream and reach their breeding habitat, and many lampreys can die during this journey. The longevity of these species, the probable irregularity of spawning, and the specific habitat requirements for completion of the life cycle, all potentially increase the vulnerability of lampreys. Based on the evidence that (a) the current distribution in S.A. is limited spatially (and likely to span from the Adelaide Plains / Gulf St Vincent area, to the Lower South East); (b) within that range, much of the available habitat has been severely modified; (c) a number of recent surveys in suitable habitat have not recorded these species, and it is thus inferred that there may be a decline in the area of occupancy; and (d) recognised threats to critical habitat are still occurring, it is recommended that these two species be listed as *Vulnerable* or *Endangered* in S.A., depending upon a formal assessment of the current area of occupancy in South Australia (i.e. less than 2000km^2 or less than 500km^2) (see National Parks and Wildlife Council and DEH, 2003, and Baker, 2007, for criteria listings).

Estuary Perch: This species, due to be listed as *Endangered* in South Australia, has a restricted range in S.A., which is at the edge of the geographic range, and there is very little suitable habitat (such as rivers and estuaries) in most parts of the State, to support the habitat requirements and life history characteristics of this species. In estuarine areas that do exist, freshwater input is also low and inconsistent. There are no recent records from the Murray Mouth, the largest estuarine area in South Australia. Paxton et al. (1989) recorded the S.A. gulfs as part of the distribution, and Hammer (2006a) reported that the species may have previously occurred in the Onkaparinga Estuary, and may occasionally still migrate to the area. Structures such as dams, weirs and barrages, and other means of changing flow quantity and rate, would interfere with the life history, and may act as a barrier to the migration of Estuary Perch between estuarine and fresher waters. Seasonal closure by sand bars of some estuaries, which prevents tidal inflows, may have marked effects on breeding success of this species. Other issues may include habitat degradation (due to various forms of water pollution, catchment development and agriculture-related activities), introduced alien and translocated native fish species. Estuary Perch is relatively long lived (to at least 30 years), hence habitat impacts have the potential to adversely affect one generation of fish for long (decadal) periods. The species is reported to have a very low resilience to exploitation, but there are inadequate data on previous commercial and current recreational catches in S.A. (which are likely to be low) (Baker, 2007).

Congolli: An estuarine species (also freshwater, and nearshore marine), now uncommonly recorded in the AMLRNRM region, but known in great numbers from the Murray Mouth area (e.g. Ye et al., 2002; Geddes, 2005; Stuart et al., 2005; Smith, 2006) and the South East (e.g. Hammer, 2002). Historically, there have been isolated records from other parts of S.A., including drainages of the Adelaide region, such as Buckland Park (1934), Grange Creek (1929) and Hallett Cove (1929) (S.A. Museum records; R. Foster, pers. comm., 2006, cited in Baker, 2007). During a survey of the Gawler River in 1998, Hicks and Sheldon (1999) reported Congolli to be present only below the junction of North and South Para Rivers. It was expected to be present (but not observed) at other sites along the river, possibly due to lack of flow or to the stream flow gauge at Gawler, which might prevent movement of this species (NABCWMB, 2001). In metropolitan GSV, some of the creeks in which Congolli was previously recorded no longer exist, and have been drained and/or filled. Those that remain have significantly reduced flow, and reduced water quality. During the late 1920s, H.M. Hale, of the S.A. Museum, reported that Congolli were plentiful in the metropolitan area of the Torrens River during the late19th century, but had “practically disappeared” from that area by the 1920s. The association of Congolli with estuarine areas (many of which are degraded in central and south-eastern S.A.), as part of the critical habitat, increases the vulnerability of this species to decline, particularly in relation to the need for Congolli to move from fresh water to estuarine / brackish areas to spawn, and return upstream to fresh water to complete the life cycle.

Significant issues for estuarine species such as Congolli include interruption of migration patterns (e.g. during their irregular spawning and recruitment periods), and restriction of access to existing habitat and new areas for colonisation. Some direct threats to Congolli populations are reported to be changes to rate, volume and direction of water flow (due to water extraction, diversion, channelisation / drain construction, and/or construction of dams, weirs and barrages); destruction of in-stream habitat and loss of riparian vegetation, point source and diffuse water pollution (from widespread residential and/or agricultural development), and stream channel damage, and introduction of exotic species which compete for habitat (see review in Baker, 2007).

Estuary Catfish: Although this species has a broad distribution across S.A., it is not common, and occurs in estuaries and shallow marine waters over a narrow depth range (to 30m). Examples of locations within the AMLRNRM and vicinity where the species has been recorded include Investigator Strait; Kangaroo I. (e.g. Pelican Lagoon; Point Tinline); northern and eastern GSV (including Port River - Barker Inlet estuary, Outer Harbour, Semaphore, North Haven, artificial reefs / wrecks in the Glenelg area, Marino, Seacliff, and Port Noarlunga Reef / Onkaparinga estuary); Fleurieu Peninsula (e.g. Normanville / Carrickalinga area); Encounter Bay (e.g. The Bluff; Granite I.), and the Murray Mouth (Glover, 1979; Johnson, 1985b; Jones et al., 1996; Jackson and Jones, 1999; MLSSA, 1999; J. Baker, pers. obs., 1999; S.A. commercial fishing records 1995-97; S. Reynolds, unpubl. data 2001, 2002; K. Smith, unpubl. data, 2002-2003 and pers. comm., 2005; Fairhead et al., 2002b; Tanner et al., 2003; S.A. Museum records, Australian Museum records, Museum of Victoria records, cited in Baker, 2007). There are few estuarine habitats in S.A. to support part of the life stage of this species, and its estuarine association makes populations susceptible to impacts that reduce estuarine water quality. Other characteristics that increase the vulnerability of Estuary Catfish to over-exploitation and decline, include strong habitat association (and the forming of semi-resident populations); little mixing between populations from different regions, even within S.A.; relatively long life and late age at maturity; low fecundity; aggregative behaviour during breeding period; and site-specific investment in producing and rearing of the young (e.g. pair mating, benthic nesting, and brooding of young). Although the species is found and caught commercially in low numbers in S.A. (mainly bycatch, in at least 5 commercial fisheries), and also with various recreational fishing gear (including spears), there are no commercial or recreational fishing restrictions on the capture of Estuary Catfish in S.A., despite the vulnerable characteristics of its populations, and inadequate knowledge of distribution, relative abundance and habitat requirements of populations in all parts of this State.

Black Bream: Although this estuarine-resident species has a broad southern Australian distribution, Black Bream in different parts of S.A. likely to comprise discrete stocks which do not mix, although there are genetic similarities amongst Black Bream from estuaries that are close in geographic proximity (Burridge et al., 2004, cited by Sloane, 2005). Examples of locations in the AMLRNRM region and surrounds where Black Bream occur include Port River – Barker Inlet Estuary (Jones et al., 1990), Onkaparinga River (Hammer, 2006a) and Hindmarsh Rivers (Burridge et al., 2004) and small estuaries on Kangaroo Island (Hall, 1984). The species can withstand a wide range of salinities and often move upstream into fresh water. Movement between estuaries and other sheltered bays is limited, and usually only occurs during periods of flooding (Hall, 1984; Cashmore et al., 2000, cited by Sloane, 2005). Vulnerable characteristics include slow growth and relatively long life span (almost 30 years - Cashmore et al., 2000); variable growth rate between locations; reliance on local spawning events (in each estuary) for successful recruitment, which in turn rely upon temperature dependent freshwater inflows during spring and summer, as a critical spawning stimulus (MDBC, 2003, cited by Sloane, 2005); and reliance upon freshwater flows of specific magnitude, timing and duration for larval survival and development, i.e. in the Coorong area, for example, a protracted flow period extending into late summer is essential to maintain estuarine conditions and low salinity levels to ensure the survival of larval and juvenile fish (Hall, 1984; Pierce and Doonan, 1999). By limiting estuarine habitat, disrupting natural flow regimes, and changing estuarine conditions, barrage construction has significantly and negatively impacted the productivity of this species in the Coorong system, by reducing spawning success and lowering survival rates of larvae (MDBC, 2003; Hera-Singh, pers. comm., cited by Sloane, 2005). It is likely that reduced flow in other estuarine systems

throughout the AMLRNRM region and surrounds, during the past century, has also reduced the abundance of Black Bream in that region.
Black Bream is a very popular recreational species targeted throughout the State's estuaries, including the Lakes and Coorong. During 2000 and 2001, the total Statewide recreational catch was estimated to be 31.9 tonnes, of which 0.6 tonnes was taken from the Lakes and Coorong (Henry and Lyle, 2003). In areas of the State other than the Coorong,. recreational fishers catch Black Bream mainly using rods and lines (Sloane, 2005). There is also a commercial fishery, largely based in the Lakes and Coorong region. The fishery is managed by minimum sizes (28cm), upper and lower limit biological reference points, and catch per unit effort reference points. In the Lakes and Coorong fishery, the species is now in low abundance, and some of the catch is non-targeted by-product (Sloane, 2005).

Estuarine Gobies: A number of the goby species in S.A. have a limited known distribution, specific habitat requirements, and have been recorded to date only in low numbers. Examples include Pale Mangrove Goby, an estuarine species known mainly from eastern Australia, but recorded in S.A. (Barnham, 1998) in the Port River – Barker Inlet estuary (Bloomfield and Gillanders, 2005; Hammer, 2006b), including evidence of a breeding population (Hammer, 2006b, cited in Baker, 2007). Also of note in the goby family is Frayed-fin Goby / Krefft's Goby, a sub-tropical species from eastern Australia, known in S.A. from shallow subtidal habitats (including seagrass) in northern Spencer Gulf and several sites in northern, western and eastern GSV. Gobies as a group are nest spawners (Hoese, 1998), a population characteristic that increases their vulnerability to site-based habitat impacts (Baker, 2007).

Estuarine Hardyheads: Marine hardyheads are abundant in S.A., but two of the estuarine species, Short-snout Hardyhead, and Pikehead Hardyhead may be of conservation concern. These two species are difficult to distinguish in the field, and are known from few records. S.A. is at the edge of the geographic range of both species, which utilise estuaries and shallow nearshore bays over a narrow depth range, and there are few estuaries in South Australia to support the habitat requirements of these species. Habitat damage and decline in water quality may be potential threats to populations of both Short-snout and Pikehead Hardyhead.

River Garfish: This species has been recorded in the AMLRNRM region, and S.A. is the edge of the geographic range. River Garfish may rely upon estuaries to carry out its life processes (including feeding and breeding), and there are few permanent estuarine areas in S.A. that could support populations of this species (Baker, 2007).

Southern Tongue Sole: This species occurs within a relatively narrow depth range in shallow coastal waters and estuaries. Impacts that degrade the quality of these habitats (see **Priority Actions**) might be a threat to nearshore populations of this species

Bandfish: A strongly site-associated, burrowing, benthic species. Very few specimens of this (or a closely related) species have been recorded to date in South Australia, with the only example in the vicinity of the AMLRNRM region being two specimens from Investigator Strait, collected in 1912 (Australian Museum data, cited in Baker, 2007). The Bandfish has specific habitat requirements in estuaries and other quiet coastal waters with sand or silt bottoms, and in the shallower part of the depth range, the estuarine habitats of Bandfish are often subject to pollution and other forms of degradation, as discussed above.

Reef Fish Species – Commercially and/or Recreationally Significant

Western Blue Groper: Western Blue Groper (WBG) is long-lived, slow-growing, late-maturing, site-associated, nearshore reef fish species that has a strong population structure, and changes sex with age. The large adults are slow-moving and inquisitive, and in some areas are known to approach divers and fishing boats. It is widely recognised that fish with such population dynamics and behaviour traits are vulnerable to over-exploitation and population decline. WBG are fished across most parts of the known range by both commercial and recreational fishers, using a variety of methods, and WBG is also a bycatch species on hook and line, and in nets and lobster pots. Fishers find it easy to locate large groper (particularly over clear-water offshore reefs, around islands, and off rocky headlands). Increased fishing

technology during recent years has enabled more fishers to locate and target large adult WBG on offshore reefs and around islands, and such fishing has been heavily promoted within the charter boat industry during the past decade. Bag limits and boat limits exist across South Australia, but it is not known how effective these are in maintaining population structure and abundance. Although there is a closure to WBG fishing in S.A. Gulfs and Investigator Strait waters, and the species is also protected in a number of small Aquatic Reserves, it appears that this is insufficient as a means of protecting WBG in South Australia, because (i) the species does not occur in the upper and most of the central parts of either gulf due to lack of suitable habitat and oceanographic conditions, and therefore only a small part of the species range in S.A. is formally protected; (ii) some fishers appear not to adhere to the prohibition of fishing for WBG in Investigator Strait; (iii) there has been increased targeting of this species in offshore areas during the past decade, particularly by charter boats operating off the central and western coasts of S.A.; and (iv) some reef fishers do not recognise juvenile WBG when they are caught as bycatch, and small specimens are thus retained for use as bait (e.g. along parts of the Fleurieu and Yorke Peninsulas). No stock assessments or fisheries assessments have been undertaken, and thus there is no firm knowledge of the population sizes and recruitment levels over time, or the total numbers taken per annum by commercial and recreational fishers, or of the sustainability of fishing under the current regulations. It is recognised that a low level of fishing mortality may be enough to keep a slow-growing, recruitment-limited species such as WBG in very low densities, even in the absence of intense fishing pressure from any source. Studies in S.A. by Shepherd (e.g. Shepherd and Brook, submitted) have shown that the mean size of sub-adult WBG is correlated with an index of fishing intensity. A considerable number of reports (spanning three decades) have alluded to the decline of populations of this species in South Australia, and consequently, there have been various calls for the complete protection of WBG for at least 30 years. Recent surveys across much of the central and western coastal waters of South Australia have shown that (i) juvenile WBG abundance appears to be highest in a limited type of habitat (i.e. sheltered nearshore reef lagoon habitats adjacent to exposed coasts); (ii) densities of adult fish are low, and (iii) both adults and juveniles exist over a small depth range. Also, given its longevity and diet, WBG may be a “keystone” species in the reef habitats where it occurs. It is possible that the species qualifies for VU (A4) listing, if it can be inferred or suspected that a population size reduction of at least 30% has occurred over a 3 generation period (and considering the long life span of 1 generation of WBG), and where the reduction or its causes may not have ceased, based on an index of abundance appropriate to the taxon, a decline in the area of occupancy, and/or the actual or potential levels of exploitation. For a number of years, various researchers have recommended that WBG be fully protected under the *South Australian Fisheries Act*, and this call is reiterated here. Notably, in 2005, the S.A. Marine Scalefish Fisheries Management Committee supported the full protection of this species under legislation. It is also recommended that WBG be listed under the *South Australian National Parks and Wildlife Act*, as a Vulnerable species.

Blue-throated Wrasse (and other large Wrasse species): 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, due to behaviours such as strong site association with macroalgae-covered reefs and other nearshore reefs; territoriality (particularly during breeding season) and inquisitive nature. All three species are caught commercially (particularly Blue-throated Wrasse) in unregulated quantities, and also by recreational line fishers, spear fishers, and charter boat fishers in South Australia. Blue-throated Wrasse in particular, has other characteristics that makes it vulnerable to over-exploitation, and population decline. The species is sedentary; long-lived (>15 years); attains a large size; has a late age at sexual maturity; and exists in haremic groups (in which there is only 1 male to a number of females), with size-based hierarchies. The species is an aggressive competitor for food as well as territory; is easy to catch; readily takes baits, and is also attracted to divers (and thus easy to spear). The protogynous hermaphroditism - i.e. sex change - in this species may also increase population vulnerability, and heavily fished populations may suffer imbalances in population structure. Intense fishing, by removing the large males and large females, can affect reproductive success and reduce the number of small Blue-throated Wrasse entering the population (Shepherd, 2003). For example, S. Shepherd (2003, also in Shepherd and Brook, in prep.), who monitored the abundance of the Blue-throated Wrasse at Cape Jervis in South Australia over a 22 year period to 2003, reported

that, due to intense coastal fishing in the area, wrasse abundance declined over the survey period, and mean size also declined steeply. After an access road was made in 1989, male Blue-throated Wrasses were not seen at all in the area. Shepherd (2003) considered that shore fishers can severely affect populations of these wrasses by fishing the males (which preferentially take the bait), ultimately causing a decline in wrasse numbers. The studies by S. Shepherd have shown that mean size of Blue-throated Wrasse, and the female to male sex ratio at a site, together provides a reliable index of intensity of nearshore rock fishing, and can be used to measure long-term and spatial changes in wrasse populations due to fishing. Large females and males are more vulnerable to line fishing gear than small ones. Due to fishing, mean size of females can decrease, and female to male sex ratio can increase. Studies in both Tasmania and S.A. have shown that mean size of Blue-throated Wrasse is larger in areas of low or no fishing pressure (including protected areas), and mean size is low in areas of moderate to high fishing pressure, such as nearshore reefs close to large population centres, or those which are visited by many tourists (Shepherd, 2006; Shepherd and Brook, in press; Barrett et al., in prep.). According to Shepherd, moderate fishing pressure alone is enough to virtually eliminate males from populations and prevent reproductive success. The potential vulnerability of Blue-throated Wrasse to over-exploitation is now recognised by marine management in S.A., with the Marine Scalefish Fishery Management Committee (2003) classing wrasses (of which Blue-throated is the main targeted species) as being at high risk of localised depletion. It is probable that populations of some other wrasse species have also declined in nearshore waters of some parts of S.A., due to line fishing (commercial and recreational) and spearfishing impacts. In the past, wrasse species have been taken in spear-fishing competitions in S.A. (see Johnson, 1985a and 1985b). In some areas, habitat degradation within the nearshore part of the range may also be a potential threat to Blue-throated Wrasse, which is strongly site-associated with macroalgae-covered reefs (see below, on **Awareness and Assessment of the Impacts of Climate Change**). 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, including effects upon the abundance of crabs, abalone and probably many other species in a community (Shepherd, 2003).

Harlequin Fish: This potentially vulnerable species is in the Serranidae family, whose members are characteristically large, slow moving, benthic, reef-associated fish that reproduce as protogynous hermaphrodites[2], and maintain specific population structures. Harlequin Fish is likely much less abundant in S.A. than in W.A.. Within the AMLRNRM region and surrounds, it is found (usually alone) on various reefs in the lower GSV region, north-eastern Kangaroo I., and Encounter Bay, to at least 30m deep. It lives on moderately to submaximally exposed rocky reefs, particularly near “drop-offs”, over reef “lumps”; also in caves and under ledges (Shepherd and Baker, in press, and references therein). There is concern that abundance may have declined over time in areas where water quality is reduced, and reefs are degraded. Harlequin Fish is caught recreationally and (to a lesser extent) commercially across its range by a number of methods (see Baker, 2007 for summary), with few controls on the capture, particularly in S.A., and no investigation of the potential impacts of fishing has been undertaken. There is a paucity of information about population sizes, biology, and population dynamics of this species in South Australia.

Rock Ling: A very large (to 120cm and 7kg), possibly long-lived, site-associated reef fish that is highly esteemed as food, has a low resilience to exploitation, and is vulnerable to over-exploitation by both commercial and recreational fishers. Rock Ling is an uncommon species in S.A., and most known records in this State GSV and Spencer Gulf. Examples of locations within the AMLRNRM region and surrounds where the species has been recorded include northern metropolitan GSV (e.g. West Lakes), central and southern metropolitan GSV (e.g. Port Noarlunga and Aldinga), including recent records from the 2000s; Fleurieu Peninsula (e.g. Rapid Bay, one of the areas where the species is taken by anglers); western GSV (e.g.

[2] Protogynous hermaphrodites first mature as females and, after spawning one or more times, they will then change sex, spawning thereafter as males (Heemstra and Randall, 1999).

Ardrossan); and the "heel" of Yorke Peninsula (Edithburgh area) (Branden et al., 1994; MLSSA, 1999; K. Smith, unpubl. data, 2000, 2004; K. Smith, pers. comm., 2005; D. Muirhead, MLSSA, pers. comm., 2005; Australian Museum record, 1978; Museum of Victoria records, 2005; S.A. Museum records, cited by T. Bertozzi, SAM, pers. comm., 2005; OZCAM database, 2006. all cited in Baker, 2007). The species is taken by spear, hook and line, nets and other recreational fishing gear, and Rock Ling is reported to have been virtually eliminated from some areas of southern Australia by recreational fishing, including netting and spear-fishing. Both juveniles in estuaries and nearshore seagrass beds, and adults in shallower reefs within easy netting and spear-fishing range (e.g. 5m – 20+m) are highly susceptible to capture. Rock Ling was one of the species taken in recreational spear fishing competitions in S.A. during the 1980s (Johnson, 1985a, 1985b) and more recently, Rock Ling was listed as one of the targets in the 54th Australian Spearfishing Titles 2006, held on northern Kangaroo I. (Australian Underwater Federation Inc., 2006, cited in Baker, 2007). Although the numbers taken by anglers in S.A. may be low (e.g. possibly in the order of 160 per annum, according to Henry and Lyle, 2003), the species is uncommon, and there are no controls over numbers taken. Rock Ling is also a minor, untargeted, commercial species in S.A., but species-specific catch and effort data are inadequate (e.g. aggregated with Pink Ling, a deep water species, or un-coded in catch returns), and there are few controls over the commercial fishing of this species. Very minor catches are also taken in prawn trawls, blue crab pots, and rock lobster pots (see Baker, 2007 for summary data).

Boarfishes: These are demersal, site-associated species that have a strong social structure (i.e. males and females are reported to form life-long pairs, and seasonal aggregations may also occur); they reach a large maximum size, and they may be slow growing and relatively long lived (i.e. more than 11 years), characteristics that increase the vulnerability of fished boarfish populations to decline. A number of studies have indicated that *Paristiopterus* species have low resilience to fishing and/or may be at high risk of population impacts from fishing (see Baker, 2007, and reference therein). Boarfish species that occur within the AMLRNRM and surrounds include:

- Brown-spotted Boarfish: the central South Australian coast is the edge of the geographic range, and within the AMLRNRM region and surrounds, examples of locations where the species has been recorded include metropolitan waters (e.g. artificial reefs and shipwrecks off Glenelg, and Seacliff Reef); southern Fleurieu Peninsula (e.g. Wirrina Reef, and Cape Jervis); Kangaroo Island, and Investigator Strait (AAA record, 1993; MLSSA, 1999; MLSSA dive records, undated; K. Smith, unpublished data, 2001; J. Brook, unpublished data, 2005; Australian Museum records; Museum of Victoria records, cited in Baker, 2007);
- Short Boarfish: infrequently seen on coastal reefs in S.A., and very little is known of its distribution and relative abundance across the geographic range. There is also little knowledge of its habitat preferences, and basic biology. Examples of locations within the AMLRNRM region and surrounds where Short Boarfish has been recorded include the metropolitan coast (e.g. Seacliff Reef); southern Fleurieu Peninsula (e.g. Rapid Bay Jetty, and Second Valley); deeper waters east of Kangaroo Island and south of the Pages Islands; south-western Gulf St Vincent / "heel" of Yorke Peninsula area, including the Port Giles Jetty and other locations (A. Brown, unpubl. data and photograph, 1983; Muirhead, 1998a; AAA record, 1998; K. Smith, unpubl. data, 2003, 2004; Museum of Victoria records, and South Australian Museum record, cited in Baker, 2007); and
- Long-snouted Boarfish (the most common species in upper and mid continental shelf waters, commonly seen along the metropolitan coast of GSV and Fleurieu Peninsula, and Kangaroo Island (see Baker, 2007, and sighting data therein).

Although commercial trawls and gillnets in Commonwealth-managed waters may be the major source of mortality for boarfishes (see fishing summary in Baker, 2007), they are also taken in lower numbers by commercial fishers in S.A. waters, and by anglers and spear fishers. For example, Long-snouted boarfish is particularly vulnerable to capture by spear fishing, netting and angling in the shallow part of its range, due to its reef association, slow movements, relatively large size, and territorial nature. There are few controls over capture in commercial and recreational fisheries, and very little information on the numbers taken (Baker, 2007). No studies have been undertaken to determine the potential impacts of fishing on boarfish populations in S.A.. Boarfishes are bottom feeders, and have a strong habitat association; therefore, habitat damage in continental shelf waters due to processes such as trawling,

dredging, nutrient pollution and sedimentation (in shallower parts of the range), may have a consequent negative impact on boarfish populations; however no specific studies have been undertaken.

Banded Sweep: This species appears to be less common in S.A. than the closely related Sea Sweep *Scorpis aequipinnis*, and is usually recorded in low numbers. It is strongly associated with nearshore habitats such as natural and artificial reefs, hence populations are vulnerable to capture, and may also be susceptible to indirect impacts (e.g. through site-specific habitat damage). The species is curious and will often approach divers, which may result in some populations being vulnerable to disturbance. Banded Sweep is caught in a variety of fisheries in S.A. (commercial hand-line fishing, commercial gillnets, lobster pots, recreational line fishing, spear fishing), and no assessments have been undertaken to determine the sustainability of fishing this species, which is hindered by the aggregation of catch statistics for Banded Sweep with Sea Sweep. It is noted that a downward trend in the commercial catch of the two Sweep species (combined) in S.A. has occurred during the past decade at least, and the extent to which this relates to changes in the fishery, compared with changes in the population abundance of Banded Sweep, is not known. The National Recreational and Indigenous Fishing Survey (Henry and Lyle, 2003; Jones and Doonan, 2005) reported that the combined catch of Sea Sweep and Banded Sweep in S.A. was 57,864 individuals (SE = 16,430), approximately 28% of the national total. The proportion of the Sweep catch that comprised Banded Sweep is not known, because Sweep were not separated by species. About 52% of the Sweep catch in S.A. is released (McLeay et al., 2002, citing Henry and Lyle, 2003). For an adequate assessment of the conservation status to be undertaken, further collection and examination of species-specific commercial and recreational data would be required, coupled with more data about the relative abundance of this species in various of S.A. (Baker, 2007).

Western Blue Devil: The cryptic habits of the species makes its conservation status difficult to assess, but there are many characteristics that increase its vulnerability to decline. The species is solitary (or forms pair bonds), territorial, slow-moving, inquisitive, strongly site-associated with reefs and caves in shallow nearshore waters, and has site-specific reproduction. These characteristics can make populations vulnerable to localised impacts. The species is taken as a food fish, by recreational anglers and spear-fishers across its range, including the AMLRNRM region (see Baker, 2007, for examples), with no controls over capture. Western Blue Devils are sought after for the specialist aquarium trade, and sustainability assessments have not been undertaken (in W.A., where the species is taken under permit), nor has there been investigation to determine whether an illegal trade exists in parts of southern Australia, including S.A. Despite its widespread distribution, from W.A. to Victoria, there is little information available on the biology or population dynamics, and little knowledge of population sizes / relative abundance. In South Australia, the species was first recommended for formal protection in 1967 (by Dr S. Shepherd), and in 1980 a complete ban on fishing this species was recommended (Ottaway et al., 1980, cited by Baker, 2004 and 2007).

Black-banded Sea Perch: Like Harlequin Fish, the Black-banded Seaperch is site-associated with shallow subtidal reefs over a relatively narrow depth range. It is also a member of the Serranidae, a family of fish whose life history characteristics and habits (see above, for *Othos dentex*) make populations highly vulnerable to capture by a number of fishing methods (and consequent over-exploitation), and susceptible to other site-specific impacts. Examples of natural and artificial reefs within the AMLRNRM region and surrounds where the species has been recorded included north-eastern Kangaroo I.; Investigator Strait; south-western GSV; Fleurieu Peninsula (e.g. Cape Jervis, and Rapid Bay), and eastern GSV (e.g. Aldinga, Port Noarlunga Reef, Lumb Wreck; Seacliff Reef; Glenelg Barge and Dredge, Grange Tyre Reef) (Branden et al., 1994; MLSSA, 1999; Anonymous, 2001; K. Smith, unpubl. data, 2001 - 2006; Edgar et al., 2006; S.A. Museum records, Museum of Victoria record, cited by Baker, 2007). Black-banded Sea Perch is fished, but there are no species-specific catch statistics (Baker, 2007), and no assessments have been undertaken on the effects of fishing on Black-banded Seaperch populations. There are no data on the relative abundance or population dynamics of this species across the range, including AMLRNRM region.

Knifejaw: A widely fished, increasingly popular food fish that is associated with reefs, mainly in deeper waters of the outer shelf. The species is possibly *Near Threatened* in S.A. and adjacent

Commonwealth waters. It is of relevance here because Investigator strait and Backstairs Passage (adjacent to the AMLRNRM region) are part of its distribution in S.A., even though the species may be more abundant (and is more heavily fished) in the GAB. Knifejaw has been classified as being at risk to population impacts from trawl fishing, long-line fishing, and gillnet fishing. Anglers also take this species, and there are inadequate regulations over the numbers taken in both commercial and recreational fisheries. Very little is known of the biology or population dynamics of Knifejaw. Despite the increased fishing mortality during the past decade, no assessments have been undertaken to determine the size of Knifejaw populations, or the sustainability of fishing them in the current quantities in South Australia (see Baker, 2007, and references therein, for details).

Southern Blue Morwong: This southern Australian species is broadly distributed in S.A., mainly on reefs in wave-exposed and moderately wave-exposed regions. Examples of locations within the AMLRNRM region and surrounds where the species occurs include southern Yorke Peninsula and Investigator Strait; north-western and northern Kangaroo Island (where the species is reported to be reasonably common – see Muirhead, 1998b); north-eastern Kangaroo I. (Dudley Peninsula) and Backstairs Passage; GSV (including metropolitan waters) and the southern Fleurieu (e.g. Rapid Head, Rapid Bay), and the Encounter Bay area. This species is site-associated, large (to 1m, though that is uncommon), relatively long-lived (to more than 20 years, according to Murdoch University, 2006), possibly slow growing, and has a low resilience to exploitation. In S.A., the species is taken mainly in Commonwealth-managed waters (e.g. GAB Trawl Fishery). In State-managed water, commercial fishers do not normally take the species in the AMLRNRM region, but it is caught in low number in other parts of the State (Baker, 2007). The recreational catch may have been in the order of 3,200 specimens during a survey period in 2000-01 (recorded as “Southern Blue Morwong” and “Queen Snapper”) (Henry and Lyle, 2003). .

Mixed Habitat Fish Species – Commercially and/or Recreationally Significant

Note: The wide-ranging pelagic species Southern Bluefin Tuna is not discussed here, because the AMLRNRM region is an insignificant part of the distribution and fisheries for this species. However, the threatened nature of Southern Bluefin Tuna across southern Australia is noted (see Baker, 2007 for summary).

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. In recent years, there has been concern amongst both scientists and fishers about a decrease in the King George Whiting (KGW) population as a whole, and also regional decreases in abundance. Generally, KGW is classified as over-fished in South Australia (Noell et al., 2005); more specifically, over-fished in Spencer Gulf and Gulf St Vincent (GSV) (MSFMC, 2003). During the past decade, there has been a substantial drop in the commercial catch and effort (McGarvey et al., 2003, 2005), 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, 2003, 2005) 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. Recreational fishers take more than half of the total catch in S.A. (McGarvey et al., 2003; Henry and Lyle, 2003; Jones and Doonan, 2005). Within the AMLRNRM region and surrounds, larger, older fish are found in the deeper, more exposed gulf waters, and deeper waters of northern Kangaroo I. New recruits are found in shallow, upper gulf waters, and there are various nurseries for whiting in these areas, with Barker Inlet being of particularly note in GSV (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 / upper gulf waters. Smaller King George Whiting are also caught in the bycatch from prawn trawling. In addition to the heavy fishing pressure on the new recruits, both commercial and recreational fishers (the latter also including charter boats) 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, northern Kangaroo I., and Tapley Shoal (see Fowler and McGarvey, 1997; McGarvey et al., 2000, 2003). The larger, older King George Whiting may be important 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 KGW 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, stocks continue to decline in S.A., and recent stock assessment reports (McGarvey et al., 2003, 2005) indicated that data (particularly recreational data) are still inadequate for a reliable stock assessment.

Pink Snapper: Since the 1990s, this species has been 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 S.A., and the species has high regional importance within the AMLRNRM. State-wide catches during the early 2000s have fluctuated significantly e.g. 647.6t in 2001/02, the highest catch ever recorded, and 413t in 2003/04 (Fowler et al., 2003,2005). There are concerns about the decline of snapper populations in both gulfs (Anonymous, 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 (Anonymous, 2000), the fishery for Snapper in southern GSV 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 GSV showed signs of “slow recovery” during the early 2000s (Fowler et al., 2003), but it is thought that only one strong year class (1991) is sustaining the fishery in that area, and that the snapper biomass is again declining (Fowler et al., 2005). 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. There is some evidence from tagging to show that adult Snapper return to “home reefs” annually to spawn (Fowler et al., 2003), and thus would be particularly vulnerable to capture at that time. Additionally, age structure studies in snapper indicate the presence of strong and weak year classes, reflecting high inter-annual variation in recruitment during the past two to three decades (McGlennon and Jones, 1997; McGlennon et al., 2000; Fowler et al., 2003). In other words, 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 (Anonymous, 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 (during one year of which the highest ever catch was recorded, despite the closure), and the use of minimum size limits, and bag limits and boat limits for the recreational fishery. 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 (Baker, 2004, and references therein).

Mulloway: Although the species is widely distributed throughout southern Australia, the S.A. population of Mulloway is currently considered to be a distinct, self-recruiting population, with recruitment likely dependent upon local spawning within S.A. (Ferguson and Ward, 2003, cited by Sloane, 2005). Mulloway are large (to ~ 1.8m), fast-growing, relatively long-lived (~30–35 years), and mature at about age 5 (Hall, 1986; Ferguson and Ward, 2003). The life history strategy of mulloway is thought to involve an early phase of rapid growth and delayed maturity, followed by prolonged longevity to ensure sufficient egg production over time (Ferguson and Ward, 2003, cited by Sloane, 2005). Mulloway is an ocean spawner, but requires *regular, freshwater outflow from rivers/estuaries for successful spawning and recruitment,* and therefore is an "estuarine dependent" species. Juvenile mulloway utilise the waters of estuaries (e.g. the Coorong) as a nursery habitat for at least five years, and then likely migrate out of the estuary and into marine waters. Mulloway have been recorded from a number of areas in the AMLRNRM region, including Encounter Bay and marine and estuarine waters in eastern GSV (see Baker, 2007 for examples). The spawning behaviour and locations used by mulloway in South Australia are uncertain, as is the proportion of the total population that use the Coorong estuary as juvenile habitat (Ferguson and Ward, 2003, cited by Sloane, 2005). Adult mulloway aggregate around the Murray Mouth (Hall, 1986; Ferguson and Ward, 2003), but the exact relation of this aggregation to the reproductive strategy is not clear (Sloane, 2005). In the Murray Mouth area, population levels of Mulloway are considered to be now reduced, principally due to altered and diminished flow regime due to barrages (and the consequent effects upon Mulloway population dynamics, and reduction in nursery habitat), modified estuarine habitat, and over-fishing (both commercial and recreational). The commercial fishery for Mulloway in the Murray Mouth area depends upon the timing and magnitude of freshwater flows, and there is a strong positive correlation between flows and catches (Ferguson and Ward, 2003). The total State-wide commercial catch of mulloway (Lakes and Coorong fishery, Marine Scalefish Fishery and Commonwealth-managed Southern Shark Fishery) was about 150t in 2000/01 and 117t in 2001-02 (Sloane, 2005). More than 90% of the total commercial catch is taken by Lakes and Coorong fishers, with about 4% taken in the Marine Scalefish Fishery. There are catch limits for taking mulloway in the Marine Scalefish Fishery and Southern Shark Fishery. There are upper and lower biological reference points and commercial catch limit reference points used in the management of fisheries for Mulloway in SA (Sloane, 2005). Mulloway is one of the most sought after species by recreational / sports fishers across S.A., particularly off ocean beaches. In 2000/01, about 90.2 tonnes were taken (i.e. approx. 27,004 fish ± 5,156) (Henry and Lyle, 2003). Across Australia, 46% of all Mulloway caught by recreational fishers are discarded, hence the total mortality associated with recreational fishing may be higher than that reports (Sloane, 2005). At the Sir Richard and Younghusband Peninsulas, the species is heavily targeted during spring and summer when mulloway aggregate around the Mouth of the Murray. Smaller mulloway are targeted in the Coorong estuarine lagoons all year round. At present, there are separate size limits, bag limits and possession limits for Mulloway taken inside estuarine waters, compared with those outside estuarine waters on the ocean beaches. This management strategy aims to provide greater protection for the adult breeding stock in coastal waters, which has long been vulnerable to commercial and recreational fishing pressure (Hall, 1986), and continues to be (Sloane, 2005). Recreational catches (including catches over the bag limit) appear not to be adequately monitored in South Australia. For this species, there is unpublished evidence of recreational catches above the bag limit in some parts of South Australia. A number of submission received by the S.A. Department of Fisheries during the early 1990s (Rohan et al., 1991) requested additional protection measures for Mulloway due to heavy fishing pressure, and adverse changes in critical habitat for Mulloway. Recreational fishing regulations (e.g. bag limits) for this species were changed in 2001, in response to concerns about stock abundance.
Mulloway are also taken by spear fishers, and specimens over 75cm and 2kg) were listed as target species in the 54th Australian Spearfishing Titles 2006, held on northern Kangaroo I. (Australian Underwater Federation Inc., 2006).

Southern Sea Garfish: A significant species for commercial fishers in S.A., including the gulfs region (~ 300 – 400 tonnes per annum total State catch), and also for recreational fisher. In

recent years, one estimated annual recreational catch was about 552,683 (+ 93,951 released) from northern GSV, and 165, 592 (+ 9,603 released) from southern GSV and Fleurieu Peninsula, according to a survey in 2000/01 (Henry and Lyle, 2003; Jones and Doonan, 2005). In S.A., the species is classified either as over-fished (Noell et al., 2005) or fully fished (DEHAA and EPA, 1998; Ye, 1999; MSFMC, 2003), according to available biological performance indicators (BPIs) (e.g. Ye, 1999; Ye, cited by Anonymous 2001b; Jones et al., 2002, cited by Baker, 2006a). Garfish is a schooling species, particularly over shallow seagrass beds, and is therefore readily captured by line fishing and netting methods. 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 Anonymous, 2001c; and see also Jones et al., 2002 for the most recent *publicly available* assessment of the stocks and the fishery).

Yellowfin Whiting: This species is more abundant in the warmer waters of the upper gulfs, than any other part of South Australia. Following stock assessment of this species, cautious management of the fishery was advised (Ferguson, 1999 and 2000), based on the following factors: (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 GSV, 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 increased in most years throughout the 1990s and early 2000s (compared with yields from the 1980s) (e.g. Knight et al., 2005). It is also noted that targeted effort on this species by commercial netters has increased by about 100% during recent years, in response to netting bans in some areas where King George whiting were previously netted, and the consequent shift towards targeting Yellowfin Whiting rather than King George whiting (McGarvey et al., 2003, cited by Baker, 2004).

Silver Trevally: This is a common and widely distributed species in southern Australia, but is of conservation concern due to its large size (to more than 90cm), relatively long life span (in excess of 20 year, according to Rowling and Raines, 2000), aggregative nature (which increases its vulnerability to capture in trawls, for example), and high popularity as a food fish (with consequent heavy levels of commercial and recreational fishing across the range. The major commercial catch in the vicinity of S.A. is from the Commonwealth-managed South East Trawl Fishery, in which the species may be over-fished. Minor tonnages are taken in the GAB Trawl Fishery. In S.A. State-managed waters, less than 10t per annum were taken during the late 1990s, and annual catches during the early 2000s ranged from a high of 22t (in 2000/01) to a low of 4t (in 2002/03 and 2003/04) (Knight et al., 2005). An estimated 27,743 specimens were taken in S.A. by recreational fishers during the period May 2000 to April 2001) (Henry and Lyle, 2003).

Dusky Morwong: This fish species is vulnerable to over-exploitation, particularly by spear fishers and line fishers, due to the strong habitat associations of adults and juvenile morwong; the large size (to 1m in areas where fishing pressures are low), and the ease of capture of all age classes, 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. Adults often occur in seagrass beds or sand near seagrass, or around rocky outcrops, to around 30m. Large fish are not often seen in nearshore areas, in populated parts of S.A., due to fishing pressures. There is anecdotal evidence from spear fishers of visible declines in dusky morwong ("strongies") in a number of near-shore reef areas of SA, particularly in southern GSV / Fleurieu Peninsula (see Baker, 2007 for summary). There are no recreational bag limits or boat limits or minimum sizes for Dusky Morwong in South Australia. Dusky Morwong was first recommended for formal protection against spearfishing by S.A. Shepherd in 1967, and again in 1980 (Ottaway et al., 1980, cited by Baker, 2004, 2007).

Luderick: This south-eastern Australian species is less common in S.A. (which is the western edge of the species range), and recent nearshore reef fish surveys over central and western S.A. coast have found few individuals, mainly on northern and eastern Kangaroo I. (e.g. Shepherd and Baker, in press, for surveys in GSV and KI region). Luderick is intensively fished in some areas of southern Australia, due to its accessibility and ease of capture in shallow waters, and reputation as a prized food fish. Therefore, it is taken by both commercial and recreational fishers wherever it is found in South Australia. Vulnerable population characteristics include the following (from Baker, 2007):

- The narrow depth range (0m to ~ 20m);
- the reliance of juveniles upon estuaries, tidal rivers and lakes, tidal pools, and mangroves, and reliance of adults upon rocky foreshores and subtidal reefs, seagrass beds, and other inshore habitats (Pollock, 1981; Kuiter, 1996a; Edgar, 2000, and S.A. fishing reports, cited by Baker, 2007). These habitat associations make populations vulnerable to impacts from nearshore habitat degradation and decline in estuarine water quality and quantity. Although estuaries are important nursery areas, the significance of estuaries in S.A. in the life cycle of local Luderick populations is not known;
- the slow growing, site-associated nature of Luderick, and its periodic aggregation in shallow waters, all of which increases its vulnerability to over-exploitation by fishers;
- the lack of fishing restrictions on this species in S.A., despite virtually no information about populations sizes / abundance in this State; and
- the probably low survival rare of juveniles that are caught and released.

Flatheads: A considerable number (at least 10) of flathead species occur in S.A., mainly in sand and seagrass habits, though some occur on reefs (see Baker, 2007 for summary). Most of the flathead species in S.A. are relatively common. Several are of conservation concern in Commonwealth-managed waters, where they are significant commercial species. The commercial catch in State waters is about 2t per annum, consistent since the late 1999s (Knight et al., 2005). Some species are also part of the trawl bycatch in all regions of S.A., which, in GSV, is not well quantified (see **Priority Actions**). Perhaps of greater relevance within the AMLRNRM region is the recreational fishing of flatheads, which are a popular recreational fishing target in S.A.; an estimated 75,566 specimens were caught in S.A. during 2000/01 001 (Henry and Lyle, 2003). Recreational flathead catches are managed using minimum sizes, bag limits and boat limits (PIRSA, 2006). Flatheads may be vulnerable to over-exploitation due to their benthic habitat, and ease of capture, and some are reported to have a low resilience to exploitation (Froese and Pauly, 2007).

Leatherjackets: This group of fishes is very well represented in S.A., which is the edge of the geographic range for a several eastern species and western species (see Baker, 2007). A number of leatherjacket species are strongly site-associated with reefs, and others school in seagrass beds. Leatherjackets reproduce at localised scales and lay demersal eggs, life history characteristics that increase their vulnerability to site-specific impacts. These fishes are popular recreational targets, with at least 155,000 taken per year in S.A. (according to a survey in 2000/01: Henry and Lyle, 2003; Jones and Doonan 2005), many of these from Fleurieu Peninsula (about 60,000 per annum: Jones and Doonan, 2005). Commercially, in the S.A. Marine Scalefish Fishery, about 20-40 tonnes per year are taken, excluding Ocean Leatherjacket, for which there is a separate fishery. Leatherjackets are one of the most significant components of the bycatch in S.A. prawn trawl fisheries, particularly species which school in large numbers over seagrass beds and/or patch reefs and sand, such as Bridled Leatherjacket *Acanthaluteres spilomelanurus*, Rough Leatherjacket *Scobinichthys granulatus*, Degen's Leatherjacket *Thamnaconus degeni*, Toothbrush Leatherjacket *Acanthaluteres vittiger* and Mosaic Leatherjacket *Eubalichthys mosaicus* (Carrick, 1997; Svane and Saunders, 2004; Dixon et al., 2005; Broadhurst et al., 1999, 2000, all cited in Baker, 2007). Species-specific catch statistics for leatherjackets are rarely collected in commercial or recreational fisheries, and data are not analysed over space or time. There are no commercial or recreational fishing regulations for the capture of leatherjackets in S.A., despite the apparent differences in the relative abundance of species, with some being quite uncommon in S.A., and occurring over a small depth range (see Baker, 2007 for summary). It is notable that, during visual surveys of more than 130 nearshore reef sites across South Australia, Six-spined Leatherjacket was uncommonly recorded, compared with more abundant species such as Horseshoe

Leatherjacket. Recorded abundances of Six-spined were higher in the aquatic reserves at Port Noarlunga (in particular) and Aldinga, than at any other site surveyed in S.A. (Shepherd et al., in prep.). Very little is known of the biology, ecology, population sizes / relative abundance, and population dynamics of almost all leatherjackets, both common and uncommon species, and including almost all of those in the AMLRNRM region.

Gurnard Perches and Scorpionfishes: Eight species in this group of related fishes are found in the AMLRNRM region and surrounds (**Appendix**). Some live on coastal reefs (particularly macroalgae-covered reefs, and "broken bottom" / mixed reef patches near sand); others have also been recorded in habitats such as estuaries, shallow subtidal seagrass beds, rubble habitats, sponge beds and near artificial structures (jetties, wrecks, etc) (see Baker, 2007 for examples). All of the gurnard perches and scorpionfishes are benthic, site-associated reef fish of limited mobility, and these characteristics increase the species' vulnerability to site-specific impacts. For example, the Southern Red Scorpionfish (particularly juveniles) utilises kelp beds, shallow seagrass beds, and estuaries, and thus processes that damage such nearshore habitats may adversely affect populations. Given the strong site association and limited dispersal ability of gurnard perches, dredging and other physical damage to shallow, soft bottom habitats may adversely affect populations at localised scales, but there are no specific data. Some of the gurnard perches (e.g. Little Gurnard Perch) have a narrow depth range in upper continental shelf waters, and for others (e.g. Gulf Gurnard Perch, Bighead Gurnard Perch, Common Gurnard Perch), S.A. is at the edge of the geographic range. A number of species (e.g. Little Gurnard Perch, Gulf Gurnard Perch and possibly Southern Gurnard Perch) are a common bycatch in prawn trawls in S.A., including part GSV (see Baker, 2007 for available data). At least one (Bighead Gurnard Perch) is a significant bycatch species in rock lobster fisheries in S.A. (e.g. Brock et al., 2004). A number of species (e.g. Common Gurnard Perch, Thetis Fish, Southern Red Scorpionfish) are also caught in seemingly large, unregulated numbers as bycatch in some of the Commonwealth-managed fisheries (see Baker, 2007, and references therein), despite little information on population sizes and the sustainability of fishing them. Overall, there are few regulations to try to minimise bycatch of benthic, site-associated fish species such as gurnard perches. A number of gurnard perches are also taken by some recreational anglers and spear fishers, with no species-specific data collected, and no regulations over catch. For most of the gurnard perches and their relatives in S.A., there is there is little knowledge of distribution and abundance within the range, no data on population sizes or population dynamics, and, apart from dietary studies, little information on the biology (particularly fecundity, annual recruitment strength, and longevity).

Sharks

Bronze Whaler and Black Whale / Dusky Shark: These whaler sharks are of conservation concern globally (IUCN, 2006); in Australia (Pogonoski et al., 2002); in South Australia (Baker, 2007), and in the AMLRNRM region. Vulnerable characteristics include the relatively long life span (more than 30 years for Bronze; and 40 – 50+ years for Black / Dusky); very late age at maturity (up to 20 years for female Bronze, and up to 22 or 23 for Black / Dusky of both sexes); the long gestation period (15 – 21 months, with a biennial cycle for Bronze, and 24 months with a 3 year cycle for Black); and small litter sizes (7-24 for Bronze, and 3-14, mostly 8-10, for Black) (Walter and Ebert, 1991; Natanson et al., 1995; Simpfendorfer et al., 2002, cited by Baker et al., in press). Other characteristics that increase the vulnerability of these sharks include their edibility (e.g. "fish and chips" species); their aggregative nature; and periodic presence in shallow water (shallow bays, surf zones, harbour channels, or even estuaries) during summer (Cappo, 1992; Last and Stevens 1994, cited by Baker et al., in press).

Black Whalers can migrate long distances (Pogonoski et al. 2002), but Bronze Whalers are not known to, except in South Africa. In S.A., tagged adult Bronze Whalers have been re-sighted at their tagging location after a year at liberty, suggesting this species is philopatric, like other sharks in the family (see Cavanagh et al., 2003). Bronze Whalers breed in S.A. waters (Cappo 1992), but Black Whalers appear to breed in northern W.A. during winter, and migrate southwards, giving birth to young in south-western W.A. during autumn and winter (see Pogonoski et al. 2002); their juveniles are seldom recorded in South Australia. Whaler sharks, including pregnant and birthing female Bronze Whalers, move seasonally to northern

gulf waters, which are important nursery and feeding areas for their young (e.g. Cappo 1992). Fishers in S.A. mostly target juveniles. State-wide catches of whaler sharks (both species combined) ranged between approximately 80t and 100t per annum, during the late 1990s and early 2000s (SARDI data, cited in Baker, 2007). In the AMLRNRM region and surrounds, some of the main fishing areas for whalers are northern GSV (with catches also from deeper waters off the metropolitan coast), mid-western GSV (on Yorke Peninsula side); southern GSV, Investigator Strait and waters east of Backstairs Passage, while sports fishers target small whalers in the lower gulf and its entrances, and off jetties (Baker 2007; Baker et al., in press). There are S.A. fishing reports of whaler sharks that are caught accidentally being bludgeoned to death by recreational boat fishers.

School Shark: This species is recorded throughout S.A., with examples of relevance to the AMLRNRM region including: waters south of the Fleurieu Peninsula and west of the Dudley Peninsula; Investigator Strait; waters south of Encounter Bay and the southern Fleurieu, and the Murray Mouth. The Pages Islands may be a significant area for pregnant females and pups (AFMA, 2003). Other areas identified as being significant for pregnant female School Sharks and/or pups include Kangaroo Island and part of Investigator Strait (Point Marsden to Cape Coutts); south coast of Fleurieu Peninsula (Cape Jervis to Encounter Bay), and the Coorong area (Encounter Bay to Robe) (see AFMA, 2002, 2003, cited by Baker, 2007). The species is recommended for listing as *Vulnerable* in South Australia (and also nationally) for the following reasons: (i) School Shark has been heavily fished in southern Australia, particularly during the mid and latter part of the 20th century; the stock appears not to have recovered, as is the case in other parts of the world, where School Shark fisheries have a history of stock collapse; (ii) in southern Australia, School Shark is classified as over-fished or severely over-fished, and such status applies to both Commonwealth-managed and State-managed fisheries; (iii) in recent years, the estimated biomass of pups has fallen to the lowest recorded level since the beginning of the fishery in the early 20th century, and the biomass is predicted to continue declining, until such time as the School Shark stocks can be "rebuilt"; (iv) various direct and indirect measures during the past decades have shown the highly depleted nature of the stocks, at both small, localised scales and large, regional scales; (v) there are indications that the numerous management measures implemented in the southern Australian commercial fisheries for School Shark have not yet been effective in rebuilding the depleted populations; (vi) recent stock assessments indicate the School Shark populations in southern Australia will be slow to recover, and the depleted status of stocks will remain, possibly in the order of decades; (vii) the current mix of control measures over commercial catch and effort, and recreational catch, may be inadequate in terms of ensuring that the depleted School Shark population can recover; (viii) School Shark is an aggregating, migratory species, that is relatively long-lived and slow-growing, and has a delayed age at maturity and relatively low reproductive capacity; (ix) population members aggregate by age and sex, and capture of such aggregations – particularly schools of pregnant females, and schools of reproductively immature juveniles and sub-adults– can further compromise the depleted abundance and reproductive capacity of the population in southern Australia; (x) some experts believe that School Sharks return to their natal areas to breed, which has led to localised depletions in some heavily fished areas, and (xi) School Sharks have restricted and defined nursery areas in various coastal waters across south-eastern and southern Australia, and such areas of importance for pregnant females and pups, are inadequately protected from fishing, and from impacts on habitat.

White Shark: This large (to 7m), warm-bodied, cosmopolitan predator has been totally protected in Australian waters since the mid-1990s, and conservation efforts for it are well supported by fishers and the public. In the shallow gulf waters, white sharks commonly swim along the bottom for prolonged periods, possibly to feed on bottom-dwelling fish and rays (CSIRO, 2005, cited by Baker et al., in press). White sharks consume a wide variety of prey items, but feed infrequently, even when "patrolling" an area over days to weeks, where suitable prey are abundant (Klimley et al. 2001). Bony fish, small sharks, rays and cephalopods are found in the diet of small White Sharks < 2.5m. Although fish may remain part of the diet as the sharks grow, larger prey such as cetaceans, pinnipeds, sharks and rays are also consumed by large white sharks (Bruce et al., 2001, cited by Baker et al., in press). The closest major pinniped colony to GSV is the Pages Is, Backstairs Passage, where White Sharks are regularly seen. Other prey include dolphins, rays, Pink Snapper (now depleted), Southern Bluefin Tuna,

and Mulloway (also depleted). The number of incidental and formally undocumented deaths that occur in S.A. waters are largely confined in other regions of the State, not the AMLRNRM. Examples from other parts of S.A. include entanglement in fish grow-out cages, illegal killings, and bycatch of trawl (e.g. GAB), long-line, and purse-seine net fisheries. Survival is low for trawl-caught specimens (Commonwealth of Australia 2002). Vulnerable species characteristics include the large size, long life span (more than 30 years), late age at maturation (10 years for males, and up to 18 years for females), low fecundity (less than 10), long gestation (12 to 18 months, with a 2 to 3 year breeding cycle), and periodic temporary residency in some areas (between periods of migration) (Klimley and Ainley, 1996; Bruce et al., 2001).

Dogfishes: Two of the three southern Australian dogfishes or spurdogs are found in AMLRNRM region, the White-spotted Spurdog and the Piked Spurdog, and the depth range of both extends to outer continental shelf and slope waters. The former of these species is cosmopolitan, but Piked Spurdog may be an Australian endemic from a complex of similar species, rather than a single, very wide-ranging species that spans the Eastern Atlantic and Indo-West Pacific (Cavanagh et al., 2003). Both species are relatively long-lived and slow-growing, producing few pups ((Baker et al., in press, and references therein). Dogfishes are caught throughout S.A., including parts of the AMLRNRM. In this State, dogfish catches are not separated by species, but most refer to Spiny Dogfish. Catches are highly variable per annum, and dogfishes are not targeted in most years. Higher catches in S.A. were recorded during the early 1990s (e.g. 150t – 260t per annum in 3 of those years). Recent catch figures are not available due to confidentiality agreement between SARDI and fishers, but are likely to be low compared with the early 1990s. It is noted that 5 or less commercial fishers have caught dogfish during the past few years. Dogfish are also a bycatch of snapper fishing (Jones and Noell, 2005). Recreational catch data are not available, but are likely to be low.

Smooth Hammerhead: Examples within the AMLRNRM region and surrounds where this widely distributed shark has been recorded include northern metropolitan (e.g. Outer Harbour, and Largs Bay) and southern metropolitan waters (e.g. O'Sullivans Beach and Wirrina), north-western GSV, Encounter Bay and the Murray Mouth (S.A. museum records; ANSA, 1999; recreational fishing reports, 2002, cited by Baker, 2007). Little is known about population sizes, movements, or migration patterns of Smooth Hammerhead in South Australia, nor the full extent of its capture by commercial and recreational fishers and charter boats in State waters (compared with Commonwealth-managed waters, where larger numbers are taken – see Baker, 2007 for summary). Hammerheads caught commercially in S.A. are not listed by species, hence it is difficult to determine the commercial take, or any patterns in the catch and effort in this State. Hammerhead Sharks in S.A. seasonally aggregate during the "mulloway run" (see **Mulloway**), and their aggregative nature increases their vulnerability to capture. There is evidence from fishing records that pregnant and birthing females of this highly fecund species aggregate in warmer waters, such as northern Spencer Gulf. Juveniles normally occupy inshore demersal habitats, which also makes them also vulnerable to capture. Hammerheads, especially when seasonally aggregating, are known to be caught by recreational / game fishers in South Australia, with the main area of note in the vicinity of the AMLRNRM being the Murray Mouth. Recreational fishing regulations appear to be inadequate for capture of Smooth Hammerheads in South Australia.

Wobbegongs / Carpetsharks: These sharks are widely distributed in S.A., and 3 species (**Appendix**) occur in the AMLRNRM region (see Baker, 2007 for examples of locations). Wobbegongs are cryptically coloured and marked benthic species that inhabit rocky reefs and sandy bottom (Compagno, 2001). Ornate Wobbegongs have also been recorded in sponge beds, on artificial structures (and near jetties etc), and barren boulders (e.g. Carraro and Gladstone 2006). Wobbegongs may have short-term fidelity to a site, but are not permanent residents, as they move out of an area over time, and are replaced by other temporary residents (e.g. Carraro and Gladstone, 2006, cited by Baker et al., in press). Wobbegongs are vulnerable to exploitation due to their large size, slow movements, presence in shallow habitats, and, in some areas, their aggregative nature. Most evidence of aggregation comes from studies in N.S.W., but it is noted that divers in some parts of S.A. (e.g. southern Yorke Peninsula) have reported that wobbegongs sometimes aggregate in that area. Wobbegongs are taken by commercial fishers (about 1 - 2t per annum in State-managed waters), and as bycatch in lobster and prawn fisheries, and also by recreational fishers in the lower gulfs, with

no bag limits or size limits (Baker et al., in press; Baker, 2007, and references therein). There is some unconfirmed evidence of relatively high numbers of wobbegongs and other benthic sharks being taken by recreational fishers in the more accessible coastal waters in parts of South Australia. The recent National Recreational and Indigenous Fishing Survey (Henry and Lyle, 2003) reported that 252 Wobbegongs and Carpetsharks were caught and kept by recreational fishers in S.A. during the survey time period (May 2000 to April 2001), but that may be an underestimate, because the number of unidentified and unspecified sharks taken during that period was much higher (in the thousands).

Whiskery Shark: This is one of the shorter life-span sharks (10 – 15 years), which is also moderately fecund (4-29 pups, average 19) (Simpfendorfer et al., 2000; Cavanagh et al. , 2003)
a southern Australian endemic shark, and thus has a very limited range on a global scale. Due to its limited distribution, Whiskery Shark is considered in principle to be more at risk of population depletion than wide-ranging sharks, although the current levels of research and management of this species serve to reduce that risk in the foreseeable future. The species is caught commercially in south-western W.A. and across S.A. The status of the Whiskery Shark population in S.A. is not well known (compared with W.A.). Within the AMLRNRM region and surrounds, examples of locations where the species has been recorded include southern Yorke Peninsula; Investigator Strait; central Gulf St Vincent; north-western and western Kangaroo Island; and deeper waters south of Encounter Bay (SARDI data, 1996-1997; CSIRO Marine Research record; S.A. Museum records, cited in Baker, 2007).

Batoids (Rays / Stingrays, Skates, Stingarees

Approximate 10-15 species of rays, stingrays, skates and stingarees of conservation concern may occur in the AMLRNRM region (**Appendix**). Many of the batoids are slow-swimming bottom-dwellers, mostly in coastal waters, and are often found on (or just under) sand or mud in estuaries or nearshore waters; or seagrass beds; or coastal reefs. Some species breed in the intertidal fringe off beaches or in shallow bays. Reproductively, batoids may be *oviparous* (e.g. in skates, following mating, females lay eggs in oblong capsules which are deposited in sandy or muddy substrates), or *aplacental viviparous* (e.g. in Southern Eagle Ray, Shovelnose Ray, Southern Fiddler Ray, and the stingrays, foetuses feed on large yolk sacs, receiving added nourishment from the mother by indirect absorption of nutrient-rich uterine fluid, through specialised structures, before finally being born fully developed); and *viviparous* (Dulvy and Reynolds 1997, cited in Baker et al., in press).

Vulnerable population characteristics include the benthic nature and strong site association; limited geographic range and depth range of some species (e.g. several of the stingarees); relatively long life span of some species (e.g. more than 15 years for some stingaree species, and 20 years for some skates); onset of maturity at a relatively large body size (stingarees); small litters (e.g. average 4 in stingrays; 6 in eagle rays; 1-6 in some stingarees) (Last and Stevens, 1994; Trinnie, 2002, cited by Baker et al., in press; IUCN, 2007); the slow moving, approachable nature (and thus ease of capture using spear, for example) of large species that grow to 2+m wide (e.g. Southern Eagle Ray, Smooth Stingray, Black Stingray), and the high mortality of batoids when caught by nets and hooks.

During the past 18 years to 2004, the annual commercial catch of rays and skates in S.A. in the marine scalefish fishery has ranged between 38t and 71t (average 51t per annum over that period), with a declining trend during the early 2000s (Knight et al., 2002, 2005). Some species are also caught in the bycatch of prawn trawls. Species-specific data are not available for GSV, but examples of trawl bycatch from Spencer Gulf include Black Stingray, Southern Fiddler Ray, Dixon's Stingaree, Common Stingaree, White-spotted Skate, and Melbourne Skate (e.g. Carrick, 1997; Dixon et al., 2005, cited by Baker, 2007). Some rays and skates are also a bycatch of snapper fishing (Jones and Noell, 2005). Rays and skates are commonly caught by recreational fishers in S.A., with an estimated catch of approximately 14,400 during the fishing survey period May 2000 to April 2001, which was the largest catch from any State in Australia (Henry and Lyle, 2003). Within the AMLRNRM region, examples of locations where rays and skates are taken by recreational fisheries include the metropolitan area, Fleurieu

Peninsula and Cape Jervis. There are no commercial or recreational fishing regulations for rays and skates in South Australia.

Of greatest concern amongst the batoids may be the Coastal Stingaree, *Urolophus orarius* (listed as *Endangered* by IUCN), likely endemic to S.A., and with low reproductive output, and high susceptibility to impacts (Fowler et al. 2005; IUCN, 2007, cited by Baker et al., in press). Stingarees are usually badly damaged in trawls, and suffer very high mortality when returned to the water, and the endemic Coastal Stingaree also aborts its young when caught in a trawl (Fowler et al. 2005, cited by Baker et al., in press).

Of interest is the uncommon and distinctive, black-and-white "Magpie Fiddler Ray", which may be a colour variant of the Southern Fiddler Ray. It is treated as such by Reardon (in IUCN, 2007), but is listed as a distinct species by Australian Museum (2006), and by CSIRO (Yearsley et al., 2006). Only a few specimens of this ray have been recorded, from Kangaroo I. (Nepean Bay area) and from western and north-eastern GSV (Scott, 1954; Glover, 1979; Paxton et al., 1989; Last and Stevens, 1994; South Australian Museum, 2001; and S.A. Museum records, cited by Baker, 2007).

Elephant Fish

Elephant Fish is a small shark-like fish with a scaleless body, cartilaginous skeleton, and a flexible, hoe-shaped, proboscis-like snout. Elephant Fish are oviparous, seasonal breeders, with females moving to shallower habitats to lay a small number of leathery egg cases, which take about 10 months to hatch (Last and Stevens, 1994; Francis, 1997; Reardon, 2001). Female Elephant Fish are vulnerable to capture (particularly by recreational / sports fishers and charter boats) during the migratory period in spring and summer, when they enter shallow estuaries to deposit their eggs. Local examples of seasonal inshore habitats include American River in north-eastern KI, parts of GSV, and Encounter Bay (Baker, 2007, and references therein). Although there are no specific data from S.A., juveniles in New Zealand may remain in the shallow habitats for up to three years, which may make them vulnerable to capture (Francis 1997, cited by Reardon et al., in Cavanagh et al., 2003). Fishing of the spawning aggregations in shallow water, and fishing for juveniles in nursery habitats, as well as habitat degradation, are all threatening processes. This is a potentially vulnerable species (D. Didier-Dagit, pers. comm. 1999, cited by Baker, 2007) with a low population resilience, due to its low fecundity; "boom and bust" recruitment levels; capture during spawning period; poorly known population dynamics; and migratory behaviour. In S.A., Elephant Fish is caught commercially as a minor species in some areas, for example, the deeper waters between Kangaroo I. and the Coorong. Annual catches during the mid to late 1990s were in the order of 500kg – 1 tonne in some S.A. 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), but available examples of total catch per annum include: 1995/96 =1.6t; 1996/97 = 1.5t; 1997/98 = 477kg, but Elephant Fish was not a target species in any of those years (SARDI Aquatic Sciences data, 2003, cited in Baker, 2007). The species is also taken as by-product in the S.A. component of the Southern Shark Fishery (Walker et al., 2003), and is a minor bycatch in prawn trawls in S.A. (e.g. Carrick, 1997).. Despite the take of this species by commercial and recreational fishers, there are few biological or population dynamics data to assist sustainable fishing practices.

2. Priority Actions

***Fish Surveys*:** During the past several years, the benefit of undertaking fish surveys in coastal South Australian waters has been well demonstrated, with examples including (i) significantly increased knowledge of the distribution, abundance and populations dynamics of Western Blue Groper (e.g. Shepherd and Brook, 2003, 2004; Shepherd et al., 2002, 2005; Shepherd, 2006) and Blue-throated Wrasse (Shepherd and Brook, in press), to assist conservation of these species and better management of threatening processes; and (ii) the distribution and relative abundance of some of the more common reef fishes in the AMLRNRM region and other parts of GSV (Shepherd and Baker, in press). A number of the species listed in part 1 of this report are known from very few specimens, in most cases likely due to (i) deficiencies / inadequacy of targeted sampling (rather than irregular and opportunistic collecting of records), and (ii) the cryptic nature of many of these species, rather than true rarity (Baker, 2006b, 2007). Specific sampling methods in each habitat type (e.g. estuarine seagrass and mud; subtidal seagrass,

subtidal sand, intertidal and subtidal reefs), in both degraded and less impacted areas, are required to determine the presence (and relative population sizes) of some of the smaller, cryptic and perhaps rare species. For a number of groups, particularly the pipefishes, this is only now starting to occur (e.g. data by Smith and Browne, in Browne, 2004; Smith, 2005). Fish surveys are essential to better determine the geographical distribution and relative abundance (or rarity) over space and time of many of the species of conservation concern listed here. For many coastal fishes, further research is also needed on the depth range, habitat requirements, and biology and population dynamics. Such research is significantly impeded by a paucity of funding in South Australia. For example, most reef fish surveys undertaken in S.A. during the early 2000s, relied significantly on volunteer effort for field work, data processing, and publication (see references above). In the interim, even if distributions of the less common reef fishes are not known, and therefore impacts (e.g. through reef degradation) on their populations cannot be well determined, ongoing programs to restore reef quality are essential, as a precautionary measure (see below).

Habitat Impact Studies: A number of species listed above, exist over a narrow depth range (e.g. 1m – 20m). For almost all of these shallow subtidal species, it is not known to what extent potentially threatening processes may impact on populations in South Australia. For example, many of the nearshore reefs in metropolitan and southern GSV are degraded (e.g. Cheshire et al., 1998; Cheshire and Westphalen, 2000; Smith, 2000, cited by EPA S.A., 2003; Turner et al., 2007), but it is not known to what extent these changes in the composition and abundance of reef cover (such as decrease in large, canopy-forming brown macroalgae, and increase in cover of mussels in previously vegetated areas) affect these reef-dwelling species. Similarly, the impacts of land-based pollutants on seagrasses are well documented (e.g. Shepherd, 1970; Shepherd et al., 1989; EPA S.A., 1998), with a loss of several thousand hectares of seagrass in GSV (Hart, 1996,1997; EPA S.A.1998 and 2003; Westphalen et al., 2005), but the effects on fishes, other than a few of the major commercial species (e.g. Scott et al., 2000) are largely unknown. Sand dredging also has a number of significant habitat impacts (e.g. Fairhead et al., 2002a, 2002b; Cheshire et al., 2002), and likely also adversely affects fish assemblages on localised scales. In deeper waters of GSV, where is some indication (e.g. Tanner, 2005) that the substantial changes to benthic composition observed during the early 2000s, compared with the 1960s, may be due to trawling over that period, possibly coupled with increased turbidity from land-based sources (Tanner, 2005). Examples include almost complete loss of the *Heterozostera* seagrass beds in Investigator Strait, and loss of the hammer oyster and razorfish assemblage in the south-eastern GSV, and replacement of both of these habitats with bare sand (Tanner, 2005). The impacts of such habitat loss on fishes within the region has not been investigated.
Given the ongoing degradation of nearshore seagrass, reef and shelly-bottom habitats in GSV (which is likely to increase as the population of Adelaide region increases, and metropolitan areas continue to expand north and south), a number of the potentially vulnerable fish species discussed in this report should be included as indicator species, in long term, ongoing monitoring programs for these habitats. For example, Soldierfish may be a suitable indicator species in some areas where seagrass cover has declined, and attempts are made to restore the habitat over time. Results of habitat monitoring programs in GSV may be assisted over the long term by the inclusion of standardised surveys for some of the less common reef-dwelling and seagrass-dwelling fish species, to monitor trends in localised abundance, and recruitment. Such species should also be included in trawl impacts studies, along with sand-dwelling species (see below), so that some indication of population sizes, and specific impacts can be determined.

Long Term Habitat Protection and Restoration Programs: Legislation to formally protect threatened marine species (see **Increased Government Involvement in Marine Threatened Species Issues**) is ineffective unless long term habitat protection and restoration programs are not maintained. Such programs must be aligned with biogeographical, rather than administrative boundaries. For example, the marine environment of GSV need to be managed as a whole, due to the cross-jurisdictional nature of oceanographic process, resources (including fishes), commercial and recreational uses, and threatening processes. Therefore, NRM boards must work co-operatively rather than in isolation. Better management of GSV would require co-operative efforts between regional boards based on Yorke Peninsula, Kangaroo Island, and Adelaide and Mt Lofty Ranges. The issues associated with habitat

degradation in GSV are well documented, and will not be reiterated in detail here, other than to briefly summarise to issues, for estuarine and subtidal habitats, and stress the need for ongoing programs to assist in the better protection and restoration, of degraded habitats:

- *Estuaries:* During the past two decades, the numerous physical, chemical, biological, and combined impacts that have caused the degradation of many of S.A. estuaries, including those in the AMLRNRM region, have been highlighted in various reports. Of particular note is the Port River-Barker Inlet estuary (see Bucher and Saenger, 1989; Barnett, 2001; GeoScience Australia, 2001; and detailed summary of impacts in Baker, 2004), but other examples in the region include the Onkaparinga Estuary (e.g. GeoScience Australia, 2001; Bryars, 2003; DEH, 2005; EPA, 2006), the River Torrens (e.g. EPA, 1998b; Torrens CWMB, 2002) and Myponga River (e.g. Bryars, 2003), amongst others. AMLRNRM's and DEH's current estuary rehabilitation programs (e.g. conjunction with councils, and Department of Water, Land, and Biodiversity), should be continued in the long term. For all estuarine areas within the AMLRNRM region, support should be given for the restoration of water quality, and of water flow (rate and volume) from upstream. This is particularly important in locations where northern and southern coastal urban areas are expanding, and where small creeks have been (and continue to be) in-filled, or polluted with nutrients, silt and other pollutants, from urban and rural runoff etc. Additional stresses include the likelihood that natural water supply to these small rivers, creeks and streams will continue to diminish in the coming decades, due to the effects of climate change on South Australia. In the Murray Mouth region, decreased freshwater flow can have significant effects on the recruitment of estuarine species such as Black Bream and Mulloway, amongst others (Pierce and Doonan, 1999; Higham et al., 2002; MDBC, 2003), and it is important that flows be improved, to maintain adequate estuarine conditions. On a small scale, freshwater flows into estuaries are similarly important for coastal rivers, creeks and streams in the AMRLNRM. Within this region, attempts to meet the catchment management goals in water management plans (e.g. Torrens CWMR, 2002) must be continued in the long term, and this will have positive, flow on effects for marine biota in the AMLRNRM, including fishes and their habitats. Outside of the AMLRNRM region, some of the recent measures to improve conditions for fishes that utilise the Murray Mouth, Lakes and Coorong region, are also of relevance to smaller estuaries within the AMLRNRM region. Of particular note is the recent advent of "fishways" (e.g. Ye et al., 2002; Stuart et al., 2005) and fish ladders, which have helped to improve fish passage upstream (e.g. in the Murray Mouth region), and these facilities are relevant to other estuarine habitats (CWMB, 2004, for River Torrens, and SARDI, 2006, for Patawalonga).
- *Subtidal Habitats:* The subtidal habitats of GSV have degraded due to a combination of nutrients (principally from sewage effluent discharge), multiple contaminants from stormwater and other run-off; sedimentation effects (from sand dredging; trawling; sewage and stormwater run-off; land reclamation and coastal erosion, and other sources), and physical damage from trawling (see **Habitat Impact Studies** above, for references). Support should be provided for all programs that continue to attempt to reduce the input of nitrogen, phosphorous, heavy metals, chemicals, silt and other contaminants into gulf waters (see Wilkinson et al., 2003 for examples), and also for those programs that are attempting to restore degraded subtidal habitats in the AMLRNRM (e.g. Seddon et al., 2005; Wear et al., 2006, for seagrass).

Bycatch Monitoring: A number of benthic, site-associated fishes are susceptible to capture in prawn trawls in the gulfs region of S.A., with examples including flatheads, flounders, soles, some leatherjacket species, Soldierfish (which forms seasonal aggregations), Goblinfish, Spiny Boxfish (from a family of fishes that are site-associated and territorial, characteristics that can increase their vulnerability to site-specific impacts), and a variety of batoids (rays, skates, stingarees). In S.A., a system should be developed for the ongoing collection and monitoring of bycatch data (with indicator species) in the GSV Prawn Fishery (as currently occurs in the Spencer Gulf Prawn Trawl Fishery), to enable identification of long-term trends in bycatch (Australian Government DEH, 2004). Collection of bycatch records with assist (in conjunction with surveys) in determining whether the apparent rarity of some species in the AMLRNRM is an artefact, or genuine. As part of that program, the presence of any uncommon benthic fishes (with location and depth data) should be recorded when specimens appears in bycatch. Measures to reduce fish bycatch in prawn trawls in GSV (e.g. Broadhurst et al., 1999, 2000) should be encouraged.

Marine Protected Areas Research and Monitoring: Marine Protected Areas are recognised (globally and nationally) as one of the most important means by which populations of strongly site-associate species can protected (if over-exploited) and replenished. Ongoing support is required for research to determine the appropriate size and placement of protected areas in S.A. for replenishment of populations of site-associated nearshore fish species. Monitoring programs are required to determine the effectiveness of the size, shape and location of protected areas, with provision for adaptations to design in light of new knowledge over time. Baseline monitoring (e.g. Edgar et al., 2006) of high protection zones in proposed marine protected areas in S.A. should continue, and some of the site-associated reef and seagrass species (particularly benthic species) would be good candidates for long-term monitoring programs. Without monitoring programs, it is almost impossible to reliably determine trends in the distribution and abundance of fishes in and out of protected areas (see **Awareness and Assessment of the Impacts of Climate Change**). Compliance with no-take regulations in new MPAs is also critically important, and it is important that government and community support the resources necessary to achieve that.

Increased Government Involvement in Marine Threatened Species Issues: Protecting threatened species is a long-standing government commitment in S.A. (e.g. TSSS Committee, 1993; South Australian Government, 1998), and has been reiterated more recently in the State Strategic Plan, under the "Lose No Species" (as a result of human impacts) target (Government of South Australia, 2007), yet almost no resources have been dedicated to marine threatened species research, planning, management, policy or legislation during the past two decades, to 2007. It is notable that from 1998 to 2001, when a national overview of threatened marine fishes was being researched and written (Pogonoski et al., 202), of the 110 respondents who provided information for that overview, only one response was received from South Australian government (S.A. Museum), being a single personal communication. Formal protection of marine fishes under legislation is a protracted process. For example, it has been over 5 years since a number of freshwater and estuarine fishes were nominated (by an expert panel) for formal protection under the *National Parks and Wildlife Act in S.A.*, and by early 2007, these species had still not been listed.

Fisheries Research and Management: For many of the commercially and recreationally significant inshore fish species, there is inadequate research on the population status and fisheries assessment (including estimates of population abundance, breeding stock size (including species that form spawning aggregations), age structure, movement patterns, recruitment strength and its relation to stock size and environmental variables, total fishing mortality, total and regional catch and effort from all sources etc). In S.A., other than Pink Snapper, King George Whiting and Garfish, most other inshore scalefish species that are targeted, are classified as "secondary" species (Noell et al., 2005) due to their lower value, hence the research effort for such species is not as large or sustained, despite the fact that several of these species are classified as being either over-fished or fully-fished. Performance measures are lacking in terms of monitoring the sustainability of fishing a number of the minor commercial species in South Australia. Some of the species in the AMLRNRM region for which further research and management effort is over-due, include Western Blue Groper and other wrasses (e.g. Blue-throated Wrasse, Brown-Spotted Wrasse and Senator Wrasse), Snook, Yellowfin Whiting, Harlequin Fish, Dusky Morwong, leatherjackets, Black Bream, Silver Trevally, Southern Blue Morwong, boarfishes, sweeps, Knifejaw, flathead and flounder species, and the commercially and recreationally targeted sharks (other than Commonwealth-managed species), rays, and skates. For some of these species, a rank-order priority for future research effort has been established (e.g. Noell et al., 2005). For others, their low economic value to date has precluded their inclusion in any fisheries research programs. Universities should be encouraged (and supported) to assist in research efforts on the less economically important fish species, because many such species are of conservation concern.

Recreational Fishing Regulations and Monitoring: For a number of fish species of conservation concern in the AMLRNRM and surrounds, the current recreational fishing regulations in S.A. (PIRSA, 2006) do not include bag, boat, or possession limits, or minimum or maximum legal sizes. Examples include Blue-throated Wrasse and other wrasses caught recreationally, Harlequin Fish, Rock Ling, Dusky Morwong, Black-banded Sea Perch,

boarfishes, Luderick, Knifejaw, Estuary Catfish, Smooth Hammerhead, Dogfishes, wobbegong sharks, rays / stingrays, skates and stingarees. It is suggested that, in the absence of other measures to ensure the sustainability of fishing these species, that at least recreational fishing regulations be introduced. For many of the targeted species, more regular monitoring of recreational catches is required in areas where there is high fishing pressure.

Monitoring of Southern Australian Aquarium Trade (Legal and Illegal): During the past decade in southern Australia, there has been increasing development of the international aquarium trade in cool temperate fishes, particularly reef species, sourced from south-eastern Australia, including Tasmania. Examples include Sculptured Seamoth, Red Velvetfish, Southern Velvetfish, Warty Prowfish, several species of Anglerfish, Barber Perch, Blue-spotted Pufferfish, Orange-barred Pufferfish, Humpback Boxfish, Western Smooth Boxfish, Black-banded Sea Perch, Western Blue Devil, and many others A number of these species are strongly site-associated (including benthic, site-specific reproduction), are of low abundance, and have limited dispersal ability, and therefore collecting may have localised population impacts. If this trade were to spread to the take of reef fishes in South Australia, a stringent population impact assessment would be required for each species. Along with an ongoing monitoring program for collecting practices over space and time.

Research Support for South Australian Museum*:* Determining the conservation status of threatened marine and estuarine fishes in S.A. could be assisted by taxonomic (meristic and molecular) work on a number of groups (e.g. clingfishes, cardinalfishes, weedfishes and snake-blennies, pipefishes and seahorses, blindfishes, flounders, amongst others) from different parts of the State, to determine the number of taxa in South Australia within these groups. For some, there is inadequate information on the taxonomy and systematics to determine species richness within a family, and distribution. A number of S.A. fish specimens are not easily identified using the currently available descriptions and keys. There is currently little research support for fish work at the South Australian Museum, nor for the much needed collaboration with expert ichthyologists from other museums in southern Australia.

Public Awareness of Potentially Threatened Species*:* Within the AMLRNRM region and surrounds, there should be ongoing, long-term support for organisations, programs and individual researchers who can increase public awareness of (i) marine species of conservation concern in S.A., (ii) the measures to mitigate and reduce threats, and (ii) ways in which the public can assist marine species conservation. As a recent example, a current (2007), funded project at the Conservation Council in S.A. is designed to promote threatened marine species issues in S.A., based upon the conservation sector's "top 12" species chosen from a comprehensive scientific report on S.A.'s potentially threatened marine and estuarine fishes, which was co-funded by J.L. Baker (consultant); the Department for Environment and Heritage (S.A.); and Marine and Coastal Community Network, during the period 2004-2007.

Awareness and Assessment of the Impacts of Climate Change: Related to habitat impact studies (see above) is the need for a better understanding of the potential effects of climate change on marine fishes in southern Australia, including those in the AMLRNRM. No specific studies have been undertaken to date in S.A., but some examples from south-eastern Australia and New Zealand are noteworthy, including:

Red Velvetfish, for which kelp cover on reefs is a critical habitat. Over longer time scales, ecosystem changes due to food chain disruption, and global warming might adversely affect macroalgae cover. During a marine protected area monitoring program in Tasmania, a major (five-fold) decline in sightings of this species was observed over a 15 year period, likely to due to reduction in critical habitat (kelp cover) (G. Edgar, University of Tasmania, pers. comm., 2006, cited by Baker, 2007);

Blue-throated Wrasse: a species that is strongly site-associated with macroalgae-covered reefs, including kelp habitat (Barrett, 1995a,b), and for which recent studies indicate that loss of macroalgae-dominated habitat can result in emigration of individuals away from their habitat, which may thus affect survival of this territorial species in the long term (Edgar et al., 2004).

Red Cod: In New Zealand (Horn, 1996) and Tasmania (Jordan et al., 1998), noticeable differences in recruitment strength from year to year have been observed. Specifically, a New

Zealand study (Beentjes and Renwick, 2001) indicated that fluctuations in Red Cod landings are dependent on sea surface temperature, controlled largely by climatic variability, including El Niño and La Niña events. Catch per unit effort data from young fish in the commercial fishery were used as an indirect index of recruitment strength of Red Cod, and there was an apparent and consistent correlation with sea surface temperature (rather than any other explanatory variable) over a wide range of time lags, followed by frequencies of southwest and northeast flow patterns. The correlations were negative with sea surface temperature, positive with occurrence of cool southwest weather types, and negative with occurrence of warm northeast weather types. It therefore appears that Red Cod have poor recruitment in La Niña years, and good recruitment in El Niño years (Beentjes and Renwick, 2001, cited by Baker, 2007).

Rock Ling, populations of which might be at risk from long-term climatic changes (G. Edgar, University of Tasmania, pers. comm., 2006, cited by Baker, 2007).

It is notable that these examples have come from Tasmania, and one from New Zealand, and long term monitoring of reefs that are protected from fishing has been undertaken in both regions. Without such monitoring programs, it is almost impossible to reliably determine trends in the distribution and abundance of fishes.

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Marine & Estuarine Fishes of Conservation Concern in the AMLRNRM region

Appendix: Species list of bony and cartilaginous fishes of conservation concern in the AMLR NRM region and surrounds. Based on knowledge of the distribution within S.A. (see Baker, 2007), species marked with an asterisk (*) are likely to occur in the region, but no specific records from within the AMLR NRM are available for those species. The species marked with a hatch (#) is included provisionally, based on a single museum specimen from Gulf St Vincent.

Common Name	**Latin Name**
Short-Finned Eel / Shortfin Eel	*Anguilla australis*
Pouched Lamprey	*Geotria australis*
Short-headed Lamprey	*Mordacia mordax*
Green Moray / Yellow Moray *	*Gymnothorax prasinus* *
Southern Conger Eel	*Conger verreauxi*
Short-finned Conger Eel	*Conger wilsoni*
Little Conger Eel *	*Gnathophis longicauda* / *G. longicaudus* *
Largepore Conger Eel *	*Gnathophis macroporis* *
Umbrella Conger Eel *	*Gnathophis umbrellabius / umbrellabia* *
Ladder Eel *	*Scalanago lateralis* *
Estuary Catfish / Cobbler	*Cnidoglanis macrocephalus*
Australian Handfish / Common Handfish	*Brachionichthys* sp.
Warty Handfish / Verrucose Handfish	*Sympterichthys verrucosus (= Brachionichthys verrucosus)*
Rough Anglerfish *	*Kuiterichthys furcipilis* *
Bougainville's Anglerfish	*Histiophryne bougainvilli*
Rodless Anglerfish / Cryptic Anglerfish	*Histiophryne cryptacantha (= H. cryptacanthus)*
Glover's Anglerfish	*Rhycherus gloveri*
Sponge Anglerfish	*Echinophryne reynoldsi*
Spinycoat Anglerfish / Mitchell's Anglerfish	*Echinophryne mitchellii* (= *Trichophryne mitchelli*)
Glauert's Anglerfish *	*Allenichthys glauerti* *
Rock Ling	*Genypterus tigerinus*
Slender Blindfish	*Dermatopsis multiradiatus*
Southern Pygmy Blindfish *	*Dinematichthys* sp. *
Short-snout Hardyhead *	*Kestratherina brevirostris* *
Pikehead Hardyhead	*Kestratherina esox*
River Garfish	*Hyporhamphus regularis ardelio* (Eastern form) *H. regularis regularis* (Western form)
Southern Sea Garfish	*Hyporhamphus melanochir*
Bight Redfish / Red Snapper / Golden Snapper *	*Centroberyx gerrardi* *
Swallowtail	*Centroberyx lineatus*
Sculptured Sea Moth / Seamoth	*Pegasus lancifer*
Threefin Velvetfish	*Neoaploactis tridorsalis*
Deep Velvetfish	*Kanekonia queenslandica*

Southern Velvetfish	*Aploactisoma milesii*
Wasp-spine Velvetfish *	*Acanthosphex leurynnis* *
Whiskered Prowfish	*Neopataecus waterhousii*
Warty Prowfish	*Aetapcus maculatus*
Red Indianfish	*Pataecus fronto*
Red Velvetfish	*Gnathanacanthus goetzeei*
White-nose Pigfish	*Perryena leucometopon*
Southern Pot-Bellied Seahorse / Southern Potbelly Seahorse	*Hippocampus abdominalis / "H. bleekeri"*
Short-headed Seahorse / Short-snouted Seahorse	*Hippocampus breviceps*
Southern Little Pipehorse / Southern Pygmy Pipehorse	*Acentronura (=Idiotropiscis) australe*
Leafy Seadragon	*Phycodurus eques*
Weedy Seadragon	*Phyllopteryx taeniolatus*
Brush-Tail Pipefish	*Leptoichthys fistularius*
Javelin Pipefish	*Lissocampus runa*
Smooth Pipefish	*Lissocampus caudalis*
Gales Pipefish	*Campichthys galei*
(Tryon's Pipefish) #	*(Campichthys tryoni)*
Red Pipefish	*Notiocampus ruber*
Ring-Back Pipefish / Ring-backed Pipefish	*Stipecampus cristatus*
Western Upsidedown Pipefish	*Heraldia* sp. 1
Macleay's Crested Pipefish / Rhino Pipefish	*Histiogamphelus cristatus*
Brigg's Pipefish	*Histiogamphelus briggsii*
Knife-Snout Pipefish	*Hypselognathus rostratus*
Tiger Pipefish *	*Filicampus tigris* *
Pug-Nose Pipefish	*Pugnaso curtirostris*
Verco's Pipefish *	*Vanacampus vercoi* *
Long-Snout Pipefish	*Vanacampus poecilolaemus*
Deep-Bodied Pipefish / Deepbody Pipefish	*Kaupus costatus*
Southern Gulf Pipefish	*Stigmatopora* sp. nov. (Browne and Smith, in review)
Gulf Gurnard Perch	*Neosebastes bougainvillii*
Black-spotted Gurnard Perch *	*Neosebastes nigropunctatus* *
Bighead Gurnard Perch	*Neosebastes pandus*
Common Gurnard Perch / Ruddy Gurnard Perch	*Neosebastes scorpaenoides*
Thetis Fish	*Neosebastes thetidis*
Little Gurnard Perch / Little Scorpion Fish	*Maxillicosta scabriceps*
Southern Gurnard Perch	*Maxillicosta meridianus*
Southern Red Scorpionfish / Southern Rock Cod / Red Rock Cod	*Scorpaena papillosa*
Goblin Fish	*Glyptauchen panduratus*
Western Fortescue *	*Centropogon latifrons* *
Soldierfish / S.A. Cobbler / Happy Moment	*Gymnapistes marmoratus*
Southern Shortfin Gurnard *	*Lepidotrigla spinosa* *
(undescribed western relative of Minor gurnard *L. modesta*)	*Lepidotrigla* sp.
Spiny Gurnard / Southern Spiny Gurnard	*Lepidotrigla papilio*

Butterfly Gurnard	*Lepidotrigla vanessa*
Latchet / Sharp-beaked Gurnard	*Pterygotrigla polyommata*
Red Gurnard / Flying Gurnard	*Chelidonichthys kumu*
Deepwater Flathead	*Neoplatycephalus conatus*
Toothy Flathead	*Neoplatycephalus aurimaculatus*
Longhead Flathead / Long-headed Flathead	*Leviprora inops*
Harlequin Fish	*Othos dentex*
Butterfly Perch	*Caesioperca lepidoptera*
Barber Perch	*Caesioperca rasor*
Black-banded Seaperch	*Hypoplectrodes nigrorubrum* / *H. nigroruber*
Estuary Perch *	*Macquaria colonorum* *
Luderick / Blackfish	*Girella tricuspidata*
Footballer Sweep / Western Footballer	*Neatypus obliquus*
Banded Sweep	*Scorpis georgiana* / *S. georgianus*
Brown-spotted Boarfish / Yellow-spotted Boarfish	*Paristiopterus gallipavo*
Short Boarfish / Hutchins' Boarfish	*Parazanclistius hutchinsi*
Long-snouted Boarfish / Longsnout Boarfish	*Pentaceropsis recurvirostris*
Western Kelpfish / Tasselled Kelpfish	*Chironemus georgianus*
Silver Spot	*Threpterius maculosus*
Southern Sea Carp / Marblefish	*Aplodactylus arctidens*
Western Sea Carp	*Aplodactylus westralis*
Knifejaw / Conway	Oplegnathus woodwardi
Western Blue Devilfish	*Paraplesiops meleagris*
Southern Hulafish / Blotch-tailed Trachinops *	*Trachinops caudimaculatus* *
Noarlunga Hulafish	*Trachinops noarlungae*
Alison's Blue Devil *	*Paraplesiops alisonae* *
Southern Longfin *	*Beliops xanthokrossos* *
Western Blue Groper	*Achoerodus gouldii*
Blue-Throated Wrasse	*Notolabrus tetricus*
Brown-Spotted Wrasse / Orange-Spotted Wrasse / Blue-Spotted Parrotfish	*Notolabrus parilus*
Maori Wrasse	*Ophthalmolepis lineolata*
Rosy Wrasse *	*Pseudolabrus psittaculus (= P. rubicundus)* *
Snakeskin Wrasse	*Eupetrichthys angustipes*
Senator Wrasse	*Pictilabrus laticlavius*
Castelnau's Wrasse / Pretty Polly	*Dotalabrus aurantiacus*
Black-spotted Wrasse	*Austrolabrus maculatus*
Western Foxfish *	*Bodianus frenchii* *
Barred Grubfish / Allport's Grubfish / Barred Weever *	*Parapercis allporti* *
Fringed Stargazer *	*Ichthyscopus barbatus* *
Deepwater Stargazer	*Kathetostoma nigrofasciatum*
Speckled Stargazer / Western Stargazer	*Kathetostoma canaster*
Common Stargazer / Eastern Stargazer	*Kathetostoma leave*

Bandfish *	(previously *Cepola australis*, but in S.A. might be undescribed species) *
Dusky Morwong / Butterfish	*Dactylophora nigricans*
Jackass Morwong / Jackass Fish / Tarakihi *	*Nemadactylus macropterus* *
Banded Morwong / Brown-banded Morwong	*Cheilodactylus (= Goniistius) spectabilis*
Southern Blue Morwong / Queen Snapper	*Nemadactylus valenciennesi*
Bastard Trumpeter / Silver Trumpeter	*Latridopsis forsteri*
Scarlet Cardinalfish	*Vincentia badia*
Smooth Cardinalfish *	*Vincentia macrocauda* *
Southern Cardinalfish / Southern Gobbleguts	*Vincentia conspersa*
King George Whiting	*Sillaginodes punctata*
Yellowfin Whiting	*Sillago schomburgkii*
Silver Trevally / White Trevally / Skippy	*Pseudocaranx dentex*
Eelblenny *	*Peronedys anguillaris* *
Variegated Snake-blenny	*Ophiclinops varius*
Spotted Snake-blenny	*Ophiclinops pardalis*
Shortfin Snake-blenny *	*Ophiclinus brevipinnis* *
Adelaide Blenny / Adelaide Snake-blenny	*Ophiclinus antarcticus*
Gabriel's Snake-blenny / Frosted Snake-blenny	*Ophiclinus gabrieli*
Rosy Weedfish	*Heteroclinus roseus*
Forster's Weedfish / Long-Snouted Weedfish / Sharp-Nose Weedfish / Longnose Weedfish	*Heteroclinus tristis (*previously named *H. forsteri*)
Johnston's Weedfish / Broad-Headed Weedfish	*Heteroclinus johnstoni*
Whitley's Weedfish	*Heteroclinus* sp. 2
Coleman's Weedfish *	*Heteroclinus* sp. 4 *
Seven-Bar Weedfish *	*Heteroclinus heptaeolus* *
Kelp Weedfish *	*Heteroclinus eckloniae* *
Wilson's Weedfish *	*Heteroclinus wilsoni* *
Tasselled Weedfish / Large-Eye Weedfish *	*Heteroclinus macrophthalmus* *
Little Weedfish / The Girls' Weedfish	*Heteroclinus puellarum*
Fewray Weedfish	*Heteroclinus* sp. 5
Milward's Weedfish *	*Heteroclinus* sp. 6 *
Sand Crawler *	*Sticharium dorsale* *
Dusky Crawler *	*Sticharium clarkae* *
Common Stinkfish	*Synchiropus calauropomus = Callionymus calauropomus = Foetorepus calauropomus*
Sand Dragonet / Spotted Dragonet	*Repomucenus calcaratus = Callionymus calcaratus*
Lagoon Goby	*Tasmanogobius lasti*
Large-mouth Goby / Largemouth Goby	*Redigobius macrostoma*
Frayed-Fin Goby / Frayedfin Goby / Krefft's Goby	*Bathygobius kreffti (= B. krefftii)*
Groove-cheek Goby / Grooved-cheek Goby / Groovecheek Goby	*Nesogobius* sp. 4 (in Gomon et al., 1994) *Nesogobius* sp. 7 (in Australian Museum, 2003b)
Sicklefin Sand Goby	*Nesogobius* sp. 5 (in Gomon et al., 1994)
Threadfin Sand Goby *	*Nesogobius* sp. 2 (in Gomon et al., 1994) *

Tamar River Goby	*Favonigobius tamarensis = Afurcagobius tamarensis*
Pale Mangrove Goby	*Mugilogobius paludis = Mugilogobius platynotus*
Obscure Little Clingfish / Obscure Clingfish *	*Parvicrepis* sp. 2 *
Long-Snout Clingfish *	*Parvicrepis* sp. 1 *
Brown-spotted Spiny Clingfish / Kelp Clingfish *	Genus A, sp. 2 (Hutchins, in Gomon et al., 1994)*
Rat Clingfish *	Genus B sp. (Hutchins, in Gomon et al., 1994) *
(Grass Clingfish, Slender Clingfish and other seagrass-dwelling gobiesocids) *	(e.g. Genus C or Genus 1, and others – Hutchins, in Gomon et al., 1994; Kuiter 1996b; W.A. Museum, 2003) *
Beardie / Largetooth Beardie *	*Lotella rhacina* *
Bearded Cod / Bearded Rock Cod	*Pseudophycis barbata*
Bastard Red Cod *	*Pseudophycis breviuscula* *
Red Cod	*Pseudophycis bachus*
Congolli / Tupong / Sandy	*Pseudaphritis urvillii*
Crested Triplefin	*Trinorfolkia* (*Norfolkia*) *cristata*
Blue-spotted Pufferfish / Blue-spotted Toadfish	*Omegophora cyanopunctata*
Orange-barred Pufferfish / Orangebarred Pufferfish	*Polyspina piosae*
Weeping Toado / Banded Toadfish	*Torquigener pleurogramma*
Globe Fish / Porcupine Fish	*Diodon nicthemerus*
Australian Burrfish / Deepwater Burrfish *	*Allomycterus pilatus* *
Humpback Boxfish / White-barred Boxfish	*Anoplocapros lenticularis*
Western Smooth Boxfish / Blue Boxfish / Robust Boxfish	*Anoplocapros amygdaloides*
Spiny Boxfish / Black-banded Pygmy Boxfish	*Capropygia unistriata*
Flimsy Flounder	*Arnoglossus sp.*
Bass Strait Flounder	*Arnoglossus bassensis*
Crested Flounder	*Lophonectes gallus*
Small-tooth Flounder	*Pseudorhombus jenynsii*
Large-tooth Flounder	*Pseudorhombus arsius*
Greenback Flounder	*Rhombosolea tapirina*
Derwent Flounder *	*Taratretis derwentensis* *
Short-fin Flounder / Shortfin Flounder	*Ammotretis brevipinnis*
Large-scale Flounder / Largescale Flounder *	*Ammotretis macrolepis* *
Long-snout Flounder	*Ammotretis rostratus*
Elongate Flounder	*Ammotretis elongatus*
Spotted Flounder	*Ammotretis lituratus*
Southern Sole / Southern Textile Sole	*Aseraggodes haackeanus*
Dusky-banded Sole / Duskybanded Sole *	*Zebrias penescalaris* *
Southern Tongue Sole / Broadhurst's Tongue Sole	*Cynoglossus broadhursti*
Blue-tailed Leatherjacket / Blue tail Leatherjacket	*Eubalichthys cyanoura*
Gunn's Leatherjacket	*Eubalichthys gunnii*
Mosaic Leatherjacket	*Eubalichthys mosaicus*
Spiny-tailed Leatherjacket / Spiny-tail Leatherjacket	*Acanthaluteres brownii*
Stars-and-Stripes Leatherjacket / Beautiful Leatherjacket *	*Meuschenia venusta* *

Blue-lined Leatherjacket / Gal's Leatherjacket / Gale's Leatherjacket	*Meuschenia galii*
Six-spined Leatherjacket	*Meuschenia freycineti*
Horseshoe Leatherjacket	*Meuschenia hippocrepis*
Brown-striped Leatherjacket / Southern Leatherjacket *	*Meuschenia australis* *
Degen's Leatherjacket / Blue-finned Leatherjacket	*Thamnaconus degeni*
Ocean Leatherjacket / Chinaman Leatherjacket *	*Nelusetta ayraudi* *
Southern Bluefin Tuna	*Thunnus maccoyii*
Black Bream	*Acanthopagrus butcheri*
Pink Snapper	*Pagrus auratus*
Mulloway	*Argyrosomus hololepidotus* = *A. japonicus*
Spotted Wobbegong	*Orectolobus maculatus*
Large Ornate Wobbegong	*Orectolobus halei*
Cobbler Carpetshark	*Sutorectus tentaculatus*
Australian Swellshark / Draughtboard Shark *	*Cephaloscyllium laticeps* *
Gulf Catshark	*Asymbolus vincenti*
Thresher Shark *	*Alopias vulpinus* *
Whiskery Shark	*Furgaleus macki*
School Shark	*Galeorhinus galeus*
Gummy Shark / Flake / Sweet William	*Mustelus antarcticus*
Dusky Shark / Black Whaler	*Carcharhinus obscurus*
Bronze Whaler / Copper Shark	*Carcharhinus brachyurus*
White Shark / Great White Shark	*Carcharodon carcharias*
Blue Shark / Blue Whaler Shark *	*Prionace glauca* *
Smooth Hammerhead	*Sphyrna zygaena*
Shortfin Mako *	*Isurus oxyrinchus* *
Porbeagle	*Lamna nasus*
Broadnose Sevengill Shark	*Notorynchus cepedianus*
Spiny Dogfish / Piked Dogfish / White-spotted Dogfish / White-spotted Spurdog	*Squalus acanthias*
Shortnose Spurdog / Spikey Dogfish / Piked Spurdog / Dogshark	*Squalus megalops*
Common Sawshark *	*Pristiophorus cirratus* *
Southern Sawshark / Shortnose Sawshark	*Pristiophorus nudipinnis*
Australian Angel Shark	*Squatina australis*
Elephant Shark / Elephant Fish	*Callorhynchus millii*
Tasmanian Numbfish *	*Narcine tasmaniensis* *
Coffin Ray / Australian Numbfish	*Hypnos monopterygius*
Southern Fiddler Ray / Banjo Ray	*Trygonorrhina fasciata*
Magpie Fiddler Ray	*"Trygonorrhina melaleuca"* (N.B. may be variant of *T. fasciata*)
Western Shovelnose Ray	*Aptychotrema vincentiana*
Peacock Skate *	*Pavoraja (Raja) nitida* *
Australian Thornback Skate *	*Dipturus (Dentiraja) lemprieri* *
Pygmy Thornback Skate *	*Dipturus (Dentiraja) Sp. M* *
White-Spotted Skate	*Dipturus (Subgenus A) cerva*

Melbourne Skate / Wedgenose Skate / Whitley's Skate *	*Dipturus (Spiniraja) whitleyi* *
Coastal Stingaree	*Urolophus orarius*
Banded Stingaree / Crossback Stingaree	*Urolophus cruciatus*
Greenback Stingaree*	*Urolophus viridis* *
Common Stingaree	*Trygonoptera testacea (= Urolophus testaceus)*
Smooth Stingray / Short-tail Stingray	*Dasyatis brevicaudata*
Black Stingray	*Dasyatis thetidis*
Southern Eagle Ray / Eagle Ray	*Myliobatis australis*