

Status of South Australian Fisheries Report

FISHERIES SNAPSHOT FOR 2012-13

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Foreword

From iconic wild catch species such as King George Whiting and Snapper to Southern Rock Lobster, Greenlip Abalone and Western King Prawns, South Australia produces some of the most sought after, premium seafood species in the world.

Harvested in pristine waters which have a reputation for being among the cleanest and safest, the State's commercial fisheries contribute \$379 million (2012-13) annually to the South Australian economy in direct and indirect impacts and produce more than 44,000 tonnes of seafood for domestic and international markets. This includes more than 2000 tonnes of Rock Lobster and Abalone, most of which is exported to the major international markets of China and Hong Kong.

Locally, the seafood industry is a vital contributor to the State economy, with the sector also supporting more than 3,000 jobs, the majority in regional South Australia.

In addition, more than one in six South Australians and numerous interstate and international visitors enjoy recreational fishing on our seas, rivers and estuaries each year.

As custodian of South Australia's fisheries, one of the State Government's most critical roles through Primary Industries and Regions South Australia (PIRSA) is managing these valuable aquatic resources in the most ecologically sustainable manner both now and for future generations.

The Status of South Australian Fisheries Report brings together the best available information to determine the status of South Australia's key wild fish stocks against an agreed national reporting framework. It presents transparent information based on scientifically robust stock assessments undertaken for 17 key species and 45 individual stocks/management units covering marine, estuarine and freshwater fish, crustaceans and shellfish. The report also provides important information describing how individual fisheries are being managed and, for those fish stocks showing signs of decline, the report documents how they are managed through tailored management strategies to improve their status.

This information provides a clear assessment, highlighting areas requiring further effort for management, industry and researchers as we work together to ensure the ecologically sustainable development of South Australia's fisheries resources.

The Status of South Australian Fisheries Report also provides an important foundation for an exciting new initiative in State fisheries management, with the development of a Harvest Strategy Policy by PIRSA. Harvest strategies have been used in South Australian fisheries for a number of years, but have been designed on a case-by-case basis with no underpinning policy. The new policy will enable a more consistent and harmonised approach in South Australia resulting in better managed fisheries with greater sensitivity to ecological, economic and social considerations.

South Australia is well-recognised as a world leader in fisheries management, compliance and stock assessment, underpinned by the strength of robust legislative frameworks, collaborative relationships with stakeholders and world class science. The adoption of the national stock status reporting framework in this report will provide a consistent approach across our fisheries which will be regularly updated. This will provide interested fishers, businesses and the wider community with a clear understanding of the current status of South Australia's key wild catch fisheries, and provide fisheries managers and researchers with a guide to managing the health of our fisheries now and into the future.

Leon Bignell MP

Minister for Agriculture, Food and Fisheries

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Executive Summary

There is widespread community interest in the biological status of South Australia's fish stocks and the marine and freshwater ecosystems that support them.

The purpose of this report is to bring together the available biological, management and fishery-related information and report on the trends in stock status for all major fisheries in South Australian waters. The report will provide a factual information source for stakeholder groups and the wider community. A summary of the environmental effects of fishing and the impacts of environmental changes on the species are also provided.

This report provides an update to the fish stock status report produced in 2006 (PIRSA 2007) and follows the national reporting framework to provide transparency and consistency in reporting across the jurisdictions (Flood et al. 2014).

The report assesses the status of 17 key species or species groups (listed in Table 1) for 2013 and provides information including

distribution of stocks in South Australia and the stock status classifications for each stock. Status assessments were carried out at the management unit level for all, some of which are also the biological stock level. In assessing the 17 species and species complexes, 45 individual stocks were assessed.

Nineteen of the 45 stocks were classified as sustainable, one transitional–recovering, 12 transitional–depleting; one overfished, and 12 undefined (Table 1).

The only stock classified as overfished was the Port River Mud Cackle, which has been closed to all fishing sectors since the start of the 2010–11 financial year.

The total volume of catch of key fish stocks reported from South Australian managed fisheries is 39,251 t, representing approximately 95% of the total South Australian wild catch reported here in the same reporting period.

Table 1: Summary information on South Australia's key wild capture fisheries and fish species for 2012–13 (NB: Value and catch information is for the commercial fishery only.)

Common name	Stock/management unit	Stock status
Blacklip Abalone	Western Zone	Transitional-depleting
	Central Zone	Transitional-depleting
	Southern Zone	Sustainable
Greenlip Abalone	Western Zone	Sustainable
	Central Zone	Transitional-depleting
	Southern Zone	Undefined
Southern Calamari	South Australia	Sustainable
Mud Cackle	West Coast	Sustainable
	Coffin Bay	Sustainable
	Port River	Overfished
Pipi	Lakes and Coorong	Sustainable
Blue Swimmer Crab	Spencer Gulf	Sustainable
	Gulf St Vincent	Transitional-recovering
	West Coast	Undefined
Giant Crab	South Australia	Undefined
King Prawn	Spencer Gulf	Sustainable
	Gulf St Vincent	Transitional-depleting
	West Coast	Sustainable

Continues on page 4.

Common name	Stock/management unit	Stock status
Southern Rock Lobster	Southern Zone	Sustainable
	Northern Zone	Sustainable
Australian Sardine	South Australia	Sustainable
Golden Perch	Lakes and Coorong	Sustainable
	Recreational River Fishery	Sustainable
	River Murray	Undefined
King George Whiting	Spencer Gulf	Transitional-depleting
	Gulf St Vincent	Transitional-depleting
	West Coast	Sustainable
Mullocky	Lakes and Coorong	Sustainable
	Marine Scalefish fishery	Undefined
Murray Cod	Lakes and Coorong	Undefined
	Recreational River Fishery	Undefined
Snapper	South East	Transitional-depleting
	Southern Gulf St Vincent	Transitional-depleting
	Northern Gulf St Vincent	Sustainable
	Southern Spencer Gulf	Transitional-depleting
	Northern Spencer Gulf	Transitional-depleting
	West Coast	Undefined
Southern Garfish	West Coast	Undefined
	Northern Spencer Gulf	Transitional-depleting
	Southern Spencer Gulf	Undefined
	Northern Gulf St Vincent	Transitional-depleting
	Southern Gulf St Vincent	Undefined
	South East	Undefined
Yelloweye Mullet	Lakes and Coorong	Sustainable
	Marine Scalefish Fishery	Sustainable

Some species are reported for financial year 2013-14 according to timing of fishing seasons.

1. Introduction

This report brings together the available biological, management and fishery-related information of key fish stocks managed by the South Australian Government. The report will act as a key reference for major stakeholder groups and the wider community.

This is the second status report prepared for South Australia's fisheries resources. It provides detail on the biological status of key fish stocks and describes the management measures in place to ensure their long-term, ecologically sustainable development. The report provides a valuable reference on the trends in stock status for all major fisheries in South Australian waters.

This report follows the national reporting framework that was developed collaboratively by fisheries scientists from around

Australia (Table 2) (Flood et al. 2014). This framework is a major step forward for Australian fisheries management and provides transparency and consistency across the jurisdictions.

1.1 Determining stock status

The set of standard classifications used in this report to determine the status of each fish stock or fishery management unit is provided in Table 2. Although performance indicators and their reference points are not specifically reported on in this report, each fish stock is assessed against these in the formal stock assessment process. The definitions for stock status are consistent with the national stock status reporting framework (Flood et al. 2014).

Table 2: Stock status terminology for the Status of South Australian Fisheries (Flood et al. 2014)

Stock status	Description	Potential implications for management of the stock
Sustainable	Stock for which biomass (or biomass proxy) is at a level sufficient to ensure that, on average, future levels of recruitment are adequate (i.e. not recruitment overfished) and for which fishing pressure is adequately controlled to avoid the stock becoming recruitment overfished.	Appropriate management is in place
Transitional—recovering	Recovering stock — biomass is recruitment overfished, but management measures are in place to promote stock recovery, and recovery is occurring	Appropriate management is in place, and the stock biomass is recovering
Transitional—depleting	Deteriorating stock — biomass is not yet recruitment overfished, but fishing pressure is too high and moving the stock in the direction of becoming recruitment overfished	Management is needed to reduce fishing pressure and ensure that the biomass does not deplete to an overfished state
Overfished	Spawning stock biomass has been reduced through catch, so that average recruitment levels are significantly reduced (ie. recruitment overfished). Current management is not adequate to recover the stock, or adequate management measures have been put in place but have not yet resulted in measurable improvements	Management is needed to recover this stock; if adequate management measures are already in place, more time may be required for them to take effect
Environmentally limited	Spawning stock biomass has been reduced to the point where average recruitment levels are significantly reduced, primarily as a result of substantial environmental changes / impacts or disease outbreaks (ie. the stock is not recruitment overfished). Fisheries management has responded appropriately to the environmental change in productivity	Appropriate management is in place
Undefined	Not enough information exists to determine stock status	Data required to assess stock status are needed

1.2 Report structure

The South Australian Fish Stocks Status Report consists of 17 separate species chapters and assesses the status of fish stocks for 2013 (listed in Table 1). Each chapter describes the distribution of stocks in South Australia and provides the stock status classification for each stock at the management unit level, some of which are also the biological stock level. Each chapter also includes information on the main fishing methods, management measures, number of licences that are permitted to catch the species and the amount of catch from commercial, recreational and Aboriginal traditional fisheries.

A summary of the environmental effects of fishing and the impacts of environmental changes on the species are also provided. They provide key references where interested people can source more of the scientific detail on which the report was based.

The term 'stock' in the report refers to the unit of assessment. Classification of stock status is at the biological level or management unit level, where appropriate. Classification of stock status is consistent with the national stock status reporting framework and is described in detail in Table 2.

For the purposes of this report, catch and effort and economic information are provided to 2012-13, or for the 2013 calendar year depending on the duration of the fishing season for individual fisheries.

2 Overview of South Australian fisheries

Primary Industries and Regions South Australia (PIRSA) is the government agency responsible for managing South Australia's fish stocks on behalf of the community. PIRSA manages South Australia's fish stocks in partnership with key stakeholder groups and the community. PIRSA manage 814 commercial fishing licences across all of the South Australian commercial fisheries, and fishing activities by an estimated 236,000 recreational fishers. The *Fisheries Management Act 2007* acknowledges Aboriginal or Indigenous fishing in the form of Aboriginal traditional fishing. Many Aboriginal communities have a long history of fishing in South Australian waters, however documented information about these activities and practices is limited.

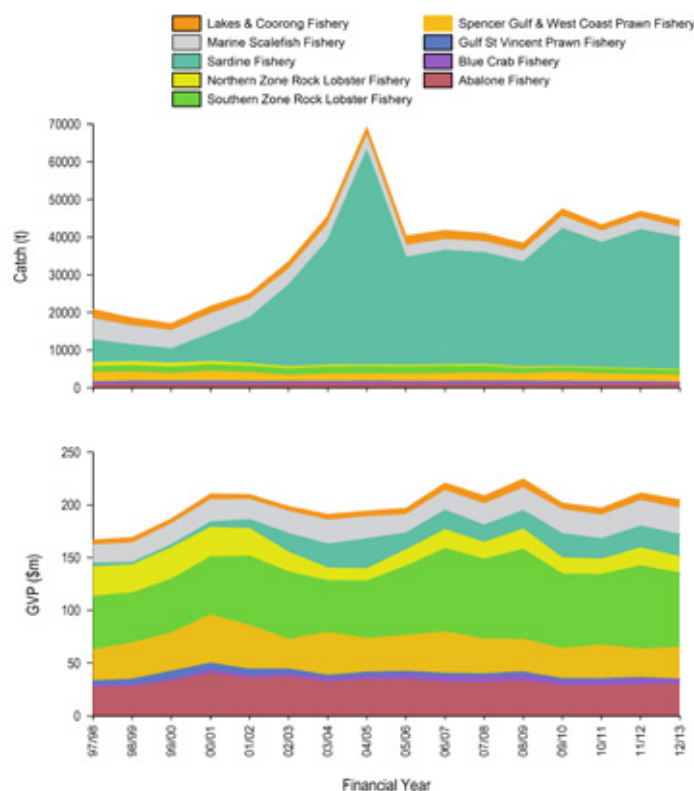
A range of management tools are used to protect the State's fisheries resources. These measures include output controls such as quota restrictions, daily catch limits, minimum and maximum size limits, and recreational bag and boat limits, as well as input controls such as closed areas, closed seasons, gear restrictions, vessel size and capacity restrictions, limited entry provisions, and limitations on the number of people that may assist with fishing operations. A Vessel Monitoring System (VMS) is also used to track the movements of vessels in some fisheries to assist in monitoring compliance with management arrangements.

2.1 Commercial fishing

In 2012-13, total catch for all State commercial fisheries was 44,202 t (Figure 1) with a GVP of \$206 million (Figure 1). South Australian commercial fisheries generated 1,576 direct full time jobs and approximately 1,532 flow-on jobs, a total of 3,108 jobs in the State; the majority in regional areas. When total direct and indirect output impacts were calculated, South Australia's commercial fisheries contributed \$379 million to the State's economy. Much of this wealth was generated in regional South Australia (EconSearch 2015).

The Rock Lobster Fishery is the most valuable fishery in terms of GVP, generating \$87 million and 495 direct fishing jobs in 2012-13. The Abalone Fishery was the second most valuable fishery, generating a GVP of \$30 million and 71 direct fishing jobs (Figure 1). The Sardine Fishery comprises the majority of the total commercial catch, with approximately 30,000 t taken annually in recent years (Figure 1) (EconSearch 2015).

Figure 1: South Australian commercial catch (upper graph) and GVP (lower graph) from South Australia's commercial fisheries 1997-98 to 2012-13



2.2 Recreational fishing

There is a popular recreational fishing sector in South Australia with an estimated 236,000 recreational fishers taking part in fishing activities in 2007-08, equating to 16.2% of the State's population (Jones 2009). Key species targeted by recreational fishers include King George Whiting, Snapper, Southern Garfish, Southern Calamari and Blue Swimmer Crab.

Fishing has provided an important recreational and sporting activity throughout South Australia since European settlement. Many early accounts of fishing in the State refer to fish being taken as part of recreational pursuits and to supplement food supplies.

Recreational fishing is undertaken from the shoreline, jetties and boats using a variety of fishing methods including lines, nets, traps and diving. Sheltered metropolitan gulf waters have been the most popular over the years but many recreational fishers are now travelling long distances to South Australia's more remote fishing locations on the West Coast, Kangaroo Island, Limestone Coast and inland to the River Murray and Lakes and Coorong regions.

The recreational fishing opportunities provided throughout South Australia contribute to the overall health and well-being of many South Australians. In return, the recreational fishing community also contributes significantly to State and regional economies through tourism and the purchase of items such as fishing equipment, vessels, bait supplies and fuel.

In 2000-01, South Australia participated in the 'National Recreational and Indigenous Fishing Survey' (Lyle and Henry 2003). To update the information gained through the survey, PIRSA undertook the 2007-08 'South Australian Recreational Fishing Survey' (Jones 2009). A further survey was underway at the time of writing this report to provide statistically robust 2013-14 estimates of recreational fisher participation rates, demographics and annual catch and effort for key species including King George Whiting, Snapper, Southern Garfish and Blue Swimmer Crabs among other species. A report on the 2013-14 survey will be completed in 2015.

These surveys provide much needed information on the levels of participation and recreational catch in South Australia. Catch and effort estimates from these surveys have contributed to improved management of South Australia's fish stocks and are reported throughout this status report in the individual chapters.

In recognition of the importance of recreational fishing to the community of South Australia, a strategic plan for recreational

fishing was developed in 2015 to set a number of future directions for the management and development of recreational fishing in the State (RecFish SA 2015).

The Government announced a \$3.25 million dollar package in 2014 to support recreational fishing including regional infrastructure grants, an artificial reef trial and supporting access to reservoirs for recreational fishers.

2.3 Aboriginal traditional fishing

Aboriginal traditional fishing is recognised under the *Fisheries Management Act 2007* as fishing engaged in by an Aboriginal person under a Traditional Fishing Management Plan. Under these arrangements, traditional fishing is non-commercial fishing for the purposes of satisfying personal, domestic or non-commercial communal needs, including; ceremonial, spiritual and educational needs, and using fish and other natural marine and freshwater products according to relevant Aboriginal custom. The *Fisheries Management Act 2007* provides the framework for integrating Aboriginal traditional fishing into the broader fisheries management framework.

Traditional fishing management plans are developed to implement Indigenous Land Use Agreements, which are a legal tool for resolving native title claims.

2.4 Fishing gear

Commercial fishing gear

The information presented here describes the main fishing gear used in South Australian fisheries. The descriptions of gear and terminology used are based on those in the national *Status of Key Australian Fish Stocks Report* (Flood et al. 2014).

A variety of fishing gear and methods are used in commercial fisheries in South Australia including nets, traps, lines and hand-held implements. Fishing gear and methods are designed to take into account the particular characteristics and behaviour of the species being targeted, including their feeding, spawning, shoaling and migratory behaviour; and their ecology or relationship with their habitat. The catchability of each species depends on the action of the gear, and the composition of the catch from a particular fishing area may therefore depend on the type of gear used. The design of fishing gear also considers ensuring the quality of the product, minimising the catch of non-target species and impacts on habitat.

Restrictions on fishing gear form an important element of sustainable fisheries management.

Nets

Fishing nets endorsed in the Prawn, Marine Scalefish, Rock Lobster and Lakes and Coorong fisheries include trawl nets, gill (mesh) nets, hauling nets and dab nets.

The main components of a common net are:

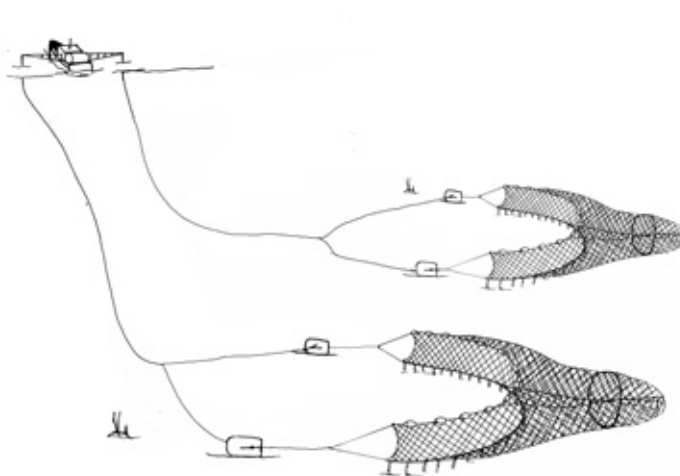
- > The netting or mesh is the panel of net that fish will encounter and be retained in. Modern nets are typically constructed from synthetic fibres, such as monofilament nylon for gillnets, and multiple twisted or braided polymer filaments for seine and trawl nets. Mesh size is important in selecting different sizes of fish and is incorporated in regulations for fisheries that allow for their use.
- > The top edge of the net is attached to a rope called the headline, floatline or corkline. Floats are attached to the headline to provide buoyancy.
- > The bottom edge of the net is attached by hanging twine to a rope called the footrope or leadline. Weights or sinkers made of lead or other materials attached to the footrope spread the net vertically in the water. The type and number of floats and weights used depend on whether the net is to be positively or negatively buoyant.

Trawl nets are more complex than the basic net set up as they are made of components that perform specialised functions. The South Australian Prawn fisheries use a demersal trawl configuration (Figure 3).

- > Warps are wire ropes connecting the trawl boards to the vessel.
- > Trawl boards (also called otter boards or trawl doors) keep the net open horizontally by acting as hydrodynamic kites. They also provide weight, which is required to keep the trawl at the desired depth of operation.
- > Backstrops are short lengths of wire or chain that connect the trawl boards to the sweeps. Sweeps are used on demersal otter trawls to connect the backstop to the bridle on each side of the net. Bridles connect the sweep on each side of the net to the headline and footrope on the wing ends of the net.
- > Ground gear is a wire or chain attached to the footrope to reduce damage from snagging by lifting the footrope and net clear of the seabed.
- > Body panels are the panels of net that make up the body of the trawl; they comprise upper and lower sections.

- > The codend or bag is the last section of the net, where prawns are collected and held during trawling operations. This area has the smallest mesh size and determines the size of prawns that the trawl will retain. The end of the codend is tied with a quick-release knot so that the prawns can easily be emptied from the net.
- > The lazy line is sometimes used to pull the codend on board so that it can be emptied.

Figure 3: Double-rig trawl gear used in the South Australia's prawn fisheries

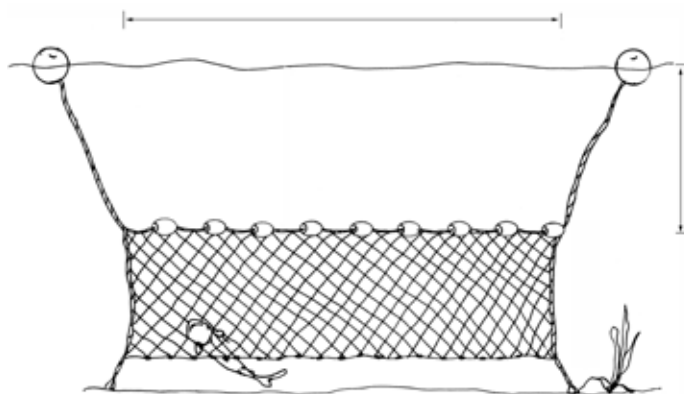


Gill nets are used to target King George Whiting, Mulloway, Southern Calamari and Yelloweye Mullet in South Australia. The nets consist of a length of net panel held vertically in the water, usually suspended between a floatline on the surface and a leadline or footrope in contact with the sea-bed. It is used as a static device to enmesh fish. The size of the mesh in the net determines the size range of the species caught. Gill nets include large and small mesh nets and swinger nets (Figure 4).

Fish are caught in gill nets or entanglement nets in one of three ways:

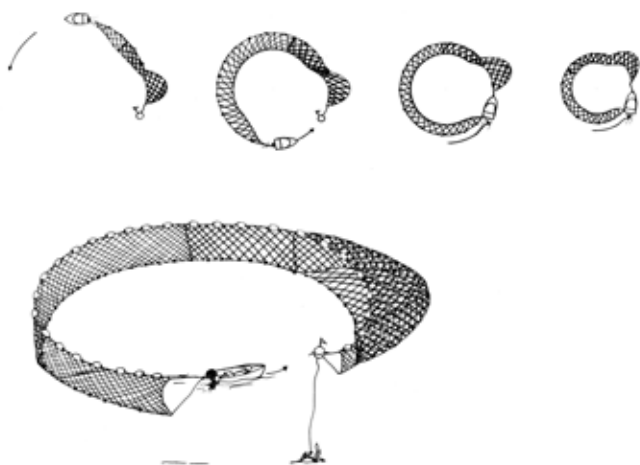
- > gilled—the fish tries to swim through one or more meshes; if it cannot pass through it becomes caught behind its gill covers as it tries to back out of the net.
- > wedged—the fish is tightly held in the net around the body by one or more meshes.
- > tangled—the fish is caught in the net by some part of its body, such as protruding fins or spines.

Figure 4: Mesh net



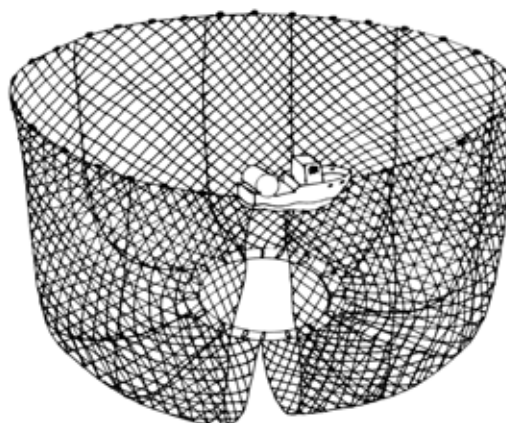
Hauling nets are used in the Marine Scalefish Fishery to target King George Whiting, Southern Garfish, Southern Calamari and Yelloweye Mullet. The nets generally consist of a straight panel of netting (a pocket section is commonly incorporated) that is set around a school of fish (Figure 5).

Figure 5: Hauling net



Purse seine nets are used in the Sardine component of the Marine Scalefish fishery to target Australian Sardine and Anchovy. The nets are positively buoyant, with sufficient flotation to support the expected catch. The end of the net that is set first (the bunt) is heavily reinforced, as this is where the fish will be concentrated when the net is hauled. The footrope of the net has purse rings attached at regular intervals by rope or chain. A purse line runs through the rings, which, when pulled, effectively closes the bottom of the net (Figure 6).

Figure 6: Purse seine net



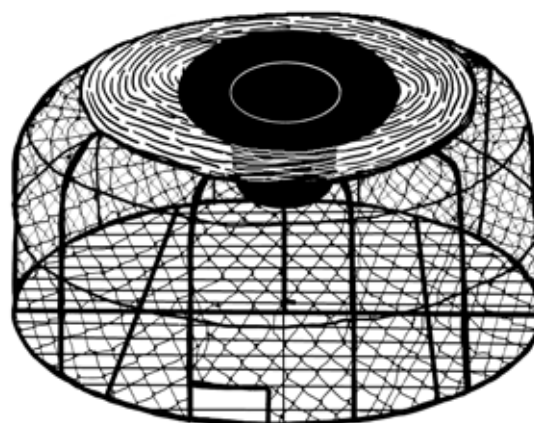
Traps and pots

A variety of traps and pots are used in South Australian commercial fisheries for harvest of Rock Lobster, Giant Crab, Blue Swimmer Crab, octopus and finfish species. Traps and pots are enclosures or devices that fish, crustaceans or molluscs enter voluntarily, or are entangled in, and are prevented from escaping in some way. Animals are enticed into the enclosure either by bait or because the apparatus appears to provide a refuge.

Most traps and pots are set on the seabed or riverbed with a haul-in line, surface float or dan buoy to mark their position. They can have one or more entrances or openings on the top or sides, depending on the target species. A line hauler is often used to pull traps and pots for checking and rebaiting.

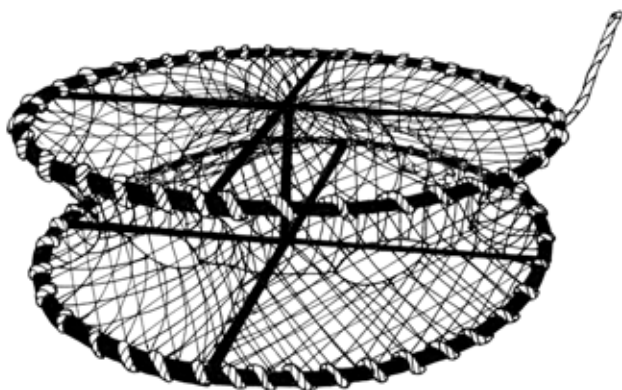
Rock Lobster pots used in South Australia are 'beehive pots' – dome-shaped pots, constructed with a wire frame covered with wire mesh or woven cane. An entrance at the top of the pot allows Rock Lobster to enter (Figure 7). In the Northern Zone of the Rock Lobster Fishery escape gaps and sea lion exclusion devices are required. These pots are also used for targeting Giant Crab in South Australia.

Figure 7: Rock Lobster pot



Blue Swimmer Crab pots are netted enclosures comprising two rings (1.2-1.4 m diameter) separated by three or four posts or through the use of a positively buoyant upper ring and a weighted lower ring. The waist of the trap is constricted, such that the trap resembles an hourglass. Crab traps are usually collapsible and may have one, two or three pairs of opposing side-entry funnels (Figure 8).

Figure 8: Blue Swimmer Crab pot

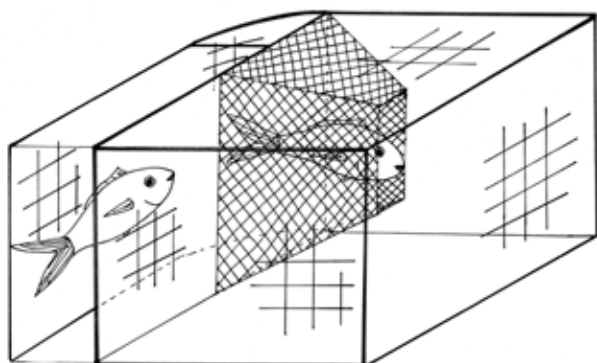


Marine Scalefish fishers are also allowed to fish for crabs in South Australia using drop nets and hoop nets. Drop nets are generally configured as two steel hoops connected by a collapsible mesh wall, while hoop nets consist of a single steel hoop. These nets are left on the sea floor for a matter of hours, and then lifted by bridles attached to the hoop in such a way that the frame remains horizontal and the catch is contained in the bag.

Fish traps may be cylindrical, rectangular or square in shape; and constructed of rigid steel rods. The traps have one or two openings through which fish enter (Figure 9).

Several configurations of hooks and lines are deployed to target a variety of species and sizes of fish in the commercial Marine Scalefish Fishery, including rods and lines, handlines, longlines and droplines.

Figure 9: Fish trap



Handlines and rod and line are the simplest form of gear used in the fishery and are generally used in inshore waters to take Snapper and King George Whiting. Squid are also often taken by lures (jigs) on handlines. Handlines consist of a hand reel with a single line and up to three hooks attached to each line (Figure 10). Rod and lines are a rod with the reel with line and up to three hooks attached to each line.

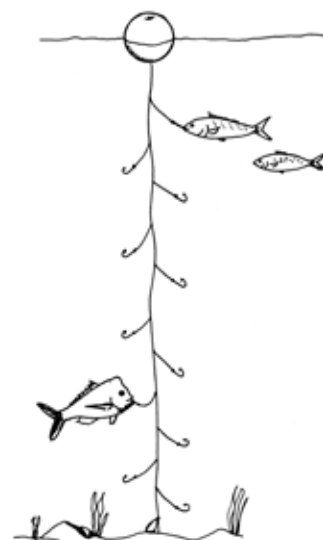
Figure 10: handline



Droplines are generally used offshore to target deep water fish species, particularly School and Gummy sharks. Droplines are a length of heavy line or rope (mainline) deployed vertically anchored by a weight at the bottom and buoyed at the surface. Snoods or traces (short lengths of line carrying baited hooks) are usually attached at regular intervals along the lower section of the mainline (Figure 11).

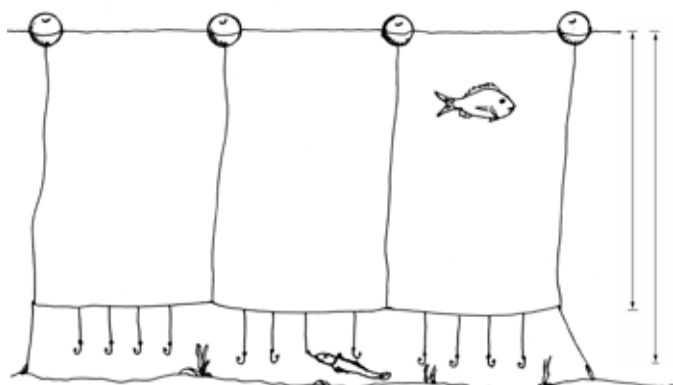
Longlines are generally used in Gulf waters to target Snapper and sharks. A longline differs from a dropline in that the mainline with

Figure 11: Dropline



baited snoods attached is set along the sea-bed or surface. It is anchored and buoyed at both ends of the mainline (Figure 12).

Figure 12: Longline



Hand-held implements

Hand-held implements are used in several commercial fisheries to target a variety of species; most often for harvesting Abalone, Mud Cockles and Pipsis. Implements are highly varied depending on the species being harvested and include rakes, hand nets, tongs, spears, bait pumps and blades (Figure 13 and 14).

Rakes and hand-held nets are used to harvest Mud Cockles, Pipsis, mussels, finfish and crabs. These implements are generally constructed of a bag, net or mesh made of metal or nylon and attached to a ring or frame on one end of a pole. The implement is used to drag through, or rake over the substrate to collect animals buried under the surface or to remove finfish from larger nets.

Bait spades, forks and bait pumps may be used for collecting worms and other bait species on tidal flats. Fish spears may be used to harvest flounder in shallow bays but must only be hand propelled. Tongs may also be used for collecting Razorfish from shallow water. Metal blades, also known as Abalone irons, are used for detaching Abalone from hard rock surfaces in South Australia's Abalone fisheries.

Figure 13: A cockle net

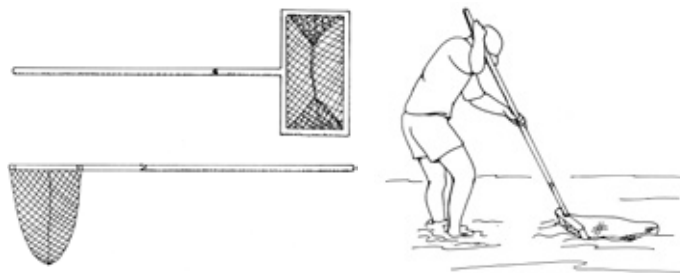
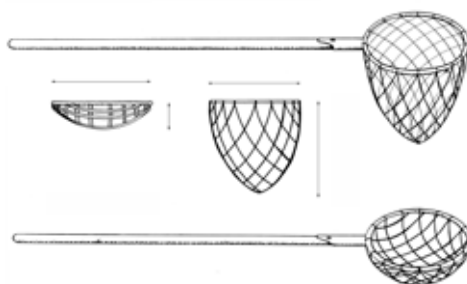


Figure 14: Dab net



Underwater dive equipment is allowed in several commercial fisheries in conjunction with hand-held implements to harvest, amongst other species, Abalone and sea urchin. Diving in South Australia includes snorkelling (or free diving), scuba (self-contained underwater breathing apparatus) and hookah diving (using surface-supplied air).

Recreational fishing gear

Recreational fishers in South Australia may use a variety of gear when undertaking recreational fishing including lines, nets, traps and hand-held implements. In many cases these are of similar construction to those used in commercial fisheries. Often there are restrictions on the number or gear type and recreational fishers are not allowed to use droplines, longlines, fish traps (for finfish) or nets other than mesh nets. Rock Lobster pots must be registered and registrations are limited to two per person. Further information about recreational fishing gear is available at pir.sa.gov.au/fishing and via the South Australian Recreational Fishing Guide smartphone app.

2.5 Legislative and policy framework

Fisheries Management Act 2007

The *Fisheries Management Act 2007* provides for the conservation and management of the aquatic resources of the State; the management of fisheries and aquatic reserves; the regulation of fishing and the processing of aquatic resources; the protection of aquatic habitats, aquatic mammals and aquatic resources; the control of exotic aquatic organisms and disease in aquatic resources; and for other purposes.

Management of fishing in South Australia is governed by the *Fisheries Management Act 2007* and the following regulations:

- > *Fisheries Management (General) Regulations 2007*: prescribes restrictions on fishing, particularly recreational fishing such as size, bag and boat limits.
- > *Fisheries Management (Fees) Regulations 2007*: sets the fees charged for licences, gear registrations and various applications under the Act.
- > *Fisheries Management (Fish Processors) Regulations 2007*: prescribes requirements for the regulations for the fish processing industry.
- > *Fisheries Management (Aquatic Reserves) Regulations 2008*: provides for the establishment of reserves with restrictions on fishing and other activities.
- > *Fisheries Management (Vessel Monitoring Scheme) Regulations 2007*: allows the monitoring of movement of certain commercial fishing vessels.
- > Regulations for individual fisheries: prescribes specific management arrangements such as quota management and licence transfers e.g. *Fisheries Management (Abalone Fisheries) Regulations 2006*.

To view South Australian legislation relating to fisheries visit www.legislation.sa.gov.au

The *Fisheries Management Act 2007* describes the requirements for fisheries management plans. Management plans developed for South Australia's fisheries provide general information about the fishery; potential impacts or risks of the fishery on the ecosystem; and the ecological factors that could impact on the fishery. It also sets out strategies to address those impacts; sets out methods for monitoring the performance of the fishery and the plan; specifies the share of resources allocated to each fishing sector; and sets out a harvest strategy for the fishery.

The *Fisheries Management Act 2007* provides that a management plan must specify the share of the fishery to be allocated to each fishing sector. PIRSA has adopted an *Allocation Policy* (PIRSA 2011a) as guidance in the development of management plans and as a source of information for members of each fishing sector and the wider community about the approach that will be taken in the administration of the Act with regard to allocation of fishery resources. The policy addresses the question of allocation of access to aquatic resources between extractive user groups – commercial, recreational and Aboriginal traditional fishing sectors.

PIRSA has adopted a *Policy for the Co-Management of Fisheries in South Australia* (PIRSA 2013a) to guide further development of co-management between PIRSA, fishing sectors and other stakeholder groups. Co-management is an arrangement whereby responsibilities and obligations for sustainable fisheries management are negotiated, shared and delegated at appropriate levels between government, the commercial fishing industry, recreational fishers, Aboriginal traditional fishers and other key stakeholders such as conservation groups (Neville 2008).

Environment Protection and Biodiversity Conservation Act 1999 (Commonwealth)

South Australian commercial fisheries are assessed by the Commonwealth Department of the Environment against the Guidelines for the Ecologically Sustainable Management of Fisheries under the *Environment Protection and Biodiversity Conservation*

Act 1999 (Commonwealth). Nine South Australian fisheries currently have exemptions from the export controls under the Act, which identifies them as ecologically sustainable. These fisheries are declared an approved Wildlife Trade Operation (WTO) while conditions are being met. Table 3 provides the current status of ecological assessment for all South Australian fisheries.

Table 3: South Australian fishery assessment status under the *Environment Protection and Biodiversity Conservation Act 1999*

Fishery	Assessment	Assessment date	Next assessment date
Rock Lobster	Exempt	October 2013	October 2018
Abalone	Exempt	August 2013	August 2018
King Prawn	Exempt	November 2009	October 2015
Sardine	Exempt	October 2009	November 2015
Marine Scaefish	WTO	January 2012	September 2015
Lakes and Coorong	WTO	May 2011	February 2016
Blue Crab	Exempt	April 2010	April 2015
Giant Crab	Exempt	March 2010	December 2015
Sea Urchin	Exempt	September 2011	October 2016
Specimen Shell	Exempt	May 2010	May 2015
Scallop and Turbo	Exempt	September 2010	May 2015
Seagrass and Algae	WTO	June 2015	May 2018

2.6 Environmental influences including climate change

South Australia's marine and freshwater regions comprise several unique ecosystems ranging from inland freshwater rivers and lakes, to inshore gulfs, estuaries and coastal marine waters, as well as offshore and shelf waters. These ecosystems support a diverse range of valuable aquatic resources (fish and aquatic plants). South Australia is surrounded by nutrient-poor waters, resulting in lower productivity in terms of volume than many other parts of the world. However, major upwelling events bring cold, nutrient-rich waters inshore (Middleton and Platov 2003) resulting in an increase in productivity of phytoplankton, believed to contribute to important fisheries such as Rock Lobster (Lewis 1981) and Sardine (Ward et al. 2006). In contrast, the gulfs are shallow embayments that in summer can become hyper-saline in the shallow northern reaches due to a paucity of freshwater influx and high evaporation.

There is growing evidence to suggest that our climate is changing. With that change, climatic patterns such as winds, currents, rainfall and temperature will change. These changes will have a direct impact on the marine environment, habitat and, ultimately, fish stocks. According to the Bureau of Meteorology, Australian air temperatures have, on average, risen 1°C since the middle of the 20th century. Rainfall patterns have also changed, with much of southern Australia experiencing a rainfall decline over the past 50 years. Various climate change models predict higher temperatures and less rainfall overall, with increases in extreme weather events such as floods and drought. As fish are influenced by climatic patterns, fish distribution, recruitment and production are bound to change (Hobday et al. 2008). Climate change will present both challenges and opportunities for South Australia's fisheries and fisheries worldwide. Understanding climate change impacts (biophysical, market and policy) and helping the fishing industry adapt to climate change is a priority for PIRSA.

2.7 Education and awareness, deterrence and enforcement

There is a strong community expectation that the State's fisheries resources will be maintained at sustainable levels and that aquatic environments will be protected. PIRSA has compliance and monitoring programs in place for the commercial and recreational fishing sectors with the objectives to maximise voluntary compliance with fisheries rules and create effective deterrence to breaching fisheries rules.

Voluntary compliance is maximised through ensuring that fishers are aware of the rules that apply to their fishing activities, understand the rules and the purpose of those rules and operate in a culture of compliance.

Effective deterrence is created through the presence of Fisheries Officers and awareness of compliance operations, as well as detection and prosecution of illegal activity.

In consultation with the various fishery industry representatives, a dedicated Compliance Plan has been developed for each fishery to ensure compliance activities are intelligence driven, cost effective efficient and outcome focussed. Compliance activity, effort and outcomes are collated and reported against each of the fishery-specific risks and strategies identified through fishery-specific compliance plans.

PIRSA has a variety of strategies in place aimed at informing and educating fishers of the rules that apply and an understanding of why these rules are necessary. Some of the strategies include the production of a range of printed material (e.g. Recreational Fishing Limits brochure, signage at popular fishing spots, information, PIRSA website), recreational fishing smartphone app, issuing of media releases, developing partnerships with schools and other educational institutions, Fishwatch reporting and information hotline and Fishcare Volunteer program.

There are approximately 90 Fishcare volunteers statewide who spoke to more than 22,000 recreational fishers and contributed approximately 6,000 hours in 2013-14.

2.8 Harvest strategies

Harvest strategies have been developed for most of South Australia's commercial fisheries to enhance fisheries management and provide an increased level of certainty and transparency for all stakeholders. Harvest strategies provide an effective fisheries management tool to integrate ecological, social and economic dimensions of fisheries management into a single framework for management decision-making (Sloan et al. 2014). A harvest strategy is a framework that specifies pre-determined actions in a fishery for a defined species (at the stock or management unit level) that are necessary to achieve the agreed ecological, economic and/or social management objectives.

A policy providing an overarching framework for the development of harvest strategies for South Australian fisheries is in development (PIRSA in prep). New harvest strategies developed in the future for South Australian fisheries will be consistent with this policy. Such harvest strategies are expected to lead to better managed fisheries and result in decisions on harvest levels being made in a more transparent and predictable manner; and with the understanding of fishers and other key stakeholders.

Harvest strategies in South Australia take a variety of different forms as they are tailored to individual fishery circumstances, and take into consideration the arrangements with other jurisdictions and fishing sectors (e.g. recreational, commercial and Aboriginal traditional fishers), the level of data availability, etc.

Key elements of harvest strategies in South Australia include:

- > Defined operational objective/s for the fishery
- > Fishery performance indicators related to the operational objectives
- > Reference points for performance indicators
- > Monitoring strategy
- > Assessment of fishery performance
- > Decision rules that control the intensity of fishing activity and/or catch

Further information on the policy framework for developing harvest strategies in South Australian fisheries is available in the *South Australian Fisheries Harvest Strategy Policy* (PIRSA in prep.). Information on individual fishery harvest strategies can be found in the relevant fishery management plan and stock assessment reports available at www.pir.sa.gov.au/fishing.

Molluscs



3 Molluscs

3.1 Blacklip Abalone (*Haliotis rubra*)

Authors: Stephen Mayfield, Lianos Triantafillos and Matthew Hoare



Table 4: Stock status determination for the Blacklip Abalone Fishery of South Australia.

Management unit	Western Zone	Central Zone	Southern Zone
Status	Transitional-depleting	Transitional-depleting	Sustainable
Primary indicator	Catch rate	Catch rate	Catch rate

Stock structure

Blacklip Abalone (*Haliotis rubra*) are found throughout southern Australia, from D'Entrecasteaux Reef in South Australia to South Cape in Tasmania, and northwards to Sydney in New South Wales. The bulk of the population is found in Tasmania (Mayfield et al. 2012). They predominantly occupy high-profile reef areas at depths ranging from three to 30 metres. Juveniles are more cryptic than adults and are commonly found in crevices.

Empirical field studies (Prince et al. 1987) and molecular techniques (Temby et al. 2007, Miller et al. 2009) demonstrate Blacklip Abalone comprise a large number of small independent stocks. Each stock may extend over only a few hundred metres. The number of biological stocks (tens to hundreds) may vary between management

zones. Given the large number of stocks it is not practical to assess each stock separately. Consequently, assessment of stock status is undertaken for each of the three commercial Blacklip Abalone management zones in South Australia (Figure 15).

Fishery overview

The South Australian Commercial Abalone Fishery targets the Blacklip Abalone *Haliotis rubra* and Greenlip Abalone *H. laevigata*. Other species of Abalone, such as *H. cyclobates*, *H. scalaris* and *H. roei* can be taken by the fishery, but as they rarely reach the minimum legal size, they are seldom landed (PIRSA 2012a).

Commercial Blacklip Abalone divers operate from small boats using hookah gear and harvest abalone by hand with a metal blade. They commonly use self-propelled cages to fish large areas with minimal

Figure 15: Distribution of commercial catch of Blacklip Abalone in the three management zones in 2013. Note: to avoid disclosure of confidential data, levels of catch are not shown for areas that relate to less than five licences.

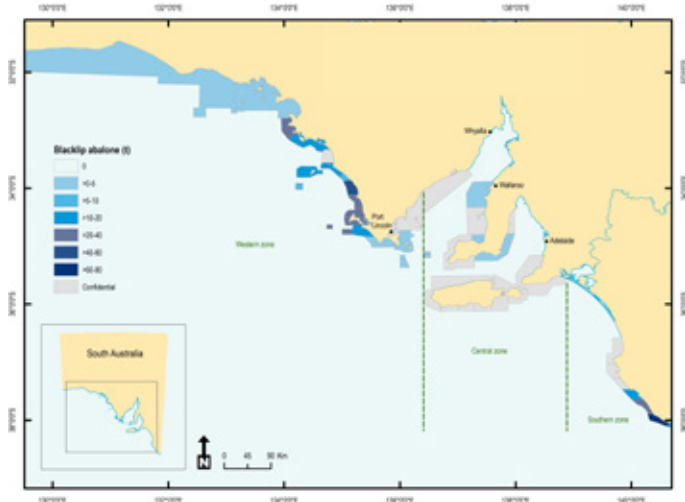


Table 5: Key biological traits of Blacklip Abalone.

Parameter	Description
Range	D'Entrecasteaux Reef in South Australia to South Cape, Tasmania and northwards to Sydney in New South Wales
Depth	3 m to 30 m
Longevity	30 years
Maximum size	210 mm shell length
Size at maturity	Age: 4-6 years Size: 70–110 mm shell length
Spawning season	March to November

effort and for protection from sharks. Blacklip Abalone meat is sold in a variety of ways including canned, frozen, dried, parboiled and live. The majority of the annual catch is exported to Asia (EconSearch 2014a).

Recreational fishing for Blacklip Abalone is either by snorkelling or SCUBA diving. A survey of recreational catch and effort levels for abalone in South Australia in 2007-08 by Jones (2009) estimated that the total catch of Blacklip Abalone by recreational fishers in South Australia was 0.6 t.

Many Aboriginal communities have a long history of fishing in what are now known as South Australian waters. Presently, there is limited information available on the take of abalone by the Aboriginal traditional fishing sector.

The South Australian Commercial Abalone Fishery began in the mid 1960s, and licence holders soon exceeded 100. In 1971, licences were made non-transferable to reduce the number of operators, and a minimum legal size limit of 130 mm shell length was imposed on

all abalone species to help conserve egg production. In the same year, the fishery was divided into three separate management zones – Western, Central and Southern – in recognition of the significant differences in geological and ecological characteristics across the South Australian coast (Figure 15). The policy of non-transferability decreased the number of licence holders with commercial access to 30 by 1976, when five new licences were issued. This brought the total number of licences to 35.

Licences were again made transferable in 1980 and the Western Zone was divided into Regions A and B in 1984. Individual quotas were introduced into the Western Zone in 1985 and the Southern Zone in 1988. One year later, individual quotas were also implemented into the Central Zone. A combined TACC for both Greenlip and Blacklip Abalone was introduced into Region B of the Western Zone in 1991 and the owner-operator regulation was abolished in 1993. Four fishdown areas were defined in 1994 in the Southern Zone, where Blacklip Abalone between 110 and 125 mm shell length could be taken.

In 1997, the first management plan for the South Australian Commercial Abalone Fishery was prepared (Zacharin 1997a) and replaced seven years later by Nobes et al. (2004). A third management plan came into effect on 1 September 2012 and includes a harvest strategy that provides a risk-based framework to support the determination of separate TACCs for Blacklip and Greenlip Abalone (PIRSA 2012a).

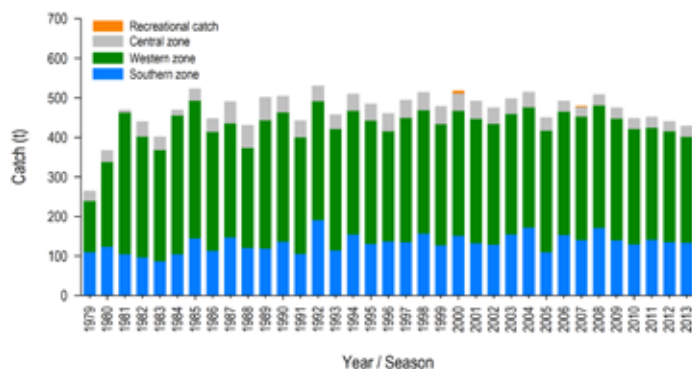
In 2013, the Southern Zone was divided into 13 different spatial assessment units (SAUs), based on differences in biological characteristics of stocks, to allow for finer-spatial scale management. Each SAU was allocated its own minimum legal size limit and catch cap for Blacklip Abalone. These minimum legal size limits and catch caps are reviewed on an annual basis.

On 1 January 2014, Regions A and B of the Western Zone were amalgamated into one region to improve the integrity of the quota management system and reduce management costs.

Catch trends

The Blacklip Abalone resource of South Australia is one among only a few worldwide that have yielded sustained wild catch commercial harvests over an extended period. Initial harvests were recorded in 1964 (Mayfield et al. 2012). The annual commercial catch of Blacklip Abalone has remained stable for more than 30 years. In 2012-13, the total catch landed by the South Australian Commercial Blacklip Abalone Fishery was 483.9 t. Most of the catch is harvested from the Western Zone (65%) and Southern Zone (30%), with considerably lower catches from the Central Zone (Figure 16). Recreational catches for this species are small (Figure 16).

Figure 16: Annual catch information for the Blacklip Abalone Fishery of South Australia. Data for the Southern Zone (blue), Western Zone (green) and Central Zone (grey) are by calendar year. Data for recreational catch (orange) are by season (i.e. 1980-81 denoted 1980) and have only been collected in 2000-01 and 2007-08 during recreational fishing surveys.



Management arrangements

Regulatory arrangements for the Blacklip Abalone Fishery are contained within the *Fisheries Management (Abalone Fisheries) Regulations 2006* and *Fisheries Management (General) Regulations 2007*.

In 2014, one licence in the Western Zone was surrendered, followed in 2015 by removal of 62.1 Blacklip Abalone quota units in the Central Zone, through the South Australia Marine Parks: Commercial Fisheries Voluntary Catch/Effort Reduction Program.

Commercial access to Blacklip Abalone is currently limited to a total of 34 commercial licences. There are 22 licences in the Western Zone and six in each of the Central and Southern Zones (Table 6).

The quota management system is the major management tool for Blacklip Abalone, with a TACC set every year in each management zone. Licences are endorsed with quota units for either the Southern, Central or Western Zones. Quota units are fully transferable among licence holders within zones.

Minimum legal size limits (shell lengths) and a weight limit (meat weight) also apply. There are three different minimum shell lengths (110 mm, 120 mm and 125 mm) for Blacklip Abalone in the Southern Zone and one minimum shell length (130 mm) for the Central Zone and Western Zone. A summary of the current management arrangements for Blacklip Abalone is shown in Table 6.

The recreational sector is managed through a combination of output and input controls that ensure the total recreational catch is maintained within sustainable limits and that access to the fishery is equitably distributed among sectors. These regulations are outlined in Table 7 and include a daily bag limit of five abalone per day per person, and a boat limit of 10 where three or more people are on board.

Table 6: Summary of management arrangements for the South Australian Commercial Blacklip Abalone Fishery in 2013-2014*. All values are in whole weight.

Management arrangements	Southern Zone	Central Zone	Western Zone
Limited entry (number of licences)	6	6	22
Minimum legal size limit	125 mm: SAU 1,2,3,5,6,8,10 120 mm: SAU 4,7,9,11,12 100 mm: SAU 13	130 mm	130 mm
Minimum weight limit	N/A	113 g	113 g
Commercial gear	Hand collection only	Hand collection only	Hand collection only
Commercial gear restrictions	Hand collection only	Hand collection only	Hand collection only
TACC	151.5 t [#]	24.3 t	252.2 t
Spatial closures	Yes	Yes	Yes
Temporal closures	No	No	No
Vessel monitoring system	Yes	No [§]	No

* 2014 season for Southern Zone Abalone fishery corresponds to September 2013 to August 2014.

[#] Each of the 13 SAUs has a catch cap.

[§] Divers use a data logger system (GPS and depth logger), but this isn't real time like VMS.

Table 7: Summary of management arrangements for the South Australian Recreational Blacklip Abalone Fishery in 2013-14.

Management arrangements	Southern Zone	Central Zone	Western Zone
Recreational gear	Hand collection only	Hand collection only	Hand collection only
Recreational gear restrictions	Hand collection only	Hand collection only	Hand collection only
Minimum legal size limit	130 mm shell length	130 mm shell length	130 mm shell length
Minimum weight limit	113 g	113 g	113 g
Recreational bag and boat limits	Bag limit: 5 per person Boat limit: 10	Bag limit: 5 per person Boat limit: 10	Bag limit: 5 per person Boat limit: 10
Spatial closures	Yes	Yes	Yes
Temporal closures	No	No	No
Possession limit	25*	25*	25*

* Combined Blacklip/Greenlip Abalone limit. Having more than 25 abalone in your possession is considered a commercial quantity.

Harvest strategy

The harvest strategy for the South Australian Commercial Abalone Fishery is the primary tool for assessing the performance of Blacklip Abalone in each management zone and for setting the TACC (PIRSA 2012a; Mayfield et al. 2013; Stobart et al. 2013). The harvest strategy uses up to six performance indicators (Table 8) to:

- > Assess the risk that the Blacklip Abalone stocks in each SAU are overfished.
- > Determine a catch-weighted stock status for the management zone.
- > Link the risk-of-overfishing category for each SAU with decision rules and industry-based information to determine TACCs.

As the magnitude of Blacklip Abalone catches vary spatially, the assessments of SAUs are prioritised (high, medium and low) and are weighted by catch.

The harvest strategy for the South Australian Commercial Abalone Fishery will be reviewed in 2015.

Monitoring and assessment

The monitoring and assessment of the commercial Blacklip Abalone Fishery uses information from three sources: (1) fishery-independent survey data; (2) fishery-dependent commercial logbook data; and (3) fishery-dependent commercial catch sampling data. These data are integrated and combined with input from commercial fishers through the harvest strategy. Fishery-independent surveys are undertaken biennially and provide information on the abundance of

Table 8: Harvest strategy components for the South Australian Commercial Blacklip Abalone Fishery.

Harvest strategy component	Blacklip Abalone Fishery
Objectives	Maintain Blacklip Abalone stocks above ecologically sustainable levels.
Performance indicators	<ul style="list-style-type: none"> > Total catch (percentage of the TACC). > Proportion of large Blacklip Abalone in the commercial catch. > Commercial catch per unit of effort (CPUE) (kg/hr) of legal-sized Blacklip Abalone. > Density of legal-sized Blacklip Abalone from fishery-independent surveys. > Density of pre-recruit Blacklip Abalone from fishery-independent surveys. > Total mortality from fishery-independent surveys.
Limit reference points	Yes
Target reference points	Yes
Trigger reference points	Yes
Decision rules	Yes

legal-sized and pre-recruit Blacklip Abalone. They also provide data on the length structure of the population. Fishing location, catch and effort are the main information obtained from the commercial logbook data. Commercial catch sampling data comprise measurements of shell length obtained from all three management zones and provide information on exploitation rate.

Current biological status

The harvest strategy in the *Management Plan for the South Australian Commercial Abalone Fishery* (PIRSA 2012a) includes a catch-weighted determination of stock status for each management zone. However, the harvest strategy does not identify a performance indicator and reference point below which the fishery would be defined as 'overfished'. In addition, the harvest strategy may result in a more optimistic assessment of stock status than those from more traditional weight of evidence methods (Mayfield et al. 2014; Stobart et al. 2013, 2014). In this assessment catch per unit effort (CPUE kg/hr) is used as the index of relative Blacklip Abalone abundance. This measure can provide a more optimistic index of relative abundance than measures from fishery-independent surveys, because catch rates in dive fisheries can be hyperstable (Shepherd and Rodda 2001; Dowling et al. 2004). Decreases in CPUE in abalone fisheries are considered to be a reliable indicator of declines in abalone abundance, but can underestimate the magnitude of the reduction (Stobart et al. 2014). These factors will be considered in the review of the harvest strategy to be conducted in 2015.

Western Zone

The commercial CPUE (meat weight) of Blacklip Abalone in the the Western Zone increased steadily from 17.1 kg/hr in 1979 to over 25.6 kg/hr in 2003, the highest level on record (Figure 17). Subsequently, the CPUE has decreased each year thereafter. In 2013 it was 20.8 kg/hr, 18% below that in 2003, and at the lowest level since 1996. The latest fishery-independent survey densities at most sites are low relative to previous years. On the basis of the evidence available, the Blacklip Abalone resource in the Western Zone management unit is categorised as **transitional-depleting**. In response to the status for Blacklip Abalone in the Western Zone, TACC was reduced by 5% in 2013 in Region A, and by 50% between 2011 and 2012 in Region B of the zone. A shortened fishing season was also introduced in Region B of the zone in 2013. Note that Region A and B have now been combined to simplify management of the Western Zone.

Central Zone

In the Central Zone, the commercial CPUE (meat weight) of Blacklip Abalone increased rapidly between 1979 (18.9 kg/hr) and 1989 (26.5 kg/hr; Figure 17), which was the highest value in the history

of the fishery. From 1990 to 2003, CPUE was relatively stable, but variable among years. Since 2003, the CPUE has generally decreased. In 2012 and 2013, the CPUE was 18.5 kg/hr and 19.2 kg/hr, respectively, and at the lowest levels since 1985. On the basis of the evidence available, the Blacklip Abalone resource in the Central Zone management unit is categorised as being **transitional-depleting**.

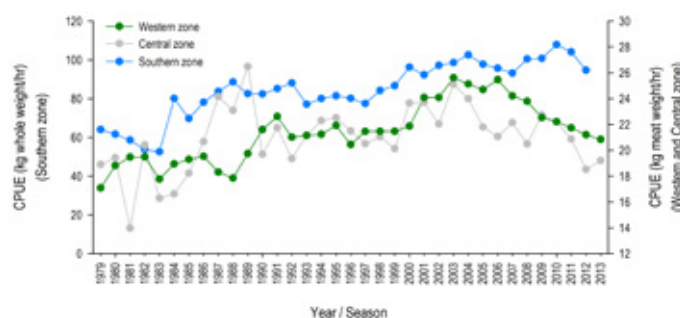
In response to the status for Blacklip Abalone in the Central Zone, scientific data collection requirements have been substantially increased since 2013 to provide additional information to inform management.

Southern Zone

The commercial CPUE (whole weight) of Blacklip Abalone in the Southern Zone increased from 64.1 kg/hr in 1979/80 to over 107.8 kg/hr in 2010-11, the highest level on record (Figure 17). Although the CPUE has subsequently declined, in 2012-13 it was 94.6 kg/hr, remaining among the highest values on record. On the basis of the evidence available, the Blacklip Abalone resource in the Southern Zone management unit is categorised as **sustainable**.

Effects of fishing on the marine environment

Figure 17: Commercial CPUE of legal-size abalone Blacklip Abalone from 1979 to 2013. Data for Western Zone (green) and Central Zone (grey) are by calendar year; data for the Southern Zone (blue) are by season (1980-81 denoted 1980).



The overall environmental impacts associated with this fishery are considered to be low because Blacklip Abalone are hand selected by divers operating from vessels that seldom anchor. Thus, the fishery has limited direct physical impact on the environment. There is also evidence that the ecosystem effects of removing abalone are minimal (Jenkins 2004; Hamer et al. 2010; Valentine et al. 2010).

An Ecologically Sustainable Development (ESD) Risk Assessment was carried out on the commercial Abalone Fishery in 2009 to inform development of the management plan for the fishery (PIRSA 2009). A total of 13 risks with a rating moderate or higher were identified. Of these, the two highest risks identified for this fishery were:

- > An outbreak of Abalone Viral Ganglioneuritis in the Southern Zone.
- > Sufficient resources for policy, management and research to ensure the Blacklip Abalone resource is harvested within sustainable limits.

This ESD Risk Assessment did not identify any general ecosystem risks from the impacts of fishing (PIRSA 2009).

The Australian Government Department of the Environment re-assessed the South Australian Abalone Fishery in August 2013 under the *Environment Protection and Biodiversity Conservation Act 1999*. The assessment concluded that this fishery was managed in an ecologically sustainable way. The South Australian commercial Abalone Fishery was provided with a five-year exemption from export controls until August 2018.

Social and economic information

The South Australian Commercial Abalone Fishery (including both the Blacklip and Greenlip Abalone) is the State's third most valuable fishery. The value of abalone fishing enterprises in South Australia was estimated to be \$29.6 million in 2012-13 (Table 9), while output from associated downstream activities (processing, transport, retail/food services and capital expenditure) was \$16.5 million. The flow-on effect to other sectors of the State economy added another \$46.4 million in output. In 2012-13, this fishery provided for the direct employment of around 71 full-time equivalent jobs and downstream activities created employment of another 51 jobs statewide. Flow-on business activity was estimated to generate a further 166 jobs State-wide (EconSearch 2014a).

Table 9: Socio-economic information for the South Australian Commercial Abalone Fishery including Blacklip and Greenlip Abalone, 2012-13 (source: EconSearch. 2014a)

Socio-economic indicator	Combined species and zones ³
GVP - Abalone (\$ million)	29.6
Contribution to GSP (\$ million)	52.6
Total employment (direct and indirect jobs)	288

³ Indicators reported in this table are combined figures for Blacklip and Greenlip Abalone from all zones.

Education, awareness, deterrence and enforcement

All compliance checks, monitoring and enforcement for Blacklip and Greenlip Abalone are undertaken and reported together.

Table 10: Compliance summary for the South Australian Abalone Fishery for Blacklip and Greenlip Abalone for 2012-13.

	Commercial	Recreational*
Key risks	<ul style="list-style-type: none"> > Quota evasion > Take of under-size abalone > Quota Management System integrity > Disease or pest incursion 	<ul style="list-style-type: none"> > Illegal, unreported, unregulated take and illegal sales > Take of under-size abalone and/or exceeding the bag and boat limit > Fishing in closed areas
Control measures	Education and awareness <ul style="list-style-type: none"> > Ongoing dialogue with fishers including inductions and briefings > Attend and contribute to fishing industry meetings > Provide information through media, Fishwatch, website and printed material 	Education and awareness <ul style="list-style-type: none"> > Fisheries Officers and Fishcare Volunteers patrolled popular fishing locations providing education material to recreational fishers > Fishcare Volunteers attended and contributed to boating and camping shows and regional field days > Provided information through media, Fishwatch, SMS Fish, Recreational Fishing App, measuring gauges, website and printed material
	Deterrence <ul style="list-style-type: none"> > Inspections at sea, at landing, in transport, at fish processors and at unregistered fish processors such as seafood outlets and grocery shops > Monitoring and audits on reports of fishing activities by commercial fishers > Monitor fishing in closed areas and during seasonal closures > Monitor abalone taken from prescribed spatial areas with prescribed size limits 	Deterrence <ul style="list-style-type: none"> > Catch inspections on the beach, at points of landing, in transit and at sea > Investigate exports of abalone through Adelaide Airport and unregistered premises > Monitor fishing activity in closed areas > Monitor abalone taken from prescribed spatial areas with prescribed size limits > Collect and analyse information provided to Fishwatch
	Enforcement <ul style="list-style-type: none"> > Covert and overt observations and conduct intelligence-driven operations > Address non-compliance where appropriate with issuing of cautions, expiations and prosecutions before court 	Enforcement <ul style="list-style-type: none"> > Intelligence driven operations > Respond and investigate calls to Fishwatch regarding illegal fishing activity > Address non-compliance where appropriate with issuing of cautions, expiations and prosecutions before court
Compliance effort and outcomes	<ul style="list-style-type: none"> > Fisheries Officers attended industry meetings and maintained ongoing contact with fishers > Education program delivered to ensure abalone are measured on the sea floor > Responded to reports of lesions on abalone and several fish kills including Point Drummond > Investigated irregularities with quota system documentation > Conducted routine, random and targeted inspections 	<ul style="list-style-type: none"> > PIRSA conducted three multi-jurisdictional investigations resulting in 11 defendants alleged to have trafficked significant quantities of abalone > 1,108 inspections conducted at sea and 8,651 inspections at points of landing or land based fishing locations in the recreational fishery > 16,974 contacts with recreational fishers were made by Fisheries Officers and Fishcare Volunteers. > 55 community events attended by Fishcare Volunteers and Fisheries Officers > 50 media releases were produced in relation to the recreational fishery
Trends/Issues	<ul style="list-style-type: none"> > Quota Management System review commenced in Western Zone Abalone Fishery > Increased size limits for Greenlip Abalone in Central Zone Abalone Fishery > Spatial management commenced in Southern Zone Abalone Fishery 	

* The South Australian Recreational Fishery is managed as one fishery statewide. As such, control measures and compliance effort and outcomes are not species specific.

3.2 Greenlip Abalone (*Haliotis laevis*)

Authors: Stephen Mayfield, Lianos Triantafillos and Matthew Hoare



Table 11: Stock status determination for the Greenlip Abalone Fishery of South Australia.

Management unit	Western Zone	Central Zone	Southern Zone
Status	Sustainable	Transitional-depleting	Undefined
Primary indicator	Catch rate	Catch rate	N/A

Stock structure

Greenlip Abalone, (*Haliotis laevis*) are distributed across southern Australia, from Cape Naturaliste in Western Australia to Flinders Island in Tasmania. The bulk of the population is found in South Australia (Mayfield et al. 2012). They predominantly occupy low-profile reef areas at depths ranging from 10 to 30 m. Juveniles are more cryptic than adults.

Genetic evidence has confirmed that like Blacklip Abalone (Miller et al. 2009), Greenlip Abalone comprise numerous, independent biological stocks, but at a spatially broader scale than those exhibited by Blacklip Abalone (Mayfield et al. 2014; Miller et al. 2014). Each stock may extend over a few hundred metres. The number of biological stocks may vary between management zones. Given the large number of stocks it is not practical to assess each stock separately. Consequently, assessment of stock status is undertaken for each of the three commercial abalone fishing zones in South Australia (Figure 18).

Figure 18: Distribution of commercial catches of Greenlip Abalone in the three management zones of South Australia in 2013. Note: to avoid disclosure of confidential data, levels of catch are not shown for areas that relate to less than five licences.

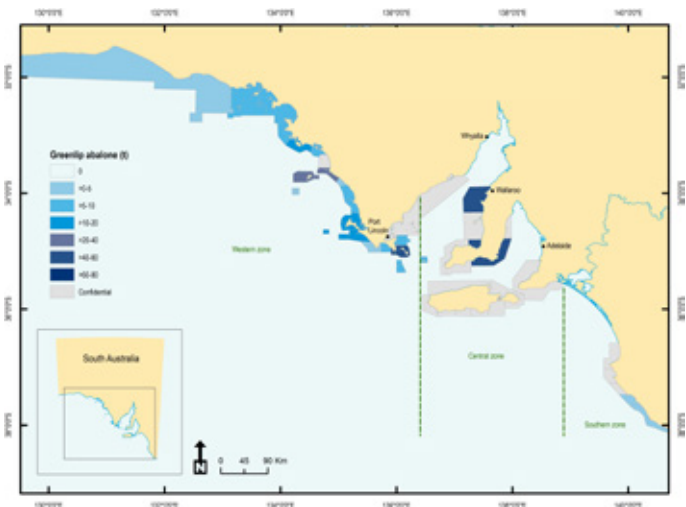


Table 12: Key biological traits of Greenlip Abalone.

Parameter	Description
Range	Cape Naturaliste, Western Australia to Flinders Island, Tasmania
Depth	5 m to 50 m, predominantly 10 m to 30 m
Longevity	30 years
Maximum size	245 mm shell length
Size at maturity	Age: 4-5 years Size: 70–120 mm shell length
Spawning season	September to February

Fishery overview

The South Australian Commercial Abalone Fishery targets Greenlip Abalone *Haliotis laevis* and Blacklip Abalone *H. rubra*. Other species of abalone, such as *H. cyclobates*, *H. scalaris* and *H. roei* can be taken by the fishery, but as they rarely reach the minimum legal size, they are seldom landed (PIRSA 2012a).

Commercial Greenlip Abalone divers operate from small boats using hookah gear and harvest abalone by hand with a metal blade. They commonly use self-propelled cages to fish large areas with minimal effort and for protection from sharks. Greenlip Abalone meat is sold in a variety of ways including canned, frozen, dried, parboiled and live. The majority of the annual catch is exported to Asia (EconSearch 2014a).

Recreational fishing for Greenlip Abalone is either by snorkelling or SCUBA diving. A survey of recreational catch and effort levels for abalone in South Australia in 2007-2008 by Jones (2009) estimated that the total catch of Greenlip Abalone by recreational fishers in South Australia was 1.7 t.

Many Aboriginal communities have a long history of fishing in what are now known as South Australian waters. Presently, there is limited information available on the take of abalone by the Aboriginal traditional fishing sector.

The South Australian Commercial Abalone Fishery began in the mid 1960s, and licence holders soon exceeded 100. In 1971, licences were made non-transferable to reduce the number of operators and minimum legal size limits of 130 mm shell length were imposed on all abalone species to help conserve egg-production. In the same year, the fishery was divided into three separate management zones – Western, Central and Southern – in recognition of the significant differences in geological and ecological characteristics across the South Australian coast (Figure 19). The policy of non-transferability decreased the number of licence holders with commercial access to 30 by 1976, when five new licences were issued. This brought the total number of licences to 35.

Licences were again made transferable in 1980 and the Western Zone was divided into Regions A and B in 1984, and individual quotas were introduced into the Western Zone in 1985 and the Southern Zone in 1988. One year later, individual quotas were also implemented into the Central Zone. A combined TACC for both Greenlip and Blacklip Abalone was introduced into Region B of the Western Zone in 1991 and the owner-operator regulation was abolished in 1993.

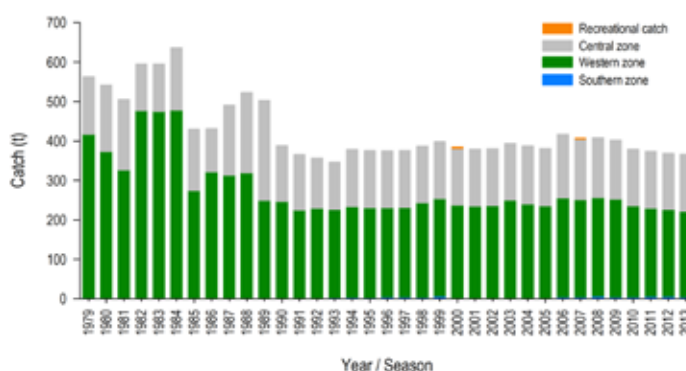
In 1997, the first management plan for the South Australian Commercial Abalone Fishery was prepared (Zacharin 1997) and replaced seven years later by Nobes et al. (2004). A third management plan for the South Australian Commercial Abalone Fishery came into effect on 1 September 2012 and includes a harvest strategy that provides a risk-based framework to support the determination of the TACC for each class of abalone (PIRSA 2012a).

In 2013, the Southern Zone was divided into 13 different spatial assessment units (SAUs), based on differences in biological characteristics of stocks, to allow for finer-spatial scale management. On 1 January 2014, Regions A and B of the Western Zone were amalgamated into one region to improve the integrity of the quota management system and reduce management costs.

Catch trends

The Greenlip Abalone resource of South Australia is one among only a few worldwide that have yielded sustained wild catch commercial harvests over an extended period. Initial harvests were recorded in 1964 (Mayfield et al. 2012). The annual commercial catch of Greenlip Abalone has remained stable for the last 25 years. In 2012-13, the total catch landed by the South Australian Commercial Greenlip Abalone Fishery was 364 t. Most of the catch is harvested from the Western Zone (64%) and Central Zone (35%), with only very small catches recorded from the Southern Zone (1%; Figure 19).

Figure 19: Annual catch information for the Greenlip Abalone Fishery of South Australia.



Data for Western Zone (green), Central Zone (grey) and Southern Zone (blue) are by calendar year; data for recreational fishing (orange) are by season (i.e. 1980-81 denoted 1980) and have only been collected in 2000-01 and 2007-08 during recreational fishing surveys.

Management arrangements

Regulatory arrangements for the Greenlip Abalone Fishery are contained within the *Fisheries Management (Abalone Fisheries) Regulations 2006* and *Fisheries Management (General) Regulations 2007*.

In 2014, one licence in the Western Zone was surrendered followed in 2015 by removal of 10.44 Greenlip Abalone quota units in the Central Zone through the South Australia Marine Parks: Commercial Fisheries Voluntary Catch/Effort Reduction Program.

Commercial access to Greenlip Abalone is limited to a total of 34 commercial licences. There are 22 licences in the Western Zone and six in each of the Central and Southern Zones (Table 13).

The quota management system is the major management tool for Greenlip Abalone, with a TACC set every year in each

management zone. Licences are endorsed with quota units for either the Southern, Central or Western Zones. Quota units are fully transferable among licence holders within zones.

Minimum legal size limits (shell lengths) and a weight limit (meat weight) also apply (Table 13). A summary of the current management arrangements for Greenlip Abalone are shown in Table 13.

The recreational sector is managed through a combination of output and input controls that ensure the total recreational catch is maintained within sustainable limits and that access to the fishery is equitably distributed among sectors. These regulations are outlined in Table 14 and include a daily bag limit of five abalone per day per person, and a boat limit of 10 where three or more people are on board.

Table 13: Summary of management arrangements for the South Australian Commercial Greenlip Abalone Fishery in 2013-14*.

Management arrangements	Southern Zone	Central Zone	Western Zone
Limited entry (number of licences)	6	6	22
Minimum legal size limit	130 mm	130 mm [†]	145 mm
Minimum weight limit (meat weight)	113 g	113 g	140 g
Commercial gear	Hand collection only	Hand collection only	Hand collection only
Commercial gear restrictions	Hand collection only	Hand collection only	Hand collection only
TACC	7.2 t [#]	143.1 t [#]	219.0 t
Spatial closures	Yes	Yes	Yes
Temporal closures	No	Yes	No
Vessel monitoring system	No	No [§]	No

TACC values are in whole weight.

* 2014 season for Southern Zone Abalone fishery corresponds to September 2013 to August 2014.

[#] Tiparra Reef SAU in the Central Zone has a catch cap of 3 t meat weight per licence holder.

[§] Divers use a data logger system (GPS and depth logger), but isn't real time like VMS.

[†] Via Ministerial Exemption the minimum legal size limit is 135 mm in the Central Zone as a licence condition.

Table 14: Summary of management arrangements for the South Australian Recreational Greenlip Abalone Fishery in 2013-14.

Management arrangements	Southern Zone	Central Zone	Western Zone
Recreational gear	Hand collection only	Hand collection only	Hand collection only
Recreational gear restrictions	Hand collection only	Hand collection only	Hand collection only
Minimum legal size limit	130 mm shell length	130 mm shell length	145 mm shell length
Minimum weight limit (meat weight)	113 g	113 g	140 g
Recreational bag and boat limits	Bag limit: 5 per person Boat limit: 10	Bag limit: 5 per person Boat limit: 10	Bag limit: 5 per person Boat limit: 10
Spatial closures	Yes	Yes	Yes
Temporal closures	No	No	No
Possession limits	25*	25*	25*

* Combined Blacklip/Greenlip limit. Having more than 25 abalone in your possession is considered a commercial quantity.

Harvest strategy

The harvest strategy for the South Australian Commercial Abalone Fishery is the primary tool for assessing the performance of Greenlip Abalone in each management zone and for setting the TACC (PIRSA 2012a; Stobart et al. 2012; Mayfield et al. 2013). The harvest strategy uses up to six performance indicators (Table 15) to:

- > Assess the risk that the Greenlip Abalone stocks in each SAU are overfished.
- > Determine a catch-weighted stock status for the management zone.
- > Link the risk-of-overfishing category for each SAU with decision rules and industry-based information to determine TACCs.

As the magnitude of Greenlip Abalone catches varies spatially, the assessment of SAUs are prioritised (high, medium, low) and weighted by catch.

The harvest strategy for the South Australian Commercial Abalone Fishery will be reviewed in 2015.

Monitoring and assessment

The monitoring and assessment of the commercial Greenlip Abalone Fishery uses information from three sources: (1) fishery-independent survey data; (2) fishery-dependent commercial logbook data; and (3) fishery-dependent commercial catch sampling data. These data are integrated and combined with input from commercial fishers through the harvest strategy. Fishery-independent surveys are undertaken biennially in high-importance SAUs and provide information on the abundance of legal-sized pre-recruit Greenlip

Abalone. They also provide data on the length structure of the population. Fishing location, catch, effort and the distribution of the catch into weight-grade categories (Western Zone) are the main information obtained from the commercial logbook data. Commercial catch sampling data comprise measurements of the shell length of Greenlip Abalone and are obtained from the Southern Zone and Central Zone, where the catch is seldom graded. The weight-grade and catch sampling data provide information on exploitation rate.

Current biological status

The harvest strategy in the *Management Plan for the South Australian Commercial Abalone Fishery* (PIRSA 2012a) includes a catch-weighted determination of stock status for each species in each management zone. However, the harvest strategy does not identify a performance indicator and reference point below which the fishery would be defined as 'overfished'. In addition, the harvest strategy may result in a more optimistic assessment of stock status than those from more traditional weight of evidence methods (Stobart et al. 2013; Mayfield et al. 2014). In this assessment, commercial catch rates (CPUE; kg/hr) are used as the index of relative Greenlip Abalone abundance. This measure can provide a more optimistic index of relative abundance than measures from fishery-independent surveys because catch rates in dive fisheries can be hyperstable (Shepherd and Rodda 2001; Dowling et al. 2004). Decreases in CPUE in abalone fisheries are considered to be a reliable indicator of declines in abalone abundance, but can underestimate the magnitude of the reduction (Stobart et al. 2014). These factors will be considered in the review of the harvest strategy to be conducted in 2015.

Table 15: Harvest strategy components for the South Australian Commercial Greenlip Abalone Fishery.

Harvest strategy component	Greenlip Abalone Fishery
Objectives	Maintain Greenlip Abalone stocks above ecologically sustainable levels
Performance indicators	<ul style="list-style-type: none"> > Total catch (percentage of the TACC). > Proportion of large Greenlip Abalone in the commercial catch. > Commercial CPUE (kg/hr) of legal-sized Greenlip Abalone. > Density of legal-sized Greenlip Abalone from fishery-independent surveys. > Density of pre-recruit Greenlip Abalone from fishery-independent surveys. > Total mortality from fishery-independent surveys.
Limit reference points	Yes
Target reference points	Yes
Trigger reference points	Yes
Decision rules	Yes

Western Zone

The commercial CPUE (meat weight) of Greenlip Abalone in the Western Zone was relatively stable between 1983 and 1996 at approximately 17 kg/hr then increased rapidly to the highest value observed in 2003 of 23.8 kg/hr (Figure 20). Since 2003, the CPUE has decreased each year. In 2013, it was 18.6 kg/hr, 22% below that in 2003 and at the lowest level since 1998. Despite these reductions, the CPUE remains above that observed through the 1990s, which preceded a substantial increase in abundance from 2000. Fishery-independent survey densities at long-term sites are similar to those in the 1990s; there are a large number of fishing grounds and large Greenlip Abalone that continue to dominate the catch (Stobart et al. 2014). The stock is unlikely to be recruitment overfished and the current level of fishing pressure is unlikely to cause the stock to become recruitment overfished. However, the recent decreases in CPUE and redistribution of catch from traditional Greenlip Abalone to Blacklip Abalone fishing grounds will be carefully monitored to ensure timely responses to any change in stock status. On the basis of the evidence available, the Greenlip Abalone resource in the Western Zone management unit is categorised as **sustainable**.

Central Zone

The commercial CPUE (meat weight) of Greenlip Abalone in the Central Zone was stable from 1979 to 1998. The CPUE increased substantially between 1999 and 2001, when it was at the highest level on record (Figure 20). Since 2002, the CPUE has declined steadily. The CPUE estimate in 2013 of 22.73 kg/hr remained substantially greater than that observed between 1979 and 1999, which preceded a substantial increase in abundance from 2000. However, the overall decline was 21% over a 12-year period and the latest fishery-independent survey densities at Tiparra Reef, historically the key fishing ground, were low relative to previous years. In response to reduced yield from Tiparra Reef, catches have been redistributed to other fishing grounds. For several of these, catch and catch rates have not been sustained. The stock is not yet considered to be in a recruitment overfished state, but the current level of fishing pressure is likely to cause the stock to become recruitment overfished. On the basis of the evidence available, the Greenlip Abalone resource in the Central Zone management unit is categorised as **transitional-depleting**.

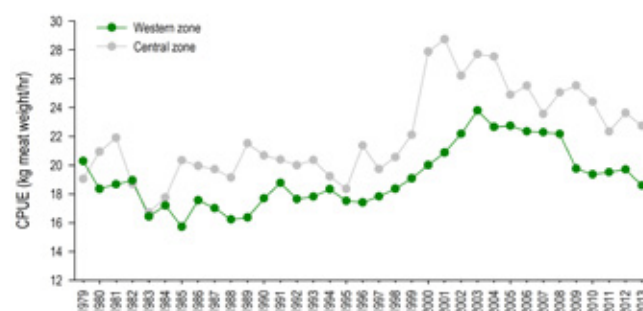
For Greenlip Abalone in the Central Zone, the total catch from the main fishing ground has been capped; the fishing season shortened and the minimum legal size increased. In response to the status of Greenlip Abalone in the Central Zone, scientific data collection

requirements have been substantially increased in the Central Zone since 2013 to provide additional information to inform management.

Southern Zone

The Greenlip Abalone resource in the Southern Zone management unit is **undefined** reflective of very low catches. Limited catch and effort data impedes assessment of stock status.

Figure 20: Commercial CPUE of legal-size Greenlip Abalone from 1979 to 2013. Data for Western Zone (green) and Central Zone (grey) are by calendar year. There are no estimates of CPUE for the Southern Zone.



Effects of fishing on the marine environment

The overall environmental impacts associated with this fishery are considered to be low because Greenlip Abalone are hand selected by divers operating from vessels that seldom anchor. Thus, the fishery has limited direct physical impact on the environment. There is also evidence that the ecosystem effects of removing abalone are minimal (Jenkins 2004; Hamer et al. 2010; Valentine et al. 2010).

An ESD Risk Assessment was carried out on the Abalone Fishery in 2009 to inform development of the management plan for the fishery (PIRSA 2009). A total of 13 risks with a rating moderate or higher were identified. Of these, the two highest risks identified for this fishery were:

- > An outbreak of Abalone Viral Ganglioneuritis in the Southern Zone.
- > Sufficient resources for policy, management and research to ensure the Greenlip Abalone resource is harvested within sustainable limits.

This ESD Risk Assessment did not identify any general ecosystem risks from the impacts of fishing (PIRSA 2009).

The Australian Government Department of the Environment re-assessed the South Australian Abalone Fishery in August 2013 under the *Environment Protection and Biodiversity Conservation Act 1999*. The assessment concluded that this fishery was managed in an ecologically sustainable way. The South Australian Commercial Abalone Fishery was provided with a five-year exemption from export controls until August 2018.

Social and economic information

The South Australian commercial Abalone Fishery (including both the Blacklip and Greenlip Abalone) is the State's third most valuable fishery. The value of abalone fishing enterprises in South Australia was estimated to be \$29.6 million in 2012-13 (Table 16), while output from associated downstream activities (processing, transport, retail/food services and capital expenditure) was \$16.5 million. The flow-on effect to other sectors of the State economy added another \$46.4 million in output. In 2012-13, this fishery provided for the direct employment of around 71 full-time equivalent jobs and downstream activities created employment of another 51 jobs statewide. Flow-on business activity was estimated to generate a further 166 jobs statewide (EconSearch 2014a).

Table 16: Socio-economic information for the South Australian commercial Abalone Fishery including Blacklip and Greenlip Abalone, 2012-13 (source: EconSearch. 2014a).

Socio-economic indicator	Combined species and zones ³
GVP - Abalone (\$ million)	29.6
Contribution to GSP (\$ million)	52.6
Total employment (direct and indirect jobs)	288

³Indicators reported in this table are combined figures for Blacklip and Greenlip Abalone from all zones.

Education, awareness, deterrence and enforcement

All compliance checks, monitoring and enforcement for Blacklip and Greenlip Abalone are undertaken and reported together. A compliance summary for the Abalone Fishery is provided in Table 10.

3.3 Southern Calamari (*Sepioteuthis australis*)

Authors: Mike Steer and Michelle Besley



Table 17: Stock status determination for the Southern Calamari Fishery of South Australia.

Management unit	State
Status	Sustainable
Primary indicator	Catch, effort, CPUE trends

Stock structure

Three different Southern Calamari (*Sepioteuthis australis*) ‘genetic-types’ were identified from southern Australian and northern New Zealand waters based on allozyme electrophoresis (Triantafillos and Adams 2001). In the 1990s, all three genetic types were collected from South Australian waters and categorised as ‘peripheral’, ‘central’ or ‘hybrid’. The peripheral and hybrid types were almost exclusively found around the offshore islands of the Far West coast (eg. Pearson and Flinders Islands), whereas the central type dominated the gulf waters. Approximately 90% of South Australia’s Southern Calamari catch is taken from gulf waters and further genetic analyses have confirmed that 99.5% of this catch consists of the central genetic type (Triantafillos and Adams 2001). Southern Calamari is therefore assessed at the State level.

Fishery overview

The South Australian fishery began developing in the early-mid 1970s when Southern Calamari were taken as a by-product of the net sector of the Marine Scalefish Fishery and the prawn fisheries. At that time, most of the catch was in poor condition and sold as bait, with a proportion sold to the public in response to increasing commercial demand and market prices.

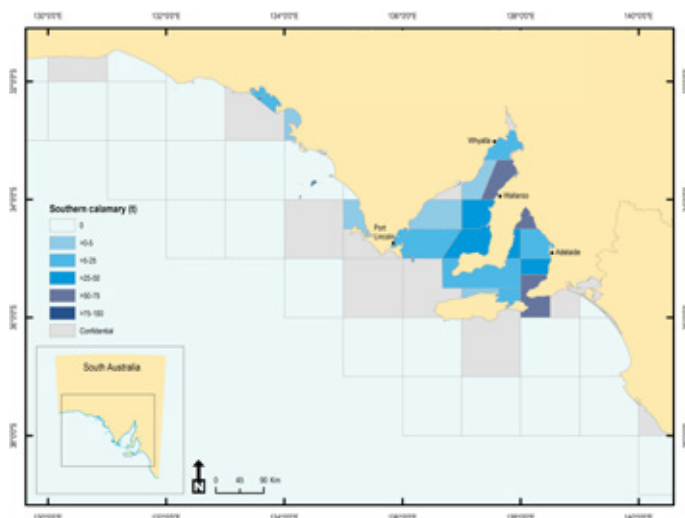
The late 1970s saw an increase in catch and effort and by 1979-80 total catch had increased four-fold to 193 t, with an estimated value of \$540,000. Most Southern Calamari is now sold for human consumption, and is highly sought after by consumer and restaurant markets.

Southern Calamari is taken by commercial fishers in most shallow, coastal waters of South Australia using a variety of techniques. Most of the catch is taken by hand jig and hauling nets, however, gill nets and dab nets are also used. Conventional 5 m to 6 m fibreglass or aluminium vessels with high-powered (>60 hp) motors are typically used by commercial and recreational fishers. However, recreational fishers also take Southern Calamari from jetties, breakwaters and other shore-based platforms. The recreational catch of Southern Calamari is mostly boat harvested, accounting for over twice the catch of shore-based recreational fishers (Jones 2009). Prawn trawlers operate in deeper waters (>10 m) of South Australia’s Gulf St Vincent, Spencer Gulf and Far West Coast take incidental catches of Southern Calamari while fishing for prawns.

The commercial Marine Scalefish Fishery accounts for over 50% of the total catch of Southern Calamari in South Australia. More than half of the State-wide catch of Southern Calamari is taken by the South Australian Commercial Marine Scalefish Fishery. Squid jigs are the dominant gear type, accounting for approximately 90% of the catch. Hauling nets constitute the remaining 10%. Southern Calamari are also incidentally caught by the commercial prawn trawling fleet where they are retained as by-product.

Together, the three prawn fisheries account for over 5% of the total catch, the majority coming from Spencer Gulf. Southern Calamari is a popular target species of the recreational sector, and accounts for nearly 40% of the total catch. The majority of the catch is taken within the gulfs.

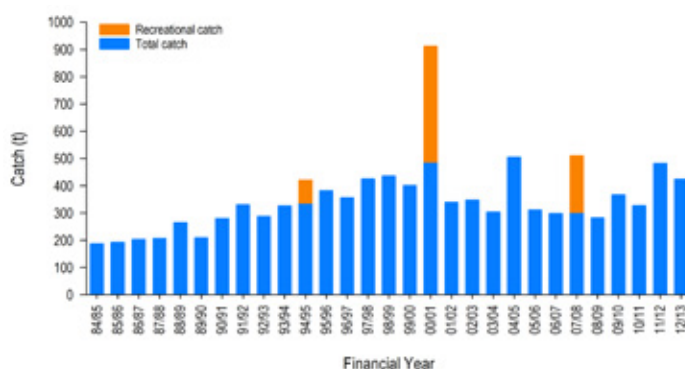
Figure 21: Distribution of commercial catches of Southern Calamari in South Australia 2012-13. Note: to avoid disclosure of confidential data, levels of catch are not shown for areas that relate to less than five licences.



Catch trends

The total commercial catch of Southern Calamari was 424.3 t in 2012-13, combined across all gear types, including both targeted and untargeted catch (Figure 22). This was 57.2 t less than the previous year, representing an annual decrease of 11.9%. The last two years represent the first time annual catch consecutively exceeded 400 t since 2000-01 (Figure 22). Recreational catches are substantial, ranging from 20% to 46% of the State-wide catch (Figure 22).

Figure 22: Annual catch information for the Southern Calamari fishery in South Australia. Data for recreational catch (orange) have only been collected in 1994-95, 2000-01 and 2007-08 during recreational fishing surveys.



Management arrangements

Management arrangements for commercial fishing for Calamari are provided in the *Management Plan for the South Australian Commercial Marine Scalefish Fishery*, the *Fisheries Management (General) Regulations 2007*, fishery specific regulations for each of the fisheries eg. *Fisheries Management (Marine Scalefish Fisheries) Regulations 2011* and licence conditions. The licence holders

Table 18: Key biological traits of Southern Calamari.

Parameter	Description
Range	Dampier in Western Australia, along the southern coast of mainland Australia and up the east coast to Moreton Bay, Queensland, as well as the surrounding waters of Tasmania
Depth	Usually < 70 m
Longevity	280 days
Maximum size	425 mm mantle length
Size at maturity	Age: not known Size: 132 to 215 mm mantle length for females, 117 to 185 mm mantle length for males
Spawning season	All year

from four different commercial fisheries have access to Southern Calamari within their respective fishery areas, ie. Marine Scalefish Fishery, Northern Zone Rock Lobster Fishery, Southern Zone Rock Lobster Fishery and Lakes and Coorong Fishery. In addition, the prawn fisheries are permitted to retain Southern Calamari as commercial by-product.

The fishery is largely managed through the use of input controls, which aim to limit the total amount of effort that can be directed on the species to ensure the sustainability of the resource on which the fishery is based.

These restrictions are aimed at not only limiting effort but also limiting the impact on the marine ecosystem.

In 2014, 12 licences in the Marine Scalefish Fishery and 2,814 effort days associated with these licences were surrendered through the South Australia Marine Parks: Commercial Fisheries Voluntary Catch/Effort Reduction Program.

The recreational fishing sector is currently managed through a range of input and output controls designed to ensure that the total catch remains sustainable and is shared equitably between recreational fishers. These controls include gear restrictions, bag and boat limits for Southern Calamari (combined with all cephalopods) and spatial closures.

The 2007-08 South Australian Recreational Fishing Survey estimated the recreational catch (including charter and aboriginal traditional) of Southern Calamari at more than 206 t per year, which accounted for 38.4% of the total state-wide harvest.

Recreational fishers target Southern Calamari with rod and line, using jigs from boats and jetties, with a very small number of Southern Calamari taken by spear fishing or crab nets. A large

portion (67%) of the recreational catch is taken by boat-based fishers. The majority (85%) of the recreational catch is taken from the two gulfs.

Table 19: Summary of management arrangements for the South Australian Commercial Southern Calamari Fishery in 2013-14.

Management arrangements	Marine Scalefish Fishery (MSF)	Northern Zone Rock Lobster Fishery (NZRL), Southern Zone Rock Lobster Fishery (SZRL)	Lakes and Coorong Fishery (LCF)	West Coast Prawn Fishery (WCP), Spencer Gulf Prawn Fishery (SGP) and Gulf St Vincent Prawn Fishery (GSVP)
Limited entry (number of licences)	MSF – 311 Restricted 7 Owner operator	NZRL – 63 SZRL – 180 Owner operator outside rock lobster season	LCF – 36 Owner operator	WCP – 3 SGP – 39 GSVP – 10
Minimum legal size limit	No			No
Commercial gear	<ul style="list-style-type: none"> > Handlines > Rod and line > Hauling nets > Gill nets 			Trawl net
Commercial gear restrictions	<ul style="list-style-type: none"> > Net <ul style="list-style-type: none"> • Net length, depth, mesh size • Southern Calamari/Cuttlefish must be retrieved from hauling nets using a brailing net • Restrictions on the use of hauling nets in conjunction with other devices • Maximum depth for setting haul net is 5 m • Gill nets must be attended > Rod and line <ul style="list-style-type: none"> • Number of rods and handlines • Number of hooks 			Boat restrictions Net headline length Mesh size
TACC	Yes	No	No	No
Spatial closures	Yes			Yes
Temporal closures	X			Yes
Vessel monitoring system	X			X

Table 20: Summary of management arrangements for the South Australian Recreational Southern Calamari Fishery in 2013-14.

Management arrangements	Recreational fishery
Recreational gear	Handline and rod and line (squid jigs)
Recreational gear restrictions	<ul style="list-style-type: none"> > Handlines > Rod and line
Minimum legal size limit	No
Recreational bag and boat limits	Daily bag limit – maximum 15 squid and/or cuttlefish Daily boat limit – maximum 45 squid and/or cuttlefish
Spatial closures	Yes
Temporal closures	Yes
Possession limits	No

Harvest strategy

The Southern Calamari harvest strategy aims to achieve long-term sustainability of the resource.

The short life cycle and high natural variability in abundance of Southern Calamari makes it difficult to predict future trends and status of the fishery or develop fishery-based models to provide biological estimates of performance. In the absence of quantitative assessments, performance indicators are based on trends in commercial catch, effort and catch rate (Lyle et al. 2012). Trigger points are set for each indicator.

The Southern Calamari harvest strategy does not prescribe specific management responses to breaches of trigger reference points. Instead breaches of trigger reference points are reviewed by the Marine Scalefish Fishery Management Advisory Group and reported to the Minister. If further action is required then specific management responses will be developed through the existing co-management framework and will be consistent with the objectives of the harvest strategy (PIRSA 2013b).

Monitoring and assessment

Fishery-dependent data are collected to monitor the Southern Calamari Fishery. Commercial catch and effort information provides the main data on which the biological status of the fishery is assessed and the majority of fisheries management decisions are based. Commercial catch and effort are fishery-dependent data collected through daily fishing logbooks.

Currently, trends in spatial and temporal commercial catch, effort and CPUE data are the indicators of stock biomass for this fishery. Southern Calamari stock status is determined on the basis of fishery performance indicators in a weight of evidence approach.

A review of the Marine Scalefish Fishery status report is undertaken within the existing co-management framework (principally the

Marine Scalefish Fishery Management Advisory Group) within one month of its release. The review considers all information in the report with particular emphasis on the primary and secondary performance indicators and the performance against the trigger reference points and objectives outlined in the harvest strategy.

Current biological status

The current management plan does not provide a pre-defined limit reference point that determines recruitment overfishing for Southern Calamari. The assessment of the fishery is based on trends in commercial catch, effort and CPUE.

The most recent stock assessment for Southern Calamari (Steer et al. 2007) considered that the resource was being harvested within sustainable limits. Since this assessment, the statewide catch of Southern Calamari has remained relatively high exceeding 400 t over the last two years. Catch rates have also remained relatively high in both the jig and hauling net sectors of the fishery (Figure 23), indicating the current level of fishing pressure is unlikely to cause the stock to become recruitment overfished. On the basis of the evidence available, the Southern Calamari resource in South Australia is categorised as **sustainable**.

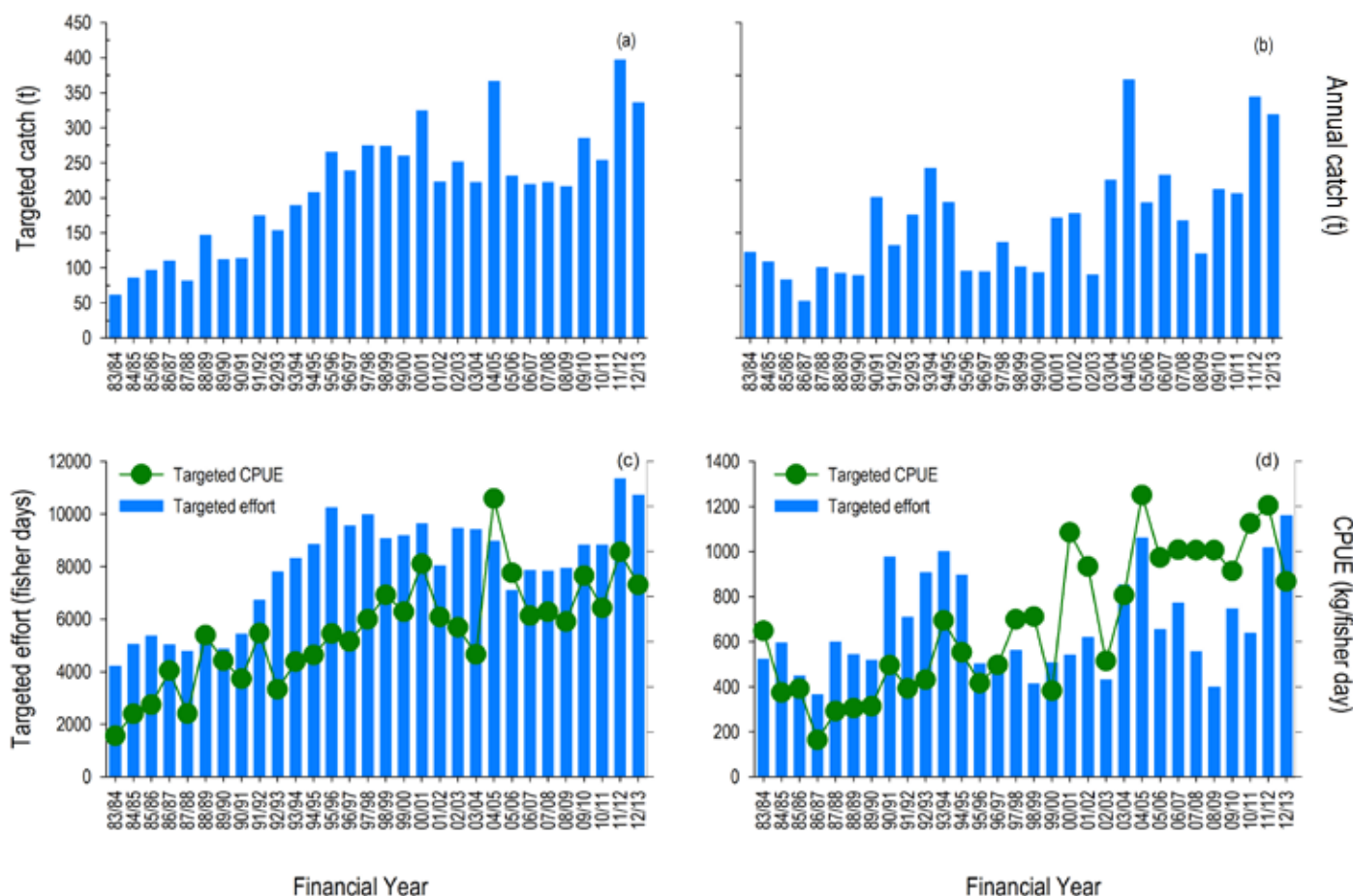
Effects of fishing on the marine environment

An ESD Risk Assessment of the South Australian Marine Scalefish Fishery was undertaken in July 2011, in preparing the *Management Plan for the South Australian Commercial Marine Scalefish Fishery* (PIRSA 2013b). The moderate, high and extreme risks were predominately related to governance and external factors affecting the performance of the fishery. Two general ecosystem risks classified as moderate were identified related to fishing effort and the introduction of marine pests or aquatic diseases. Southern Calamari was ranked as low risk through this process (PIRSA 2011b). The moderate and higher risks have strategies outlined in the management plan to address those risks.

Table 21: Harvest strategy components for the South Australian Commercial Southern Calamari Fishery.

Harvest strategy component	Description
Operational objective	Maintaining performance indicators within the trigger reference points described below
Performance indicators	<ul style="list-style-type: none"> > Trends in total commercial catch > Trends in jig and haul net effort > Trends in jig and haul net CPUE
Limit reference points	No
Target reference points	No
Trigger reference points	Yes
Decision rules	Yes

Figure 23: Statewide commercial targeted jig (a, c) and hauling net (b, d) catch and effort data for Southern Calamari from 1983-84 to 2012-13



There are two different methods of capture used to target Southern Calamari, jigs and hauling nets. It is considered that these activities pose a low to negligible risk to habitat and ecosystem function (PIRSA 2011b).

Jigs are extremely selective fishing gears that have minimal interactions with by-catch species or marine habitats. There are potential ecosystem impacts associated with the taking of Southern Calamari on spawning grounds, however, given the short life cycle this is perhaps the only opportunity to effectively target this species.

There are potential impacts on the ecosystem through the capture of by-catch species and unintended mortality of non-target species with all gear types used. Hauling nets pose a higher risk to the capture of non-target species, with a large range of species being captured during fishing operations. The by-catch risks associated with hauling nets when used to target Southern Calamari are not fully understood. A by-catch study by Fowler et al. (2009) demonstrated that hauling nets have the potential to capture large numbers of different by-catch species. The mesh size of the wings is generally smaller than that of the pocket, typically constructed

of different material and designed to herd fish into the pocket of the net rather than enmesh them. The size-selective properties of the hauling net are largely determined by the dimensions and construction of the pocket. The herding properties of the net reduce the discard mortality of by-catch as it can be released from the net pocket live and in good condition. Those entangled in the mesh, however, are generally in poor condition (Fowler et al. 2009). The risk to such species is mitigated to some extent through regulations that require catches to be sorted in water, with a hand-held brailing net and are released or retained, which increases the likelihood that by-catch species are released alive if not retained.

The Marine Scalefish Fishery has been assessed by the Australian Government Department of the Environment against the *Guidelines for Ecological Sustainable Management of Fisheries*, which are set out in the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999*. The South Australian Marine Scalefish Fishery was provided with an exemption to September 2015 from the export controls of the Act, subject to a number of recommendations and conditions.

Social and economic information

The commercial Marine Scalefish Fishery generates direct and indirect employment, contributes to regional development, and supports many small businesses in direct fishing enterprises, as well as various support industries, primarily in regional South Australia (EconSearch 2014b) (Table 22). The fishery is an owner operator fishery with fishing undertaken by the licence owner.

Many of the commercial fishers live in small communities. There is a high level of involvement by family and friends in the fishing business. The participants are predominantly (but not solely) male; there is also a high number of women who undertake unpaid work involved in managing the fishing businesses (Schirmer and Pickworth 2005).

Around half have a family history of involvement in commercial fishing. Fishers may fish on a part-time or full-time basis with some defining their fishing operation as a lifestyle that has its own culture and customs.

Key regions where Southern Calamari fishing has a high regional impact, in terms of economic spending, membership of community groups and historical links to the local area are Yorke Peninsula, Kangaroo Island, the West Coast (principally Ceduna, Thevenard and Streaky Bay) and Port Lincoln.

Southern Calamari is sold domestically and contributes to seafood supply and tourism.

Southern Calamari is a key target species in the recreational fishery. Recreational catches of Southern Calamari are taken mostly within the two gulfs from boats. Recreational fishing contributes to the wellbeing of recreational fishers, particularly for fishers that rate the following aspects as important when fishing: spending time in the outdoors, spending time with family, eating their own catch and getting away from people.

Table 22: Socio-economic information for the South Australian commercial Calamari Fishery, 2012-13 (EconSearch. 2014b).

Socio-economic indicator	Combined sectors
GVP – Southern Calamari (\$ million)	5.2
Contribution to GSP from Marine Scalefish Fishery (\$ million)*	49.7
Total employment from Marine Scalefish Fishery (direct and indirect jobs)*	587

* GSP and employment figures are the total contribution of all species from the Marine Scalefish Fishery.

Education, awareness, deterrence and enforcement

All compliance checks, monitoring and enforcement for Southern Calamari are undertaken and reported along with other species as part of the Marine Scalefish Fishery (See Table 83 for a full report).

3.4 Mud Cockle (*Katelysia* spp.)

Authors: Stephen Mayfield, Jay Dent, Lianos Triantafillos and Matthew Hoare



Table 23: Stock status determination for the Mud Cockle Fishery of South Australia.

Management unit	West Coast cockle fishing zone	Coffin Bay cockle fishing zone	Port River cockle fishing zone
Status	Sustainable	Sustainable	Overfished ⁶
Primary indicator	Harvest fraction	Harvest fraction	Harvest fraction

⁶ Most recent assessment was conducted in 2010. Fishery has been closed to all fishing since 2011-12.

Stock structure

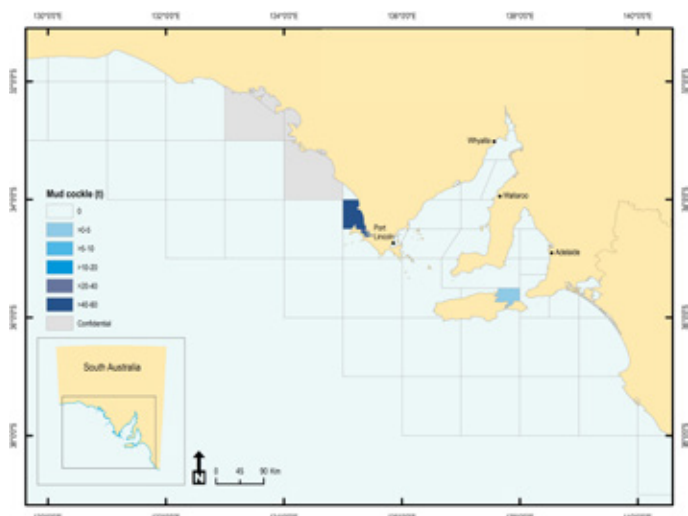
Mud Cockles (*Katelysia* spp.) inhabit the coastal waters from Augusta in Western Australia to Port Jackson in New South Wales. In South Australia, they are found throughout the State on sand banks, shallow bays and estuaries from the intertidal zone to a depth of 5 m, but are most abundant in Coffin Bay, the West Coast (Streaky Bay, Venus Bay and Smoky Bay) and Port River (Cantin 2010). There is limited information on stock structure; however, given the short larval life span, it is expected that Mud Cockles in individual bays would constitute separate stocks. As such, assessment of stock status is undertaken for each of the three commercial Mud Cockle fishing zones in South Australia (Port River, Coffin Bay and West Coast).

Fishery overview

The Mud Cockle (also known as Vongole) Fishery in South Australia supports the commercial harvest of three species of the genus *Katelysia*. These are *K. peronii*, *K. rhytiphora* and *K. scalarina*, also known as white, yellow and grey Mud Cockles, respectively (Dent et al. 2014). Mud Cockle are harvested commercially using cockle rakes/nets.

A minimum legal size limit of 30 mm shell length for Mud Cockle in all South Australian waters was introduced in January 1974. The minimum legal size limit for Mud Cockles from Coffin Bay was increased to 38 mm shell length in 1991. Prior to the development of a human consumption market in the mid 1990s, Mud Cockles were lightly exploited commercially as they were largely harvested for bait or berley (when targeting King George Whiting) (Gorman et al. 2010). In 1999, a licence condition limiting licence holders to using one cockle rake to take *Katelysia* spp. was introduced. A recreational daily bag limit of 300 Mud Cockle was introduced in July 2001. The fishery implemented the South Australian Shellfish Quality Assurance Program (SASQAP) to ensure that all Mud Cockles harvested for human consumption meet national food safety standards. Licence holders wishing to harvest Mud Cockle for human consumption after 1 July 2006 could only do so from waters classified and monitored by the SASQAP. Concerns for the sustainability of the resource saw the introduction of a quota management system in 2008 (Dent et al. 2012). The

Figure 24: Distribution of commercial catches of Mud Cocks in South Australia in 2013.



Note: to avoid disclosure of confidential data, levels of catch are not shown for areas that relate to less than five licences.

Table 24: Key biological traits of Mud Cackle.

Parameter	Description
Range	Augusta, Western Australia to Port Jackson, New South Wales
Depth	Up to 5 m
Longevity	29 years
Maximum size	55 mm shell length (SL)
Size at maturity	Age: 4 years Size Coffin Bay: 26.1 mm SL <i>K. scalarina</i> ; 31 mm SL <i>K. rhytiphora</i> West Coast: 23 mm SL <i>K. scalarina</i>
Spawning season	June to August

quota management system utilised existing boundaries classified under the SASQAP. The classified areas of the Port River (Section Bank), Coffin Bay, Venus Bay, Streaky Bay and Smoky Bay formed the three cockle fishing zones (with the latter three forming a singular, West Coast Zone) from where Mud Cackle quota could be harvested.

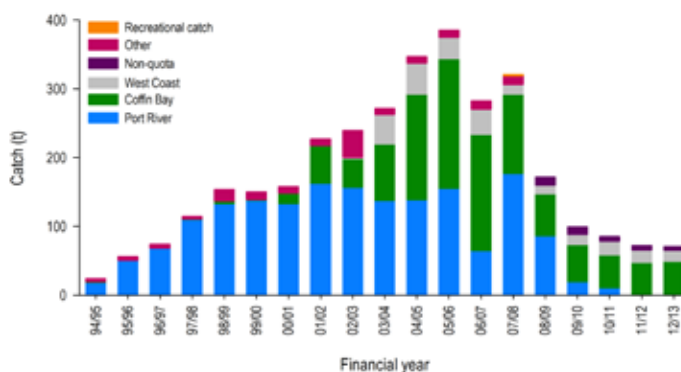
Due to ongoing sustainability concerns, the Port River Zone has been closed to the taking of Mud Cocks by all fishing sectors since the start of the 2011-12 financial year.

Recreational fishers typically target Mud Cackle for use as bait (usually for King George Whiting), with most taken from the shore in the intertidal zone using a cockle rake or cockle net. The 2007/08 South Australian Recreational Fishing Survey estimated the recreational catch of Mud Cocks at more than 1,012 kg per year. This represented 0.3% of the total statewide harvest (Jones 2009).

Catch trends

Mud Cocks are harvested throughout the State, primarily from Coffin Bay (Figure 24). Total commercial harvest of Mud Cackle increased rapidly from less than 50 t in 1994-95 to almost 400 t in 2005-06 (Figure 25), with most of that catch harvested from the Port River Zone. In more recent years, catches have been distributed more broadly among the three zones and since 2008-09 have been considerably smaller than those recorded during the early 2000s. No Mud Cocks have been landed from the Port River Zone since it was closed to all fishing sectors in 2011-12 due to ongoing sustainability concerns. Catches by recreational fishers have been low relative to catches from the commercial sector (Figure 25).

Figure 25: Annual catch information for the Mud Cackle Fishery of South Australia from 1994 to 2012.



Non-quota catch refers to harvest outside of the three cockle fishing zones. Data for recreational catch (orange) have only been collected in 2000-01 and 2007-08 during recreational fishing surveys.

Management arrangements

Management arrangements for the commercial fishery are provided in the *Management Plan for the South Australian Commercial Marine Scalefish Fishery*, the *Fisheries Management (Marine Scalefish Fisheries) Regulations 2006*, *Fisheries Management (Rock Lobster Fisheries) Regulations 2006*, *Fisheries Management (Lakes and Coorong Fishery) Regulations 2009*, and *Fisheries Management (General) Regulations 2007*.

There are two groups of licence holders that have commercial access to Mud Cackle (Table 26):

- > 15 licence holders with quota entitlements for Mud Cackle (all currently from the Marine Scalefish Fishery)
- > Approximately 590 licence holders within the Marine Scalefish, Southern Zone Rock Lobster, Northern Zone Rock Lobster and Lakes and Coorong fisheries with access to marine scalefish species, who do not have quota entitlements for Mud Cackle.

Licence holders with quota entitlements are restricted to taking Mud Cackle within the three cockle fishing zone(s) in Port River, Coffin

Bay and the West Coast for which they hold quota. Note, the Port River zone is currently closed to fishing. All three of these zones are approved under the SASQAP as areas where Mud Cocks are tested and considered safe for human consumption. Mud Cockerle quota units are transferable between licence holders, but they are not transferable between zones.

Licence holders who do not hold quota entitlements for Mud Cockerle are permitted to take a daily bag limit of 10 kg from the Coffin Bay or West Coast zones. This is for bait or berley purposes only and cannot be sold.

Licence holders in the Southern Zone Rock Lobster, Northern Zone Rock Lobster and Lakes and Coorong fisheries are permitted to harvest Mud Cocks from within the boundaries of their respective fisheries. Licence holders with quota are also permitted to take Mud Cockerle for bait or berley purposes in the cockle fishing zones, where they have no quota entitlements once they have caught their quota.

Licence holders are permitted to take Mud Cocks outside the three zones, with no restrictions on the level of take. This is to allow for the development of new fishing areas should they be discovered. If this catch is taken from one of the 27 SASQAP approved areas

throughout the State and the licence holder is accredited by SASQAP then it may be sold for human consumption.

Fishers may collect Mud Cockerle using one cockle rake or cockle net (if this gear is endorsed on their licence). If not, collection can only be undertaken by hand.

A minimum legal size limit of 38 mm shell length applies to *K. rhytiphora* and *K. peronii* commercially taken within Coffin Bay. Under Ministerial Exemption, a reduced shell length of 30 mm is permitted for *K. scalarina* taken commercially within Coffin Bay. For the rest of State waters, the minimum legal size limit is 30 mm shell length for all *Katelsysia* spp.

The recreational sector is managed through a combination of output and input controls that ensure the total recreational catch is maintained within sustainable limits and that access to the fishery and fishing opportunities are equitably distributed between recreational participants. These arrangements are described in Table 26 and include a maximum daily bag limit of 300 Mud Cocks per person per day. The take of Mud Cockerle in the Port River Zone for recreational purposes is not currently permitted.

Table 25: Summary of management arrangements for the South Australian Commercial Mud Cockerle Fishery in 2013-14.

Management arrangements	Mud Cockerle quota holders	Marine Scalefish Fishery	Northern Zone Rock Lobster Fishery (NZRL), Southern Zone Rock Lobster Fishery (SZRL)	Lakes and Coorong Fishery
Limited entry (number of licences)	15	311	NZRL – 63; SZRL - 180	36
Minimum legal size limit	38 mm shell length for <i>K. peronii</i> and <i>K. rhytiphora</i> from Coffin Bay. 30 mm shell length for <i>K. scalarina</i> from Coffin Bay. 30 mm shell length for all <i>Katelsysia</i> spp. outside Coffin Bay.	38 mm shell length for all <i>Katelsysia</i> spp. from Coffin Bay. 30 mm shell length for all <i>Katelsysia</i> spp. outside Coffin Bay.	NZRLF - 38 mm shell length for all <i>Katelsysia</i> spp. from Coffin Bay. NZRLF/SZRLF - 30 mm shell length for all <i>Katelsysia</i> spp. outside Coffin Bay.	30 mm shell length for all <i>Katelsysia</i> spp.
Commercial gear	> Cockerle rake/net > Hand collection	> Cockerle rake/net > Hand collection	> Cockerle rake/net > Hand collection	> Cockerle rake/net > Hand collection
Commercial gear restrictions	Number of cockle rakes and/or nets	Number of cockle rakes and/or nets	Number of cockle rakes and/or nets	Number of cockle rakes and/or nets
TACC	> Port River: 0 t > Coffin Bay: 50 t > West Coast: 18.5 t	NO 10 kg daily limit/licence	NO 10 kg daily limit/licence	NO 10 kg daily limit/licence
Spatial closures	Yes	Yes	Yes	Yes
Temporal closures	Yes	Yes	Yes	Yes
Vessel monitoring system	No	No	No	No

Fishing is currently not permitted in the Port River Mud Cockerle fishing zone and spatial and temporal closures may be implemented at any time (through SASQAP).

Table 26: Summary of management arrangements for the South Australian Recreational Mud Cackle Fishery in 2013-2014.

Management arrangements	Recreational fishery
Recreational gear	<ul style="list-style-type: none"> > Cockle rake/net > Bait spade > Bait pump > Bait fork > Hand
Recreational gear restrictions	None
Minimum legal size limit	38 mm shell length within Coffin Bay 30 mm shell length outside Coffin Bay
Recreational bag and boat limits	Bag limit: 300 Mud Cockles per person Boat limit: 900 Mud Cockles
Spatial closures*	Yes
Temporal closures*	Yes
Possession limits	No

* Spatial and temporal closures of the Port River Mud Cackle fishing zone and SASQAP areas apply.

Harvest strategy

The harvest strategy for the South Australian Commercial Mud Cackle Fishery is built around setting a TACC for each of the three cockle fishing zones (Table 27; PIRSA 2013b).

The TACC for each zone is determined as a fraction of the estimated harvestable biomass of Mud Cackle, with a maximum harvest fraction of 7.5%.

Harvestable biomass is that part of the total biomass which may be taken in accordance with minimum legal size limits, and is calculated as the combined biomass estimate for Mud Cackle above the minimum legal size limit. This is calculated using fishery independent surveys. The TACC is recommended for two quota years (1 July – 30 June) determined annually following a review (PIRSA 2013b).

When determining the harvest fraction for each zone a range of factors are also taken into consideration, including:

- > Fishery status (e.g. recovering from overfishing)
- > Environmental conditions
- > Geographic attributes
- > Biological evidence of pre-recruits
- > Industry views of external factors e.g. market price

There are no quantitative measures or decision rules associated with these factors; rather they are a qualitative assessment of the quota holders' observations and experience.

Table 27: Harvest strategy components for the South Australian Commercial Mud Cackle Fishery.

Harvest strategy component	Description
Objectives	Ensure the Mud Cackle resource is harvested within ecologically sustainable limits
Performance indicators	Fishery-independent estimates of harvestable biomass (with 80% confidence)
Limit reference points	No
Target reference points	Yes
Trigger reference points	No
Decision rules	Yes

Monitoring and assessment

Monitoring and assessment of the Mud Cackle zones relies on fishery-independent survey data. Surveys are undertaken biennially and provide three key measures:

- > Density and harvestable biomass of legal-sized Mud Cackle
- > Density and biomass of pre-recruits
- > Length-frequency structure of the population.

The estimates of harvestable biomass are used directly to set TACCs. Commercial logbook data provides useful supplementary information including the distribution of the catch among species. Derived estimates of CPUE are considered unreliable and are not used for assessment of stock status (Dent et al. 2014).

Current biological status

The *Management Plan for the South Australian Commercial Marine Scalefish Fishery* does not identify a performance indicator or limit reference point below which the fishery would be defined as overfished (PIRSA 2013b). In the absence of such a performance indicator and limit reference point, harvest fraction provides the most appropriate measure of stock status. Harvest fractions less than 7.5% are considered conservative for these species (PIRSA 2013b).

Port River

The most recent harvestable biomass survey of Mud Cackles in the Port River Zone was conducted in 2009, when the harvestable biomass (with 80% confidence) for Mud Cackles in this zone was estimated at 225.9 t (Gorman et al. 2010). Due to declining catches (Figure 26), low stock abundance and the absence of recruits (Gorman et al. 2010). The fishery in the Port River has been closed to all fishing since 2010-11 to allow stocks to rebuild.

Industry based observations of Mud Cackle abundance in the Port River has shown no evidence of recovery since the closure. The Mud Cackle resource in the Port River management unit is categorised as **overfished**.

A Fisheries Research and Development Corporation (FRDC) project is underway to promote recovery of this stock.

Coffin Bay

The most recent harvestable biomass survey of Mud Cackles in the Coffin Bay Zone was conducted in October 2013. The biomass estimate (with 80% confidence) for *K. rhytiphora* and *K. scalarina* in this zone was 806.4 t (Dent et al. 2014). The TACC for 2014-15 was set at 46 t, which represented a harvest fraction of 5.7%. Harvest fractions have remained below 7.5% since 2010-11. On

the basis of the evidence available, the Mud Cackle resource in the Coffin Bay management unit is categorised as **sustainable**.

West Coast

Harvestable biomass surveys of Mud Cackles in the West Coast Zone were conducted in October and November 2013 and February 2014. The biomass estimate (with 80% confidence) for *K. rhytiphora*, *K. scalarina* and *K. peronii* was 501.7 t (Dent et al. 2014). The West Coast TACC for 2014-15 was set at 16 t representing a harvest fraction of 3.2%. Harvest fractions have remained below 7.5% since 2010-11. On the basis of the evidence available, the Mud Cackle resource in the West Coast management unit is categorised as **sustainable**.

Effects of fishing on the marine environment

An ESD Risk Assessment of the South Australian Marine Scalefish Fishery was undertaken in July 2011, in preparing the *Management Plan for the South Australian Commercial Marine Scalefish Fishery* (PIRSA 2013b). The moderate, high and extreme risks were predominately related to governance and external factors effecting performance of the fishery. Two general ecosystem risks of moderate were identified related to fishing and introduction of marine pests or aquatic diseases. Mud Cackle was ranked as moderate risk through this process (PIRSA 2011b). The moderate and higher risks have strategies outlined in the Management Plan to address those risks.

The overall environmental impacts associated with the Mud Cackle Fishery are considered to be low. The commercial Mud Cackle catch represents a relatively small proportion of the biomass and, as such, there are unlikely to be significant impacts on the food chain from this fishery. Although the impact of cockle rakes on the benthic community is poorly understood, it is unlikely to be significant. This is because only a small proportion of the available Mud Cackle habitat is fished each year and communities in sand habitats, where the majority of fishing is concentrated, tend to be resilient to change.

The Mud Cackle Fishery has been assessed as part of the South Australian Marine Scalefish Fishery by the Australian Government Department of the Environment against the *Guidelines for Ecological Sustainable Management of Fisheries*, which are set out in the *Environment Protection and Biodiversity Conservation Act 1999*. In January 2012, the South Australian Marine Scalefish Fishery was approved as a wildlife trade operation until September 2015.

Social and economic information

Due to the limited number of operators in the fishery, the socio-economic information for the Mud Cackle Fishery is currently not reported on other than the GVP (Table 28) (EconSearch 2014b).

The commercial Mud Cackle Fishery generates direct and indirect employment, contributes to regional productivity, and supports many small businesses in direct fishing enterprises, as well as various support industries, primarily in regional South Australia (EconSearch 2014b). Most of the activity in the fishery centres around Coffin Bay.

Education and awareness, deterrence and enforcement

Table 28: Socio-economic information for the South Australian Commercial Mud Cackle Fishery, 2012-13 (source: EconSearch 2014a).

Socio-economic indicator	Combined sectors
GVP – Mud Cackle (\$ million)	0.9
Contribution to GSP (\$ million)	Not Available
Total employment (direct and indirect jobs)	Not Available

Table 29: Compliance summary for the South Australian Mud Cackle Fishery for 2012-13.

	Commercial	Recreational*
Key risks	<ul style="list-style-type: none"> > Take of under-size Mud Cackle > Quota Management System integrity > Quota evasion > Fishing in closed seasons > Disease or pest incursion 	<ul style="list-style-type: none"> > Take of under-size Mud Cackle and/or exceeding the bag limit > Fishing in closed areas > Illegal sales > Take of Mud Cackle using illegal gear
Control measures	Education and awareness <ul style="list-style-type: none"> > Direct contact with fishers > Attend and contribute to fishing industry meetings > Provide information through media, Fishwatch, website and printed material 	Education and awareness <ul style="list-style-type: none"> > Fisheries Officers and Fishcare Volunteers patrolled popular Mud Cackle fishing locations providing educational material to recreational fishers > Fishcare Volunteers attended and contributed to boating and camping shows and regional field days > Provided information through media, Fishwatch, SMS Fish, Recreational Fishing App, measuring gauges, website and printed material
	Deterrence <ul style="list-style-type: none"> > Inspections at sea, at landing, in transport, at fish processors > Fishing activities that include returning tagged Mud Cackle to the water for purging are monitored and subject to audits > Monitoring and audits on reports of fishing activities by commercial fishers 	Deterrence <ul style="list-style-type: none"> > Catch inspections on the beach, at points of landing, in transit and at sea
	Enforcement <ul style="list-style-type: none"> > Covert and overt observations and conduct intelligence-driven operations > Address non-compliance where appropriate with issuing of cautions, expiations and prosecutions before court 	Enforcement <ul style="list-style-type: none"> > Conduct intelligence driven covert and overt operations > Address non-compliance where appropriate with issuing of cautions, expiations and prosecutions before court
Compliance effort and outcomes ⁷	<ul style="list-style-type: none"> > Fisheries Officers attended industry meetings and maintained ongoing contact with fishers > Commercial Mud Cackle fishers inspected > A few instances of under-size Mud Cackles detected in commercial catch inspected 	<ul style="list-style-type: none"> > 1,108 inspections conducted at sea and 8,651 inspections at points of landing or land based fishing locations in the recreational fishery > 16,974 contacts with recreational fishers were made by Fisheries Officers and Fishcare Volunteers > 55 community events attended by Fishcare Volunteers and Fisheries Officers > 50 media releases were produced in relation to the recreational fishery > Signs erected at four public boat ramps regarding section bank closure
Trends/Issues	<ul style="list-style-type: none"> > Risks of fishing outside allocated quota zones identified as requiring attention 	

* The South Australian Recreational Fishery is managed as one fishery statewide. As such, control measures and compliance effort and outcomes are not species specific.

3.5 Pipi (*Donax deltoides*)

Authors: Greg Ferguson and Jonathan McPhail



Table 30: Stock status determination for the Pipi Fishery in the Lakes and Coorong Fishery of South Australia.

Stock	Lakes and Coorong Fishery
Stock Status	Sustainable
Primary indicator	Survey catch rate

Stock structure

Pipi (*Donax deltoides*) is common to high-energy sandy beaches in south-eastern Australia. Its distribution on mainland Australia extends from southern Queensland more than 3000 km south along the coast to the mouth of the Murray River in South Australia (Murray-Jones and Ayre 1997).

High genetic variation between populations on either side of Bass Strait suggests two biological stocks of Pipi with the East Australian Current and South Australian Current acting as key drivers of gene flow on the east and south coasts of Australia respectively (Miller et al. 2012, 2013). For locations south west of Bass Strait in South Australia and western Victoria, no evidence of genetic structuring of Pipi has been detected (Miller et al. 2013). Similarly, a study of Pipi from Fraser Island, Queensland to southern New South Wales indicated panmixia driven by ocean currents associated with the East Australian Current (Murray-Jones and Ayre 1997). Miller et al. (2013) suggested that it is important that populations of Pipi on the east and south coasts of Australia be considered independently for fishery management.

Fishery overview

Pipi are an important species which supports commercial and recreational fishing in South Australia. The main commercial fishery for Pipi in South Australia operates on the ocean beach of the Younghusband Peninsula, adjacent to the Coorong Estuary. As of June 2014, there were 23 licence holders with Pipi quota entitlements (21 from the Lakes and Coorong Fishery and two from the Marine Scalefish Fishery). The commercial fishery harvests Pipi manually using cockle rakes, which consist of a pole and frame with a net attached.

The Pipi Fishery has expanded rapidly over the last 10 years in response to a growing human consumption market. During this period of increasing catch and effort, there were also declining catch rates. In response to concerns about the future sustainability of the fishery, a quota management system was introduced to the commercial fishery in 2007. The quota system provided a mechanism to restrain catch; however there were no clear guidelines to support the annual decision making process of setting a TACC to promote recovery of the fishery. In 2011-12, a Pipi harvest strategy was developed by PIRSA in collaboration with SARDI and the fishing industry. The harvest strategy uses biological performance indicators to assess the status of the fishery based on information from fishery-independent surveys. It also incorporates economic performance indicators and market price estimates to analyse economic returns over a range of sustainable TACCs.

Figure 26: Distribution of commercial catches of Pipi in the Lakes and Coorong Fishery on the ocean beach of Younghusband Peninsula in 2013.



In 2013-14, the Pipi Fishery recovered to a sustainable position with the TACC set at 450 t for the 2014-15 fishing season. The gross value of production for the fishery increased from \$752,000 in the early 1990s to \$3.2m in 2012-13.

The Lakes and Coorong Fishery has also implemented the South Australian Shellfish Quality Assurance Program (SASQAP), which commenced in 2001 and ensures that all Pipi harvested meet national food safety standards. Only Pipi harvested from the waters classified and monitored by SASQAP can be sold for human consumption.

The recreational fishery also target Papis either for bait or human consumption from Goolwa Beach on the Fleurieu Peninsula and Gunyah Beach on Eyre Peninsula. There is little information about the recreational fishery for Pipi in South Australia. The 2001-02 and 2007-08 recreational fishing surveys highlighted that Goolwa Beach is recognised as the main location where significant harvesting of Pipi is undertaken. Recreational fishers are also known to dig with a spade or their hands and feet to dislodge Papis in the sand.

Catch trends

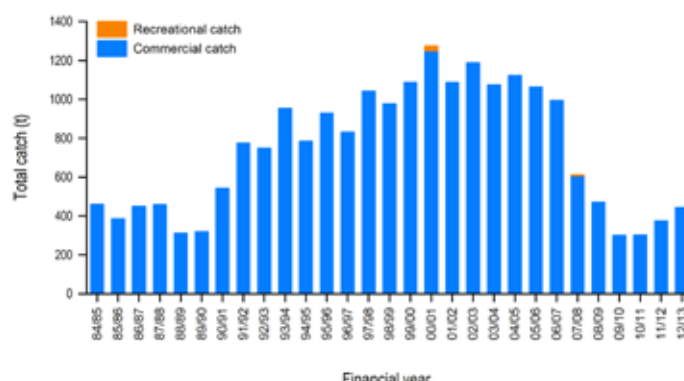
Available information suggested that the Pipi resource was depleted during the mid- to late-2000s. Annual catches (including catches from the Lakes and Coorong Fishery and Marine Scalefish Fishery) of Pipi increased from 459 t in 1984-85 to a peak of 1,250 t in 2000-01 (Figure 27). Annual catches remained stable from 2002-03 to 2006-07 then declined steeply to 607 t in 2007-08. TACCs were in place from 2007-08 and catch was constrained from 2009-10 to 2012-13 (Figure 27).

Table 31: Key biological traits of Pipi.

Parameter	Description
Range	South coast from Eyre Peninsula in South Australia, through Tasmania to Fraser Island in south-eastern Queensland
Depth	Surf zone
Longevity	3.5 years (King 1976)
Maximum size	62 mm (Ferguson 2013)
Size at maturity	50% - 28 mm; 95% - 32 mm (Ferguson 2013)
Spawning season	October – November

The 2007-08 South Australian Recreational Fishing Survey estimated the recreational catch of Pipi was 5 t per year, which accounted for approximately 0.8% of the statewide harvest in that year (Jones 2009).

Figure 27: Annual catch information for the South Australian Pipi Fishery comprising catches from the Lakes and Coorong Fishery and Marine Scalefish Fishery (blue). Data for recreational catch (orange) have only been collected in 2000-01 and 2007-08 during recreational fishing surveys.



Management arrangements

Management arrangements for the commercial fishery are provided in the *Management Plan for the Lakes and Coorong Fishery*, the *Fisheries Management (General) Regulations 2007* and the specific regulations for each of the fisheries (eg. *Fisheries Management (Lakes and Coorong Fishery) Regulations 2009*). Licence holders from four different commercial fisheries have access to Pipi within their respective fishery areas (ie. Marine Scalefish Fishery, Southern Zone Rock Lobster Fishery, Northern Zone Rock Lobster Fishery and Lakes and Coorong Fishery). Of these fisheries only 23 (21 Lakes and Coorong and two Marine Scalefish) licence holders have quota entitlements for Pipi. Licence holders with quota entitlements are restricted to harvesting Pipi for human consumption within a 60 km

SASQAP area. Quota units are transferable between quota unit holders. Only Pipi harvested from the waters classified and monitored by SASQAP and can be sold for human consumption. Quota holders also have the option of selling Pipi for the bait market. Other licence holders who do not hold a quota entitlement can harvest Pipi, but are limited to 10 kg per day for bait purposes.

Historically, the commercial Pipi Fishery had access to both the Goolwa Beach and Younghusband Peninsula; however, from 2009 restrictions were introduced to only allow the commercial harvesting of Pipi on the Younghusband Peninsula (Coorong Beach) from the

River Mouth to Kingston SE. These restrictions were introduced to equitably reduce the impacts of both commercial and recreational fishing on the Pipi.

The recreational fishing sector is currently managed through a range of input and output controls designed to ensure that the total catch remains sustainable and is shared equitably between recreational fishers. Recreational fishers are subject to some of the same restrictions applied to commercial fishers, including size limits, gear and a closed season. During the season, the recreational sector is also restricted to fishing for Pipi on the Sir Richard Peninsula and between 28 Mile Crossing and the Kingston SE jetty.

Table 32: Summary of management arrangements for the South Australian Commercial Pipi Fishery in 2013-14.

Management arrangements	Lakes and Coorong Fishery	Marine Scalefish Fishery
Limited entry (number of licences)	36 licence holders 21 Pipi quota holders Owner/operator	311 Licence holders 7 Restricted 2 Pipi quota holders Owner operator
Minimum legal size limit	3.5 cm	
Commercial gear	Cockle rake	
Gear restrictions	Number of cockle rakes	
TACC	450 t (2013-14)	
Spatial closures	Yes	
Temporal closures	Yes	
Vessel Monitoring System	No	

Table 33: Summary of management arrangements for the South Australian Recreational Pipi Fishery in 2013-14.

Management arrangements	Recreational fishery
Recreational gear	Cockle rake, cockle spade
Recreational gear restrictions	Cockle rake construction
Minimum legal size limit	3.5 cm
Recreational bag and boat limits	Bag limit of 100 per day - West of longitude 136°E, 300 per day - East of longitude 136°E Boat limit – N/A
Spatial closures	Yes
Temporal closures	Yes
Possession Limit	1200

Harvest strategy

The Pipi harvest strategy aims to maintain Pipi stocks and ensure that the resource is harvested within ecologically sustainable limits.

Biological performance indicators are used to assess the current status of the Pipi Fishery. Fishery economic performance indicators (fishery gross margin) and market price estimates to analyse economic returns over a range of sustainable TACC levels are also considered. Industry has an opportunity to provide structured and

direct input on the impacts of external factors on expected future prices over a range of TACCs. Reference points and decision rules then guide the TACC-setting process to ensure the Pipi resource is harvested within ecologically sustainable limits and also to maximise economic returns from the fishery within those limits. The decision rules in the harvest strategy state that a specific response will be triggered in terms of TACC adjustment based on fishery performance.

Table 34: Harvest strategy components for the South Australian Commercial Lakes and Coorong Fishery for Pipi.

Harvest strategy component	Description
Objectives	<ul style="list-style-type: none"> > Pipi relative biomass ≥ 4 kg/4.5 m² > Target Pipi relative biomass >10 kg/4.5 m² and not less than 8 kg/4.5 m² > Maximise fishery gross margin
Performance indicators	<ul style="list-style-type: none"> > Catch vs TACC > CPUE (fishery dependent) > Pre-recruit relative abundance index (in development) > Seasonality and spatial abundance
Limit reference points	Yes
Target reference points	Yes
Trigger reference points	Yes
Decision rules	Yes

Monitoring and assessment

Stock assessments are conducted every four years. Annual summaries of commercial catch and effort have been provided in stock status reports since 2006 with the most recent report in December 2012 (Ferguson 2012). Additionally, since 2007, results of fishery-independent surveys have been presented at annual TACC setting workshops.

Fishery-independent surveys of relative biomass have been conducted since 2007-08 (Ward et al. 2010) and provide the most reliable source of information for assessment, including estimates of relative abundance and size frequency distributions at a fine spatial resolution (2 km). Surveys are currently undertaken in October - November, February - March, and April - May to provide pre-, mid-, and post-season information. In 2012, a fourth survey was conducted in August. Also, development of a pre-recruit index for Pipi began in 2013.

Commercial logbook data provide useful supplementary measures of relative abundance of legal-sized Pipi. Additional information collected since 2009-10 includes location of catch (nearest 5 km) and destination market (local bait market, human consumption market). Fishery gross margin, which provides an indicator of the

economic performance of the fishery, is an important element of the harvest strategy and estimated annually from economic data collected from the fishery.

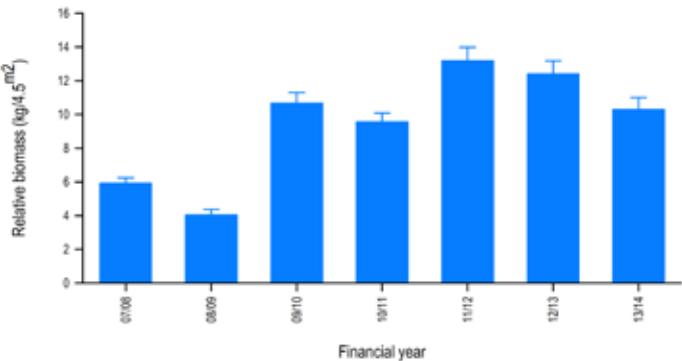
Current biological status

The secondary performance indicator for the Lakes and Coorong Fishery for Pipi is presence/absence of pre-recruits. Pre-recruits (<35 mm) were present in size frequency distributions (i.e. comprised $>30\%$ of samples) during October-November 2007, 2009, 2011, 2012 and 2013.

Increasing mean annual relative biomass and increasing complexity of size structures from 2007-08 to 2011-12 suggest recovery of the stock from 2009-10. Although some spatial contraction of the resource has occurred and relative biomass decreased after 2011-12, it has remained high compared to the period before 2011-12 and in 2013-14 (10.3 kg/4.5 m²) remained above the target reference limit of 10 kg/4.5 m² (Figure 28).

On the basis of the information available, the Pipi resource in South Australia is categorised as **sustainable**.

Figure 28: Annual estimates of the primary performance indicator for the Lakes and Coorong Fishery for Pigi: fishery-independent relative biomass from 2007-08 to 2013-14



Effects of fishing on the marine environment

An ESD Risk Assessment was carried out on the South Australian Lakes and Coorong Fishery in 2011. The risk to Pigi was ranked as moderate and the risk of capture of threatened, endangered and protected species in the Lakes and Coorong Fishery as low for sea birds and Long-nosed Fur Seals and negligible for all other species. The general ecosystem risks from the impacts of fishing were high for the freshwater and estuarine environment, moderate for the marine environment, and moderate for the introduction of marine pests and aquatic diseases (PIRSA 2011c).

The overall environmental impacts associated with fishing for Pigi are considered to be low. Since 2009, the TACC has constrained annual catches of Pigi.

The Lakes and Coorong Fishery was assessed against the Marine Stewardship Council environmental standard for sustainable fishing and certified as sustainable in 2008.

The Lakes and Coorong Fishery for Pigi has been assessed by the Australian Government Department of the Environment against the *Guidelines for Ecological Sustainable Management of Fisheries*, which are set out in the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999*. The South Australian Lakes and Coorong Fishery was provided with a three-year exemption in May 2011 and an extension until February 2016 from the export controls of the Act, subject to a number of recommendations and conditions.

Social and economic information

The Pigi Fishery is a significant contributor to the socio-economic well-being of regional coastal communities in the Lakes and Coorong region. The Pigi Fishery contributed \$3.2m to the total \$7.1m GVP in 2012-13 in the Lakes and Coorong Fishery, and directly and indirectly contributes to the provision, maintenance and expansion of a number of local and regional services and businesses (EconSearch 2014c).

Table 35: Socio-economic information for the South Australian commercial Pigi Fishery, 2012-13 (source: EconSearch 2014c).

Socio-economic indicator	Combined sectors
GVP - Pigi (\$ million)#	3.2
Contribution to GSP from the Lakes and Coorong Fishery (\$ million)*	18.8
Total employment in the Lakes and Coorong Fishery (direct and indirect jobs)*	151

GVP figure for Pigi is provided by SARDI (unpublished data).
* GSP and employment figures are the total contribution of all species in the Lakes and Coorong Fishery reported in EconSearch (2014c).

Education and awareness, deterrence and enforcement

Table 36: Compliance summary for the South Australian Piri Fishery for 2012-13.

	Commercial	Recreational*
Key risks	<ul style="list-style-type: none"> > Take of under-size Piri > Quota Management System integrity > Quota evasion > Piri taken outside quota zones sold for human consumption 	<ul style="list-style-type: none"> > Take of under-size Piri and/or exceeding the bag/boat limits
Control measures	Education and awareness <ul style="list-style-type: none"> > Direct contact with fishers > Attend and contribute to fishing industry meetings > Biosecurity awareness and response training > Provide information through media, Fishwatch, website and printed material 	Education and awareness <ul style="list-style-type: none"> > Fisheries Officers and Fishcare Volunteers patrolled popular Piri fishing locations providing education material to recreational fishers > Fishcare Volunteers attended and contributed to boating and camping shows and regional field days > Provided information through media, Fishwatch, SMS Fish, Recreational Fishing App, measuring gauges, website and printed material
	Deterrence <ul style="list-style-type: none"> > Inspections at point of landing, in transit, at registered fish processors and at unregistered fish processors 	Deterrence <ul style="list-style-type: none"> > Inspection of recreational catch on the beach and in transit > Publish media articles about compliance activities
	Enforcement <ul style="list-style-type: none"> > Covert and overt observations > Monitoring and audits on reports of fishing activities by commercial fishers > Conduct intelligence driven operations and collect and respond to intelligence > Address non-compliance where appropriate with issuing of cautions, expiations and prosecutions before court 	Enforcement <ul style="list-style-type: none"> > Respond to reports of illegal sales > Conduct intelligence driven operations and collect and respond to intelligence > Covert and overt observations > Address non-compliance where appropriate with issuing of cautions, expiations and prosecutions before court
Compliance effort and outcomes	<ul style="list-style-type: none"> > Catch inspections of commercial Piri fishers > Biosecurity Emergency Response training undertaken > Audits conducted on commercial Piri fishers and fish processors > Investigations conducted into allegations of under-size Piri being discarded above the high water mark > No under-size Piri detected in commercial catches > No under-size Piri located at bait outlets 	<ul style="list-style-type: none"> > 1,108 inspections conducted at sea and 8,651 inspections at points of landing or land based fishing locations in the recreational fishery > 16,974 contacts with recreational fishers were made by Fisheries Officers and Fishcare Volunteers > 55 community events attended by Fishcare Volunteers and Fisheries Officers > 50 media releases were produced in relation to the recreational fishery including Piri seasonal closures, fishing limits and possession limits

* The South Australian Recreational Fishery is managed as one fishery statewide. As such, control measures and compliance effort and outcomes are not species specific.

Crustaceans



4 Crustaceans

4.1 Blue Swimmer Crab (*Portunus armatus*)

Authors: Craig Noell, Crystal Beckmann and Keith Rowling



Table 37: Stock status determination for the Blue Swimmer Crab Fishery of South Australia.

Management unit	Spencer Gulf	Gulf St Vincent	West Coast
Status	Sustainable	Transitional - recovering	Undefined
Primary indicator	Survey catch rate of legal-sized and pre-recruit crabs	Survey catch rate of legal-sized and pre-recruit crabs	Catch

Stock structure

The Blue Swimmer Crab (*Portunus armatus*) inhabits the coastal waters of the tropical regions of the western Indian Ocean and eastern Pacific Ocean. In South Australia, the majority of the stocks inhabit the warmer shallow waters of Gulf St Vincent and Spencer Gulf in algal and seagrass bottoms, and on sandy and muddy substrata, from the intertidal zone to at least 50 m depth. Blue Swimmer Crabs are typically targeted in the shallow waters of both gulfs.

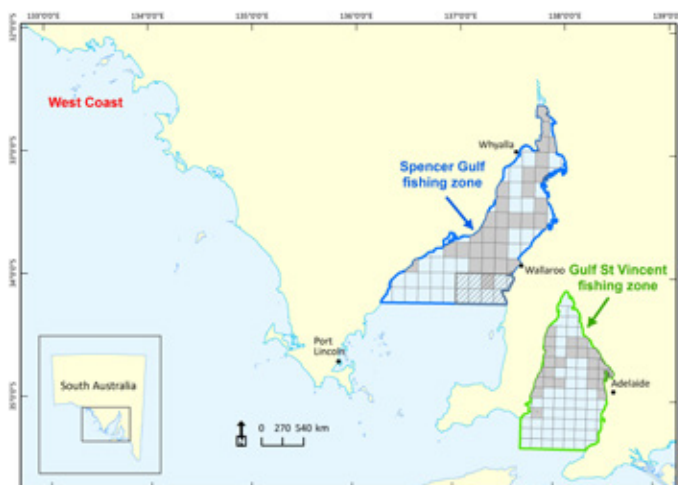
In South Australia, research has identified separate biological stocks of Blue Swimmer Crab in Spencer Gulf, Gulf St Vincent and west of the Eyre Peninsula (Bryars and Adams 1997) (Figure 30); the latter is referred to as the 'West Coast' biological stock.

Fishery overview

In 1996, the South Australian Government established a commercial pot fishery for Blue Swimmer Crabs and implemented management and research strategies to maintain a sustainable and financially viable fishery. The new management arrangements developed a limited entry fishery in each of the two gulfs, with access arrangements determined by historical catches.

Through the establishment of the commercial Blue Crab Fishery, a number of Marine Scalefish Fishery licence holders who had historically targeted Blue Swimmer Crabs in waters adjacent to Yorke Peninsula using hoop and drop nets were provided access to either the Spencer Gulf or Gulf St Vincent zones of the fishery. Since the establishment of the fishery, an individual transferable quota

Figure 29: Distribution of commercial catch of Blue Swimmer Crab in the management zones of the Blue Crab Fishery in 2012-13.



Also shown are the areas (hatched) in which catches of Blue Swimmer Crab were caught by Marine Scalefish Fishery licence holders. Note: to avoid disclosure of confidential data, the levels of catch are not shown as they relate to less than five licences.

Table 38: Key biological traits of Blue Swimmer Crab.

Parameter	Description
Range	Cape Naturaliste in Western Australia north to the Northern Territory, across Queensland, and down the east coast to the New South Wales – Victoria border, and in the warmer waters of the South Australian gulfs and west coast
Depth	Intertidal to 50 m depth
Longevity	3-4 years
Maximum size	Approx. 20 cm carapace width
Size at maturity	Age: 6-14 months Size: 8.6-9.8 cm carapace width
Spawning season	October - January (Kumar et al. 2003)

management system has been in place. The TACC is set on an annual basis for each zone of the fishery. The quota period applies from 1 July to 30 June each year.

In addition to those licence holders with access to the Blue Crab Fishery, some licence holders in the Marine Scalefish Fishery have access to Blue Swimmer Crabs in South Australian waters west of longitude 135°E.

Blue Crab Fishery licence holders (pot fishers) generally fish in waters deeper than those fished by Marine Scalefish net fishers and recreational fishers. Drop nets and hoop nets are used by Marine Scalefish fishers to take Blue Swimmer Crabs in both gulfs and west of 135°E. Commercial fishing for Blue Swimmer Crabs outside the Blue Crab Fishery has been seasonally based, especially on the West Coast of South Australia in waters adjacent to Streaky Bay and Ceduna.

Blue Swimmer Crabs are a significant target catch of recreational fishers, particularly over the summer months. Crabs are taken from boats by using drop or hoop nets, and shore-based activities such as raking and dabbling with a hand net while wading in the shallows following the tidal movement.

Catch trends

Catches of Blue Swimmer Crab were first recorded in 1983/84, when 86.7 t were harvested (Figure 30), most of which was harvested by the Marine Scalefish Fishery on the West Coast. Over the following 12 years, catches progressively increased for all commercial sectors of the Blue Crab Fishery (Spencer Gulf and Gulf St Vincent pot fishing sectors, and the Marine Scalefish Fishery), reaching 654.4 t in 1995-96 (Figure 30). The introduction of quota for the Spencer Gulf and Gulf St Vincent fishing zones in the following season (1996-97) resulted in a 29% reduction in total catch to 463.9 t. The total catch increased to 668.8 t in 2007-08, but has fluctuated since that time. The statewide catch of 568.8 t in 2012-13 was the lowest since 2001-02, and is mainly attributed to the Gulf St Vincent pot fishing sector only taking just over half (129.0 t, 53%) their component of the TACC (245.1 t).

The 2007-08 South Australian Recreational Fishing Survey estimated the recreational catch of Blue Swimmer Crabs at more than 283 t per year, which accounted for approximately 29% of the total State-wide harvest (Jones 2009).

Figure 30: Annual catch information for the Blue Crab Fishery of South Australia.



Data for recreational catch (orange) have only been collected in 2000-01 and 2007-08 during recreational fishing surveys.

Management arrangements

Management arrangements for the Blue Crab Fishery are provided in the *Management Plan for the South Australian Commercial Blue Crab Fishery* (PIRSA 2012b), the *Fisheries Management (Blue Crab Fishery) Regulations 1998*, *Fisheries Management (General) Regulations 2007* and the *Fisheries Management (Marine Scale Fisheries)*

Regulations 2006.

Commercial access is principally divided into two areas: 1) commercial licence holders with Blue Crab quota operating in the area defined as the Blue Crab Fishery (i.e. the gulfs); and 2) commercial licence holders operating west of 135°E within three nautical miles of the coast. The management arrangements for the Blue Crab Fishery are summarised in Table 39.

Two groups of licence holders operate within the Blue Crab Fishery: Blue Crab Fishery licence holders; and Marine Scalefish Fishery licence holders. Marine Scalefish Fishery licence holders are required to hold Blue Swimmer Crab quota should they wish to catch Blue Swimmer Crabs in the areas of water defining the Blue Crab Fishery. Blue Crab Fishery licence holders are restricted to catching Blue Swimmer Crabs in the waters defining the Blue Crab Fishery. Should a Marine Scalefish Fishery licence holder with quota wish to obtain a Blue Crab Fishery licence, forfeiture of their Marine Scalefish Fishery licence is required.

Commercial fishers are allocated an agreed level of access to the area defined as the Blue Crab Fishery. This access is provided in units of quota, transferable between the Blue Crab Fishery and Marine Scalefish Fishery. Units are not transferable between Gulf St Vincent

and Spencer Gulf fishing zones. The Marine Scalefish Fishery sector currently holds 1% of the TACC for the Blue Crab Fishery across both gulfs. Minimum quota unit holdings are required for Marine Scalefish Fishery licences to encourage the efficient use of the resource.

A commercial closed season and gear restrictions apply. There are a number of commercial area closures and females bearing eggs are protected. Further, a minimum size limit of an 11 cm carapace width applies to both the recreational and commercial sector.

Historically the TACC has been set at 626.8 t (381.7 t in Spencer Gulf and 245.1 t in Gulf St Vincent). However, based on the results of the 2011-12 Blue Crab Fishery stock assessment report which indicated sustainability concerns in Gulf St Vincent (Dixon et al. 2013), the TACC in Gulf St Vincent was reduced by 20% to 196.1 t for 2013-14. The Spencer Gulf TACC remained at 381.7 t.

Recreational fishers are subject to some of the same restrictions applied to commercial fishers, including minimum legal size limits and the protection of berried females. While a closed season does not apply to the recreational sector, each fisher is subject to daily bag and boat limits. Due to sustainability concerns in Gulf St Vincent, a temporary commercial catch reduction and recreational bag limit reduction was implemented for the 2013-14 fishing season, with both continuing in 2014-2015. Restrictions on the number of nets that can be used

Table 39: Summary of management arrangements for the South Australian Commercial Blue Crab Fishery in 2013-14.

Management arrangements	Details
Limited entry (number of licences)	Blue Crab Fishery (9) Marine Scalefish Fishery with blue crab quota (3) Other Marine Scalefish Fishery licence holders are permitted to take Blue Swimmer Crabs west of longitude 135°E
Minimum legal size limit	11 cm carapace width
Commercial gear	> Crab pots > Drop nets > Hoop nets
Commercial gear restrictions	> Number of crab pots (related to quota units on licence) > Escape gaps on crab pots > Crab pots dimensions > Number of drop nets or hoop nets
Protected species	No retention of females with external eggs
TACC	Spencer Gulf: 381.7 t Gulf St Vincent: 196.1 t
Spatial closures	Yes
Temporal closures	Yes
Vessel Monitoring System	No

Table 40: Summary of management arrangements for the South Australian Recreational Blue Crab Fishery in 2013-14.

Management arrangements	Details
Recreational gear	> Hoop and Drop net > Hand net > Hand spear > Crab rake
Recreational gear restrictions	Number of drop nets or hoop nets
Minimum legal size limit	11 cm carapace width
Recreational bag and boat limits	Bag limit - 40 per day Boat limit - 120 ⁸
Protected species	No retention of females with external eggs
Spatial closures	No
Temporal closures	No
Possession limit	No

⁸Except Gulf St Vincent fishing zone, where a temporary bag limit of 20 Blue Swimmer Crabs per day and 60 per boat was in place for 2013-14.

is also in place. A summary of management arrangements for the recreational sector are provided in Table 40.

Harvest strategy

The harvest strategy for the Blue Crab Fishery monitors performance of the fishery in both the Spencer Gulf and Gulf St Vincent fishing zones separately to account for differences in distribution and stock structure of the population. The harvest strategy is designed to implement a precautionary approach to managing the fishery and set the TACC at a level that promotes stock sustainability, and provides certainty and stability for the industry.

Primary biological performance indicators include relative abundance indices from fishery-independent survey catch rates of

legal and pre-recruit crabs, and commercial CPUE. The decision rules provide that should the reference point be breached for any performance indicator, a review of the TACC by PIRSA and the relevant co-management body will be undertaken, with the possibility of a decrease from the baseline TACC.

The harvest strategy is currently under review, due to be completed in 2015.

Monitoring and assessment

The monitoring and assessment of the Blue Crab Fishery uses information from three different sources: fishery-independent survey data; fishery-dependent commercial logbook data; and fishery-dependent pot-sampling data.

Table 41: Harvest strategy components for the South Australian Commercial Blue Crab Fishery.

Harvest strategy component	Spencer Gulf	Gulf St Vincent
Objectives	<ul style="list-style-type: none"> > Pre-recruit crabs in fishery-independent surveys >2 crabs/potlift > Legal-sized crabs in fishery-independent surveys >5 crabs/potlift > Commercial catch rate of legal-sized crabs >2 kg/potlift 	<ul style="list-style-type: none"> > Pre-recruit crabs in fishery-independent surveys >1.5 crabs/potlift > Legal-sized crabs in fishery-independent surveys >1.5 crabs/potlift > Commercial catch rate of legal-sized crabs >2 kg/potlift
Performance indicators	<ul style="list-style-type: none"> > Relative abundance of pre-recruit and legal-sized crabs from a fishery-independent survey > Commercial CPUE 	<ul style="list-style-type: none"> > Relative abundance of pre-recruit and legal-sized crabs from a fishery-independent survey > Commercial CPUE
Limit reference points	No	No
Target reference points	Yes	Yes
Trigger reference points	Yes	Yes
Decision rules	Yes	Yes

Fishery-independent survey data are the most reliable source of information for assessment and provide a snapshot of the relative abundance of each fishing zone at the end/beginning of the quota season (June-July). Two key measures are determined from surveys:

- > The relative abundance of legal-size crabs
- > The relative abundance of pre-recruit crabs.

Commercial logbook data provide a useful supplementary measure of relative abundance of legal-sized crabs, as well as information on the sex ratio of the commercial catch.

Current biological status

The current *Management Plan for the South Australian Commercial Blue Crab Fishery* (PIRSA 2012b) does not define recruitment overfished; therefore, the primary indicators for stock status are the indices of relative abundance of legal-size and pre-recruit crabs determined from annual fishery-independent surveys, noting that the harvest strategy is under review.

Spencer Gulf

No survey was conducted in the Spencer Gulf fishing zone in 2013 due to high abundance of pre-recruits in the 2012 survey. The index of relative abundance for legal-size crabs in 2012 was 9.23 crabs per potlift, which is above the lower trigger reference point (5 crabs per potlift) (Figure 31). The index of relative abundance for pre-recruit crabs in 2012 was 8.81 crabs per potlift, which is above the lower trigger reference point (2 crabs per potlift) (Figure 31).

On the basis of the evidence available, the Blue Swimmer Crab resource in the Spencer Gulf management unit is categorised as **sustainable**.

Gulf St Vincent

The index of relative abundance for legal-size crabs in 2013 was 1.45 crabs per potlift, which is lower than the lower trigger reference point (1.5 crabs per potlift) (Figure 31), which is assumed to be an appropriate level below which the stock is recruitment overfished. The index of relative abundance for pre-recruit crabs in 2013 was 1.23 crabs per potlift. Whilst this is lower than the lower limit reference point (1.5 crabs per potlift), it represents an improvement from 0.78 crabs per potlift in 2012 (Figure 31).

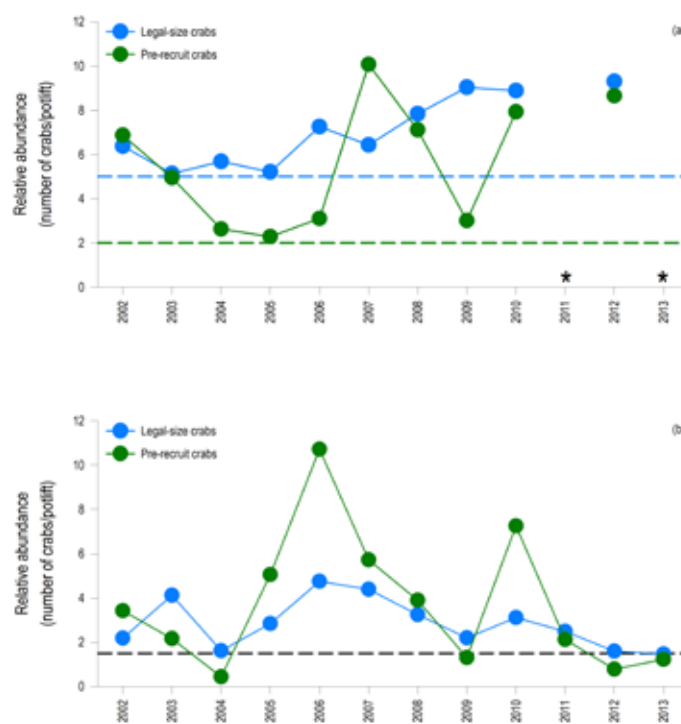
On the basis of the evidence available, the Blue Swimmer Crab resource in the Gulf St Vincent management unit is categorised as **transitional – recovering**.

In response to the stock status, the Government acted to reduce the total allowable commercial catch (TACC) of Blue Swimmer Crab by 20% for the 2013-14 fishing year (from 245.1 t to 196.1

t). The pot fishing sector also voluntarily closed the zone for more than six months in 2013-14 (1 July 2013 to 15 January 2014). The individual recreational daily bag limits for Gulf St Vincent were reduced to 20 (from 40) and the daily boat limit was reduced to 60 (from 120).

The current reduced catch levels in Gulf St Vincent have been

Figure 31: Indices of relative abundance of legal-size (blue) and pre-recruit crabs (green) for the Blue Crab Fishery from 2002-2013 in (a) Spencer Gulf and (b) Gulf St Vincent.



*The dashed lines indicate the trigger reference points. The asterisks indicate when no survey was conducted.

maintained for 2014-15, to continue to promote stock recovery of this important community resource.

West Coast

Blue Swimmer Crabs are captured in low volumes (generally <50 t annually) on the West Coast as a part of the Marine Scalefish Fishery. Given the low catches taken from this region over a long period, it is unlikely that the West Coast Blue Swimmer Crab stock is recruitment overfished, however, insufficient information is available to classify its status. On the basis of the evidence provided above, the Blue Swimmer Crab stock in the West Coast management unit is classified as **undefined**.

Effects of fishing on the marine environment

An ESD Risk Assessment was carried out on the Blue Crab Fishery in 2009 to inform development of the management plan for the fishery. A total of 18 risks with a rating moderate or higher were

identified. Of these, the three highest risks identified as a high or extreme risk for the fishery were related to governance. This ESD risk assessment identified three moderate risks related to general ecosystem impacts of fishing: translocation, emissions and oil discharge. The moderate and higher risks have strategies outlined in the management plan to address those risks.

The overall environmental impacts associated with Blue Swimmer Crab fishing are considered to be low. As the commercial catch of crabs generally represents a small proportion of the relative abundance, which is renewed annually, there are unlikely to be significant impacts on the food chain from these fisheries. Fishing with traps results in limited habitat disturbance and is generally conducted over sand habitats that are resilient.

The South Australian Blue Crab Fishery has been assessed by the Australian Department of the Environment against the *Guidelines for Ecological Sustainable Management of Fisheries*, which are set out in the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999*. The South Australian Blue Crab Fishery was last assessed in April 2010 and is exempt until December 2015.

Social and economic information

The commercial fishery generates direct and indirect employment, contributes to regional development, and supports many small businesses in direct fishing enterprises, as well as various support industries, primarily in regional South Australia (EconSearch 2014d) (Table 42). The three regional areas associated with the fishery are Port Broughton, Port Wakefield and Wallaroo.

Blue Swimmer Crabs are a significant target catch for recreational fishers in South Australia. The importance of this species to recreational fishers was highlighted in a temporary closure to the Commercial Blue Crab Fishery along the Adelaide coastline (in 2013-14 and 2014-15) and on the eastern side of the Yorke Peninsula (2014-15) during peak recreational fishing periods to enhance opportunities for recreational fishers.

Table 42: Socio-economic information for the South Australian Commercial Blue Crab Fishery of South Australia, 2012-13 (EconSearch 2014d).

Socio-economic indicator	Combined sectors
GVP – Blue Swimmer Crab (\$ million)	4.9
Contribution to GSP (\$ million)	9.8
Total employment (direct and indirect jobs)	78

Education and awareness, deterrence and enforcement

Table 43: Compliance summary for the South Australian Blue Crab Fishery for 2012-13.

	Commercial	Recreational*
Key risks	<ul style="list-style-type: none"> > Take of under-size Blue Crab > Quota Management System integrity > Quota evasion > Using excess pots > Fishing in closed seasons 	<ul style="list-style-type: none"> > Take of under-size Blue Crab > Exceeding the bag and boat limit
Control measures	Education and awareness <ul style="list-style-type: none"> > Direct contact with fishers > Attend and contribute to fishing industry meetings > Provide information through media, website and printed material 	Education and awareness <ul style="list-style-type: none"> > Fisheries Officers and Fishcare Volunteers patrolled popular Blue Crab fishing locations providing educational material to recreational fishers about fishing rules > Fishcare Volunteers attended and contributed to boating and camping shows and regional field days > Provided information through media, Fishwatch, SMS Fish, Recreational Fishing App, measuring gauges, website and printed material
	Deterrence <ul style="list-style-type: none"> > Inspections at sea, at landing, in transport, at fish processors and at unregistered fish processors such as seafood outlets and grocery shops > Monitoring and audits on reports of fishing activities by commercial fishers 	Deterrence <ul style="list-style-type: none"> > Catch inspections on the beach, at points of landing, in transit and at sea > Published articles in the media about compliance activities
	Enforcement <ul style="list-style-type: none"> > Covert and overt observations and conduct intelligence driven operations > Address non-compliance where appropriate with issuing of cautions, expiations and prosecutions before court 	Enforcement <ul style="list-style-type: none"> > Conduct intelligence driven covert and overt operations. > Address non-compliance where appropriate with issuing of cautions, expiations and prosecutions before court
Compliance effort and outcomes	<ul style="list-style-type: none"> > Fisheries Officers attended industry meetings and maintained ongoing contact with fishers > Commercial Blue Crab fishers inspected with no detections of females carrying external eggs and no under-size Blue Crabs 	<ul style="list-style-type: none"> > 1,108 inspections conducted at sea and 8,651 inspections at points of landing or land based fishing locations in the recreational fishery > 16,974 contacts with recreational fishers were made by Fisheries Officers and Fishcare Volunteers > 55 community events attended by Fishcare Volunteers and Fisheries Officers > 50 media releases were produced in relation to the recreational fishery
Trends/Issues	<ul style="list-style-type: none"> > Recreational Blue Crab non-compliance remains high in the recreational sector 	

* The South Australian Recreational Fishery is managed as one fishery statewide. As such, control measures and compliance effort and outcomes are not species specific.

4.2 Giant Crab (*Pseudocarcinus gigas*)

Authors: Adrian Linnane, Ben Stobart and Annabel Jones



Table 44: Stock status determination for the Giant Crab Fishery of South Australia.

Stock	South Australia
Stock Status	Undefined
Performance indicator	Weight of evidence

Stock structure

Giant crabs (*Pseudocarcinus gigas*) are endemic to Australian waters and are distributed from southern Western Australia to central New South Wales. Although they occur at depths ranging from 20 to 600 m, the highest population densities are found at the edge of the continental shelf on soft sedimentary environments in a depth of about 200 m.

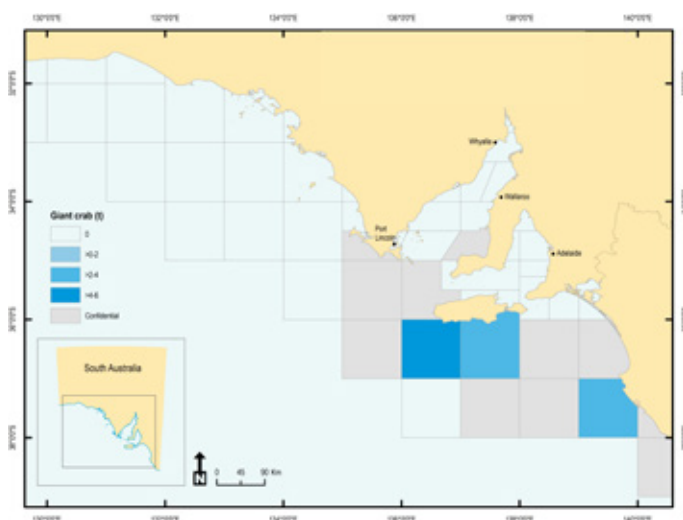
The genetic structure of the population is poorly understood, but studies using allozyme and DNA techniques have indicated a genetically homogeneous stock (Levings et al. 2001). Factors including a three to four month planktonic larval phase (Gardner and Quintana 1998) and adult movements of up to 400 km are thought to contribute to dispersion and mixing within the stock. Consequently, assessment of stock status is undertaken for South Australia.

Fishery overview

Targeted commercial fishing for Giant Crab was initiated in Tasmanian waters in 1990, and began in South Australian waters in 1992, as a by-product from Rock Lobster fishing operations. Giant Crabs support commercial fisheries in South Australia, Tasmania, Victoria and Western Australia. The most productive fishing grounds are in waters adjacent to Tasmania, which have historically supported the largest fishery.

Prior to 1992, access to Giant Crabs off the South Australian coastline was controlled by the Commonwealth Government through the Australian Fisheries Service. Joint Commonwealth-State management regimes were established in 1992. Since January 1997, Giant Crabs targeted off the South Australian coastline have been managed by the South Australian Government under an Offshore Constitutional Settlement arrangement between the South Australian and Commonwealth Governments.

Figure 32: Distribution of commercial catches of Giant Crab in 2013.



Note: to avoid disclosure of confidential data, levels of catch are not shown for areas that relate to less than five licences.

During the mid 1990s, two South Australian-based fishers began targeted fishing for Giant Crabs in Commonwealth waters adjacent to South Australia under Commonwealth Fishing Permits. These two fishers were subsequently issued with South Australian Miscellaneous Fishery licences in January 1997. Rock Lobster Fishery licence holders can also access Giant Crabs.

The fishery is divided into two zones, based on the Rock Lobster Fishery zones, being the Northern Zone and Southern Zone. Regulations for a quota management system were introduced from 2002 with separate TACCs allocated to each fishery with access to Giant Crab.

Steel-framed lobster pots fitted with moulded plastic necks and covered in 50 x 75 mm plastic mesh are used in the fishery. The Miscellaneous Fishery may use purpose built traps.

Giant Crabs are rarely caught by recreational fishers due to the inaccessibility of the fishing grounds and limited types of fishing gear that is suitable to take them.

Catch trends

Most Giant Crabs are harvested from the southern waters of South Australia (Figure 33). The total annual catch of Giant Crab varied considerably prior to the introduction of a catch limit in 1999 (Figure 34). Annual catch reached a historical high of 34.7 t in 1997-98. Subsequently, catches declined and, after the introduction of quotas in 1999, have remained relatively stable (18-22 t). In 2012-13, 22.2 t of Giant Crab were harvested by commercial fishers, the highest catch since 2000. There are no reported recreational fishery catches for this species (Jones et al. 2009).

Table 45: Key biological traits of Giant Crabs.

Parameter	Description
Range	Southern Western Australia to central New South Wales
Depth	20 to 600 m (18-400 m, Winstanley 1979)
Longevity	Females > 40 years, males 25 years (Shepherd and Edgar 2013)
Maximum size	Maximum size 240 mm carapace length, weight ~ 17 kg (Shepherd and Edgar 2013)
Size at maturity	Age: 7 years Size: 125 cm carapace width
Spawning season	May-June (Levings et al. 2001)

Figure 33: Annual catch information for the Giant Crab Fishery of South Australia.



Management arrangements

Management arrangements for the Giant Crab Fishery are included in the *Fisheries Management (Miscellaneous Fishery) Regulations 2000*, *Fisheries Management (Rock Lobster Fisheries) Regulations 2006*, and *Fisheries Management (General) Regulations 2007*. There is currently no formal management plan for the fishery, however management arrangements are described in Sloan (2002).

Within the commercial Giant Crab Fishery there are two groups of licence holders — Miscellaneous Fishery and Rock Lobster Fishery licence holders. Rock Lobster Fishery licence holders are required to hold Giant Crab quota if they wish to target Giant Crabs, or are limited to taking five Giant Crabs per trip if they do not hold quota. Where a Rock Lobster Fishery licence holder has quota endorsed on their licence they are not permitted to access Giant Crab as by-catch.

Individual transferable quotas were established for the Giant Crab Fishery in 2002 and set at 1000 units per zone with 50 of these

units allocated to Rock Lobster Fishery licence holders without Giant Crab quota for by-catch. Units are transferable between Miscellaneous and Rock Lobster Fishery licence holders, but are not transferable between the two commercial Giant Crab fishing zones. The TACC is set annually and in 2012 was 22.1 t.

A closed season and commercial gear restrictions apply. A minimum legal size limit of 150 mm carapace length is enforced for both the recreational and commercial fisheries, as well as prohibiting the taking of berried females. These management measures are summarised in Table 46.

The two Miscellaneous Fishery licence holders may use a maximum of 100 Giant Crab pots whereas Rock Lobster Fishery licence holders with Giant Crab quota are restricted to the maximum number of Rock Lobster pots endorsed on their licence to take Rock Lobster (maximum 100 in the Southern Zone and 80 in the

Northern Zone). Rock Lobster licence holders in the Northern Zone may use up to 100 Giant Crab pots if they are only targeting Giant Crabs. Rock Lobster fishers who do not hold Giant Crab quota are permitted a maximum of five Giant Crabs per trip as by-catch and are restricted to the maximum number of Rock Lobster pots endorsed on their licence to take Rock Lobster.

Recreational fishers are required to register Rock Lobster pots with PIRSA with a maximum of two Rock Lobster pots permitted per person.

Recreational fishers are subject to many of the restrictions applied to commercial fishers, including a closed fishing season, size limits and protection of berried females. Due to the low recreational take of Giant Crab, there is no bag limit for recreational fishers. These management measures are summarised in Table 47.

Table 46: Summary of management arrangements for the South Australian Commercial Giant Crab Fishery in 2013-14.

Management arrangements	Northern Zone	Southern Zone
Limited entry (number of licences)	Miscellaneous (with quota) - 2 Rock Lobster (with quota) - 3 Rock Lobster (by-catch) - 78	Miscellaneous (with quota) - 2 Rock Lobster (with quota) - 10 Rock Lobster (by-catch) - 170
Minimum legal size limit	150 mm carapace length	
Commercial gear	Pots	
Commercial gear restrictions	Limit on number of pots Escape gaps Sea lion exclusion devices in waters <100 m*	Limit on number of pots Escape gaps (optional)
Protected species	No retention of females with external eggs	No retention of females with external eggs
TACC	13.4 t	8.7 t
Spatial closures	Yes	Yes
Temporal closures	Yes	Yes
Vessel Monitoring System	Yes	Yes

* Applies to Rock Lobster fishers.

Table 47: Summary of management arrangements for the South Australian Recreational Giant Crab Fishery in 2013-14.

Management arrangements	Recreational fishery
Recreational gear	Rock Lobster pots
Recreational gear restrictions	Number of pots Escape gaps (Northern Zone only) Sea lion exclusion devices in waters <100 m (Northern Zone only)
Minimum legal size limit	150 mm carapace length
Recreational bag and boat limits	No
Protected species	No retention of females with external eggs
Spatial closures	Yes
Temporal closures	Yes
Possession limits	No

Harvest strategy

A formal harvest strategy for the commercial Giant Crab Fishery has not been developed. The fishery is monitored annually against a range of performance indicators identified for the fishery (Sloan 2002; see Table 48).

Performance indicators including commercial catch rate (legal size and pre-recruits), and total commercial catch provide measures of the status of the fishery using a weight of evidence approach. Fishery performance is considered in setting the TACC each year.

Table 48: Harvest strategy components for the South Australian Commercial Giant Crab Fishery.

Harvest strategy component	Giant Crab
Objectives	n/a
Performance indicators	<ul style="list-style-type: none"> > Commercial CPUE > Total effort > Total catch relative to TACC > Mean weight > Pre-recruit abundance > Sex ratio > Spawning female abundance index
Limit reference points	No
Target reference points	No
Trigger reference points	Yes
Decision rules	Yes

Monitoring and assessment

The monitoring and assessment of the Giant Crab Fishery uses information from different sources: fishery-dependent commercial logbook data and commercial catch and disposal records data.

Commercial logbook data provide the best available information on the total effort, catch rates and relative abundance of pre-recruit crabs, as well as information on the sex-ratio of the commercial catch. The catch and disposal data provides the total catch by sector and the overall fishery and mean weight.

The Giant Crab Fishery assessment is primarily based on interpretation of the CPUE of the Miscellaneous Fishery. The total catch, total effort and pre-recruit abundances from these sources are all considered. Data are analysed and presented for each zone separately.

Current biological status

Due to data limitations and contrasting information derived from performance indicators for the fishery (Stobart 2014), the Giant Crab resource in South Australia is categorised as **undefined**.

Effects of fishing on the marine environment

The overall environmental impacts associated with Giant Crab fishing are considered to be low. Fishing with traps results in limited habitat disturbance and are generally conducted in sandy habitats that are resilient.

The South Australian Giant Crab Fishery has been assessed by the Australian Government Department of the Environment against the *Guidelines for ecological sustainable management of fisheries*, which are set out in the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999*. The South Australian Giant Crab Fishery was provided with Wildlife Trade Operation approval to allow for export of South Australian catches until December 2015.

Social and economic information

Due to the small size of the fishery, the socio-economic information for the Giant Crab Fishery is currently not reported on. The production value of the Giant Crab Fishery was valued at \$692,000 in 2012-13 (SARDI unpublished).

Education and awareness, deterrence and enforcement

All compliance checks, monitoring and enforcement for the Giant Crab Fishery are undertaken and reported along with the Rock Lobster Fishery (see Table 61).

4.3 Western King Prawn (*Penaeus (Melicertus) latisulcatus*)

Authors: Craig Noell, Brad Milic and Crystal Beckmann

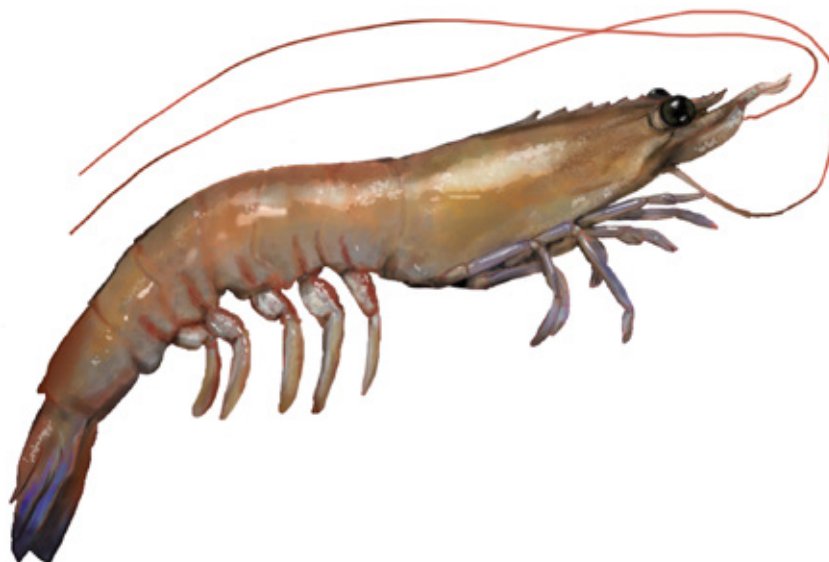


Table 49: Stock status determination for the Western King Prawn Fisheries of South Australia.

Management unit	Spencer Gulf	Gulf St Vincent	West Coast
Status	Sustainable	Transitional-depleting ¹⁰	Sustainable
Primary indicator (or weight of evidence)	Survey catch rate	Survey catch rate	Survey catch rate and catch

¹⁰ Fishery closed in 2012-13 and has not been formally assessed since closure.

Stock structure

The Western King Prawn (*Penaeus (Melicertus) latisulcatus*) is distributed throughout the Indo-west Pacific (Grey et al. 1983), and is a benthic species that prefers sandy areas to seagrass or vegetated habitats. Its distribution in South Australia is unique, as it is at its lowest temperature range, restricted to waters of Spencer Gulf, Gulf St Vincent and along the West Coast. While there is no genetic evidence of separate stocks in South Australia, the Western King Prawn resource is managed and assessed within these three regions as separate management units.

Fishery overview

Three commercial prawn fisheries occur within South Australia: Spencer Gulf Prawn Fishery, Gulf St Vincent Prawn Fishery and West Coast Prawn Fishery (Figure 34), all of which exclusively target a single penaeid species, the Western King Prawn (*Penaeus (Melicertus) latisulcatus*) in waters deeper than 10 m.

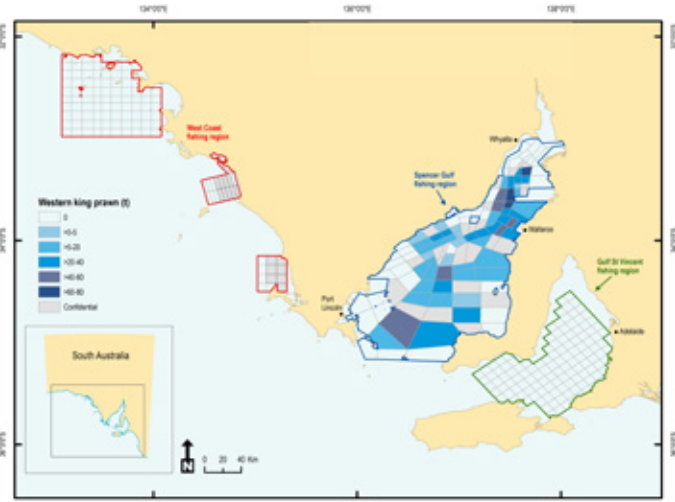
Trawling is undertaken at night using demersal otter trawl gear. The Spencer Gulf and Gulf St Vincent fisheries are generally closed in January and February, and from July to October each year. In other

months, fishing periods are generally restricted to the last quarter to first quarter of the moon phase. Fishing on the West Coast is more opportunistic, but generally occurs each month of the year except for January, February, May and October, during the same moon phases as the gulf fisheries.

Licensed prawn fishers are permitted to take several other species as by-product, which are incidentally captured during fishing operations. The Spencer Gulf and Gulf St Vincent fisheries are permitted to retain Balmain Bug (*Ibacus* spp.) and Southern Calamari (*Sepioteuthis australis*), while the West Coast fishery is permitted to retain these species, as well as Octopus (*Octopus* spp.), scallop (*Family Pectinidae*) and Gould's Squid (*Nototodaru gouldi*).

Recreational fishing for Western King Prawns is negligible, as fishers are only allowed to use permitted devices in waters greater than 10 m in depth (the same depth limitation that applies to commercial fishers). The most recent recreational fishing survey highlighted that the recreational sector does not take Western King Prawns (Jones 2009). There are no records of Aboriginal traditional fishing for Western King Prawns in South Australia.

Figure 34: Distribution of commercial catches of Western King Prawns in the Spencer Gulf Prawn Fishery (2012-13), West Coast Prawn Fishery (2013) and Gulf St Vincent Prawn Fishery (2012-13: fishery closed).



Note: to avoid disclosure of confidential data, levels of catch are not shown for areas that relate to less than five licences.

Table 50: Key biological traits of the Western King Prawn.

Parameter	Description
Range	Throughout the Indo-west Pacific (Grey et al. 1983). In South Australian waters, the species is at the lowest temperature of its geographical range.
Depth	Up to 60 m in Spencer Gulf
Longevity	2-3 years, maximum 4 years
Maximum size	Up to 60 mm carapace length for males, up to 68 mm carapace length for females
Size at maturity	6-8 months, 23-27 mm carapace length
Spawning season	October - February

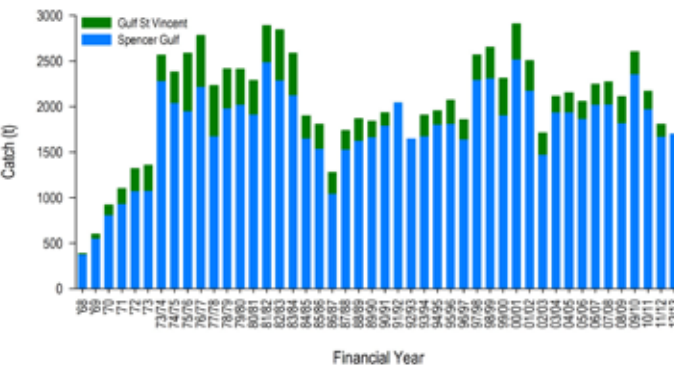
Catch trends

Most of the catch is harvested from Spencer Gulf, with substantially smaller catches harvested from Gulf St Vincent and the West Coast (Figure 35). For Spencer Gulf, the total catch of 1,699 t for 2012-13 was only marginally higher than 2011-12 (1,675 t), and within the historical range (~1,600-2,400 t).

Annual harvests from Gulf St Vincent peaked at 631 t in 1975-76 (Figure 35). Catch declined rapidly from 1982-83 until closure of the fishery in 1991-92 and 1992-93. The closure period enabled the biomass to begin recovery and catches were subsequently restricted to the late and non-spawning periods in the next two fishing years. Catch fluctuated for the next 20 years, characterised by two peaks, in 1999-2000 (400 t) and 2008-09 (288 t), then declined to 129 t in 2011-12. The fishery was closed in 2012-13 due to economic and biological reasons, until 2014-15.

To avoid disclosure of confidential data, levels of catch are not shown for the West Coast Fishery as they relate to less than five licences. The catch history of the West Coast Prawn Fishery is punctuated by rapid declines and increases in production. Catch increased rapidly from 1968 to 1973, then rapidly decreased to a low catch in 1978. Catches recovered rapidly and were maintained at high levels from 1980 to 1991. The second decline in 1992 was more rapid. High catches were again recorded from 1994 to 2001, before another decline in 2002. The fishery remained in low production during 2002 to 2007, with no fishing undertaken in 2006. From 2008 to 2013, high catches were again reported. The total catch for the 2013 fishing year was within the historical range.

Figure 35: Annual catch for the Spencer Gulf Prawn Fishery and Gulf St Vincent Prawn Fishery of South Australia.



Note: the Gulf St Vincent Prawn Fishery was closed in 1991-92, 1992-93 and 2012-13. To avoid disclosure of confidential data, levels of catch are not shown for the West Coast Fishery as they relate to less than five licences.

Management arrangements

The management arrangements for South Australian Spencer Gulf Prawn and West Coast Prawn fisheries are described in their management plan and management policy, implemented in 2014 and 2010, respectively (Dixon and Sloan 2007, Anon. 2010, PIRSA 2014a). The arrangements are prescribed in the *Fisheries Management (General) Regulations 2007* and the *Fisheries Management (Prawn Fisheries) Regulations 2006*.

The commercial fisheries are managed using a mix of input controls aimed at matching harvesting capacity with resource availability and promoting stock recovery (Table 51). Harvest strategies for the Spencer Gulf and West Coast Prawn fisheries restrict fishing effort spatially and temporarily by size of prawns, and daily catch rate. Co-management arrangements allow for some responsibility for day-to-day operations to be authorised by the relevant industry association.

Limited entry regulations apply to each fishery, restricting the number of licences to 39 in Spencer Gulf, 10 in Gulf St Vincent, and three in the West Coast Fishery.

Following a review by Knuckey et al. (2011), use of 'T-90' mesh cod-ends and a by-catch reduction grid were introduced for the Gulf St Vincent Prawn Fishery to improve catch selectivity for higher-value medium and large prawns, decrease impact on by-catch and increase fuel efficiency.

The Gulf St Vincent Prawn Fishery was closed in December 2012 at the request of all 10 licence holders due to poor economic performance. A new management framework for the fishery was implemented when the fishery reopened in November 2014. The framework was designed to improve the economic performance

of the fishery, allowing for greater business flexibility for operators to improve economic viability. A revised management plan for the fishery is currently in development.

A summary of the management arrangements for the South Australian prawn fisheries is provided in Table 51.

Recreational fishing for King Prawns is negligible, as fishers are only allowed to use permitted devices in waters greater than 10 m in depth (the same depth limitation that applies to commercial fishers).

Table 51: Summary of management arrangements for the South Australian Commercial Western King Prawn Fishery in 2013-14.

Management control	Spencer Gulf Prawn Fishery	Gulf St Vincent Prawn Fishery	West Coast Prawn Fishery
Limited entry (number of licences)	39 licences	10 licences	3 licences
Minimum legal size limit	No	No	No
Commercial gear	Demersal otter board trawl		
Commercial gear restrictions	<ul style="list-style-type: none"> > Boat restrictions > Net headline length > Mesh size 		
TAE	No	Yes	No
Spatial closures	Yes	Yes	No
Temporal closures	Yes	Yes	Yes
Vessel Monitoring System	No	No	No

Harvest strategy

Harvest strategies for all three of the South Australian prawn fisheries have been developed in consultation with stakeholders and are incorporated into management plans for the Spencer Gulf and Gulf St Vincent fisheries, and a management policy for the West Coast Fishery.

The harvest strategies are the mechanism for managing fishing effort using spatial and temporal closures. Specifically, this involves setting appropriate closure lines (defined by a series of GPS co-ordinates), and dates and times for trawling. The primary aim of the harvest strategy is for the fleet to target areas of high catch rate of appropriately sized prawns, ensuring biological sustainability

and promoting economic efficiency. Fishing operations (termed fishing strategies) developed under the harvest strategies function at two levels: fishing strategy development (on land) and fishing strategy management (at sea). The development phase involves the determination of suitable areas to open to fishing based on data obtained from either fishery-independent stock assessment surveys or industry-driven spot surveys. Once established, the fishing strategy is managed on a daily or even hourly basis during a fishing run informed by commercial fishing data. This involves managing fishing areas to target appropriate sized prawns at agreed catch rates, in accordance with pre-determined criteria.

Table 52: Harvest strategy components for the South Australian Commercial Western King Prawn Fishery.

Harvest strategy	Spencer Gulf	Gulf St Vincent	West Coast
Objectives	Maintain sustainable biomass	Promote stock recovery Promote optimal utilisation	Ensure biological sustainability Promote optimal utilisation
Performance indicators	<ul style="list-style-type: none"> > Indices of current and future biomass (recruits) > Mean prawn size > Mean daily catch per vessel 	<ul style="list-style-type: none"> > Indices of current and future biomass (recruits) > Mean prawn size > Mean daily catch per vessel 	<ul style="list-style-type: none"> > Index of harvestable biomass > Mean prawn size > Mean daily catch per vessel > Total effort (nights)
Limit reference points	Yes	Yes	Yes
Target reference points	Yes	Yes	No
Trigger reference points	No	No	No
Decision rules	Yes	Yes	Yes

Note: the harvest strategy for Gulf St Vincent Prawn Fishery is currently under review.

¹¹ Following an independent review of the Gulf St Vincent Prawn Fishery, the number of surveys was rationalised to two for 2011-12 (April and May 2012).

Monitoring and assessment

The monitoring and assessment of South Australia's prawn fisheries uses information from two different sources: 1) fishery-independent survey data; and 2) fishery-dependent commercial logbook data.

Stock assessment surveys have traditionally been conducted three times per year in the Spencer Gulf and West Coast fisheries, and four times per year in Gulf St Vincent prior to fishing runs in each fishery. Stock assessment surveys are comprehensive surveys across all regions of each fishery that aim to determine the status of the resource. These surveys are an integral element of the harvest strategy, as well as for monitoring the status of the fishery.

During fishing, fishers in the Spencer Gulf Prawn Fishery provide information on their fishing on a daily basis to inform the real-time fishing strategy management process. All fishers are compulsorily required to complete catch and effort information in logbooks supplied to PIRSA Fisheries and Aquaculture.

Current biological status

The current biological status of South Australia's prawn fisheries are based on the latest information available for each fishery: 2012-13 for the Spencer Gulf Prawn Fishery (Noell et al. 2014), 2011-12 for the Gulf St Vincent Prawn Fishery (SARDI, unpublished data) and 2013 for the West Coast Prawn Fishery (Beckmann 2014).

Spencer Gulf Prawn Fishery

The former management plan for the Spencer Gulf Prawn Fishery used to assess the fishery in 2012-13 (Dixon and Sloan 2007) does not define recruitment overfished, therefore fishery-independent survey catch rates are the primary indicators of stock status. The primary measures for stock status in Spencer Gulf are the average total and juvenile catch rates which are used as indices of current and future biomass, respectively, and are obtained during fishery-independent surveys conducted in November, February and April. Upper and lower thresholds are set at relatively conservative levels

and aim to maintain survey catch rates within historical ranges, so triggering the lower thresholds does not necessarily imply overfishing.

For the 2012-13 fishing season, mean total catch rates for surveys conducted in November 2012, and February and April 2013 were 94, 100 and 171 kg/h, respectively (Noell et al. 2014) (Figure 36). The mean total catch rates for November and April were above their lower thresholds (90 and 160 kg/h, respectively), while the February catch rate was at its lower threshold (100 kg/h). With regard to the average 20+ grade catch rate, only February (35 kg/h) was below the lower threshold (50 kg/h).

Stable measures of relative biomass by size (as determined by survey catch rates) indicate that the fishery is not recruitment overfished and current fishing pressure is unlikely to cause the fishery to become recruitment overfished.

On the basis of the evidence available the Western King Prawn resource in the Spencer Gulf management unit is categorised as **sustainable**.

Gulf St Vincent Prawn Fishery

Combined with poor economic performance in recent years, the decline in commercial catch from 288 t in 2008-09 to 129 t in 2011-12 and similar declines in survey catch rates for the same period, led to closure of the Gulf St Vincent Prawn Fishery for the 2012-13 fishing year until 2014-15.

Although the fishery was not considered to be recruitment overfished, declining trends in survey catch rates before the closure indicated that the biomass was moving towards recruitment overfished.

On the basis of the latest evidence available the Western King Prawn resource in the Gulf St Vincent management unit is categorised as **transitional-depleting**.

Note, that since the fishery was opened in November 2014, above average catch rates have been achieved.

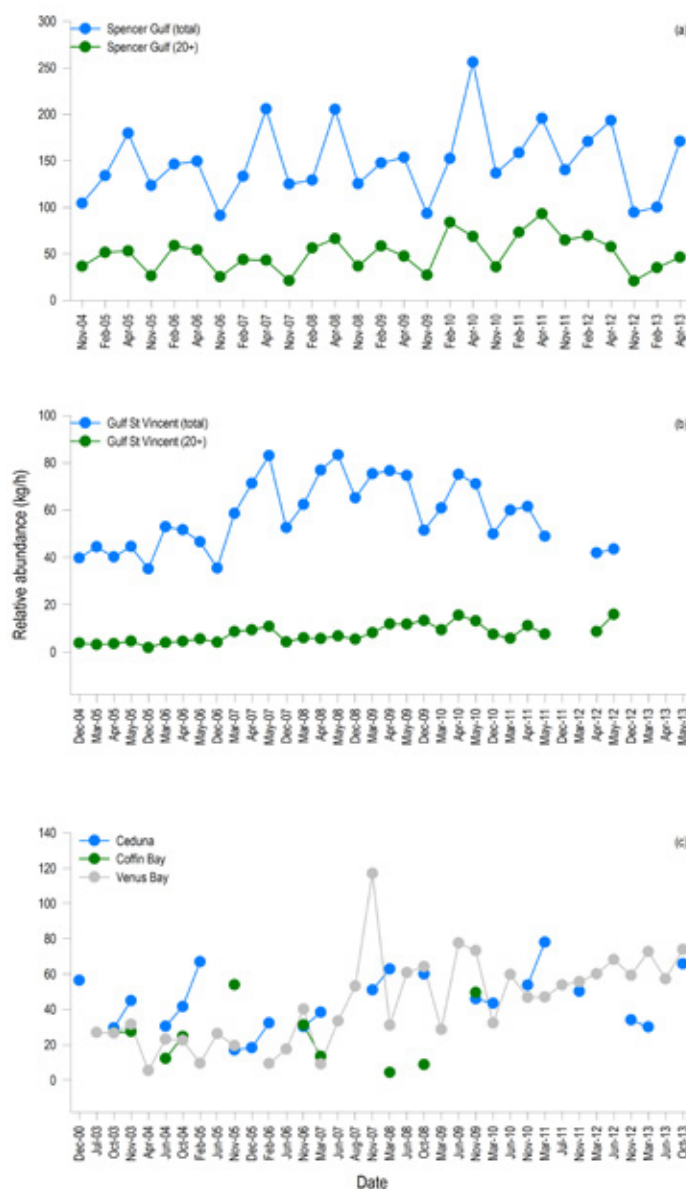
West Coast Prawn Fishery

The West Coast Prawn Fishery harvests from an oceanic stock that experiences large fluctuations in recruitment and commercial catch. The primary measures for stock status on the West Coast are the total commercial catch and average catch rates obtained during fishery-independent surveys conducted in March, June and November, which are used as indices of relative biomass. Comparisons of mean commercial catch and survey catch rates during the most recent period of decline (2002 to 2007) provide the

basis for assessment of stock status. During 2013, the commercial catch increased to 148.5 t and the March mean survey catch rate increased to 73 kg/h in Venus Bay, which was comparable with 1998 (77kg/h; Figure 36). Commercial catch and survey catch rates are now comparable to the previous period of stable catches, suggesting the stock has recovered.

On the basis of the evidence available the Western King Prawn resource in the West Coast management unit is categorised as **sustainable**.

Figure 36: Survey mean total (blue) and 20+ grade (green) catch rates (as indices of current and future biomass, respectively) from 2004-05 to 2012-13 for (a) the Spencer Gulf Prawn Fishery and (b) Gulf St Vincent Prawn Fishery; and (c) survey mean total catch rates from Ceduna (blue), Coffin Bay (green) and Venus Bay (red) (as indices of current biomass) for the West Coast Prawn Fishery from 2000-13.



Effects of fishing on the marine environment

An ESD Risk Assessment of the Spencer Gulf Prawn Fishery was completed in March 2014 in preparing the *Management Plan for the South Australian Commercial Spencer Gulf Prawn Fishery*. For the non-species components of the fishery, 31 were identified as moderate risk or greater, including four general ecosystem components. The general ecosystem components were all rated as moderate risk and related to impacts on trophic structure, habitat disturbance and broader environment impacts such as oil spills. Western King Prawns were found to be at moderate risk and by-product species were found to be at low risk. Non-retained species as a group were assessed to be of high risk (PIRSA 2014b). Regardless of their ranking all species components were assessed further in the ecological risk assessment of the effects of fishing (Hobday et al. 2011). The moderate and higher risks have strategies outlined in the management plan to address those risks.

The Spencer Gulf Prawn Fishery was assessed against the Marine Stewardship Council environmental standard for sustainable fishing and was certified as sustainable in August 2011.

While trawling can impact on the benthic habitat, these impacts are well managed in South Australia with extensive permanent and temporary closures over time, which have resulted in the reduction of trawl effort across the three prawn fisheries by more than 60% from their historic peak. Permanent spatial closures prohibit the take of prawns from any waters of the State less than 10 m depth to ensure protection of seagrass habitat and juvenile prawns.

Fishing for Western King Prawns in South Australia is considered low risk to the trophic structure of the marine ecosystem. Given the short periods throughout the year and the reduced area in which the fishery operates, it is considered unlikely that the commercial take of prawns impacts significantly on other trophic levels.

Across the three prawn fisheries, all vessels use crab bags and most use hopper systems to ensure rapid return of by-catch to the water. In Gulf St Vincent, all vessels recently adopted 'T-90' mesh cod-ends with rigid grids that substantially reduce by-catch (SARDI unpublished data). While trawling captures a wide variety of by-catch species, Currie et al. (2009) found no significant difference in biodiversity between trawled and non-trawled areas.

The South Australian Prawn Fishery has been assessed by the Australian Government Department of the Environment against the *Guidelines for Ecological Sustainable Management of Fisheries*, which are set out in the Commonwealth *Environment Protection and*

Biodiversity Conservation Act 1999. The South Australian prawn fisheries are currently considered to be ecologically sustainable and are due for reassessment in October 2015.

Social and economic information

The South Australia's prawn fisheries are some of the most valuable fisheries in Australia. Port Lincoln and Venus Bay, both on the Eyre Peninsula are the main ports of operation for the West Coast and Spencer Gulf fisheries, respectively, while the Gulf St Vincent Fishery operates out of Adelaide. While the employment generated may be relatively small in dollar terms compared to other industries, the benefits of local employment contribute to communities in other ways. Regional communities rely on employment to exist as it allows individuals and families to maintain an income and stay in the region.

The fishing operations tend to be family operated businesses operating single licences, and there have been few licence sales to new operators in the last 10 years. The licence holders are generally long-term operators, with Spencer Gulf Prawn Fishery licence holders working co-operatively in developing co-management arrangements with government in order to sustainably manage the fishery.

A summary of the main socio-economic indicators is provided in Table 53.

Table 53: Socio-economic information for the South Australian Commercial Western King Prawn Fishery, 2012-13 (source: EconSearch 2015 and SARDI unpublished).

Socio-economic indicator	Combined fisheries
GVP – King Prawns* (\$ million)	30.1
Contribution to GSP from Spencer Gulf Fishery # (\$ million)	65
Total employment from Spencer Gulf Fishery # (direct and indirect jobs)	516

* GVP provided by SARDI (unpublished data).

GSP and employment figures are from the Spencer Gulf Fishery only. The Gulf St Vincent Fishery was closed in 2012-13. GSP and employment were not available for the West Coast Fishery for 2012-13.

Education and awareness, deterrence and enforcement

Table 54: Compliance summary for the South Australian Western King Prawn Fishery for 2012-13.

	Commercial	Recreational
Key risks	<ul style="list-style-type: none"> > Take protected and or non-permitted species > Illegal gear/illegal use of gear > Interactions with fishing obstructions placed on sea bed 	<ul style="list-style-type: none"> > Nil
Control measures	Education and awareness <ul style="list-style-type: none"> > Direct contact with fishers > Attend and contribute to fishing industry meetings 	Education and awareness <ul style="list-style-type: none"> > Nil
	Deterrence <ul style="list-style-type: none"> > Pre-season gear inspections > Inspections at sea, at landing, in transit and at fish processors > Conduct audits of gear > Checks of horsepower ratings 	Deterrence <ul style="list-style-type: none"> > Nil
	Enforcement <ul style="list-style-type: none"> > Covert and overt observations > Conduct intelligence driven operations and collect and respond to intelligence > Address non-compliance where appropriate with issuing of cautions, expiations and prosecutions before court 	Enforcement <ul style="list-style-type: none"> > Nil
Compliance effort and outcomes	<ul style="list-style-type: none"> > At sea inspections during fishing activity > Numerous inspections of vessels and prawn nets > Audits of horsepower ratings > Covert radar monitoring of fishing activity by <i>FPV Southern Ranger</i>, as well as overt patrols 	<ul style="list-style-type: none"> > Nil
Trends/Issues	<ul style="list-style-type: none"> > Ongoing education regarding return of non-permitted species to the water > Concerns raised by industry regarding horsepower ratings and fishing outside prescribed areas 	

4.4 Southern Rock Lobster (*Jasus edwardsii*)

Authors: Adrian Linnane and Annabel Jones



Table 55: Stock status determination for the Southern Rock Lobster Fishery of South Australia.

Stock	Northern Zone	Southern Zone
Stock Status	Sustainable	Sustainable
Primary indicator	Commercial catch rate	Commercial catch rate

Stock structure

The Southern Rock Lobster (*Jasus edwardsii*) is distributed around southern mainland Australia, Tasmania and New Zealand (Phillips 2013). In Australia, the northerly limits of distribution are Geraldton in Western Australia and Coffs Harbor in northern New South Wales; however, the bulk of the population can be found in South Australia, Victoria and Tasmania, where they occur in depths from 1 to 200 m (Brown and Phillips 1994).

There is little evidence of population sub-structuring across mainland Australia, Tasmania and New Zealand (Ovenden et al. 1992). This reflects the extended duration (12 months) and widespread occurrence of larvae across the central and south Tasman Sea, which in conjunction with known current flows allows for genetic mixing of Rock Lobster between Australia and New Zealand.

Fishery overview

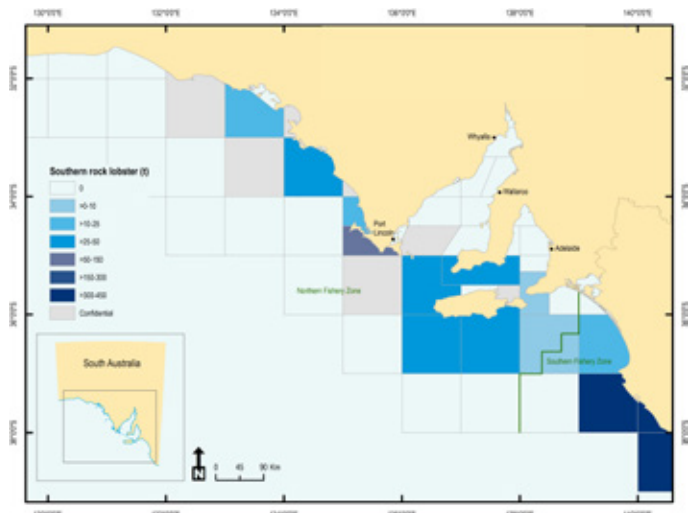
Southern Rock Lobster has been harvested in South Australian waters since the 1890s, but the commercial fishery did not develop until the late 1940s-early 1950s.

The fishery includes all South Australian waters from the Victorian to the Western Australian border, out to 200 nautical miles from shore to the edge of the Australian Fishing Zone. The South Australian Rock Lobster Fishery was separated into the Northern and Southern Zones in 1968 (Figure 37), in recognition of the significant differences in biological, geological and ecological characteristics between the eastern and western borders of the South Australian coast.

The commercial fishery initially developed on a market of frozen lobster tails but has seen gradual change to live export. Over 90% of commercial catch is now exported live, mainly to China. Rock Lobster is commercially harvested with pots that are set overnight. The pots are steel-framed and covered with wire mesh with a moulded plastic neck.

Southern Rock Lobster is an important species for recreational fishers and recreational fishing opportunities provided by both Rock Lobster fisheries contribute to the overall well-being of many South Australians. Recreational fishers target Southern Rock Lobster using either pots or hoop nets or by hand on SCUBA or snorkelling trips.

Figure 37: Distribution of commercial catch of Southern Rock Lobster in 2012-13.



Note: to avoid disclosure of confidential data, levels of catch are not shown for areas that relate to less than five licences.

Table 56: Key biological traits of Southern Rock Lobster.

Parameter	Description
Range	Western Australia to northern New South Wales
Depth	Up to 200 m
Longevity	20+ years
Maximum size	Males up to 200 mm carapace length; Females up to 150 mm carapace length
Size at maturity	Size: varies spatially, ranges from 68-115 mm carapace length
Spawning season	June-November

Catch trends

Catch information for both the commercial and recreational Northern and Southern Zone Rock Lobster Fishery sectors is provided in Figure 38.

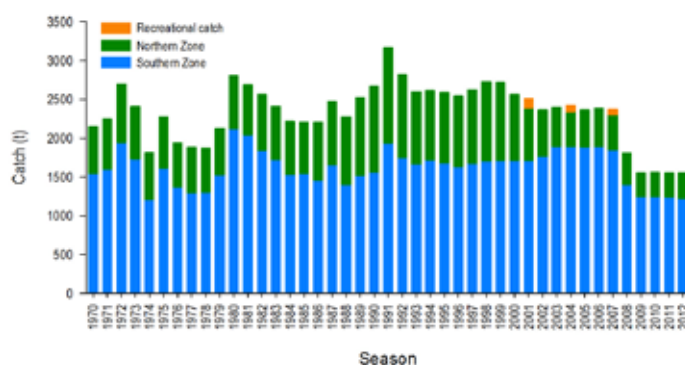
Through the 1970s and 1980s catch in the Southern Zone fishery was variable, ranging between 1,200 and 2,100 t. In 1993 a TACC was introduced and initially set at 1,720 t before being incrementally increased to 1900 t in 2003-04. Poor fishery performance subsequently led to TACC reductions, with a gradual decrease in catch to 1,250 t by 2010-11. The TACC has been fully taken at this level over the last three seasons.

In the Northern Zone fishery, annual catches gradually increased from approximately 600 t in the 1970s to a peak of 1,221 t in 1991-92. Over the next decade, catch gradually decreased before a TACC was introduced at 625 t in 2003. Poor fishery performance led to catch reductions, with incremental decreases in the TACC to

310 t by 2009. In 2012-13, the TACC was increased to 345 t with a logbook estimated catch of 325.1 t (94% of the TACC).

The 2007/08 South Australian Recreational Fishing Survey estimated that the recreational catch of Rock Lobsters was about 60 t across both zones or 2.5% of the total catch in that year (Jones 2009).

Figure 38: Annual catch information for the South Australian Rock Lobster Fishery.



Data for recreational catch (orange) have only been collected in 2001 (Venema et al. 2003), 2004 (Currie et al. 2006) and 2007 (Jones 2009) during recreational fishing surveys.

Management arrangements

Regulatory arrangements for the South Australian Rock Lobster Fishery are contained within the *Fisheries Management (Rock Lobster Fisheries) Regulations 2006*, *Fisheries Management (Marine Scalefish Fisheries) Regulations 2006* and the *Fisheries Management (General) Regulations 2007*. Management of the fishery is described in management plans for the Northern Zone Rock Lobster Fishery (PIRSA 2014c) and the Southern Zone Rock Lobster Fishery (PIRSA 2013c).

A series of management arrangements have been introduced for the commercial fishery to control the catch of Rock Lobster in South Australia. A quota management system was introduced in the Southern Zone in 1993. The TACC level in 2012-2013 was 1,250 t. Quota was introduced in the Northern Zone Rock Lobster Fishery in 2003. The TACC level in 2012-2013 was 345 t. Input controls including restrictions on the number of pots and seasonal closures are also in place. Minimum legal size limits and protection for spawning females also apply.

In 2014, one licence in the Southern Zone Rock Lobster Fishery with 41 quota units and four Northern Zone Rock Lobster Fishery licences with 3,955 quota units were surrendered through the South Australia Marine Parks: Commercial Fisheries Voluntary Catch/Effort Reduction Program.

Licence holders in the South Australian Rock Lobster Fishery are also permitted to land and sell Giant Crabs (*Pseudocarcinus gigas*) and Octopus (*Octopus maorum*) when taken as a by-product in Rock Lobster pots; and have varied levels of access to the South Australian Marine Scalefish Fishery.

The current management arrangements for the commercial fishery are summarised in Table 57.

The recreational sector is managed through a combination of input and output controls that ensure the total recreational catch is maintained within sustainable limits; and that access to the fishery and fishing opportunities are equitably distributed between recreational participants.

Recreational fishing is primarily managed using minimum legal size limits and recreational daily bag and boat limits and is limited to two registered pots per person. Recreational fishers target Southern Rock Lobster using either pots, or hoop nets, or by hand on SCUBA or snorkelling trips.

A synopsis of the management arrangements for the recreational sector is provided in Table 58.

Table 57: Summary of management arrangements for the South Australian Commercial Rock Lobster Fishery in 2013-2014.

Management arrangements	Northern Zone	Southern Zone
Limited entry (number of licences)	63	180
Minimum legal size limit	105 mm carapace length	98.5 mm carapace length
Commercial gear	Rock Lobster pots	
Commercial gear restrictions	<ul style="list-style-type: none"> > Number of pots > Escape gaps > Sea lion exclusion device 	<ul style="list-style-type: none"> > Number of pots > Escape gaps (optional)
Protected species	No retention of females with external eggs	No retention of females with external eggs
TACC	345 t	1250 t
Spatial closures	Yes	Yes
Temporal closures	Yes	Yes
Vessel Monitoring System	Yes	No

Table 58: Summary of management arrangements for the South Australian Recreational Rock Lobster Fishery in 2013-2014.

Management arrangements	Northern Zone	Southern Zone
Recreational gear	<ul style="list-style-type: none"> > Rock Lobster pots > Drop nets > Hand-held implements such as snares 	<ul style="list-style-type: none"> > Rock Lobster pots > Drop nets > Hand-held implements such as snares
Recreational gear restrictions	<ul style="list-style-type: none"> > Maximum of two pots with escape gaps and sea lion exclusion device > Spear, hook or other pointed instruments prohibited 	<ul style="list-style-type: none"> > Maximum of two pots with escape gaps (optional) > Spear, hook or other pointed instruments prohibited
Minimum legal size limit	105 mm carapace length	98.5 mm carapace length
Seasonal closures	1 June to 31 October	1 June to 30 September
Recreational bag and boat limits	Maximum of four per person per day Maximum of eight per boat per day	
Protected species	No retention of females with external eggs	No retention of females with external eggs
Spatial closures	Yes	Yes
Temporal closures	Yes	Yes
Possession limits	No	No

Harvest strategy

Harvest strategies for both the Northern and Southern Zones provide guidance for TACC setting annually, and ensure that ecologically sustainable development objectives are achieved. The level of commercial catch rate, as a proxy for abundance of legal-sized Rock Lobster, is the primary biological performance indicator in the harvest strategy. The level of under-sized abundance is also monitored in

consideration of an increase in TACC as a secondary biological performance indicator. Additional performance indicators are monitored and considered, but are not specifically included in the decision rules. The harvest strategy formally includes a process of considering industry feedback on the impacts of external factors on catch rate each year in the decision-making process.

Table 59: Harvest strategy components for the South Australian Commercial Rock Lobster fisheries.

Harvest strategy component	Northern Zone	Southern Zone
Objectives	CPUE > 0.70 kg/potlift	CPUE > 0.60 kg/potlift
Performance indicators	<ul style="list-style-type: none"> > Commercial CPUE > Number of under-sized Rock Lobster/potlift <p>Additional:</p> <ul style="list-style-type: none"> > puerulus settlement index > exploitable biomass estimates and levels of exploitation; and > length-frequency data. 	<ul style="list-style-type: none"> > Commercial CPUE > Number of under-sized Rock Lobster/potlift <p>Additional:</p> <ul style="list-style-type: none"> > puerulus settlement index > exploitable biomass estimates and levels of exploitation; and > length-frequency data.
Limit reference points	Yes	Yes
Target reference points	Yes	Yes
Trigger reference points	Yes	Yes
Decision rules	Yes	Yes

Monitoring and assessment

The monitoring and assessment of the South Australian Rock Lobster Fishery uses information from a number of different sources, including fishery-dependent commercial logbook and catch sampling data, fishery-independent survey data, puerulus monitoring and fishery model outputs.

The collection of the catch and effort data used to measure CPUE is facilitated by a logbook program, which requires all commercial fishers to compulsorily record daily information on catch and effort levels, as well as other details on daily fishing operations.

Commercial fishers and researchers have collaborated in an at-sea voluntary pot-sampling program for both fishery zones since 1991, with the main aim of providing temporal and spatial data on pre-recruit indices, length frequencies, reproductive status, sex ratios and estimates of lobster mortality.

Fishery-independent monitoring of puerulus settlement at sites in the Northern and Southern Zone Rock Lobster Fisheries has been conducted since 1996 and 1991, respectively. The annual puerulus settlement index (PSI) is used to estimate future recruitment in

the fishery using a four to five year time span between settlement and recruitment. PSI is a third tiered performance measure in the harvest strategies.

Fishery-independent monitoring surveys have been conducted in the Southern Zone since 2005, collecting catch rate, length-frequency and reproductive status information. This survey provides an index of abundance that is unaffected by factors such as fishing behaviour, market volatility and other external issues impacting on commercial catch rate.

Two models have also been designed for the fishery to provide estimates of biomass, egg production and exploitation rates and are detailed in McGarvey and Matthews (2001) and McGarvey et al. (2010).

Current biological status

The most recent status report for both the Northern and Southern Zone Rock Lobster Fisheries assessed the fisheries in the 2012-2013 fishing seasons (Linnane et al. 2013a, b). The primary measure for stock status in both zones of the South Australian Rock Lobster Fishery is the commercial CPUE of legal-sized Rock Lobster (kg/potlift).

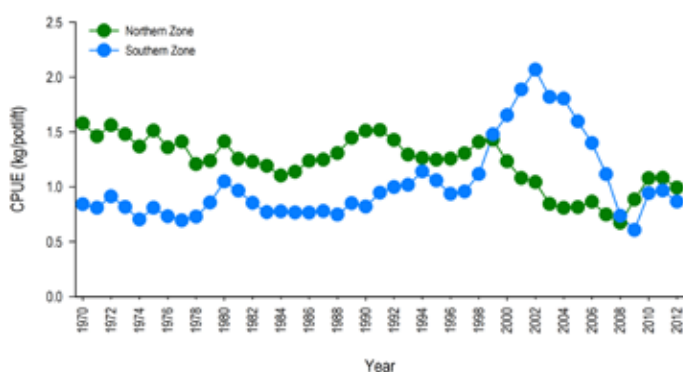
CPUE in lobster fisheries is accepted as being representative of lobster abundance and is measured using catch and effort data recorded and submitted in logbook returns. Stock status is determined as part of the annual harvest strategy and TACC-setting process. Lobster stocks with estimated commercial CPUE levels greater than 0.70 kg/potlift and 0.60 kg/potlift for the Northern and Southern Zones, respectively, are considered to be sustainable at pre-determined levels of TACC.

In 2012-13, the Southern Zone Rock Lobster Fishery CPUE was 0.86 kg/potlift (Figure 39), which placed the catch rate of the fishery within the range considered to be sustainably fished at a TACC of 1,250 t.

In 2012-13, the Northern Zone Rock Lobster Fishery CPUE was 0.99 kg/potlift (Figure 39), which placed the catch rate of the fishery within the range considered to be sustainably fished at a TACC of 345 t.

On the basis of the evidence available, the Southern Zone Rock Lobster resource in both management units are classified as **sustainable**.

Figure 39: Inter-annual trends in CPUE in the South Australian Rock Lobster Fishery between 1970 and 2012.



Effects of fishing on the marine environment

An ESD Risk Assessment of the South Australian Southern Rock Lobster Fishery was conducted in 2011. The assessment ranked the risk to Southern Rock Lobster as moderate; and the risk of capture of threatened, endangered and protected species in the Northern Zone (specifically Australian sea lions) as moderate. It did not identify any general ecosystem risks from the impacts of fishing (PIRSA 2011d). The moderate and higher risks have strategies outlined in the management plan to address those risks.

Risks to the marine environment are mitigated through management arrangements that control effort in the fishery (through implementation of TACCs, as well as temporal and spatial closures), and use of escape gaps.

Rock Lobster pots are generally considered to be a benign fishing method that targets particular species and size ranges, while allowing for release of by-catch and by-product in good condition. The by-catch from the fishery mainly consists of finfish (Blue-throat

Wrasse and leather jacket species), octopus and crustaceans (Velvet Crabs) (Brock et al. 2007).

Octopus are a major predator of Rock Lobster in pots and the main species taken as by-product in the Southern Zone (Brock and Ward 2004). Octopus catch rates have fluctuated significantly from year to year (Linnane et al. 2013a, b), likely due to changes in environmental conditions.

In the Northern Zone Rock Lobster Fishery, pots are required to be fitted with sea lion exclusion devices for both the commercial and recreational fishing sectors. The approved devices have been demonstrated to effectively prohibit the entry of Australian sea lion pups into Rock Lobster pots.

The South Australian Rock Lobster Fishery has been assessed by the Australian Government Department of the Environment against the *Guidelines for Ecological Sustainable Management of Fisheries*, which are set out in the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. The South Australian Rock Lobster Fishery is currently accredited as an export fishery until 26 October 2018.

Social and economic information

The South Australian Rock Lobster Fishery operates mainly out of regional areas with major centres being the State's South East, Kangaroo Island and Port Lincoln. The fishery generates direct and indirect employment, contributes to regional development, and supports many small businesses primarily in regional South Australia (EconSearch 2014e, f).

As a majority of the product is destined for export to China, there is a reliance on this overseas market. This exposes the fishery to interruptions to the trade routes into China that may result in significant impacts on GVP and profitability.

There is some evidence that there has been a shift in the past decade from licences held by owner/operators to ownership by investors and vertically integrated businesses. The shift in ownership may affect quota leasing costs and subsequently profits for operators.

A summary of the main socio-economic indicators is provided in Table 60.

Table 60: Socio-economic information for the South Australian Commercial Southern Rock Lobster Fishery, 2012-13 (source: EconSearch 2014e and f).

Socio-economic indicator	Combined sectors
GVP – Southern Rock Lobster (\$ million)	86.7
Contribution to GSP (\$ million)	141.5
Total employment (direct and indirect jobs)	1202

Education and awareness, deterrence and enforcement

Table 61: Compliance summary for the South Australian Southern Rock Lobster Fishery for 2012-13

	Commercial	Recreational*
Key risks	<ul style="list-style-type: none"> > Take of under-size Rock Lobster > Quota Management System integrity > Quota evasion > Take of female Rock Lobster carrying external eggs > Using illegal gear 	<ul style="list-style-type: none"> > Take of under-size or over bag/boat limits > Take of female Rock Lobster carrying external eggs > Fishing in closed seasons/areas > Using illegal gear > Illegal sales of Rock Lobster by recreational fishers
Control measures	Education and awareness <ul style="list-style-type: none"> > Direct contact with fishers > Attend and contribute to fishing industry meetings > Provide information through media, Fishwatch, website and printed material 	Education and awareness <ul style="list-style-type: none"> > Fisheries Officers and Fishcare Volunteers patrolled popular Rock Lobster fishing locations providing educational material to recreational fishers about fishing rules > Fishcare Volunteers attended and contributed to boating and camping shows and regional field days > Provided information through media, Fishwatch, SMS Fish, Recreational Fishing App, measuring gauges, website and printed material
	Deterrence <ul style="list-style-type: none"> > Inspections at sea, at landing, in transport, at fish processors > Published articles in the media about compliance activities > Monitor closed areas and season through vessel monitoring system (Northern Zone) > Monitoring and audits on reports of fishing activities by commercial fishers 	Deterrence <ul style="list-style-type: none"> > Catch inspections on the beach, at points of landing, in transit and at sea > Published articles in the media about compliance activities > Monitor closed areas and fishing during closed seasons
	Enforcement <ul style="list-style-type: none"> > Covert and overt observations > Conduct intelligence driven operations and collect and respond to intelligence > Address non-compliance where appropriate with issuing of cautions, expiations and prosecutions before court 	Enforcement <ul style="list-style-type: none"> > Covert and overt observations > Conduct intelligence driven operations and collect and respond to intelligence > Address non-compliance where appropriate with issuing of cautions, expiations and prosecutions before court
Compliance effort and outcomes	<ul style="list-style-type: none"> > Fisheries Officers attended industry meetings and maintained ongoing contact with fishers > Commercial Rock Lobster fishers inspected with a focus on under-size and female Rock Lobster carrying external eggs > Prosecution initiated for fisher acting as a fish processor while unregistered > Audits of compliance with sea lion exclusion device requirements 	<ul style="list-style-type: none"> > 1,108 inspections conducted at sea and 8,651 inspections at points of landing or land based fishing locations in the recreational fishery > 16,974 contacts with recreational fishers were made by Fisheries Officers and Fishcare volunteers > 55 community events attended by Fishcare volunteers and Fisheries Officers > 50 media releases were produced in relation to the recreational fishery
Trends/Issues	<ul style="list-style-type: none"> > Implementation of sea lion exclusion devices in the commercial sector in 2013 and in recreational sector in 2014 	

* The South Australian Recreational Fishery is managed as one fishery statewide. As such, control measures and compliance effort and outcomes are not species specific. All compliance checks, monitoring and enforcement for the Commercial Rock Lobster Fishery are undertaken and reported along with the Giant Crab Fishery.

Finfish



5 Finfish

5.1 Australian Sardine (*Sardinops sagax*)

Authors: Tim Ward and Brad Milic



Table 62: Stock status determination for the Sardine Fishery of South Australia.

Management unit	Northern Zone
Stock Status	Sustainable
Primary indicator (or weight of evidence)	Spawning biomass

Stock structure

There is a growing consensus that the Australian Sardine (*Sardinops sagax*) population is comprised of four separate stocks (Whittington et al. 2008; Izzo et al. 2012). Bass Strait effectively separates the stocks that occur off eastern and southern Australia (Bulman et al. 2008). A single stock occurs off South Australia and western Victoria (Izzo et al. 2012). A further two separate stocks occur off the south and west coasts of Western Australia (Whittington et al. 2008). The Sardine Fishery (part of the Marine Scalefish Fishery using a sardine net) targets the stock off South Australia.

Fishery overview

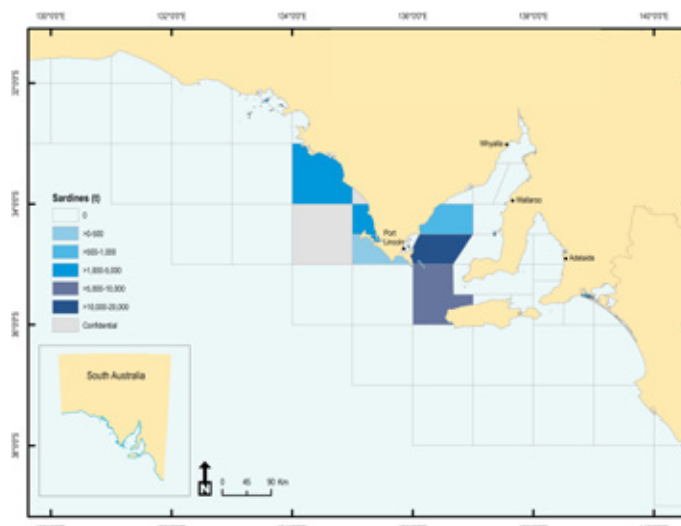
The area of the Sardine Fishery includes all waters adjacent to South Australia to the edge of the 200 nautical mile Australian Fishing Zone, with the exception of closed areas (Figure 40).

The Sardine Fishery was established in 1991 with the first management plan implemented in 1995, the same year the first experimental survey of the stock was completed.

The most significant events in the history of the fishery were the 1995 and 1998 mass mortality events, which saw the fishery closed for a short period of time during each event. These events have been attributed to a Herpes virus of unknown origin that killed approximately 70% of the spawning biomass in South Australian waters (Ward et al. 2001; Whittington et al. 2008). The fact that recoveries have occurred relatively quickly highlights the productivity of the stock.

Australian Sardines are primarily used as feed for Southern Bluefin Tuna, which are ranched by the aquaculture industry near Port Lincoln, South Australia. Small amounts are also sold for human consumption and as recreational fishing bait.

Figure 40: Distribution of commercial catch of Australian Sardines in 2013 (calendar year).



Note: to avoid disclosure of confidential data, levels of catch are not shown for areas that relate to less than five licences.

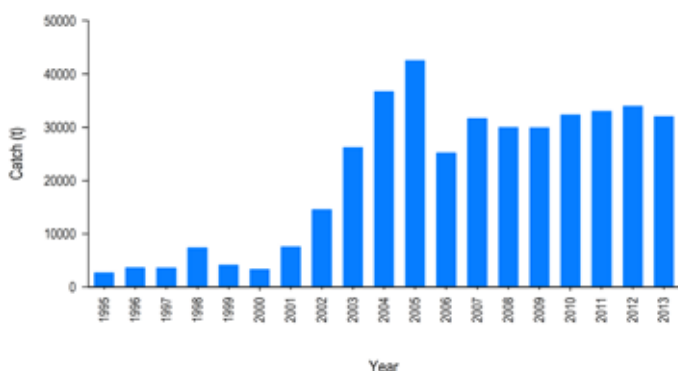
Table 63: Key biological traits of Australian Sardine.

Parameter	Description
Range	Rockhampton, Queensland to Shark Bay, Western Australia, including northern Tasmania
Depth	Not applicable
Longevity	9 years
Maximum size	20-25 cm caudal fork length
Size at maturity	Age: 1-2 years Size: 14.5 cm
Spawning season	Serial spawners occurring during January to April

Catch trends

Annual catches in the Sardine Fishery grew steadily from about 10 t in 1991 to over 40,000 t in 2005. Catch has been around 30,000 to 34,000 t over the last six years (Figure 41).

Figure 41: Annual catch information (by calendar year) for the Sardine Fishery of South Australia.



Management arrangements

Management arrangements for commercial fishing of Australian Sardines are included in the *Fisheries Management (Marine Scalefish Fisheries) Regulations 2006*, *Fisheries Management (General) Regulations 2007* and *Fisheries Management (Vessel Monitoring System) Regulations 2007*. The management framework for the commercial fishery is described in the management plan for the Sardine Fishery (PIRSA 2014d).

The commercial Sardine Fishery is managed through an individual transferrable quota system with a TACC set for each calendar year. Permanent transfer of quota units between licence holders is not permitted. Complementary input controls are also in place, including limited entry and gear restrictions.

Since 2010, spatial management zones have been used to encourage the development of the fishery outside of the gulfs. In

2013, two zones were established to address declines in size and age composition of sardines caught in southern Spencer Gulf.

Marine Scalefish Fishery licence holders also have access to the marine scalefish species listed on Schedule 1 of the *Fisheries Management (Marine Scalefish Fisheries) Regulations 2006*, depending on the endorsements of their licences.

The most recent recreational fishing survey highlighted that recreational fishers do not take Australian Sardines or Australian Anchovy. Management arrangements for recreational harvest of sardines are similar to those for other marine scalefish species included in the *Fisheries Management (Marine Scalefish Fisheries) Regulations 2006*.

Licence holders in the Sardine Fishery are permitted to take Australian Sardines and Australian Anchovy using a purse seine net pursuant to a Marine Scalefish Fishery licence.

Table 64: Summary of management arrangements for the South Australian Commercial Sardine Fishery in 2014.

Management arrangements	Details
Limited entry (number of licences)	14
Minimum legal size limit	No
Commercial gear	> Purse seine net
Commercial gear restrictions	> Mesh size > Net length
TACC	32,000 t
Spatial closure	No
Temporal closures	No
Vessel Monitoring System	Yes

Table 65: Summary of management arrangements for the South Australian Recreational Sardine Fishery in 2014.

Management control	Recreational fishery
Recreational gear	Dab net
Recreational gear restrictions	Yes
Minimum legal size limit	No
Recreational Bag and Boat limits	No
Spatial closure	No
Temporal Closure	No
Possession limit	No

Harvest strategy

The harvest strategy for the Sardine Fishery in South Australia requires collection and analysis of data from commercial fishing operations and fishery-independent surveys. Information from these two sources is used to assess the status of the Sardine Fishery and maintain the harvest within sustainable levels. The TACC is determined by the size of the spawning biomass and level of monitoring undertaken.

Historically, the majority of the catch by the Sardine Fishery has been taken from southern Spencer Gulf. To protect this region from depletion of target-sized fish and adverse impacts on the ecosystem, the harvest strategy establishes a spatial management framework that limits the catch that can be taken from the two gulfs.

Table 66: Harvest strategy components for the South Australian Commercial Sardine Fishery.

Harvest strategy component	Sardine Fishery
Objectives	Ensure the sardine resource is harvested within ecologically sustainable limits
Performance indicators	Spawning biomass estimates from fishery-independent surveys or stock assessments Mean size of sardines from observer samples
Limit reference points	Yes
Target reference points	Yes
Trigger reference points	No
Decision rules	Yes

Monitoring and assessment

The commercial fishery is monitored using data obtained from logbooks and catch samples collected by observers.

Fishery-independent surveys using the daily egg production method are undertaken every one to two years, depending on the exploitation rate. The survey provides a snapshot of the abundance of adult sardines in shelf and gulf waters during the spawning season. Estimates of spawning biomass are also generated by a stock assessment model.

Current biological status

The most recent estimates of spawning biomass are 180,000 t from the stock assessment model (Ward et al. 2012) and between 135,438 t and 162,645 t from the 2013 survey (Ward et al. 2013). The 2013 survey may not have covered the entire spawning area and was repeated in 2014. The sardine stock is considered to be above the target reference point of 150,000 t (Ward et al. 2013).

On the basis of the evidence available, the Australian Sardine resource of South Australia is categorised as **sustainable**.

Effects of fishing on the marine environment

An ESD Risk Assessment of the Sardine Fishery was undertaken in preparing the *Management Plan for the South Australian Commercial Marine Scalefish Fishery - Part B Management Arrangements for the taking of Sardines* (2014d). The assessment identified 16 components that were ranked as medium risks or higher. The risk to Australian Sardines was assessed to be medium. Only one risk to the general ecosystem was found to be medium and was related to water quality – brine discharge. The medium and

high risks have strategies outlined in the management plan (PIRSA 2014d) to address those risks.

The overall trophic level impacts associated with Australian Sardine fishing have been assessed as low (Goldsworthy et al. 2013). The revised harvest strategy includes management arrangements that consider the ecosystem effects of fishing for a low trophic species.

In 2005, the Sardine Fishery was closed following an observer program that showed high rates of encirclement and mortality of the Short-beaked Common Dolphin. The fishery was reopened two months later upon the introduction of a Code of Practice to reduce interaction rates. An ongoing observer program was implemented to monitor and report on interactions with threatened endangered and protected species (Ward et al. 2015). PIRSA Fisheries and Aquaculture, SARDI and industry are continuing to improve mitigation measures with the aim of minimising interactions with the Short-beaked Common Dolphin. Ongoing monitoring indicates the Code of Practice is effectively minimising impacts on TEPs (Ward et al. 2015).

The Sardine Fishery has been assessed by the Australian Government Department of the Environment, against the *Guidelines for Ecological Sustainable Management of Fisheries*, which are set out in the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999*. In November 2009, the Commonwealth Environment Minister provided the South Australian Sardine Fishery with an exemption from the export control provisions and approved the management arrangements to manage the fishery in an ecologically sustainable way. This export control provision expires in November 2015.

Social and economic information

The South Australian Sardine Fishery is based out of Port Lincoln. It is the largest tonnage fishery in Australia, with the majority of Australian Sardines being used as feed on Southern Bluefin Tuna aquaculture farms.

The economics of the fishery are affected by the Australian dollar, TACC, markets for Southern Bluefin Tuna, size of sardine caught, whether sardines are sold fresh or frozen, etc. These variables make it difficult to understand and predict economic trends in the fishery.

Another impediment to understanding the economics of the South Australian Sardine Fishery is that many companies are vertically

integrated; owning licences that allow sardine fishing, as well as the harvesting, ranching and marketing of Southern Bluefin Tuna.

Table 67: Socio-economic information for the South Australian Commercial Sardine Fishery of South Australia, 2012-13 (source: EconSearch 2014g).

Economic indicator	Value
GVP – Australian Sardines (\$ million)	21.0
Contribution to GSP (\$ million)	29.8
Total employment (direct and indirect jobs)	171

Education and awareness, deterrence and enforcement

Table 68: Compliance summary for the South Australian Sardine Fishery for 2012-13.

	Commercial	Recreational
Key risks	<ul style="list-style-type: none"> > Interactions with threatened, endangered and protected species > Take of non-permitted species > Quota integrity > Quota evasion > Illegal gear/illegal use of gear > Disease or pest incursion 	> Nil
Control measures	Education and awareness <ul style="list-style-type: none"> > Direct contact with fishers > Attend and contribute to fishing industry meetings > Fisher responsibilities regarding threatened, endangered and protected species and requirements of industry code of practice 	Education and awareness <ul style="list-style-type: none"> > Nil
	Deterrence <ul style="list-style-type: none"> > Monitor and investigate threatened, endangered and protected species interactions > Monitoring and audits on reports of fishing activities by commercial fishers > Monitoring fishing locations using Vessel Monitoring System 	Deterrence <ul style="list-style-type: none"> > Nil
	Enforcement <ul style="list-style-type: none"> > Covert and overt observations > Conduct intelligence driven operations and collect and respond to intelligence 	Enforcement <ul style="list-style-type: none"> > Nil
Compliance effort and outcomes	<ul style="list-style-type: none"> > Random and targeted inspections conducted including at sea inspections by <i>FPV Southern Ranger</i> > Fisheries Officers attended industry meetings and maintained ongoing contact with fishers > Anomalies in submission of catch data result forms investigated and appropriately addressed > Interactions with threatened, endangered and protected species investigated 	> Nil
Trends/Issues	> Review of quota monitoring system for at sea offloads of Australian Sardines	

5.2 Golden Perch (*Macquaria ambigua*)

Authors: Jason Earl, Qifeng Ye and Jonathan McPhail



Table 69: Stock status determination for the Golden Perch Fishery of South Australia.

Management unit	Lakes and Coorong Fishery	Recreational River Fishery	Lake Eyre Basin Fishery
Status	Sustainable	Sustainable	Undefined
Primary indicator (or weight of evidence)	Weight of evidence	Weight of evidence	Weight of evidence

Stock structure

Golden Perch (*Macquaria ambigua*), or Callop as they are commonly known in South Australia, naturally occur in rivers, creeks, billabongs, floodplains and lakes throughout the Murray-Darling River system (except at higher altitudes), Lake Eyre Basin and the Bulloo-Bancannia and Dawson-Fitzroy drainage systems (Ferguson and Ye 2012). Translocated fish also occur in numerous other waterways throughout south-eastern Australia (Allen et al. 2002). In South Australia, Golden Perch are most common in anabranches, wetlands and main channel habitats of the River Murray, and in Lakes Alexandrina and Albert where they occupy areas of deep, slow-flowing water and areas comprising large woody debris and snags.

Research has identified four distinct populations of Golden Perch across Australia: the Murray-Darling Basin; Fitzroy catchment; Lake Eyre Basin; and Bulloo drainage system populations (Musyl and Keenan 1992; Faulks et al. 2010a, b). Within the Murray-Darling Basin, several stocks have been identified (Keenan et al. 1995). This includes two main stocks: (1) the central stock, which is situated in the lower- and mid-basin waters (i.e. throughout New South Wales, Victoria and South Australia); and (2) the lakes stock, which occurs

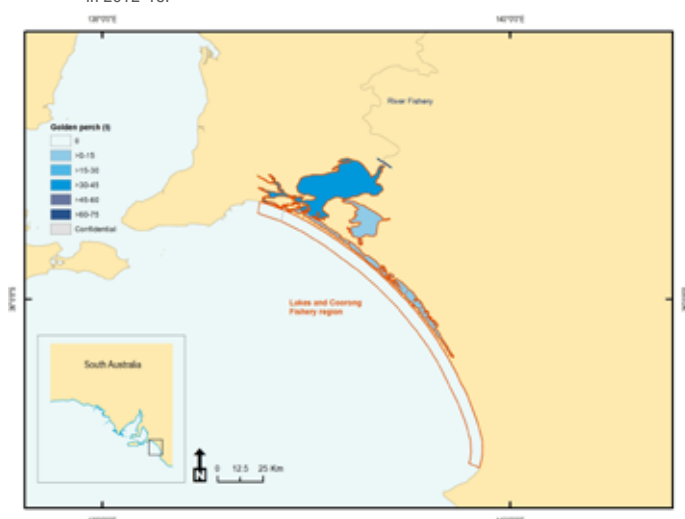
in Lakes Alexandrina and Lake Albert, and extends upstream to Renmark in South Australia. Due to the overlapping occurrence of the central and lakes stocks in South Australia, the assessment of stock status for Golden Perch is undertaken at the management unit level for: (1) the commercial Lakes and Coorong Fishery; and (2) the recreational River Fishery. Status is also reported for the commercial Lake Eyre Basin Fishery management unit.

Fishery overview

Historically, the commercial fishery for Golden Perch in South Australia had three main sectors: Lakes and Coorong Fishery, River (or Reach) Fishery and Lake Eyre Basin Fishery.

The Lakes and Coorong Fishery is a multi-species, multi-gear fishery that operates in, and adjacent to the River Murray estuary, which comprises the Lower Lakes of the River Murray (Lakes Alexandrina and Albert), the Coorong lagoons and Coorong coastal waters (Sir Richard and Young Husband peninsulas) (Sloan 2005). Fishers in the Lakes and Coorong Fishery use mainly large mesh gill nets to target Golden Perch in Lakes Alexandrina and Albert, while smaller catches are taken in the Coorong during periods of high river discharge.

Figure 42: Distribution of commercial catch of Golden Perch in the Lakes and Coorong Fishery in 2012-13.



Information on the distribution and magnitude of catches in the Recreational River Fishery is not available for 2012-13. The distribution of catch in the Lake Eyre Basin Fishery is limited to Lake Hope and Red Lake (not shown).

Table 70: Key biological traits of Golden Perch.

Parameter	Description
Range	Murray-Darling River system (except at higher altitudes), Lake Eyre, and the Bulloo-Bancannia and Dawson-Fitzroy drainage systems. In South Australia, Golden Perch are most common in the lower Murray River, and Lakes Alexandrina and Albert.
Depth	Unknown
Longevity	26 years
Maximum size	Approximately 76 cm total length
Size at maturity	Males: 21-32 cm Females: 29-40 cm
Spawning season	June to November

The commercial River Fishery was established in 1923. Under this system, the South Australian section of the River Murray was divided into 222 reaches and each commercial fisher was responsible for the exploitation and administration of their own reach. This fishery continued until 2003, although management arrangements underwent a series of amendments throughout the life of the fishery, including changes to the number of reaches, access to backwaters, and restrictions on gear types (Ye 2005). The commercial River Fishery was formally closed in 2003, although an extensive recreational fishery continues to exploit Golden Perch stocks throughout the region (Jones 2009).

The Lake Eyre Basin commercial fishery was established in 1992. It has one licensed commercial fisher that operates on the pastoral

holding of Mulka Station and is permitted to take Golden Perch from Lake Hope and Red Lake, located within the boundaries of the station. The Lake Eyre Basin Fishery is a unique fishery due to the harsh environment in which it operates and its dependence on the dispersion of Golden Perch to the region during large scale flood events within the Cooper Creek system. As such, the fishery has operated and reported catches of Golden Perch in only seven of the past 29 years, including in 2011-12 and 2012-13.

Currently, Golden Perch is the only native fish species that is permitted to be taken by recreational fishers along the entire length of the River Murray in South Australia. Recreational fishers target Golden Perch mainly with rod and line using baits and lures, while a limited number of registered nets are also permitted for use in the Lower Lakes, Coorong and Lake George.

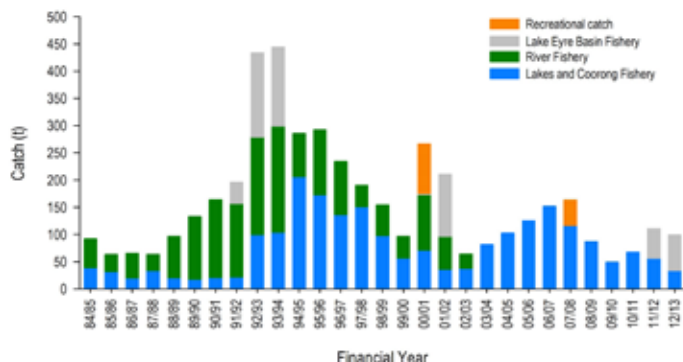
The lower Murray Lakes has been important to Aboriginal people throughout the entire period of their habitation of Australia. The Aboriginal (Ngarrindjeri) history associated with the Lakes region extends over at least 45,000 years. Archaeological evidence to support this is provided by middens containing the remains of fish and terrestrial animals, traditional camp sites, meeting places, rock formations and burial sites. The Ngarrindjeri people targeted several species and smoked and dried fish for storage and trading (Jenkin 1979). Species targeted by the Ngarrindjeri people and associated levels of catch are poorly understood (Ferguson and Ye 2012).

Aboriginal traditional fishing activities in the Lake Eyre Basin take place in a unique social and cultural environment, and often in areas of high conservation and heritage value. Aboriginal traditional fishing activities are undertaken throughout the Lake Eyre Basin region by the Yandruwandha Yawarrawarrka, Dieri, Arabunna and Wangkangurru/Yarluyandi People.

Catch trends

Estimates of total annual statewide commercial catch of Golden Perch were first recorded in 1984-85 when 92 t were harvested (Figure 43). Since then, catch has varied cyclically, with each cycle encompassing a number of years. Catch increased to a historical peak of 444 t in 1993-94, of which 44% was taken by the River Fishery, 33% by the Lake Eyre Basin Fishery and 23% by the Lakes and Coorong Fishery. Since the closure of the commercial River Fishery in June 2003, annual statewide catch has been relatively low with cyclical peaks of 151 t in 2006-07 and 111 t in 2011-12. In 2012-13, catch declined to 99 t, of which 66% and 34% was taken by the Lake Eyre Basin Fishery and Lakes and Coorong Fishery, respectively (Figure 43).

Figure 43: Annual catch information for the Golden Perch Fishery in South Australia, subdivided by management unit.



Data for recreational catch (orange) have only been collected in 2000-01 and 2007-08 during recreational fishing surveys.

Inter-annual trends in targeted effort closely followed those of total catch for the three commercial sectors, which often reflected changes in the environment associated with variation in river flows. For example, the recent increase in catch in 2011-12 was associated with the re-commencement of fishing activity in the commercial Lake Eyre Basin Fishery.

The 2007-08 South Australian Recreational Fishing Survey estimated the recreational catch of Golden Perch at 47 t, which accounted for approximately 28% of the statewide catch (Jones 2009).

Management arrangements

Management of the Lakes and Coorong Fishery is governed by the *Fisheries Management (Lakes and Coorong Fishery) Regulations 2009* and *Fisheries Management (General) Regulations 2007*. Detailed management arrangements for the commercial fishery are provided in the management plan for the fishery (Sloan 2005).

The Lakes and Coorong Fishery has been managed through a mixture of input and output controls (Table 71). Since the early 1980s, input controls have included limited entry (36 licences since 2006), with gear entitlements and owner/operator provisions applied to each licence. Other input controls include gear restrictions applying to the numbers of nets, net dimensions and mesh sizes. An updated management plan, which includes a new harvest strategy for finfish, is due for completion in 2015.

The Lake Eyre Basin Fishery is managed differently to other commercial fisheries, as Lake Hope and Red Lake are only accessible for commercial fishing during and immediately after large scale flood events. This occurs approximately once every 10 years. The Lake Eyre Basin commercial fishery is limited to one Miscellaneous Fishery licence, which is formally constituted by the *Fisheries Management (Miscellaneous Fishery) Regulations 2000*. A number of licence conditions have been placed on the Lake Eyre Basin Fishery licence holder to protect the spawning population of Golden Perch. Through the development of the management plan (PIRSA, 2013d), a seasonal TACC of 350 t was implemented for Lake Eyre Golden Perch. Only Lake Eyre Golden Perch (*Macquaria* spp. B), Welch's Grunter (*Bidyanus welchii*) and Barcoo Grunter (*Scortum barcoo*) may be harvested by this fishery.

The recreational sector is managed through a combination of input and output controls, aimed at ensuring the total catch is maintained within sustainable limits and to ensure that recreational access to the fishery is equitably distributed between recreational participants. A bag and boat limit apply to this fishery. Management arrangements also comprise general gear restrictions and are summarised in Table 72.

Table 71: Summary of management arrangements for the South Australian Commercial Golden Perch Fishery in 2013-14.

Management arrangements	Lakes and Coorong Fishery	Lake Eyre Basin Fishery
Limited entry (number of licences)	36 licences - owner/operator	1 licence - non-transferable
Minimum legal size limit	33 cm total length	
Gear	<ul style="list-style-type: none"> > Mesh nets > Drum nets > Longlines > Set line 	> Mesh nets
Gear restrictions	Net length, mesh size, maximum drop and minimum breaking strain	Net length, mesh size and maximum drop
TACC	No	350 t
Spatial closures	Yes	No (Limited to Lake Hope and Red Lake)
Temporal closures	Yes	Yes
Vessel Monitoring System	No	No

In association with the Yandruwandha Yawarrawarrka people, the South Australian Government has implemented a Yandruwandha Yawarrawarrka Traditional Management Plan. The plan has been implemented for the purposes of the Yandruwandha Yawarrawarrka Fishing Indigenous Land Use Agreement and ensures that members of the Yandruwandha Yawarrawarrka People are able to enjoy, exercise and maintain Aboriginal traditional fishing practices in a way that is sustainable. Management arrangements for this fishery are summarised in Table 73.

Table 72: Summary of management arrangements for the South Australian Recreational Golden Perch Fishery in 2013-14.

Management arrangements	River Murray and Lakes	Lake Eyre Basin
Recreational gear	<ul style="list-style-type: none"> > Rods > Handlines > Mesh nets (Lakes Albert and Alexandrina) 	<ul style="list-style-type: none"> > Rods > Handlines
Recreational gear restrictions	Number rods and hooks	
Minimum legal size limit	33 cm total length	
Recreational bag and boat limits	Bag limit - 5 Boat limit - 15	
Spatial closures	Yes	
Temporal closures	Yes	
Possession limit	No	

Harvest strategy

Lakes and Coorong Fishery

The Lakes and Coorong Fishery harvest strategy framework integrates a set of basic environmental management principles into the day-to-day management of the fishery. This ensures that management decision-making incorporates critical environmental factors, such as the timing and volume of freshwater flows and barriers to fish passage. This approach aims to ensure that fundamental environmental processes are maintained or, where necessary, restored to maximise benefits for Golden Perch stocks. Under this integrated approach, instead of simply measuring the performance of individual fish stocks against management objectives, critical environmental drivers are explicitly taken into account when assessing the overall health of the fishery and in decision-making processes. If water flow rates or other key environmental parameters fall outside of reference levels in any given period, a management response will be initiated to ensure Golden Perch stocks are managed during periods of low ecosystem health, such as extended periods of drought or low river flow.

Table 73: Summary of management arrangements for the Yandruwandha Yawarrawarrka People, Lake Eyre Basin 2013-14.

Management control	Traditional fishery
Minimum legal size limit	33 cm total length
Gear	<ul style="list-style-type: none"> > Mesh nets > Rods > Handlines > Traditional
Gear restrictions	Mesh size
Spatial limitations	Yes

A new harvest strategy specific to finfish harvested by the Lakes and Coorong Fishery is currently being developed as part of the Lakes and Coorong Fishery Management Plan, due for completion in 2015.

Table 74: Harvest strategy components for the South Australian Commercial Lakes and Coorong Fishery for Golden Perch.

Harvest strategy component	Lakes and Coorong Fishery
Objectives	Maintain the primary performance indicators within limit and target reference points
Performance indicators	<ul style="list-style-type: none"> > Total catch (t) > Commercial CPUE > 4-year total catch trend > 4-year CPUE trend > Age composition of the fished population > 4-year net freshwater flows over the barrages
Limit reference points	Yes
Target reference points	Yes
Trigger reference points	No
Decision rules	Yes

Monitoring and assessment

Lakes and Coorong Fishery

Fishery-dependent data are collected to monitor the performance of the Lakes and Coorong Fishery for Golden Perch. Commercial catch and effort information provides the primary data on which the biological status of the fishery is assessed and on which the majority of fisheries management decisions are based. Commercial catch and effort data are collected through daily fishing logbooks.

Currently, temporal trends in commercial catch and CPUE data are the main indicators of stock biomass for the Lakes and Coorong Fishery for Golden Perch. These indicators are compared against limit reference points to assess fishery performance and form a weight of evidence approach to the assessment of stock status. When available, commercial fishery statistics are augmented by limited data on fish ages collected through sampling of commercial catches from Lakes Alexandrina and Albert. Data on the age composition of the population provide important information on recruitment of young fish to the population and presence/absence of mature individuals within the population. Supplementary information on the presence of young-of-the-year Golden Perch may be available from other studies.

Previous stock assessment reports for Golden Perch were undertaken in 2005 and 2012 (Ye 2005, Ferguson and Ye 2012). Performance indicators were also assessed in the 2014 stock status report for the fishery (Earl and Ward 2014).

Recreational River Fishery

No ongoing fishery-dependent information is available to monitor the status of the Golden Perch stock in areas of the River Murray upstream from Wellington. While Golden Perch continue to be harvested by the recreational fishing sector in these areas, estimates of total annual recreational catch are only available for two years (ie. 2000-01 and 2007-08). As such, estimates of relative abundance and population age structures for Golden Perch collected through fishery-independent sampling (Native Fish Monitoring Program, 2005-2013) are used to assess stock status for this management unit. The assessment is supported by research outcomes from other projects (eg. Zampatti and Leigh 2013).

Lake Eyre Basin Fishery

Minimal information exists on Golden Perch populations in the Lake Eyre Basin.

An ecological assessment and monitoring program developed as part of the Lake Eyre Basin Rivers Assessment provides the only available information for determining and monitoring river health through the Lake Eyre Basin. Quantitative data on fish abundances, hydrology and water quality are currently being collected through

field sampling which commenced in 2011. The results of this monitoring will not be available until 2018.

Current biological status

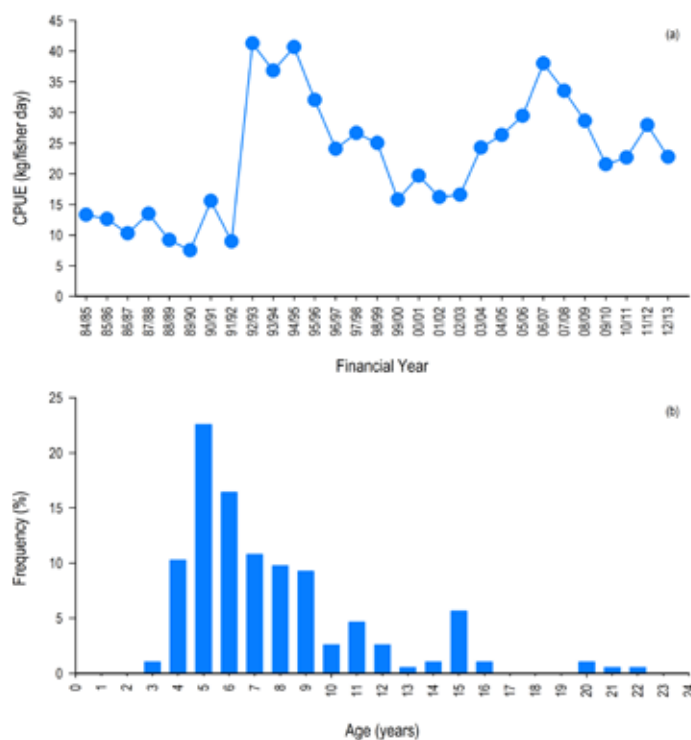
Lakes and Coorong Fishery

The management plan for the Lakes and Coorong Fishery does not involve fishery performance indicators or limit reference points that are framed around recruitment overfishing (Sloan 2005). Rather, stock assessment for Golden Perch utilises a weight of evidence approach that involves numerous performance indicators (Ferguson and Ye 2012). CPUE and catch are the best fishery performance indicators for this management unit. These data are augmented by data on fish ages collected through sampling of commercial catches.

From 2006-07 to 2009-10, there were substantial declines in catch (Figure 43) and CPUE (Figure 44a) for Golden Perch in the Lakes and Coorong Fishery. However since then, catch and CPUE have been relatively stable and above their respective limit reference points. The age structure of the fished population for 2011-12 showed numerous strong year classes having recruited to the population over the past decade (Figure 44b). Furthermore, the presence of small juveniles (<1 year olds) in barrage fish-ways below Lake Alexandrina suggests that a significant recruitment event also occurred in 2010-11 (Zampatti et al. 2012).

On the basis of the evidence available Golden Perch in the Lakes and Coorong management unit is categorised as **sustainable**.

Figure 44: (a) CPUE for the Lakes and Coorong Fishery (large mesh gill nets) for Golden Perch from 1984-85 to 2012-13; and (b) Age structures for Golden Perch from commercial catches in 2011-12 taken from Ferguson and Ye (2012).



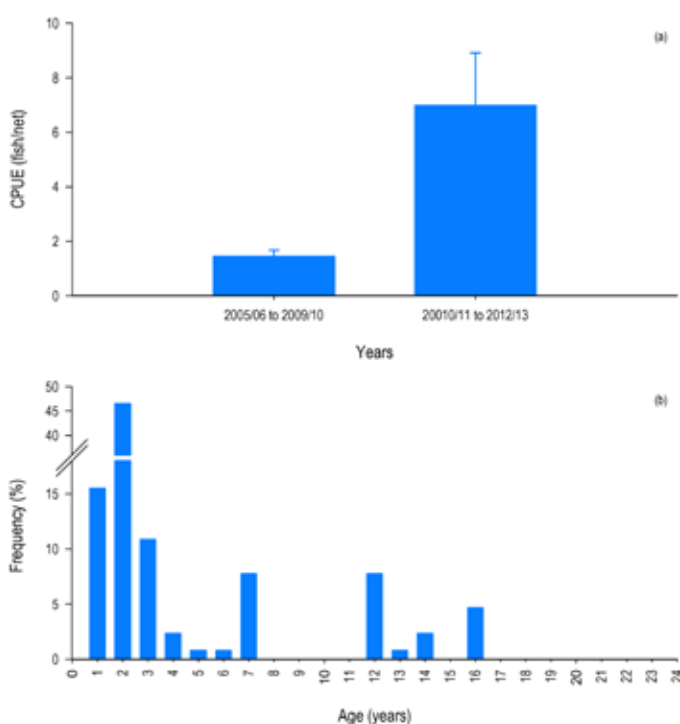
Recreational River Fishery

Assessment of the status of the Recreational River Fishery for Golden Perch does not involve fishery performance indicators or limit reference points that are framed around recruitment overfishing. Rather, it utilises a weight of evidence approach that involves two key performance indicators: (1) the index of relative abundance (CPUE), based on fishery-independent surveys through the Native Fish Monitoring Program (2005-2013); and (2) information on the age structure of the population for 2012-13.

Since 2010-11, the mean annual CPUE has increased significantly to a level about five times higher than that of the preceding years from 2005-06 to 2009-10 (Figure 45a). Age structure analyses revealed that the recent increase in relative abundance was due mostly to higher numbers of two year old fish spawned during the overbank flood in 2010-11, as well as one and three year old fish spawned in 2011-12 and 2009-10, respectively (Figure 45b). Several other strong year classes are also present in the age structure for 2012-13 (Figure 45b). The increase in abundance and recruitment of Golden Perch in the lower River Murray since 2010-11 is also supported by data from other research and monitoring projects (Zampatti and Leigh 2013).

On the basis of the evidence available, the Golden Perch resource in the Recreational River Fishery management unit is categorised as **sustainable**.

Figure 45: (a) Comparison of the relative abundance (mean annual CPUE) of Golden Perch in the Recreational River Fishery between 2005-06 to 2009-2010 and after 2010-2011 to 2012-2013. (b) Age structures for Golden Perch collected through fishery-independent surveys by drum netting undertaken at multiple sites in the lower Murray River between the SA/NSW border and Wellington in 2012-13 (unpublished data, Q. Ye).



Lake Eyre Basin Fishery

As no formal stock assessments have been undertaken for Golden Perch in the Lake Eyre Basin, there is insufficient information available to classify the status of this management unit.

On the basis of the evidence available the Golden Perch resource in the Lake Eyre Basin management unit is categorised as **undefined**.

Effects of fishing on the freshwater environment

An ESD Risk Assessment of the Lake Eyre Basin Fishery was carried out in 2010 and in the Lakes and Coorong Fishery in 2011. The risk to Golden Perch in the Lakes and Coorong Fishery was ranked as high and the risk of capture of threatened, endangered and protected species in the Lakes and Coorong Fishery as low for sea birds and Long-nosed fur seals. The general ecosystem risks from the impacts of fishing in the Lakes and Coorong were high for the freshwater environment and for the introduction of marine pests and aquatic diseases (PIRSA 2011c). The risk to the Lake Eyre Basin Golden Perch stock was ranked as low and the risk of capture of threatened, endangered and protected species low for water rats and turtles and negligible for all other species. The general ecosystem risks from the impacts of fishing were extreme for the translocation of species into the Lake Eyre Basin; moderate for translocation of species across the Lake Eyre Basin; and low for ecological disturbance (PIRSA 2010).

The Lakes and Coorong Fishery was assessed against the Marine Stewardship Council environmental standard for sustainable fishing and was certified as sustainable in 2008.

The overall environmental impacts associated with current Golden Perch fishing in the Lower Lakes are considered to be relatively low. Large mesh gill nets are the dominant gear type used in the Lakes and Coorong Fishery to target Golden Perch. While information on discarding of non-target species and under-sized Golden Perch is not available for the freshwater sector of the Lakes and Coorong Fishery, the size-selective nature of gill nets used to target Golden Perch suggests that discard rates of under-size fish is likely to be low. However the large-bodied invasive Common Carp, which comprises >50% of the total annual finfish catch in Lakes Alexandrina and Albert, is likely to be a major by-catch species for this part of the fishery. Non-targeted catches of this alien species is likely to benefit native fish populations in the lower lakes.

The South Australian Lakes and Coorong Fishery has been assessed by the Australian Government Department of the Environment against the *Guidelines for Ecological Sustainable Management of Fisheries*, which are set out in the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. The South Australian Lakes and

Coorong Fishery has been provided with an exemption from the export controls of the Act, subject to a number of recommendations and conditions, until February 2016.

When the commercial Lake Eyre Basin Fishery is operational, gill nets are used, and there is no evidence that nets have been lost or discarded in Lake Hope or Red Lake. Information on discarding of non-target species and under-sized Golden Perch is not available for the Lake Eyre Basin Fishery.

Social and economic information

The Commercial Golden Perch Fishery is an important contributor to the socio-economic well-being of regional communities in the Lakes and Coorong region. The commercial Golden Perch fishery contributes \$341,000 of the total \$7.1m GVP and directly and indirectly

contributes to the provision, maintenance and expansion of a number of local and regional services and businesses (EconSearch 2014c).

Table 75: Socio-economic information for the South Australian Commercial Golden Perch Fishery, 2012-13 (source: EconSearch 2014c and SARDI unpublished).

Economic indicator	Total Fishery
GVP - Golden Perch*(\$ million)	0.34
Contribution to GSP from Lakes and Coorong Fishery (\$ million)#	18.8
Total employment from Lakes and Coorong Fishery (direct and indirect jobs) #	151

* GVP for Golden Perch provided by SARDI (unpublished)

GSP and employment are the total contribution of all species in the Lakes and Coorong Fishery.

Education and awareness, deterrence and enforcement

Table 76: Compliance summary for the South Australian Lakes and Coorong Fishery for 2012-13.

	Commercial	Recreational*
Key risks	<ul style="list-style-type: none"> > Take of under-size fish > Using illegal gear > Reporting requirements not met 	<ul style="list-style-type: none"> > Take of under-size fish or exceeding the bag limit > Fishing in closed areas or during closed seasons
Control measures	<p>Education and awareness</p> <ul style="list-style-type: none"> > Direct contact with fishers > Attend and contribute to fishing industry meetings > Provide information through media, Fishwatch, website and printed material <p>Deterrence</p> <ul style="list-style-type: none"> > Inspections on the water, at landing, in transport, at fish processors > Monitoring and audits on reports of fishing activities by commercial fishers <p>Enforcement</p> <ul style="list-style-type: none"> > Covert and overt observations and conduct intelligence driven operations > Address non-compliance where appropriate with issuing of cautions, expiations and prosecutions before court 	<p>Education and awareness</p> <ul style="list-style-type: none"> > Fisheries Officers and Fishcare Volunteers patrolled popular fishing locations providing education material to recreational fishers about fishing rules > Fishcare Volunteers attended and contributed to boating and camping shows and regional field days > Provided information through media, Fishwatch, SMS Fish, Recreational Fishing App, measuring gauges, website and printed material <p>Deterrence</p> <ul style="list-style-type: none"> > Catch inspections on the beach, at points of landing, in transit and on the water <p>Enforcement</p> <ul style="list-style-type: none"> > Conduct intelligence driven covert and overt operations > Address non-compliance where appropriate with issuing of cautions, expiations and prosecutions before court
Compliance effort and outcomes	<ul style="list-style-type: none"> > Fisheries Officers attended industry meetings and maintained ongoing contact with fishers > Routine, random and targeted inspections of fish processors and commercial fishers > Operation Talisker completed inspections on commercial Lakes and Coorong net fishers who target species in the Lakes and Coorong Fishery 	<ul style="list-style-type: none"> > 1,108 inspections conducted at sea and 8,651 inspections at points of landing or land based fishing locations in the recreational fishery > 16,974 contacts with recreational fishers were made by Fisheries Officers and Fishcare Volunteers > 55 community events attended by Fishcare Volunteers and Fisheries Officers > 50 media releases were produced in relation to the recreational fishery

* The South Australian Recreational Fishery is managed as one fishery statewide. As such, most control measures and compliance effort and outcomes are not species specific. They cover all key lakes and Coorong species, including Mulloway, Golden Perch, Murray Cod and Yelloweye Mullet.

5.3 King George Whiting (*Sillaginodes punctatus*)

Authors: Anthony Fowler and Michelle Besley



Table 77: Stock status determination for the King George Whiting Fishery of South Australia.

Stock	Spencer Gulf	Gulf St Vincent	West Coast
Status	Transitional-depleting	Transitional-depleting	Sustainable
Primary indicator	Weight of evidence	Weight of evidence	Weight of evidence

Stock structure

South Australia’s King George Whiting (*Sillaginodes punctatus*) population is genetically homogeneous (Fowler and McGarvey 2000). Nevertheless, several stocks are recognised based on our understanding of the spatial aspects of the life history that involve: the interaction between adult movement determined from tag/recapture studies; reproductive biology with respect to the location of spawning grounds and nursery areas; and larval advection pathways and distances, based on early life history and hydrodynamic modelling (Fowler et al. 1999, 2000, 2002). So, for management and stock assessment purposes, the King George Whiting population is divided into three adjacent stocks: Gulf St Vincent; Spencer Gulf; and west coast of Eyre Peninsula (Figure 46).

Fishery overview

King George Whiting is the largest and most valuable member of the family Sillaginidae (Australian whittings) (Kailola et al. 1993). It is endemic to southern Australia where it is distributed along the southern coastline from south Western Australia to central New South Wales, including northern Tasmania. Throughout this distribution it is one of the most significant inshore fishery species. Its habitat use varies throughout its life cycle: nursery areas are shallow protected embayments; juveniles and young adults are found in shallow coastal waters; while the larger, older adults occur in deeper offshore waters and even in continental shelf waters to 200 m (Kailola et al. 1993).

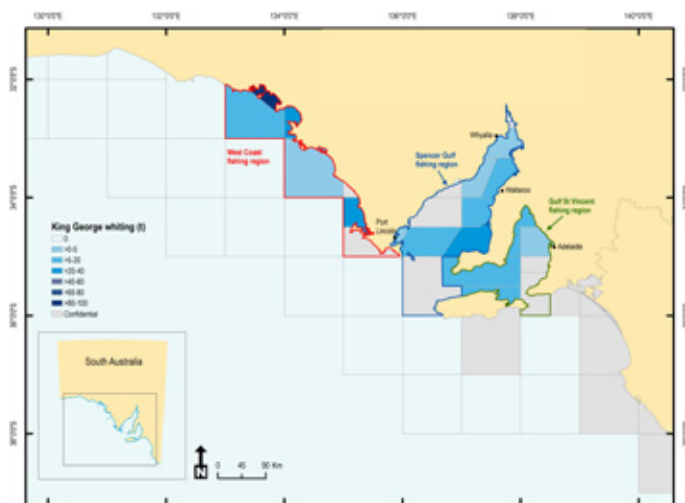
In South Australia, King George Whiting are heavily targeted by commercial and recreational fishers, reflecting their relatively high abundance and high quality as a table fish. They are targeted by the commercial sector using handlines, hauling nets and gill nets, while the recreational sector use handlines and rods and line.

The fishery is geographically extensive and includes all coastal waters from the South East of the State to Denial Bay on the west coast of Eyre Peninsula. The commercial fishery is managed as part of South Australia’s complex, multi-species, and multi-gear Marine Scalefish Fishery.

King George Whiting are also a significant target catch of the recreational fishery, being the most frequently caught marine finfish species in South Australia by recreational fishers (Jones 2009). Recreational fishers target King George Whiting with rod and line; from boats, shore and jetties. A small number are taken by spears. A large portion (67%) of the recreational catch is taken by boat-based fishers. The majority (79%) of the recreational catch is taken from the two gulfs and around Kangaroo Island (Jones 2009).

The King George Whiting Fishery has generally been described as a ‘gauntlet’ fishery, which relates to the migration behaviour that the fish undertake. When the fish reach approximately three years of age and approximately 30 cm in length, they undertake a once-off migration between the shallow, protected waterways to deeper, offshore waters (Fowler et al. 2002). As they do this, they run the

Figure 46: Distribution of commercial catch of King George Whiting in 2013.



Note: to avoid disclosure of confidential data, levels of catch are not shown for areas that relate to less than five licences.

Table 78: Key biological traits of King George Whiting.

Parameter	Description
Range	Port Jackson in the east, along the southern coastline to Jurien Bay in the west, including northern Tasmania.
Depth	Intertidal to 200 m
Longevity	22 years
Maximum size	59 cm total length
Size at maturity	Age: 3 years Size: 32 cm total length
Spawning season	March to June

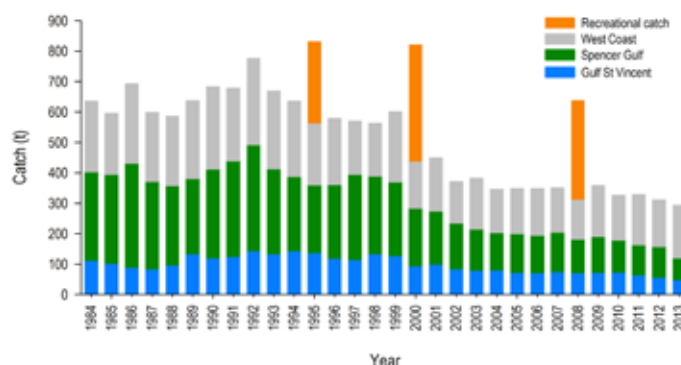
gauntlet of fishing lines and nets that are used to target them. Some fish must complete this migration in order to replenish the populations of mature, adult fish that undertake the reproductive activity.

Catch trends

The annual statewide estimates of commercial catch for King George Whiting were variable but increased to 1992 when the record catch of 776 t was recorded (Figure 47). Since then, they have declined substantially. The largest single annual decline occurred in 2000 after which there has been a further gradual decline to the lowest commercial catch of 293 t in 2013. The declines are most evident for Spencer Gulf and Gulf St Vincent (Figure 47). The falling catches reflect declines in targeted effort for each of the main gear types of handlines, gill nets and hauling nets, which reflect reductions in the numbers of commercial fishers who target King George Whiting with the different gear types.

The creel survey undertaken in 1994-96 gave an estimate of statewide recreational catch of 266 t (McGlennon and Kinloch 1997) (Figure 47). Since then, two telephone surveys completed in 2000-01 and 2007-08 provided estimates of recreational catch of 382 t and 324 t, respectively, (Jones and Doonan 2005, Jones 2009). These accounted for 46.5% and 49.6% of total catch in the respective years (Fowler et al. 2011).

Figure 47: Annual catch information (by calendar year) for the King George Whiting Fishery.



Data for recreational catch (orange) have only been collected in 1994-95, 2000-01 and 2007-08 during recreational fishing surveys.

Management arrangements

Management arrangements for the fishery are provided in the *Management Plan for the South Australian Commercial Marine Scalefish Fishery*, the *Fisheries Management (General) Regulations 2007*, licence conditions and the fishery specific regulations for each of the fisheries e.g. *Fisheries Management (Marine Scalefish Fisheries) Regulations 2011*.

Licence holders from four different commercial fisheries have access to King George Whiting in their respective fishery (ie. Marine Scalefish Fishery, Northern Zone Rock Lobster Fishery, Southern Zone Rock Lobster Fishery and Lakes and Coorong Fishery).

The commercial fishery is largely managed through the use of input controls, which aim to limit the total effort that can be directed into the fishery. The principal gears used to commercially target King George Whiting are rod and lines, hauling nets and gill nets. Significant net closures and gear restrictions govern the use of the nets and restrict their area of operation to relatively small areas within the northern gulfs. A net buy-back in 2005 significantly reduced the number of nets operating, effectively accounting for 45% of commercial hauling net fishing effort during 2000 to 2003.

In 2014, 12 licences in the Marine Scalefish Fishery and 2,814 effort days associated with these licences were surrendered through the South Australia Marine Parks: Commercial Fisheries Voluntary Catch/Effort Reduction Program.

King George Whiting minimum legal size limits were reviewed in 2004 and increased to reduce fishing pressure on the juveniles.

In addition, there is an ongoing commercial licence amalgamation scheme which requires two licences to be amalgamated on transfer and limits the number of agents that may fish from a licence. These restrictions are aimed at limiting fishing effort, as well as the impact on the marine ecosystem.

The recreational fishing sector is currently managed through a range of input and output controls designed to ensure that the total catch remains sustainable and is shared equitably between recreational fishers and other fishing sectors. These controls include bag, boat and size limits, and gear restrictions.

King George Whiting is subject to a possession limit. This was implemented in September 2012 due to community concern that fish stocks were being depleted by recreational fishers from within South Australia and interstate who visit areas of the State specifically to take and stockpile large quantities of fish.

A management review is being undertaken to respond to the recent decline in King George Whiting stock abundance. Consultation will be undertaken as part of this review.

Harvest strategy

Trigger points are set for each indicator. The King George Whiting harvest strategy does not prescribe specific management responses to breaches of trigger reference points. Instead breaches of trigger reference points are reviewed by the Marine Scalefish Fishery Management Advisory Group and reported to the Minister (or his/her delegate). If further action is required then specific management

responses will be developed through the existing co-management framework that will be consistent with the objectives of the harvest strategy (PIRSA 2013b).

Monitoring and assessment

Fishery-dependent data are collected to monitor the King George Whiting fishery. Commercial catch and effort information provides the primary data on which the biological status of the fishery is assessed and on which the majority of fisheries management decisions are based. These fishery-dependent data are collected through daily fishing logbooks. Stock status is determined on the basis of fishery performance indicators by a weight of evidence approach (PIRSA 2013b).

A market sampling program undertaken at the SAFCOL fish market in Adelaide, and commercial fish processing plants on the west coast of Eyre Peninsula and Kangaroo Island, has provided information on the sizes and ages of fish captured in the fishery in most years since 2000. This sampling provides a view of population structure from which the recent demographic processes can be inferred, thereby providing an insight into stock status. The recent regional age structures for the three stocks are assessed for change over the most recent five years and longer time periods by comparison against historical age structures that were developed through the 1990s (Fowler and McGarvey 2000).

Handline effort and CPUE are derived from commercial logbook data and provide a direct measure of the relative abundance of the stock.

The stock assessment model uses a combination of fishery-dependent catch and effort information and the size and age structure information to estimate population biomass, exploitation rate and annual recruitment rates.

Reviews of the *Marine Scalefish Fishery Status Report* and *King George Whiting Stock Assessment Report* are undertaken within the existing co-management framework (principally by the Marine Scalefish Fishery Management Advisory Group) within one month of their release. Reviews consider all information in the reports with particular emphasis on the primary and secondary performance indicators and the performance against the trigger reference points and objectives outlined in the harvest strategy.

Current biological status

The *Management Plan for the South Australian Commercial Marine Scalefish Fishery* does not have fishery performance indicators or trigger reference points that are framed around recruitment overfishing. Rather, the stock assessment utilises a weight of evidence approach that considers commercial catch and effort data,

Table 79: Harvest strategy components for the South Australian Commercial King George Whiting Fishery.

Harvest strategy component	Whole of fishery
Objectives	Maintain the primary performance indicators within acceptable trigger reference points
Performance indicators	<ul style="list-style-type: none"> > Handline effort (by region) (fisher days) > Handline CPUE (by region) (kg/fisher day) > Age structure/composition > Fishable biomass > Exploitation rate (harvest fraction)
Limit reference points	No
Target reference points	No
Trigger reference points	Yes
Decision rules	Yes

Table 80: Summary of management arrangements for the South Australian Commercial King George Whiting Fishery in 2013-14.

Management arrangements	Marine Scalefish Fishery	Northern Zone Rock Lobster Fishery (NZRL), Southern Zone Rock Lobster Fishery (SZRL)	Lakes and Coorong Fishery
Limited entry (number of licences)	311 Restricted 7 Owner/operator	NZRL – 63 SZRL – 180 Owner/operator outside Rock Lobster season	36 Owner/operator
Minimum legal size limit	31 cm in all waters east of longitude 136° E (runs through Cape Catastrophe just south of Port Lincoln) including all waters of Spencer Gulf and Gulf St Vincent 30 cm in all waters west of longitude 136° E		
Commercial gear	> Rod and line > Hauling net > Gill net		
Commercial gear restrictions	> Net <ul style="list-style-type: none"> • Net length, depth, mesh size • Fish must be retrieved from hauling nets using a brailing net • Restrictions on the use of hauling nets in conjunction with other devices • Maximum depth for setting haul net is 5 m • Gill nets must be attended > Rod and line <ul style="list-style-type: none"> • Number of rod and handlines • Number of hooks 		
TACC	No		
Spatial closures	Yes		
Temporal closures	Yes		
Vessel Monitoring System	No		

Table 81: Summary of management arrangements for the South Australian Recreational King George Whiting Fishery in 2013-14.

Management arrangements	Recreational Fishery
Recreational gear	> Handlines > Rod and line > Spear
Recreational gear restrictions	> Number of rod and handlines > Number of hooks > Spear - restrictions on their use apply in some areas and they cannot be used to take fish while using SCUBA or hookah gear and if they have an explosive cartridge.
Minimum legal size limit	31 cm in all waters east of longitude 136° E (runs through Cape Catastrophe just south of Port Lincoln) including all waters of Spencer Gulf and Gulf St Vincent 30 cm in all waters west of longitude 136° E
Recreational bag and boat limits	Bag limit: 12 fish per day Boat limit: 36
Temporal closures	No
Spatial closures	No
Possession limits	Yes

recreational fishery data, biological information on population size and age structures, as well as output parameters from the fishery stock assessment model (Fowler and McGarvey 2000). The primary indicators are handline effort and CPUE, and exploitation rate and biomass from the assessment model. The most recent assessment was completed in August 2014 (Fowler et al. 2014).

Gulf St Vincent

Handline effort and CPUE have declined since 2009 (Fowler et al. 2014). These declining trends are consistent with declining levels of biomass. The model-estimated biomass for this stock indicated a declining trend subsequent to a peak estimate in 2008 (Figure 48). Since the estimates of effort and CPUE used in the model did not take into consideration likely increases in effective effort (eg. advancements in fishing gear, power of vessels and electronic equipment) and because of uncertainty in the time-series of recreational catch and effort, the decline in fishable biomass may have been greater than suggested by the model output. Although it appears that the biomass of King George Whiting has declined between 2009 and 2013, the stock is not yet considered to be in a recruitment overfished state.

On the basis of the evidence available, the King George Whiting resource in the Gulf St Vincent management unit is categorised as **transitional-depleting**.

In response to the status for King George Whiting in Gulf St Vincent, a review of management options for King George Whiting in response to the latest scientific advice has commenced. The full suite of management options will be explored and consultation will occur with key stakeholder groups. Management changes will be introduced during 2015.

Spencer Gulf

There are recent declining trends for both catch and effort for this region culminating in the lowest recorded values in 2013 (Fowler et al. 2014). Furthermore, CPUE has declined since 2007. Such trends in fishery statistics are consistent with declining biomass. This is reflected in the model outputs, which show a marginal decline in biomass between 2008 and 2013 (Figure 48). Since the estimates of effort and CPUE used in the model did not take into consideration likely increases in 'effective' effort and because of uncertainty in the time-series of recreational catch and effort, the decline in fishable biomass may have been greater than suggested by the model output. Although declining slowly, the stock is not yet considered to be in a recruitment overfished state.

On the basis of the evidence available, the King George Whiting resource in the Spencer Gulf management unit is categorised as **transitional-depleting**.

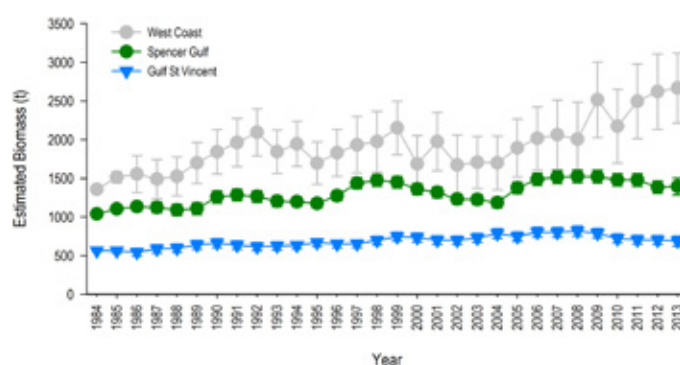
In response to the status for King George Whiting in Spencer Gulf, a review of management options for King George Whiting in response to the latest scientific advice has commenced. The full suite of management options will be explored and consultation will occur with key stakeholder groups. Management changes will be introduced during 2015.

West Coast

For this stock in recent years, handline fishing effort was relatively stable; catch increased; and handline CPUE increased to 2013, reaching the highest ever recorded level (Fowler et al. 2014). Output from the stock assessment model showed trends of increasing recruitment rates and levels of biomass between 2004 and 2013. Furthermore, between 1984 and 2013 the exploitation rate fell, relating to long-term declines in commercial and recreational fishing effort. The above evidence indicates that the biomass of this stock is unlikely to be recruitment overfished and that the current level of fishing mortality is unlikely to cause the fishable biomass to become recruitment overfished.

On the basis of the evidence available, the King George Whiting resource in the West Coast management unit is categorised as **sustainable**.

Figure 48: Time-series of fishable biomass of King George Whiting estimated by the stock assessment model for each of the three stocks.



Effects of fishing on the marine environment

An ESD Risk Assessment of the South Australian Marine Scalefish Fishery was undertaken in July 2011, in preparing the *Management Plan for the South Australian Commercial Marine Scalefish Fishery* (PIRSA 2013b). The moderate, high and extreme risks were predominately related to governance and external factors affecting the performance of the fishery. Two general ecosystem risks of moderate were identified related to fishing and the introduction of marine pests or aquatic diseases. King George Whiting was ranked as low risk through this process (PIRSA 2011b). The moderate and higher risks have strategies outlined in the management plan to address those risks.

King George Whiting are targeted by the commercial sector using handlines, hauling nets and gill nets (small mesh). These activities are considered to pose a low to negligible risk to habitat and ecosystem function. None of these gear types are likely to cause considerable damage to the benthic habitats in which they are deployed.

There are potential impacts on the ecosystem through the capture of unwanted species (by-catch) and unintended mortality of non-target species with each of the gear types. Of these, hauling nets pose a higher risk to the capture of non-target species, with a large range of species captured during fishing operations. A by-catch study by Fowler et al. (2009) demonstrated that hauling nets have the potential to capture large numbers of species. The risk to such by-catch species is mitigated, to some extent, through regulations that require catches to be sorted in-water (as this increases the likelihood that species are released alive). The low numbers of discarded fish were generally released in relatively good condition; however, the relatively few fish that had become enmeshed in the wing of the net were discarded in poor condition. The study demonstrated that when handlines were used to target King George Whiting they were highly selective, producing relatively low capture rates of by-catch species.

The Marine Scalefish Fishery has been assessed by the Australian Government Department of the Environment against the *Guidelines for Ecological Sustainable Management of Fisheries*, which are set out in the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. The South Australian Marine Scalefish Fishery was provided with an exemption to September 2015 from the export controls of the Act, subject to a number of recommendations and conditions.

Social and economic information

Commercial and recreational King George Whiting fishing brings economic, social and tourism benefits to a number of coastal fishing communities. The commercial fishery is owner/operator run with fishing undertaken by the licence owner. King George Whiting is sold domestically and contributes to seafood supply and tourism. It is highly valued as a premium seafood species in South Australia.

Many of the commercial fishers live in small communities. There is a high level of involvement by family and friends in the fishing business. Around half have a family history of involvement in commercial fishing. Fishers may fish on a part-time or full-time basis with some defining their fishing operation as a lifestyle that has its own culture and customs.

Key regions where King George Whiting fishing has a high regional impact, in terms of economic spending, membership of community groups and historical links to the local area, are the West Coast (principally Ceduna, Thevenard and Streaky Bay), Yorke Peninsula, Kangaroo Island and Port Lincoln.

Recreational catches of King George Whiting are taken mostly within the two gulfs and from the far West Coast from boats. Recreational fishing contributes to the well-being of recreational fishers, particularly for fishers that rate the following aspects as important when fishing; spending time in the outdoors, spending time with family, eating their own catch and getting away from people.

Table 82: Socio-economic information for the South Australian Commercial King George Whiting Fishery, 2012-13 (source: EconSearch 2014b).

Socio-economic indicator	Combined sectors
GVP – King George Whiting (\$ million)	4.8
Contribution to GSP (\$ million) from Marine Scalefish Fishery*	49.7
Total employment (direct and indirect jobs) from the Marine Scalefish Fishery*	587

* GSP and employment figures are the total contribution of all species from the Marine Scalefish Fishery.

Education and awareness, deterrence and enforcement

Table 83: Compliance summary for the South Australian Marine Scalefish Fishery for 2012-13.

	Commercial	Recreational*
Key risks	<ul style="list-style-type: none"> > Take of under-size fish > Take of fish using illegal gear > Reporting accuracy by commercial fishers > Take of fish during closures > Exceeding trip limits (Snapper, Gummy Shark and School Shark only) 	<ul style="list-style-type: none"> > Take of under-size fish or exceeding bag/boat limit > Take of fish in closed areas > Take of fish in closed seasons (Snapper and Bream only) > Illegal sales of recreationally caught fish
Control measures	Education and awareness <ul style="list-style-type: none"> > Direct contact with fishers > Attend and contribute to fishing industry meetings > Publish Information through media, Fishwatch, website and printed material 	Education and awareness <ul style="list-style-type: none"> > Fisheries Officers and Fishcare Volunteers patrolled popular fishing locations providing education material to recreational fishers about fishing rules > Fishcare Volunteers attended and contributed to boating and camping shows and regional field days > Provided information through media, Fishwatch, SMS Fish, Recreational Fishing Guide App, measuring gauges, website and printed materials
	Deterrence <ul style="list-style-type: none"> > Inspections on the water, at landing, in transport, at fish processors and at unregistered fish processors > Published articles in media about compliance activities > Monitoring and audits on reports of fishing activities by commercial fishers, consigned weights, sales dockets and logbooks 	Deterrence <ul style="list-style-type: none"> > Inspections of catches taken by recreational fishers at points of landing, in transit and on the water > Publish information in media about compliance activities > Monitor fishing activity during closed seasons and in closed areas
	Enforcement <ul style="list-style-type: none"> > Covert and overt observations and conduct intelligence driven operations > Address non-compliance where appropriate with issuing of cautions, expiations and prosecutions before court 	Enforcement <ul style="list-style-type: none"> > Intelligence driven operations > Address non-compliance where appropriate with issuing of cautions, expiations and prosecutions before court
Compliance effort and outcomes	<ul style="list-style-type: none"> > Routine, random and targeted inspections of commercial fishers and fish processors > Licence holders provided advice by Fisheries Officers, including new entrants into the Commercial Marine Scalefish Fishery > Fisheries Officers attended industry meetings and maintained ongoing contact with fishers > Haul nets inspected to ensure compliance with newly legislated net dimensions 	<ul style="list-style-type: none"> > 1,108 inspections conducted at sea and 8,651 inspections at points of landing or land based fishing locations in the recreational fishery > 16,974 contacts with recreational fishers were made by Fisheries Officers and Fishcare Volunteers > 55 community events attended by Fishcare Volunteers and Fisheries Officers > 50 media releases were produced in relation to the recreational fishery
Trends/issues	<ul style="list-style-type: none"> > Participated in the development of Snapper spatial closure areas in conjunction with PIRSA Fisheries and Aquaculture Policy 	

* The South Australian Recreational Fishery is managed as one fishery statewide. As such, most control measures and compliance effort and outcomes are not species specific. They cover all key marine scalefish species, including Snapper, Southern Garfish, Southern Calamari and King George Whiting.

5.4 Mulloway (*Argyrosomus japonicus*)

Authors: Jason Earl and Jonathan McPhail

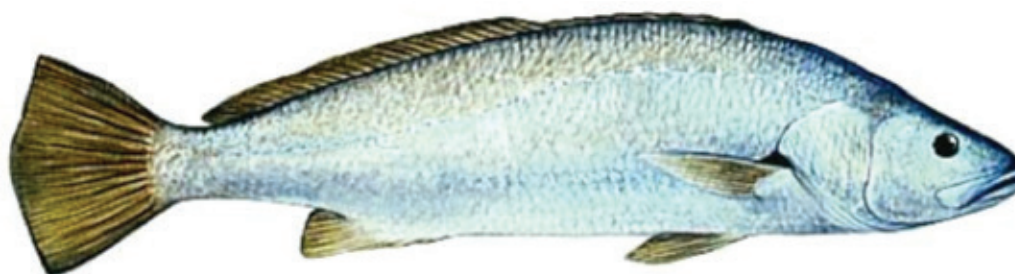


Table 84: Stock status determination for the Mulloway Fishery of South Australia.

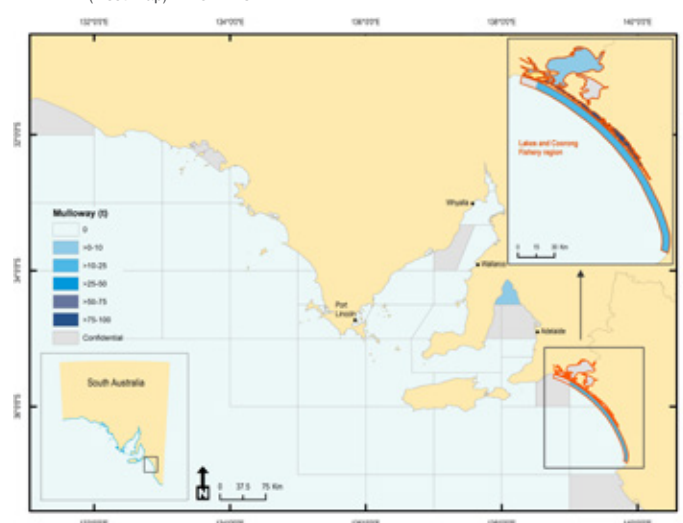
Management unit	Lakes and Coorong Fishery	Marine Scalefish Fishery
Status	Sustainable	Undefined
Primary indicator (or weight of evidence)	Weight of evidence	Weight of evidence

Stock structure

Mulloway (*Argyrosomus japonicus*) have an Indo-Pacific distribution where they inhabit coastal waters and estuaries in both northern and southern hemispheres. The species occurs from the east coast of South Africa, along the Chinese coast from Hong Kong to southern Korea and Japan, and along the south coast of Australia from North West Cape in Western Australia to the Burnett River in Queensland (Kailola et al. 1993). In South Australia, juveniles are most common in estuaries and nearshore habitats, whereas adults occupy deeper habitats and shallow high-energy surf zones.

Recent research investigating the stock structure of Mulloway in southern Australia suggested that populations in South Australia may form two discrete stocks, i.e. western and eastern stocks, based on differences in the elemental composition and shape of otoliths (Ferguson et al. 2011) and microsatellite data (Barnes et al. 2014). The eastern stock occurs in the south-east of the State including the Coorong and waters along Younghusband Peninsula, while the western stock occurs on the far west coast. However, biological delineation of these stocks relative to Gulf St Vincent and Spencer Gulf is uncertain. As such, the assessment of stock status for Mulloway is undertaken at the management unit level for both the Lakes and Coorong Fishery and the Marine Scalefish Fishery (Figure 49).

Figure 49: Distribution of commercial catch of Mulloway in the Marine Scalefish Fishery (all State marine waters, except for the Coorong) and Lakes and Coorong Fishery (inset map) in 2012-13.



Note: to avoid disclosure of confidential data, levels of catch are not shown for areas that relate to less than five licences.

Fishery overview

In South Australia, the commercial fishery for Mulloway has two main sectors, the Lakes and Coorong Fishery, which accounted for 95% of the total statewide commercial catch in 2012-13, and the Marine Scalefish Fishery. The Southern and Northern Zone Rock Lobster fisheries also have access to Mulloway, but have minimal catches.

The Lakes and Coorong Fishery is a multi-species, multi-gear fishery that operates in, and adjacent to, the River Murray estuary, which comprises the Lower Lakes of the River Murray (Lakes Alexandrina

and Albert), the Coorong lagoons and Coorong coastal waters (Sloan 2005). Lakes and Coorong fishers target Mulloway mainly using large mesh gill nets in the River Murray estuary and Coorong lagoons. Catches from these nets account for >80% of the total commercial catch for the fishery and comprise mainly juvenile fish (Ferguson and Ward 2011). Small catches of larger Mulloway are taken using swinger nets in nearshore marine waters adjacent to the Murray Mouth during Spring and Summer (Earl and Ward 2014).

Similar to the Lakes and Coorong Fishery, the Marine Scalefish Fishery is a multi-species, multi-gear fishery. The Marine Scalefish Fishery operates in all coastal waters of South Australia, excluding the River Murray estuary and Coorong (Figure 49). Fishers in the Marine Scalefish Fishery use mainly hauling nets, gill nets and fishing poles to target Mulloway.

Mulloway are a significant target catch of recreational fishers in near shore coastal waters. Mulloway are taken mainly by land-based fishers using rod and line. Fishing for Mulloway is most common near the Murray Mouth and on the State's far west coast. Recreational fishers can also target Mulloway using registered mesh nets in the Coorong lagoons and Lake George in the State's south east. Recreational net fishing is prohibited in all other coastal waters of South Australia.

Table 85: Key biological traits of Mulloway.

Parameter	Description
Range	Indo-Pacific region, in marine and estuarine habitats
Depth	Intertidal to 200 m
Longevity	41 years
Maximum size	Approximately 1.5 m total length
Size at maturity	Females - 85 cm total length Males - 78 cm total length
Spawning season	October to February

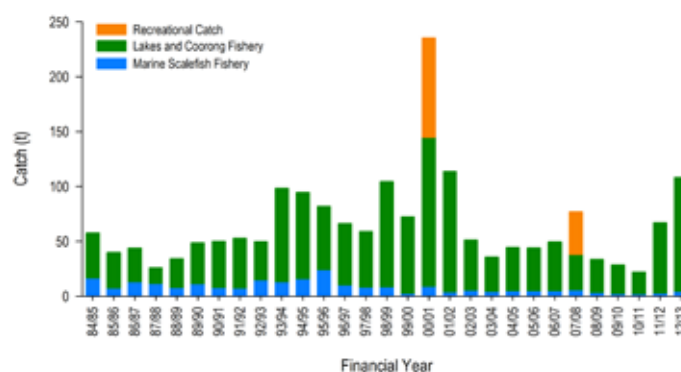
Catch trends

Estimates of total annual statewide commercial catch of Mulloway were first recorded in 1984-85, when 58 t were harvested (Figure 50). In 1993-94, catch increased to 98 t, reflecting a 140% increase in catch by the Lakes and Coorong Fishery. From then until 2001-02, annual statewide catches varied considerably and ranged from 66 t in 1996-97 to a historical peak of 145 t in 2000-01. Catches then declined to 34 t in 2003-04 and remained relatively low throughout the 2000s, reflecting low targeted fishing effort by the Lakes and Coorong Fishery during that period. Drought-breaking freshwater inflows to the Coorong estuary in late 2010 led to a sharp increase in

catches of Mulloway by the Lakes and Coorong Fishery from 22 t in 2010-11 to 108 t in 2012-13 (Figure 50).

The 2007/08 South Australian Recreational Fishing Survey estimated the recreational catch of Mulloway at 61.7 t, which accounted for approximately 62% of the total annual statewide harvest (Jones 2009).

Figure 50: Annual catch information for the Mulloway Fishery of South Australia.



Data for recreational catch (orange) have only been collected in 2000-01 and 2007-08 during recreational fishing surveys.

Management arrangements

Management arrangements for the fishery are provided in the *Management Plan for the Lakes and Coorong Fishery*, the *Fisheries Management (General) Regulations 2007* and the fishery specific regulations the *Fisheries Management (Lakes and Coorong Fishery) Regulations 2009* and *Fisheries Management (Marine Scalefish Fisheries) Regulations 2011*.

The commercial fishery is largely managed through the use of input controls, which aim to limit the total amount of effort that can be directed into the fishery to ensure the sustainability of the resources on which the fishery is based. Licences are limited and must be operated by the owner. These restrictions are aimed at not only limiting effort but also the impact on the marine ecosystem.

The recreational sector is managed through a combination of input and output controls aimed at ensuring the total catch is maintained within sustainable limits and that recreational access to the fishery is equitably distributed between recreational participants. Management arrangements include bag and boat limits and general gear restrictions. A limited number of recreational mesh nets are permitted for use in the Coorong and Lake George. These are subject to area restrictions and must meet regulated specifications.

Table 86: Summary of management arrangements for the South Australian Commercial Mulloway Fishery in 2013-14.

Management arrangements	Lakes and Coorong Fishery	Marine Scalefish Fishery
Limited entry (number of licences)	36 licences Owner/operator	311 licences Restricted 7 Owner/operator
Minimum legal size limit	In the Coorong: 46 cm total length All other waters: 75 cm total length	All other waters: 75 cm total length
Commercial gear	> Handlines > Hauling nets > Swinger nets > Rod and line > Gill nets	> Handlines > Rod and line > Hauling nets > Gill nets
Commercial gear restrictions	> Rod and line <ul style="list-style-type: none"> • Number of rod and handlines • Number of hooks > Nets <ul style="list-style-type: none"> • Net length, depth, mesh size, break strain • Restrictions on the use of nets in conjunction with other devices > Long line	> Rod and line <ul style="list-style-type: none"> • Number of rod and handlines • Number of hooks > Nets <ul style="list-style-type: none"> • Net length, depth, mesh size, break strain • Restrictions on the use of hauling nets in conjunction with other devices • Gill nets must be attended • Maximum depth of setting gill net 5 m
TACC	No	
Spatial closures	Yes	
Temporal closures	Yes	
Vessel Monitoring System	No	

Table 87: Summary of management arrangements for the South Australian Recreational Mulloway Fishery in 2013-14.

Management arrangements	Recreational Fishery
Recreational gear	> Fishing rods > Handlines > Mesh nets (Coorong and Lake George only)
Recreational gear restrictions	> Number of rods and hooks > Registration of mesh nets - 1 per person
Minimum legal size limit	In the waters of the Coorong: 46 cm total length In all other waters of the State: 75 cm total length
Recreational bag and boat limits	Bag limit per person: > In the waters of the Coorong 10 (46-75 cm) and 2 (75+ cm) > In all other waters of the State 2 (75+ cm) Boat limit: > In the waters of the Coorong - no limit > In all other waters of the State 6 fish
Spatial closures	Yes
Temporal closures	Yes
Possession limit	No

Harvest strategy

Lakes and Coorong Fishery

The harvest strategy framework integrates a set of basic environmental management principles into the day-to-day management of the fishery to ensure that management decision-making incorporates critical environmental factors, such as the timing and volume of freshwater flows and barriers to fish passage. This approach aims to ensure that fundamental environmental processes are maintained or, where necessary, restored to maximise benefits for Mulloway stocks. Under this integrated approach, instead of simply measuring the performance of individual fish stocks against management objectives, critical environmental drivers are explicitly taken into account when assessing the overall health of the fishery and in decision-making processes. If water flow rates or other key environmental parameters fall outside of reference levels in any given period, a management response is to be initiated to ensure Mulloway stocks are managed during periods of low ecosystem health, such as extended periods of drought or low water flow.

A new harvest strategy specific to finfish harvested by the Lakes and Coorong Fishery is currently being developed as part of the Lakes and Coorong Fishery Management Plan, due for completion in 2015.

Marine Scalefish Fishery

With over 60 marine scalefish species harvested annually, developing individual performance indicators and reference points would require significant resources (Noell et al. 2006). Rather, the

majority of management and monitoring resources are targeted on the priority species in the fishery. Mulloway are classified as a secondary species and therefore the harvest strategy for Mulloway in the Marine Scalefish Fishery contains broad management objectives and indicators that are used to monitor the performance of Mulloway.

Monitoring and assessment

Fishery-dependent data are collected to monitor the performance of the Mulloway fishery in South Australia. Commercial catch and effort information provides the primary data on which the biological status of the fishery is assessed and the majority of fisheries management decisions are based. Commercial catch and effort data are collected through daily fishing logbooks.

Currently, temporal trends in commercial catch and CPUE data are the main indicators of stock biomass for Mulloway in both the Lakes and Coorong Fishery and Marine Scalefish Fishery. These indicators are compared against limit reference points to assess fishery performance and form a weight of evidence approach to the assessment of stock status. When available, commercial fishery statistics for the Lakes and Coorong Fishery are augmented by data on fish ages collected through sampling of commercial catches. Data on the age composition of the population provide important information on recruitment of young fish to the population and presence/absence of mature individuals in the population.

Previous stock assessment of the Lakes and Coorong Fishery for Mulloway were undertaken in 2003 and 2011 (Ferguson and Ward 2003, 2011). Performance indicators for catch and CPUE were also

Table 88: Harvest strategy components for the South Australian Commercial Mulloway Fishery.

Harvest strategy component	Lakes and Coorong Fishery	Marine Scalefish Fishery
Objectives	Maintain the primary performance indicator within limit and target reference points	Maintain the primary performance indicator within limit and target reference points
Performance indicators	<ul style="list-style-type: none"> > Total catch (t) > Commercial CPUE > 4-year total catch trend > 4-year CPUE trend > Age composition of the population > 4-year net freshwater flows over the barrages 	<ul style="list-style-type: none"> > Total catch (t) > Targeted handline and fishing pole effort > Targeted hauling net and gill net effort > Targeted handline and fishing pole CPUE > Targeted hauling net + gill net
Limit reference points	Yes	Yes
Target reference points	Yes	Yes
Trigger reference points	No	No
Decision rules	Yes	Yes

assessed in the 2014 stock status report for the Lakes and Coorong Fishery (Earl and Ward 2014) and Marine Scalefish Fishery (Fowler et al. 2013a).

Current biological status

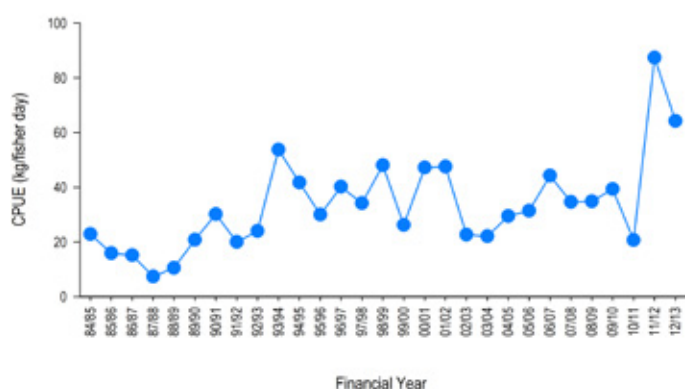
Lakes and Coorong Fishery

The *Management Plan for the Lakes and Coorong Fishery* does not involve fishery performance indicators or limit reference points that are framed around recruitment overfishing (Sloan 2005). Rather, stock assessment for Mulloway utilises a weight of evidence approach that involves numerous performance indicators (Ferguson and Ward 2011). CPUE and catch are the best fishery performance indicators for this management unit. These data are augmented by data on fish ages collected through sampling of commercial catches.

Traditionally the Lakes and Coorong Fishery has contributed most to the statewide catch of Mulloway. From 2002-03 to 2010-11, annual catches of Mulloway by the Lakes and Coorong Fishery were relatively low (< 45 t), reflecting a reduction in targeted effort and low catch rates. Since then, annual catch increased sharply to 67 t and 103 t in 2011-12 and 2012-13, respectively. Similarly, catch rates increased sharply from 21 kg/fisher day in 2010-11 to a historical peak of 87 kg/fisher day in 2011-12 (Figure 51). While catch rates declined slightly in 2012-13, it remained among the highest recorded in the fishery. Age structure analysis revealed that the recent high catches and catch rates were due mainly to the recruitment of a large biomass of juvenile (3-6 year old) fish to the fishery (Earl and Ward 2014). The information provided above suggests that the biomass of Mulloway harvested by the Lakes and Coorong Fishery is unlikely to be recruitment overfished.

On the basis of the evidence available, the Mulloway resource in the Lakes and Coorong Fishery management unit is categorised as **sustainable**.

Figure 51: Annual CPUE for the Lakes and Coorong Fishery (large mesh gill nets) for Mulloway from 1984-85 to 2012-13.



Marine Scalefish Fishery

The Management Plan for the Marine Scalefish fishery does not involve fishery performance indicators or trigger reference points that are framed around recruitment overfishing (PIRSA 2013b). Rather, stock assessment for Mulloway utilises a weight of evidence approach that involves numerous performance indicators, including commercial catch, targeted effort and CPUE.

The Marine Scalefish Fishery has traditionally provided much lower catches than the Lakes and Coorong Fishery (Figure 50). Catches were historically low through the mid to late 2000s as a result of historically low targeted fishing effort. However, since the early 1990s, commercial CPUE (all gears combined) has followed an increasing trend, indicating a possible gradual increase in fishable biomass. The lack of recent fish age data for Mulloway harvested by the Marine Scalefish Fishery limits our understanding of recruitment patterns that could otherwise confirm a trend of increasing biomass. As such, there is insufficient information available to classify the status of Mulloway in this management unit.

The Mulloway resource in the Marine Scalefish management unit is categorised as **undefined**.

Effects of fishing on the marine environment

Lakes and Coorong Fishery

An ESD Risk Assessment of the Lakes and Coorong Fishery was carried out in 2011. The risk to Mulloway in the Lakes and Coorong Fishery was ranked as high and the risk of capture of threatened, endangered and protected species in the Lakes and Coorong Fishery was low for sea birds and Long-nosed fur seals and negligible for all other species. The general ecosystem risks from the impacts of fishing in the Lakes and Coorong were high for the freshwater environment and for the introduction of marine pests and aquatic diseases (PIRSA 2011c).

The overall environmental impacts associated with Mulloway fishing in the Coorong estuary are considered to be relatively low compared to other fisheries around Australia (Gray 2002; Gray et al. 2004). Large mesh gill nets are the dominant gear type used by the fishery to target Mulloway. Overall discarding from gill nets in the River Murray estuary and Coorong in 2005-06 (Ferguson 2010) was lower than for other published studies (Gray 2002; Gray et al. 2004). However, discard rates from large mesh gill nets when targeting Mulloway were relatively high compared to other gear types used in the fishery. This may be attributable to the practise of overnight net sets, bottom setting of nets and the deeper drop (2 m) of these nets.

The South Australian Lakes and Coorong Fishery has been assessed by the Australian Government Department of the Environment against the *Guidelines for Ecological Sustainable Management of Fisheries*, which are set out in the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. The South Australian Lakes and Coorong Fishery was provided with an exemption from the export controls of the Act, subject to a number of recommendations, until February 2016.

The Lakes and Coorong Fishery was assessed against the Marine Stewardship Council environmental standard for sustainable fishing and was certified as sustainable in 2008.

Marine Scalefish Fishery

An ESD Risk Assessment of the South Australian Marine Scalefish Fishery was undertaken in July 2011, in preparing the *Management Plan for the South Australian Commercial Marine Scalefish Fishery* (PIRSA 2013b). The moderate, high and extreme risks were predominately related to governance and external factors affecting performance of the fishery. Two general ecosystem risks of moderate were identified related to fishing and the introduction of marine pests or aquatic diseases. Mulloway in the Marine Scalefish Fishery was ranked as a negligible risk through this process (PIRSA 2011b). The moderate and higher risks have strategies outlined in the management plan to address those risks.

Mulloway are targeted by the Marine Scalefish Fishery using handlines, fishing poles, hauling nets and gill nets. It is considered that these activities pose a low to negligible risk to habitat and ecosystem function. However, there are potential impacts on the ecosystem through the capture of unwanted species (by-catch) and unintended mortality of non-target species with all gear types used. Of the gear types used to target Mulloway, hauling nets and gill nets pose a higher risk to the capture of non-target species. A recent by-catch study by Fowler et al. (2009) demonstrated that hauling nets have the potential to capture large numbers of species. The risk to such species is mitigated, to some extent, through regulations that require catches to be sorted in-water, which increases the likelihood that by-catch species are released alive. The low numbers of discarded fish were generally released in relatively good condition; however, the relatively few fish that had become enmeshed in the wings of the nets were discarded in poor condition. The low number of Marine Scalefish Fishery operators targeting Mulloway in recent years suggests that the impact of Mulloway fishing on the marine environment is likely to have been low.

Social and economic information

The Mulloway Fishery is an important contributor to the socio-economic well-being of regional coastal communities in South Australia. The Mulloway Fishery contributes a GVP of \$747,000 and directly and indirectly contributes to the provision, maintenance and expansion of a number of local and regional services and businesses (EconSearch 2014c).

Table 89: Socio-economic information for the South Australian commercial Mulloway Fishery, 2012-13 (source: EconSearch 2014c).

Socio-economic indicator	Total Fishery
GVP - Mulloway (\$ million)	0.74
Contribution to GSP from Lakes and Coorong Fishery and Marine Scalefish Fishery (\$ million)*	68.5
Total employment from the Lakes and Coorong Fishery and Marine Scalefish Fishery (direct and indirect jobs)*	738

* GSP and employment figures are the total contribution of all species from the Lakes and Coorong and Marine Scalefish Fishery.

Education and awareness, deterrence and enforcement

All compliance checks, monitoring and enforcement for Mulloway is undertaken and reported along with other species in the Lakes and Coorong Fishery. See Table 76 for a full report.

5.5 Murray Cod (*Maccullochella peelii*)

Authors: Qifeng Ye and Jonathan McPhail



Table 90: Stock status determination for the Murray Cod Fishery of South Australia.

Management unit	Lakes and Coorong Fishery	Recreational River Fishery
Status	Undefined	Undefined
Primary indicator	Weight of evidence	Weight of evidence

Stock structure

Murray Cod (*Maccullochella peelii*) belongs to the family Percichthyidae, and is the largest freshwater fish in Australia. Its natural distribution is widespread throughout most of the Murray-Darling system, except for the upper reaches of some tributaries in Victoria and southern New South Wales. In South Australia, Murray Cod are found within the Lower Lakes, the main stem of the River Murray and connecting anabranches.

Figure 52: Distribution of Murray Cod in the South Australian Murray-Darling Basin.



Fishery overview

Murray Cod is an important species in the Murray-Darling Basin (MDB) and an integral part of the riverine ecosystem. Murray Cod has acquired an iconic status among many Australian communities due to its large size; its position at the top of the food chain in the freshwater food web; and the aggressive/territorial nature it displays. The Murray Cod Fishery has significant cultural, environmental, recreational and economic importance for all South Australians. Historically, Murray Cod were common throughout the South Australian Murray-Darling Basin and supported a large commercial and recreational fishery.

Significant changes to the lower River Murray, including extensive flow regulation and habitat modification, have resulted in significant declines in the abundance and potentially the distribution of Murray Cod (Ye et al. 2000). Murray Cod was listed as a species vulnerable to extinction under the *Environment Protection and Biodiversity Conservation Act 1999* in 2003.

In July 2003, the commercial fishery underwent a major restructure to targeting non-native species. Murray Cod are permitted to be taken in the Lakes and Coorong Commercial Fishery, however licence holders extended an agreement in 2009 to not target Murray Cod until the condition of the stock improves.

Murray Cod is an icon of the MDB and has provided an important recreational and sporting activity along the South Australian River Murray and Lakes since European settlement. Many early accounts of fishing in South Australia refer to fish being taken as part of recreational pursuits, to supplement food supplies and to trade for goods and services. Murray Cod is still today a popular recreational fishery species in the South Australian River Murray with most anglers fishing with lures or bait, using locally caught shrimp and yabbies as the primary bait.

‘Ponde’ is the name used for Murray Cod by Aboriginal people of the lower River Murray. In Aboriginal mythology, the Murray Cod was responsible for the formation of the River Murray and its fish (Rowland 1988). According to legend, “the Murray Cod burst forth from the depths of the earth at the source of the River Murray, which was then only a small stream of water trickling to the southern ocean. The Murray Cod struggled down the narrow stream, digging with its head and swinging its powerful tail, making it wide, forming bends and creating the River Murray. The Great Prophet, Nepelle, and the creative hero, Ngurunderi, then speared the huge cod at the site known as Lake Alexandrina. They cut it into pieces and threw them back into the water, naming them Tarki (Golden Perch), Tukkeri (Bony Bream), Tinuwarre (Silver Perch) and all the other fish of the inland waters. When they had finished, they threw the rest back and said ‘You keep on being Ponde (Murray Cod)’” (Rowland 1988). Murray-Darling fish, such as Murray Cod, have traditionally played a major role as a food source and cultural icon for indigenous Australians (Lawrence 1971).

In South Australia, the Ngarrindjeri and Nganguraku people have their traditional homelands along the River Murray and Coorong, and maintain an intimate and detailed knowledge of the land, wildlife, seasons and climate.

Table 91: Key biological traits of Murray Cod.

Parameter	Description
Range	Most of the Murray-Darling system internal drainage systems of Queensland, New South Wales, Victoria and South Australia
Depth	Unknown
Longevity	48 years
Maximum size	Typically 600-1200 mm total length, may reach 1800 mm
Size at maturity	Highly variable across geographic regions Unknown in South Australia
Spawning season	September to December (Ye and Zampatti 2007)

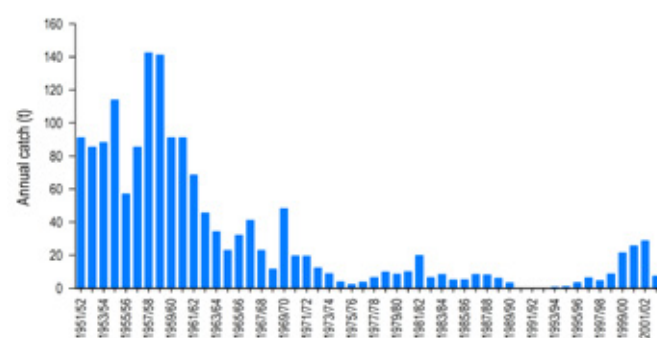
Catch trends

Stock status reports have highlighted a significant decline in Murray Cod commercial landings from 140 t in the late 1950s to approximately 20 t in 1964-65 (Figure 53). Apart from some fluctuations in the mid and late 1960s, the South Australian catch averaged less than 10 t per year from the early 1970s through to a closure from 1990 to 1993. The fishery recommenced in 1994 (due to high flows in the River Murray), catches increased gradually to approximately 25 t in 1999-2000.

The Murray Cod commercial fishery ceased in the River Murray from July 2003. In the following three years (2003-04 to 2005-06), the total harvest of Murray Cod from the Lakes and Coorong commercial fishery was less than 1 t, and there has been no commercial catch of Murray Cod since 2006-07.

The 2007-08 South Australian Recreational Fishing Survey estimated that 1,853 Murray Cod were reported to have been caught by South Australian recreational fishers, with 507 harvested and 1,346 released, representing a release rate of 72.7% (Jones 2009). The lower section of the River Murray in SA was the only region where a harvest was reported, with releases occurring in the upper section of the River Murray in SA and other inland waters of the State. No Murray Cod were reportedly caught in the Lower Lakes region. Slightly higher total numbers were caught by boat fishers than shore-based fishers and line fishing was the only method of capture. It appears that there has been little change in the total numbers of Murray Cod caught since the 2000-01 survey (Henry and Lyle 2003); however, release rates have increased from 48% in 2000-01 to 73% in 2007-08.

Figure 53: Annual commercial catch information for the Murray Cod Fishery of South Australia.



Catch is not shown from 2003-04 when the commercial fishery for Murray Cod ceased with catch being < 1 t.

Management arrangements

The regulations for management of fishing for Murray Cod are described in the *Fisheries Management (Lakes and Coorong Fishery) Regulations 2009* and the *Fisheries Management (General) Regulations 2007*. A management plan for the commercial Lakes and Coorong Fishery was implemented in 2005 and provides a strategic policy framework for the management of the fishery

(Sloan 2005). Management of the Lakes and Coorong Fishery is implemented in the context of international legal instruments including the Ramsar Convention.

The Lakes and Coorong Fishery operates within the boundaries of the Lakes and Coorong National Park, an area recognised primarily for its wetland habitats and importance for a variety of migratory waterbirds. The commercial fishery is managed using a complex mix of input and output controls aimed at matching harvesting capacity with resource availability. Existing controls include limitations on the number of licences, a wide range of gear restrictions, spatial and temporal closures, restrictions on the number of commercial agents permitted to undertake fishing operations and legal size limits for individual species. However, on agreement of the licence holders, there is no targeting of Murray Cod until the condition of the stock improves.

Table 92: Summary of management arrangements for the South Australian Commercial Murray Cod Fishery in 2013–14.

Management arrangements	Lakes and Coorong Fishery
Limited entry (number of licences)	36 – Owner operator
Minimum legal size limit	N/A – Fishery closed
Commercial gear	N/A – Fishery closed
Commercial gear restrictions	N/A – Fishery closed
TACC	N/A – Fishery closed
Spatial closures	N/A – Fishery closed
Temporal closures	N/A – Fishery closed
Vessel Monitoring System	No

The recreational fishing sector is managed through a combination of input and output controls aimed at ensuring the total catch is maintained within sustainable limits and access to the fishery is equitably distributed. These controls include limitations on the type and amount of fishing gear that may be used, spatial and temporal closures, legal size limits for individual species (which are consistent with those in place for the commercial sector), and bag and boat limits for individual species.

A spawning season closure is in place before and during the peak spawning period from 1 August to 31 December each year. Fishing for Murray Cod is allowed as a catch and release recreational fishery from 1 January to 31 July.

Table 93: Summary of management arrangements for the South Australian Recreational Murray Cod Fishery in 2013–14.

Management control	Recreational fishery
Recreational gear	> Rods > Handlines
Recreational gear restrictions	> Number of rods and hooks
Minimum legal size limit	N/A - Catch and release fishing only
Recreational bag and boat limits	N/A - Catch and release fishing only
Spatial closure	Yes
Temporal closure	Yes
Possession limit	N/A - Catch and release fishing only

Harvest strategy

There is no detailed harvest strategy for Murray Cod. A framework detailing the specific objectives and management strategies for the future management of Murray Cod is in development. The framework aims to integrate a set of environmental principles into the management of the fishery to ensure that decision-making incorporates critical environmental factors. This approach aims to ensure that fundamental environmental processes are maintained or, where necessary, restored to maximise benefits for fish stocks.

Monitoring and assessment

In the absence of a commercial fishery or ongoing recreational fishing surveys, and/or a dedicated fishery-independent Murray Cod monitoring program, a project was undertaken recently to interrogate data from fish monitoring and research projects undertaken in the lower River Murray between 2002 and 2013 to provide an overview of the current status of Murray Cod populations (Zampatti et al. 2014). Analysis was conducted for data from three long-term fish monitoring projects conducted in the South Australian reaches of the River Murray over a period of hydrological extremes, incorporating seven years of drought and unprecedented low flow, followed by three years of overbank or elevated within-channel flow. The three monitoring projects included were the Chowilla Fish Assemblage Condition monitoring, Murray River Fishway Assessment Program Locks 1 to 3 fish sampling and the Native Fish Monitoring Program. Key biological performance indicators include the relative abundance of Murray Cod, and length-frequency distributions with the presence of juvenile fish (<500 mm total length) indicating new recruits in recent years (two to three years prior to the capture time).

Current biological status

Trends in CPUE indicate that Murray Cod relative abundance has remained reasonably constant over the last eight to 11 years. The increase in catch rate in 2010-11 was likely due to the flow-induced fish movement and accumulation below weirs and increased catchability by drum net (Figure 54).

Length-frequency distributions of Murray Cod from the monitoring projects were analysed to assess the recruitment pattern in the main channel of the lower River Murray and Chowilla anabranch system (Zampatti et al. 2014). It was suggested that Murray Cod recruitment was minimal where water was not flowing in the main channel habitats of the River Murray during the drought (2001 to 2010). At the same time, however, consistent recruitment was evident in the flowing water habitats of the Chowilla system. Low numbers of juvenile fish (<500 mm total length) were collected in main channel habitats in years following increases in flow contained within the river channel and overbank. The report indicates that elevated flow increases water velocities and promotes movement and mixing of water (hydraulic complexity) in the regulated weir pools of the lower River Murray. These hydraulic characteristics are permanent features of the free-flowing reaches of the mid-upper River Murray and flowing anabranches where broad size structures of Murray Cod are observed. They appear fundamental to promoting the survival of early life stage Murray Cod and also provide preferred habitat for juveniles and adults.

Based on this most recent assessment, the majority of Murray Cod collected in the main channel habitats of the lower River Murray were generally large (≥ 800 mm) and these fish represent a broad range of age classes (eight to 46 years) (Zampatti et al. 2014). The current population abundance of Murray Cod is relatively low but reasonably stable, with limited numbers of new recruits in the lower River Murray.

Overbank flows in 2010-11 were reported to be associated with an extensive anoxic blackwater event that caused substantial mortalities of adult Murray Cod. Despite this, data from anabranch (creeks and streams off the main channel of the River Murray) and main channel habitats indicated that spawning occurred in the high river flows of 2010-11, although new recruits were difficult to detect until they reached 300 to 400 mm or two to three years of age. However, the above information is insufficient to confidently classify the status of Murray Cod in the South Australian River Murray.

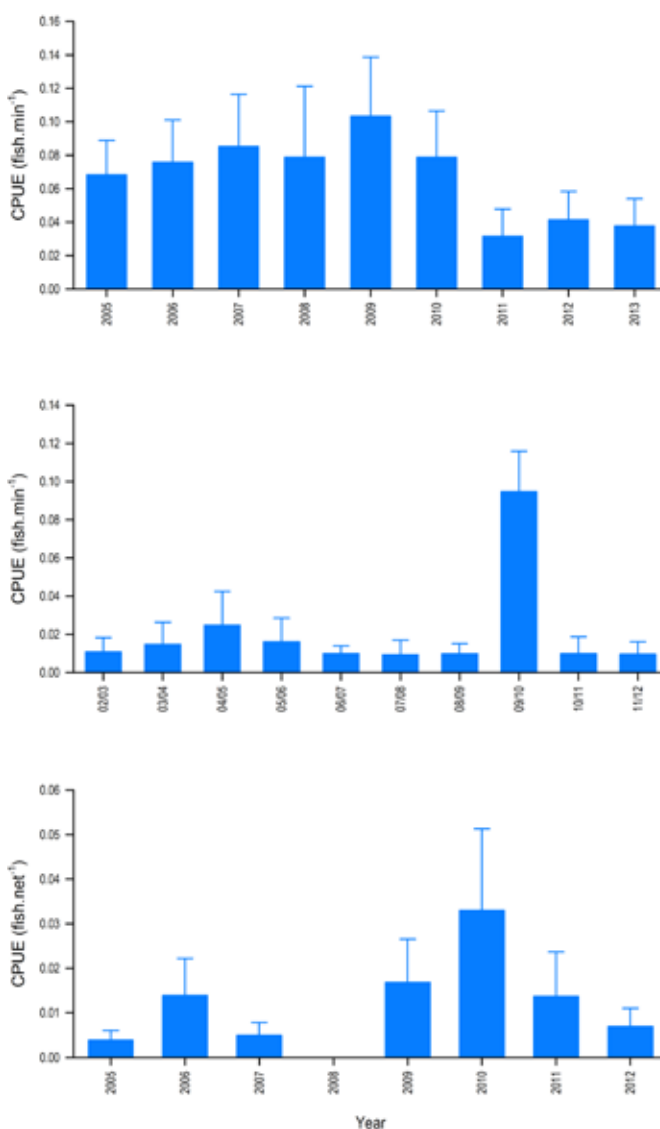
Flowing water is likely to be important to promoting Murray Cod recruitment (Zampatti et al. 2014). River regulation has severely modified the lower River Murray environment, leading to reduced velocity and hydraulic complexity in the regulated weir pools. These

changes had likely led to the declines of Murray Cod, in conjunction with historical over-harvesting. In recent years, a range of ecological restoration work has been implemented to improve the health of the River Murray, including environmental flows and fish passage. These would benefit native fish including Murray Cod.

Despite the above data, due to the uncertainty around current biomass and mortality of recreational fishing (i.e. catch, effort and mortality associated with catch-and-release), the information is insufficient to classify the status of this stock.

On the basis of the evidence available, the Murray Cod resource in the River Murray and Lakes and Coorong Fishery management unit is categorised as **undefined**.

Figure 54: Mean (\pm SE) CPUE (fish/m) of Murray Cod collected annually during standardised boat electrofishing surveys a) from 2005 to 2013 at 10 sites in the Chowilla Anabranch system and adjacent River Murray, b) from 2002 to 2013 at sites in the River Murray downstream of Locks 1–3, and c) CPUE (fish.net night⁻¹) of Murray Cod collected annually during standardised drum netting from 2005 to 2012 at Locks 1, 2, 5 and 6 on the River Murray (adapted from Zampatti et al. 2014).



Effects of fishing on the freshwater environment

An ESD Risk Assessment of the Lakes and Coorong Fishery was carried out in 2011. The risk to Murray Cod in the Lakes and Coorong Fishery was ranked as low. The risk of capture of threatened, endangered and protected species in the Lakes and Coorong Fishery was also low for sea birds and Long-nosed fur seals and negligible for all other species. The general ecosystem risks from the impacts of fishing in the Lakes and Coorong were high for the freshwater environment and the introduction of marine pests and aquatic diseases (PIRSA 2011c).

The natural ecosystems supporting fisheries resources throughout the River Murray and lower Lakes and Coorong region have been dramatically modified since early European settlement in South Australia. The installation of a series of weirs in the lower River Murray in the 1930s-1940s and an extensive barrage network near the Murray Mouth has changed the natural flow and altered the morphology of the Murray Mouth. This change has imposed significant impediments to natural fish passage, although fishways have been installed over the last decade to mitigate the impact.

From 1996 to 2010, the MDB experienced a severe drought; inflows into the River Murray system were approximately 40% of the historical mean (MDBA 2011). The ecological community in the lower River Murray suffered severe stress. The drought was broken in late 2010 by a significant flood, this and subsequent high flows have led to signs of ecosystem improvement.

The overall environmental impacts associated with current fishing in the Lower Lakes are considered to be relatively low. Large mesh gill nets are the dominant gear type used in the Lakes and Coorong Fishery; however, there is no targeting of Murray Cod. The large-bodied invasive Common Carp, which comprises >50% of the total finfish catch in Lakes Alexandrina and Albert, is likely to be a major by-catch species for this part of the fishery. Non-targeted catches of this alien species is likely to benefit native fish populations in the Lower Lakes.

The South Australian Lakes and Coorong Fishery has been assessed by the Australian Government Department of the Environment against the *Guidelines for Ecological Sustainable Management of Fisheries*, which are set out in the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999*. The South Australian Lakes and Coorong Fishery was provided with an exemption from the export controls of the Act, subject to a number of recommendations and conditions, until February 2016.

The Lakes and Coorong Fishery was assessed against the Marine Stewardship Council environmental standard for sustainable fishing and was certified as sustainable in 2008.

Social and economic information

There is no social or economic information available with regard to commercial harvest of Murray Cod as commercial targeting of this species is not undertaken.

Education and awareness, deterrence and enforcement

All compliance checks, monitoring and enforcement for Murray Cod are undertaken and reported along with other species for the Lakes and Coorong Fishery. See Table 76 for a full report.

5.6 Snapper (*Chrysophrys auratus*)

Authors: Anthony Fowler and Michelle Besley

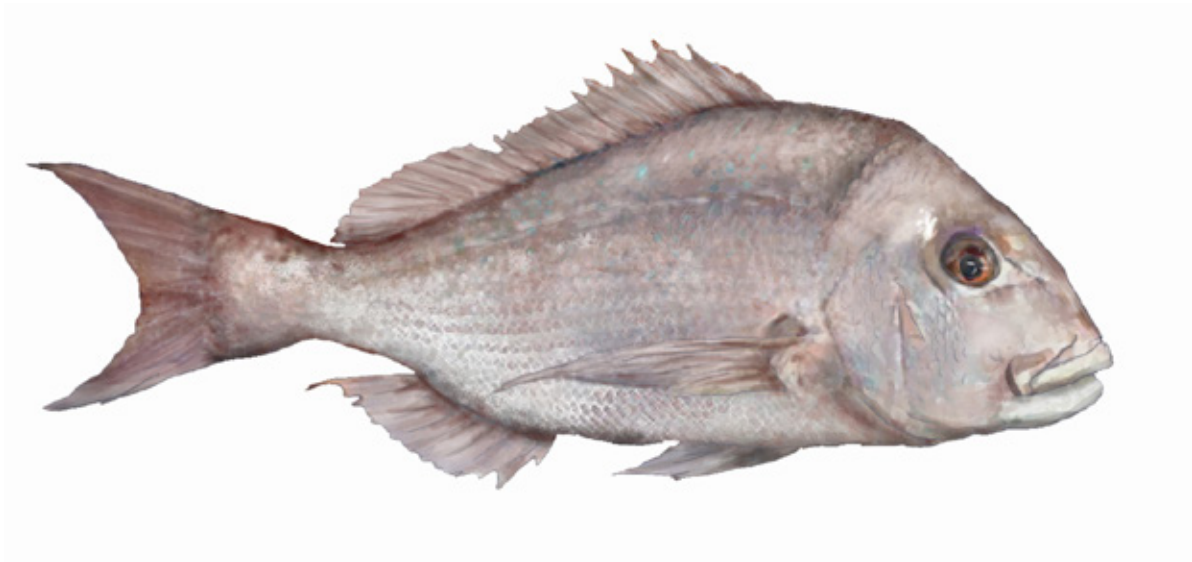


Table 94: Stock status determination for the Snapper Fishery of South Australia.

Management unit	South East	Southern Gulf St Vincent	Northern Gulf St Vincent	Southern Spencer Gulf	Northern Spencer Gulf	West Coast
Status	Transitional-depleting	Transitional-depleting	Sustainable	Transitional-depleting	Transitional-depleting	Undefined
Primary indicator (or weight of evidence)	Weight of evidence	Weight of evidence	Weight of evidence	Weight of evidence	Weight of evidence	Longline catch and CPUE

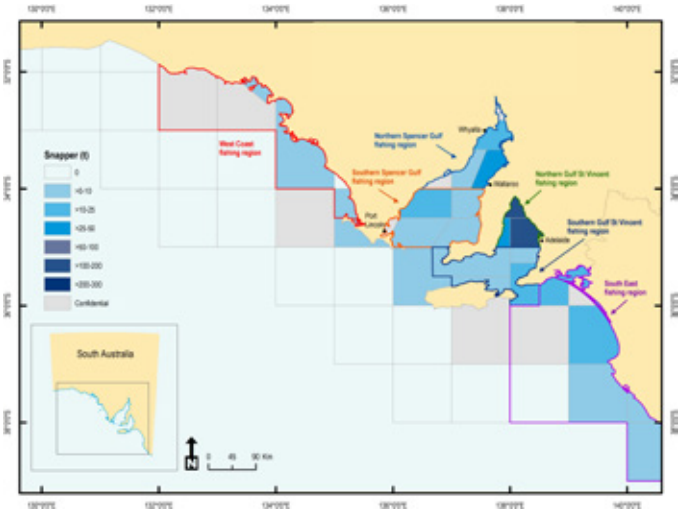
Stock structure

The Snapper (*Chrysophrys auratus*) is a long-lived, demersal species from the *Sparidae* family. It has a wide Australian distribution from the Gascoyne region of Western Australia, around the south of the continent, including the north coast of Tasmania, and up to north Queensland (Kailola et al. 1993). Throughout this distribution, Snapper are dispersed across a variety of habitats from shallow coastal bays and inlets to the edge of the continental shelf throughout a depth range of one to 200 m.

There is considerable uncertainty about the stock structure of Snapper in South Australia. There is some evidence of genetic differentiation between the populations of the South East and those of the other five regions, with the boundary in the vicinity of the mouth of the River Murray (Donnellan and McGlennon 1996). However, the five regional populations to the west of the Murray Mouth are genetically similar. While there is some evidence of morphological differences between these populations (Fowler et al. 2004), there is considerable uncertainty about adult movement patterns that prevents determining the location of likely stock

boundaries. From an assessment perspective, the Snapper population is divided into six regional management units: South East; Southern Gulf St Vincent; Northern Gulf St Vincent; Southern Spencer Gulf; Northern Spencer Gulf; and the West Coast (Figure 55).

Figure 55: Distribution of the commercial catch of Snapper in 2013.



Fishery overview

Snapper is one of Australia's most important coastal fishery species as each mainland State supports significant commercial and recreational fisheries (Fowler et al. 2013a). Since 2006-07, South Australia's commercial fishery has provided the dominant contribution to Australia's commercial catch of the species (Fowler et al. 2013a).

Harvest of Snapper in South Australia is geographically extensive, extending from the waters of the west coast of Eyre Peninsula to the south east region near the Victorian border; but historically has largely been concentrated in the waters of Spencer Gulf and Gulf St Vincent (Figure 55).

Commercial harvest of Snapper is predominately by licence holders in the Marine Scalefish Fishery, however licence holders in the Southern Zone Rock Lobster Fishery, Northern Zone Rock Lobster Fishery and Lakes and Coorong Fishery can also access this species. The main gear types that are used by commercial fishers to target Snapper are handlines and longlines. Historically, handlines were the dominant gear type, but in recent years there has been significant uptake of new longline technology that has resulted in longline effort displacing handline effort in some regions.

In South Australia, Snapper is an iconic species for the recreational sector, with fishers particularly interested in targeting the large 'trophy' fish that can be found, particularly in the two gulfs. As such, Snapper is one of the primary target species for both the charter and general recreational fishing sectors. Recreational fishers generally use handlines and rods and line to target Snapper.

Table 95: Key biological traits of Snapper.

Parameter	Description
Range	Distributed broadly throughout the Indo-Pacific region. In Australian waters the distribution is continuous around the southern mainland coastline from Hinchinbrook Island, Queensland to Barrow Island, Western Australian including Bass Strait and northern Tasmania.
Depth	Intertidal to 200 m
Longevity	36 years
Maximum size	100 cm total length in South Australia
Size at maturity	Age: 2 – 3 years Size: 23 cm caudal fork length
Spawning season	November to February

Catch trends

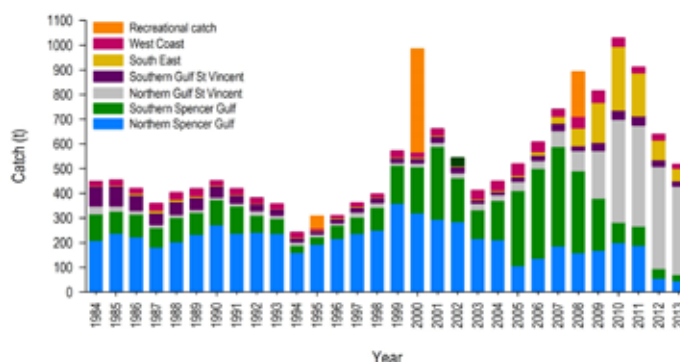
The estimates of statewide commercial catch of Snapper vary cyclically, with the cycles encompassing a number of years (Figure 56). The most recent cycle has been the longest on record, with commercial catch increasing by 150% from a low of 412 t in 2003 to 1,032 t in 2010. Since then, it has declined to 519 t in 2013.

A significant shift from handlines to longline fishing in the 2000s is thought to have resulted in the increased catch through to 2010 as longlines are shown to significantly improve fishing efficiency. Targeted longline effort increased from 1,734 fisher days in 2003 to a peak of 7,199 fisher days in 2011, which subsequently declined to 4,567 fisher days in 2013.

The recent recorded catches have also been associated with a significant change in the spatial structure of the fishery. Commercial catches were dominated by those from northern Spencer Gulf up to the early 2000s and then southern Spencer Gulf up to 2008 (Figure 56). From 2009 to 2011, the dominant regions were northern Gulf St Vincent and the South East. Since 2011, the contribution of the latter has declined leaving northern Gulf St Vincent as the primary fishing region.

The recreational fishing survey undertaken in 1994 to 1996 estimated the statewide catch of Snapper of 48 t (McGlennon and Kinloch 1997) (Figure 56). Further surveys in 2000-01 and 2007-08 estimated the recreational catch of 416 t and 178 t, respectively (Jones and Doonan 2005; Jones 2009). Recreational fishers target Snapper with rod and line, from boats, shore and jetties, with a very small number taken by spear. A total of 96% of the recreational catch is taken by boat-based fishers. The majority (90%) of the recreational catch is taken by boat-based fishers. The majority (90%) of the recreational catch is taken from the two gulfs.

Figure 56: Annual catch information (by calendar year) for the Snapper Fishery.



Data for recreational catch (orange) have only been collected in 1994-95, 2000-01 and 2007-08 during recreational fishing surveys.

Management arrangements

Management arrangements for the fishery are provided in the *Management Plan for the South Australian Commercial Marine Scalefish Fishery* (PIRSA 2013b), *Fisheries Management (General) Regulations 2007* and *Fisheries Management (Marine Scalefish Fisheries) Regulations 2011*.

The licence holders from four different commercial fisheries have access to Snapper within their respective fishery areas (ie. the Marine Scalefish Fishery, Northern Zone Rock Lobster Fishery, Southern Zone Rock Lobster Fishery, and Lakes and Coorong Fishery).

A range of input and output controls are in place to manage the Commercial Snapper Fishery, including those in Table 97. In addition, there is an ongoing commercial licence amalgamation scheme which requires two licences to be amalgamated on transfer to enter the Marine Scalefish Fishery and limits the number of agents that may fish from a licence. These restrictions are aimed at limiting fishing effort, as well as the impact on the marine ecosystem.

In 2014, 12 licences in the Marine Scalefish Fishery and 2,814 effort days associated with these licences were surrendered through the South Australia Marine Parks: Commercial Fisheries Voluntary Catch/Effort Reduction Program.

The recreational fishing sector is currently managed through a range of input and output controls designed to ensure that the total catch remains sustainable and shared equitably between recreational fishers and other fishing sectors. These controls include gear restrictions, bag and boat limits for Snapper and are summarised in Table 97.

Harvest strategy

The harvest strategy for South Australia's Snapper fishery aims to rebuild stocks in Spencer Gulf to sustainable levels or above and maintain the stocks in Gulf St Vincent and other regions at or above sustainable levels.

Snapper stock status is determined on the basis of fishery performance indicators by a weight of evidence approach. Trigger points are set for each indicator. The Snapper harvest strategy does not prescribe specific management responses to breaches of trigger reference points. Instead breaches of trigger reference points will be reviewed by the Marine Scalefish Fishery Management Advisory Group and reported to the Minister (or his/her delegate). If further action is required then specific management responses will be developed through the existing co-management framework and will be consistent with the objectives of the harvest strategy (PIRSA 2013b).

Table 96: Harvest strategy components for the South Australian Commercial Snapper Fishery.

Harvest strategy component	Whole of fishery
Objectives	Rebuilding Snapper stocks in Spencer Gulf to sustainable levels or above. Maintaining, at or above sustainable levels, the Snapper stocks in Gulf St Vincent and other regions of the fishery.
Performance indicators	<ul style="list-style-type: none"> > Handline and longline effort, expressed as boatdays and hook sets (longline) > Handline CPUE, expressed as kg/boatdays > Yearly proportion of handline trips reaching 250 kg (excluding November - January) > Age composition > Fishable biomass > Exploitation rate (harvest fraction)
Limit reference points	No
Target reference points	No
Trigger reference points	Yes
Decision rules	Yes

Monitoring and assessment

The monitoring and assessment of the South Australian Snapper stocks primarily involve two types of fishery-dependent data; commercial fishery statistics, and biological data from market sampling. Commercial catch and effort are fishery-dependent data collected through daily fishing logbooks.

A market sampling program undertaken at the SAFCOL fish market in Adelaide, has provided information on the sizes and ages of fish captured in the fishery in most years since 2000. This sampling provides a view of population structure from which the recent demographic processes can be inferred, thereby providing insight into stock status.

Stock status for Snapper is determined from the calculation of fishery performance indicators that are compared against limit reference points (PIRSA 2013b). Changes to the management arrangements for Snapper made in 2012 have impacted on the value of CPUE as an indicator of stock status. As such, a project is currently underway to develop the use of the daily egg production method for estimating the stock biomass as a new indicator of stock status.

Stock status is also considered for regional stocks, i.e. Northern Spencer Gulf, Southern Spencer Gulf and Gulf St Vincent, using the stock assessment fishery model 'SnapEst' (McGarvey and Feenstra 2004). This model integrates all available data, i.e. fishery and biological data for these regions, and provides estimates of fishery

Table 97: Summary of management arrangements for the South Australian Commercial Snapper Fishery in 2013-14.

Management arrangements	Marine Scalefish Fishery	Northern Zone Rock Lobster Fishery (NZRL), Southern Zone Rock Lobster Fishery (SZRL)	Lakes and Coorong Fishery
Limited entry (number of licences)	MSF – 311 Restricted – 7 Owner operator	NZRL – 63 SZRL – 180 Owner operator outside rock lobster season	LCF – 36 Owner operator
Minimum legal size limit	38 cm total length		
Commercial gear	<ul style="list-style-type: none"> > Handlines > Rod and line > Longlines > Droplines 		
Commercial gear restrictions	<ul style="list-style-type: none"> > Handlines - same as recreational fishers (see below) > Longlines and droplines <ul style="list-style-type: none"> • Number of hooks • Fishers must be in attendance of long line 		
TACC	No Commercial daily catch limit of 500 kg/trip		
Spatial closures	Yes		
Temporal closures	Yes		
Vessel Monitoring System	No		

Table 98: Summary of management arrangements for the South Australian Recreational Snapper Fishery in 2013-14.

Management arrangements	Recreational fishery
Recreational gear	<ul style="list-style-type: none"> > Handlines > Rod and line
Recreational gear restrictions	<ul style="list-style-type: none"> > Number of rods or handlines > Number of hooks each line may have. > Restrictions on the use of teaser lines.
Minimum legal size limit	38 cm total length
Recreational bag and boat limits	<p>Bag limit per person:</p> <ul style="list-style-type: none"> > in the waters of Gulf St Vincent, Investigator Strait, Backstairs Passage 5 (38-60 cm) and 2 (60+ cm) > in all other waters of the State 10 (38-60 cm) and 2 (60+ cm) <p>Boat limit:</p> <ul style="list-style-type: none"> > in the waters of Gulf St Vincent, Investigator Strait, Backstairs Passage 15 (38-60 cm total length) and, 6 (>60 cm total length) > in all other waters of the State (38-60 cm total length) 30 fish, and (>60 cm total length) 6 fish
Temporal closures	Yes
Spatial closures	Yes
Possession limit	No

performance indicators back to 1983-84. These indicators include fishable biomass, exploitation rate, recruitment and egg production. The most recent estimates of these parameters are then assessed against particular reference points as presented in the management plan (PIRSA 2013b).

A review of the Marine Scalefish Fishery status report and the stock assessment report is undertaken within the existing co-management framework (principally the Marine Scalefish Fishery Management Advisory Group) within one month of its release. The review considers all information in the report with particular emphasis on the primary and secondary performance indicators and the performance against the trigger reference points and objectives outlined in the harvest strategy.

Current biological status

The Management Plan for the South Australian Commercial Marine Scalefish Fishery does not involve fishery performance indicators or trigger reference points that are framed around recruitment overfishing (PIRSA 2013b). Rather, stock assessment for Snapper utilises a weight of evidence approach that involves numerous primary and secondary performance indicators. These include commercial fishing statistics, as well as output parameters from the fishery assessment model (McGarvey and Feenstra 2004).

South East

Commercial catches and catch rates are the best fishery performance indicators for this management unit. These fishery statistics are augmented by limited data on fish ages collected through market sampling since 2007-08. This regional management unit is not considered in the stock assessment model.

This region has traditionally supported low commercial catches of Snapper (Figure 57). However, between 2005 and 2010, there were substantial increases in catch and CPUE, particularly for longlines, culminating in this region producing 25% of the State's catch in 2010. These results are consistent with a considerable increase in fishable biomass. This was related to recruitment of two strong year classes (2001 and 2004), evident in the population age structures (Fowler et al. 2013b). Nevertheless, after 2010, catch and CPUE declined considerably, which is consistent with declining biomass due to depletion of these two strong year classes (Figure 57).

On the basis of the evidence available, the Snapper resource in the South East management unit is categorised as **transitional-depleting**.

In response to the status of Snapper in the South East the November statewide closure was extended from 1 November to 15 December annually. Commercial catch trip limits of 500 kg have

been introduced as well as increased restrictions on the number of hooks used on commercial longlines (reduced from 400 to 200 hooks maximum) to control the level of commercial impact on Snapper stocks. In 2013, five Snapper spawning spatial closures were introduced for the 2013-14 and 2014-15 spawning periods. The spawning spatial closures will also remain in place for 2015-2016.

Southern Gulf St Vincent

Commercial fishery statistics provide the best fishery performance indicators for this regional fishery, augmented by age structure data (Fowler et al. 2013b). While this region is considered in the model region of Gulf St Vincent in the stock assessment model, its influence on model outputs has recently been dominated by Northern Gulf St Vincent.

This regional fishery has traditionally produced low catches (Figure 57). Nevertheless, longline catches and CPUE increased from 2008 to 2010, consistent with an increase in biomass. This was associated with recruitment of two strong year classes (2001 and 2004), evident in age structures. However, catch and CPUE then declined in 2011 and 2012, suggesting the depletion of these strong year classes (Figure 57).

On the basis of the evidence available, the Snapper resource in the Southern Gulf St Vincent management unit is categorised as **transitional-depleting** (Fowler et al. 2013).

In response to the status of Snapper in the Southern Gulf St Vincent the November closure was extended from 1 November to 15 December annually. Commercial catch trip limits of 500 kg have been introduced, as well as increased restrictions on the number of hooks used on commercial longlines (reduced from 400 to 200 hooks maximum) to control the level of commercial impact on Snapper stocks. In 2013, five Snapper spawning spatial closures were introduced for the 2013-14 and 2014-15 spawning periods. The spawning spatial closures will also remain in place for 2015-2016.

Northern Gulf St Vincent

Commercial fishery statistics, population age structures and output parameters from the stock assessment model are all significant performance indicators for this regional fishery (Fowler et al. 2013b).

Since 2008, there has been a significant shift to longlines and dramatic increases in longline catch, effort and CPUE have culminated in this fishery becoming the dominant contributor to the State's Snapper catches (Figure 57). These data are consistent with a substantial increase in fishable biomass from 2005 onwards. The age structures show numerous strong year classes having recruited

to the population in 1991, 1997, 1999, 2001, 2004 and 2006 (Fowler et al. 2013b). The time series of estimated biomass, shows a significant increase between 2006 and 2012, as a consequence of the extended period of relatively high recruitment.

On the basis of the evidence available, the Snapper resource in the Northern Gulf St Vincent management unit is categorised as **sustainable**.

Southern Spencer Gulf

Commercial fishery statistics, population age structures and output parameters from the stock assessment model are all significant performance indicators for this region of the fishery (Fowler et al. 2013b).

From 2003 to 2008, there were significant increases in catch and CPUE in this fishery (Figure 57). This was partly associated with the adoption of longlines that improved the efficiency of some fishers. However after 2007, the catches and CPUE declined dramatically, suggesting a considerable decline in fishable biomass (Figure 57). Age composition data indicate that no strong year classes have recruited to this region since 1999 (Fowler et al. 2013b), and fishable biomass from 2005 has declined.

On the basis of the evidence available, the Snapper resource in the Southern Spencer Gulf management unit is categorised as **transitional-depleting**.

In response to the status of Snapper in the Southern Spencer Gulf the November statewide closure was extended from 1 November to 15 December annually. Commercial catch trip limits of 500 kg have been introduced as well as increased restrictions on the number of hooks used on commercial longlines (reduced from 400 to 200 hooks maximum) to control the level of commercial impact on Snapper stocks. In 2013, five Snapper spawning spatial closures were introduced for the 2013-14 and 2014-15 spawning periods. The spawning spatial closures will also remain in place for 2015-2016.

Northern Spencer Gulf

Commercial fishery statistics, population age structures and output parameters from the stock assessment model are all significant performance indicators for this regional fishery (Fowler et al. 2013b).

Northern Spencer Gulf was traditionally the most important of South Australia's Snapper regions. It generally provided >50% of the State's total catch, but its contribution fell during the mid-late 2000s to <10% by 2012 (Figure 57). These lower catches reflect declines in fishing effort. They were also associated with high levels of CPUE, which declined significantly in 2012 (Figure 57). These data are thought to relate to 'hyperstability', where the aggregative behaviour of Snapper and the experience of the fishers maintained high catch rates, whilst

biomass was declining (Fowler and McGlennon 2011). Eventually the biomass and catch rates dropped considerably due to the lack of recruitment to the population since 1999 (Fowler et al. 2013b).

The output parameters from the stock assessment model for Northern Spencer Gulf are, to some extent, at odds with the observations described above (Fowler et al. 2013b). The estimates of biomass for the 2000s showed an increasing trend that reflects strong recruitment years in 1997, 1999 and 2004. However, this result is thought to be an artefact reflecting the inflated values of CPUE (i.e. the consequence of the hyperstability). Output from the model indicates that recruitment through the 2000s was significantly lower than the 1990s.

It is unclear if the poor recruitment in Northern Spencer Gulf through the 2000s is a result of the stock being overfished or from poor environmental conditions for egg and larval survivorship. In the absence of recruitment of a strong year class to the population in the coming few years, fishing mortality is likely to deplete the fishable biomass further.

On the basis of the evidence available, the Snapper resource in the Northern Spencer Gulf management unit is categorised as **transitional-depleting**.

In response to the status of Snapper in the Northern Spencer Gulf management units, the November statewide closure was extended from 1 November to 15 December annually. Commercial catch trip limits of 500 kg have been introduced as well as increased restrictions on the number of hooks used on commercial longlines (reduced from 400 to 200 hooks maximum) to control the level of commercial impact on Snapper stocks. In 2013, five Snapper spawning spatial closures were introduced for the 2013-14 and 2014-15 spawning periods.

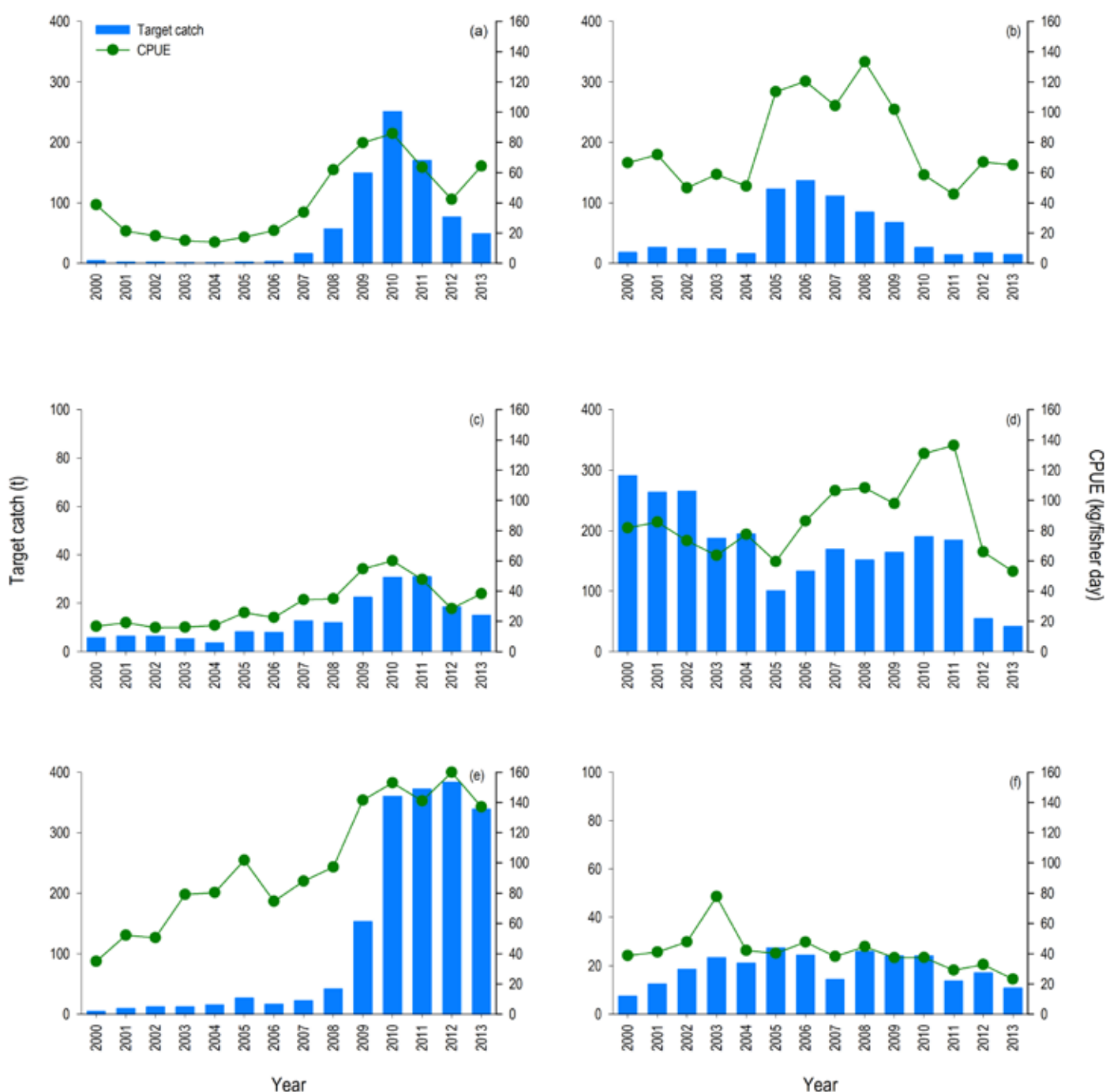
West Coast

Commercial catch and catch rate data provide the only indicators of the status for this region of the fishery.

This fishery has traditionally provided much lower catches than the gulf-based management units (Figure 57). Catches were relatively high through the mid-late 2000s as a result of substantial increases in longline fishing effort, reflecting the uptake of longlines. However, since 2003-04, longline CPUE has declined, indicating possible declining fishable biomass (Figure 57). The lack of size and age data for this region limits our understanding of recruitment patterns that could otherwise confirm a trend of declining biomass.

Because of the lack of sufficient information to confidently classify the Snapper stock in the West Coast, the Snapper resource in the West Coast management unit is categorised as **undefined**.

Figure 57: Estimates of targeted commercial Snapper catch and CPUE for the six management units: a. longline fishery in South East, b. longline fishery in Southern Spencer Gulf, c. longline fishery in Southern Gulf St Vincent, d. handline fishery in Northern Spencer Gulf, e. longline fishery in Northern Gulf St Vincent, f. longline fishery for the West Coast. Note the different scales for axes for target catch.



Effects of fishing on the marine environment

An ESD Risk Assessment of the South Australian Marine Scalefish Fishery was undertaken in July 2011, in preparing the *Management Plan for the South Australian Commercial Marine Scalefish Fishery* (PIRSA 2013b). The moderate, high and extreme risks were predominately related to governance and external factors affecting performance of the fishery. Two general ecosystem risks of moderate

were identified related to fishing and introduction of marine pests or aquatic diseases. Snapper was ranked as high risk through this process (PIRSA 2011b). The moderate and higher risks have strategies outlined in the management plan to address those risks.

In South Australian waters, Snapper are targeted using line-based gears. Line-based gears are not likely to damage the benthic habitats over which they are deployed. Consequently, the most

likely environmental issue for the Snapper Fishery is the capture and discarding of by-catch. Nevertheless, a by-catch study for the commercial sector indicated that the targeting of Snapper with either handlines or longlines resulted in relatively low levels of discards (Fowler et al. 2009), which primarily involved under-sized Snapper and some non-commercial species. Most non-commercial by-catch species were discarded in good condition, however the under-sized Snapper were often in poor condition, suffering from barotrauma.

Longline fishing with small hooks accounted for the highest rate of discarding of under-sized Snapper (Fowler et al. 2009). For the recreational sector, only 25.3% of Snapper captured in 2007-08 were retained suggesting a high capture and release rate of under-sized fish (Jones 2009).

The Marine Scalefish Fishery has been assessed by the (then) Australian Government Department of the Environment against the *Guidelines for Ecological Sustainable Management of Fisheries*, which are set out in the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. The Marine Scalefish Fishery was provided with an exemption from the export controls of the Act, subject to a number of recommendations and conditions, until September 2015.

Social and economic information

Commercial and recreational Snapper fishing brings economic, social and tourism benefits to a number of coastal fishing communities.

The Marine Scalefish Fishery generates direct and indirect employment, contributes to regional development, and supports many small businesses in direct fishing enterprises as well as various support industries, primarily in regional South Australia (EconSearch 2014b). The commercial fishery is an owner operator fishery with fishing undertaken by the licence owner. Snapper is sold domestically and contributes to seafood supply and tourism.

Many of the commercial fishers live in small communities. There is a high level of involvement by family and friends in the fishing business. The participants are predominantly (but not solely) male; there is also a high number of women who undertake unpaid work involved in managing the fishing businesses (Schirmer and Pickworth 2005).

Around half have a family history of involvement in commercial fishing. Fishers may fish on a part-time or full-time basis with some defining their fishing operation as a lifestyle that has its own culture and customs.

Key regions where Snapper fishing has a high regional impact, in terms of economic spending, membership of community groups

and historical links to the local area, include surrounding towns in the upper gulf regions, Yorke Peninsula, Fleurieu Peninsula, Port Lincoln and to a lesser extent the West Coast (principally Ceduna, Thevenard and Streaky Bay) and South East (Robe). In western Adelaide there is a high impact, primarily via delivery of catch to fish receivers, but also through a relatively high number of participants residing in the region.

Snapper is an iconic recreational species in South Australia. Recreational catches of Snapper are taken mostly within the two gulfs, almost exclusively from boats. Recreational fishing contributes to the wellbeing of recreational fishers, particularly for fishers that rate the following aspects as important when fishing; spending time in the outdoors, spending time with family, eating their own catch and getting away from people.

Table 99: Socio-economic information for the South Australian commercial Snapper Fishery, 2012-13 (source: EconSearch, 2014b).

Socio-economic indicator	Combined sectors
GVP – Snapper (\$ million)	5.2
Contribution to GSP from the Marine Scalefish Fishery (\$ million)*	49.7
Total employment in the Marine Scalefish Fishery (direct and indirect jobs)*	587

* GSP and employment figures are the total contribution of all species from the Marine Scalefish Fishery

Education and awareness, deterrence and enforcement

All compliance checks, monitoring and enforcement for Snapper are undertaken and reported along with other species as part of the Marine Scalefish Fishery. See Table 83 for a full report.

5.7 Southern Garfish (*Hyporhamphus melanochir*)

Authors: Mike Steer and Michelle Besley



Table 100: Stock status determination for the Southern Garfish Fishery of South Australia.

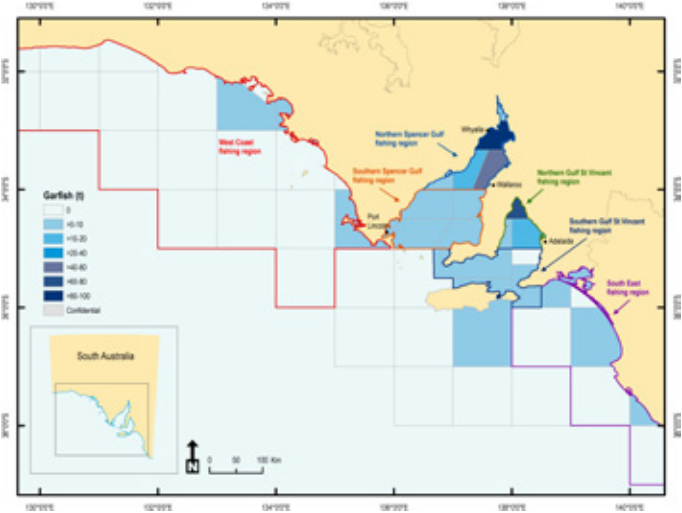
Management unit	West Coast	Northern Spencer Gulf	Southern Spencer Gulf	Northern Gulf St Vincent	Southern Gulf St Vincent	South East
Status	Undefined	Transitional-depleting	Undefined	Transitional-depleting	Undefined	Undefined
Primary indicators	Harvest fraction, egg production, fishable biomass					

Stock structure

Southern Garfish (*Hyporhamphus melanochir*) is distributed from Shark Bay in Western Australia, along the southern coast of mainland Australia and up the east coast to Eden in southern New South Wales, as well as the surrounding waters of Tasmania.

A multi-disciplinary otolith-based study identified at least five biological stocks of Southern Garfish in South Australia: West Coast, Northern Spencer Gulf, Southern Spencer Gulf, Northern Gulf St Vincent and Southern Gulf St Vincent (Steer et al. 2009). Given the level of spatial separation of garfish observed within the gulfs it was assumed that garfish from the South East also comprised a distinct biological stock.

Figure 58: Distribution of commercial catch of Southern Garfish in 2012-13.



Fishery overview

The Southern Garfish is one of the most significant inshore fishery species of southern Australia, with fisheries in Victoria, Tasmania, South Australia and Western Australia. Historically, the national commercial catch for this species has been dominated by that from South Australia. This species is also a popular target species for South Australian recreational anglers (Jones 2009).

In South Australia, the commercial fishery is principally located in the northern parts of Spencer Gulf and Gulf St Vincent and is managed as part of the multi-species, multi-gear Marine Scalefish Fishery. Commercial fishers target Southern Garfish using hauling nets and dab nets. Hauling net fishers account for the majority (~90%) of the commercial catch even though their fishing activities are restricted by regulation to waters less than 5 m deep. Commercial dab net fishers take the remainder of the commercial catch. A net buy-back in 2005 significantly reduced the number of nets operating in the fishery, accounting for approximately 45% of commercial hauling net fishing effort during 2000 to 2003.

Recreational fishers are also permitted to use dab nets but predominantly use traditional hook and line as they fish from boats and shore-based platforms throughout the State. Most of the recreational Southern Garfish catch is harvested from the gulfs, with a small amount of the catch taken in the West Coast and South East.

Table 101: Key biological traits of Southern Garfish.

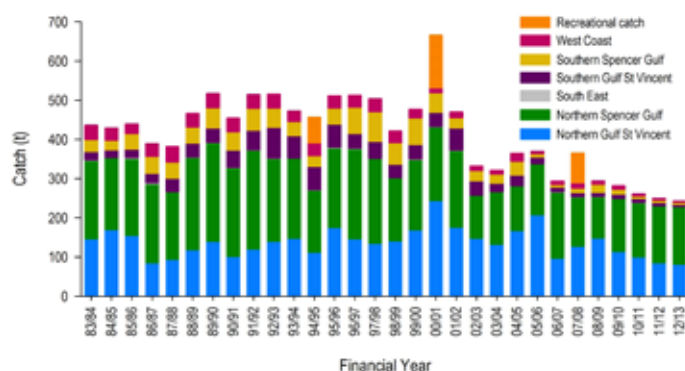
Parameter	Description
Range	Southern coast from Shark Bay Western Australia, to Eden New South Wales, including waters of Tasmania
Depth	Near surface of shallow inshore waters
Longevity	10 years
Maximum size	38 cm total length
Size at maturity	Age: 17.5 months Size: 21.5 cm total length
Spawning season	October to March

Catch trends

The total commercial catch of Southern Garfish was 242.4 t in 2012-13, combined across all gear types (Figure 59). This was 7.1 t less than the previous year, representing an annual decrease of 2.8% and was the lowest since 1983-84. With the exception of a two-year spike in 2004-05 and 2005-06, annual catches have sequentially declined from the peak of 532.3 t in 2000-01.

The 2007/08 South Australian Recreational Fishing Survey estimated the recreational catch of garfish at more than 74 t per year, which accounted for 20.5% of the total statewide harvest (Figure 59).

Figure 59: Annual catch information for the Southern Garfish Fishery of South Australia.



Data for recreational catch (orange) have only been collected in 1994-95, 2000-01 and 2007-08 during recreational fishing surveys.

Management arrangements

Management arrangements for the fishery are provided in the *Management Plan for the South Australian Commercial Marine Scalefish Fishery* (PIRSA 2013b), the *Fisheries Management (General) Regulations 2007*, licence conditions and fishery specific regulations for each of the fisheries (eg. *Fisheries Management (Marine Scalefish Fisheries) Regulations 2011*).

Licence holders from four different commercial fisheries have access to Southern Garfish within their respective fishery areas. This includes

the Marine Scalefish Fishery, Northern Zone Rock Lobster Fishery, Southern Zone Rock Lobster Fishery and Lakes and Coorong Fishery.

The commercial fishery is largely managed through the use of input controls, which aim to limit the total effort that can be directed into the fishery, including those in Table 102. The principal gears used to target Southern Garfish are hauling nets and dab nets. Significant net closures and gear restrictions govern the use of the nets and restrict their area of operation to relatively small areas within the northern gulfs.

In addition, there is an ongoing commercial licence amalgamation scheme which requires two licences to be amalgamated on transfer to enter the Marine Scalefish Fishery and limits the number of agents that may fish from a licence. These restrictions are aimed at limiting fishing effort, as well as the impact on the marine ecosystem.

In 2014, 12 licences in the Marine Scalefish Fishery and 2,814 effort days associated with these licences were surrendered through the South Australia Marine Parks: Commercial Fisheries Voluntary Catch/Effort Reduction Program.

To assist in rebuilding Southern Garfish stocks, commercial seasonal closures have been developed and implemented in collaboration with the commercial fishing industry. In addition, the introduction of requirements for a larger mesh size for hauling nets and an increase to the commercial size limit have been largely driven by the commercial fishing industry in pursuit of improved ecologically sustainable outcomes for the fishery. These arrangements were trialled through a collaborative research project between SARDI and industry and assist fishers to avoid the incidental capture of under-size garfish (Steer et al. 2011).

The recreational fishing sector is currently managed through a range of input and output controls designed to ensure that the total catch remains sustainable and shared equitably between recreational fishers and other fishing sectors. These controls include gear restrictions, bag and boat limits. Current output controls for Southern Garfish caught in South Australia include a legal minimum legal size limit of 230 mm and a recreational bag and boat limit of 60 and 180 garfish, respectively.

The 2007-08 South Australian Recreational Fishing Survey estimated the recreational catch (including charter and Aboriginal traditional) of Southern Garfish at 75 t per year, which accounted for 20.5% of the total statewide harvest (Jones 2009).

Recreational fishers target garfish with rod and line, from boats, shore and jetties, and some by dab nets. A total of 96% of the recreational catch is taken by boat-based fishers. The majority of the catch is taken by boat fishers. The majority (86%) of the recreational catch is taken from the two gulfs.

Table 102: Summary of management arrangements for the South Australian Commercial Southern Garfish Fishery in 2013-14.

Management arrangements	Marine Scalefish Fishery	Northern Zone Rock Lobster Fishery (NZRL), Southern Zone Rock Lobster Fishery (SZRL)	Lakes and Coorong Fishery (LCF)
Limited entry (number of licences)	MSF – 311 Restricted – 7 Owner/operator	NZRL – 63; SZRL – 180 Owner/operator outside Rock Lobster season	LCF – 36 Owner/operator
Minimum legal size limit	23 cm total length (changed to 25 cm total length in April 2015)		
Commercial gear	<ul style="list-style-type: none"> > Hauling nets > Dab nets > Handline > Rod and line 		
Commercial gear restrictions	<ul style="list-style-type: none"> > Hauling nets <ul style="list-style-type: none"> • Net length and maximum depth of 5 m for setting haul net • Mesh size • Fish must be retrieved using a brailing net • Restrictions on the use of hauling nets in conjunction with other devices > Dab nets <ul style="list-style-type: none"> • Hoop size • Net depth > Handline and rod and line <ul style="list-style-type: none"> • Number of rods and handlines • Number of hooks • Must be in attendance when used in shore-based platforms 		
TACC	No		
Spatial closures	Yes		
Temporal closures	Yes		
Vessel Monitoring System	No		

Table 103: Summary of management arrangements for the South Australian Recreational Southern Garfish Fishery in 2013-14.

Management arrangements	Details
Recreational gear	<ul style="list-style-type: none"> > Dab nets > Rod and line > Handlines
Recreational gear restrictions	<ul style="list-style-type: none"> > Handline and rod and line <ul style="list-style-type: none"> • Number of rods and handlines • Number of hooks • Must be in attendance when used in shore-based platforms
Minimum legal size limit	23 cm total length
Recreational bag and boat limits	Bag limit: 60 per person Boat limit: 180 per boat
Temporal closures	No
Spatial closures	No
Possession limit	No

Harvest strategy

A harvest strategy for Southern Garfish is included in the *Management Plan for the South Australian Commercial Marine Scalefish Fishery* (PIRSA 2013b). The harvest strategy aims to rebuild stocks and sets a series of specific targets:

- > Reduce harvest fraction to $\leq 60\%$ by 2014
- > Reduce harvest fraction to $\leq 45\%$ by 2017
- > Reduce harvest fraction to $\leq 30\%$ by 2020
- > Increase egg production to $\geq 25\%$ of pristine population by 2017
- > Increase egg production to $\geq 30\%$ of pristine population by 2020

Southern Garfish stock status is determined on the basis of fishery performance indicators in a weight of evidence approach. The following primary performance indicators have been selected as the key determinants of fishery performance:

- > Harvest fraction
- > Egg production

The Southern Garfish harvest strategy does not prescribe specific management responses to breaches of trigger reference points. Instead breaches of trigger reference points will be reviewed by the Marine Scalefish Fishery Management Advisory Group and reported to the Minister (or his/her delegate) along with recommendations

about future management action, which must be consistent with the objectives of the harvest strategy.

If further action is required then specific management responses will be developed through the existing co-management framework and will be consistent with the objectives of the harvest strategy (PIRSA 2013).

Monitoring and assessment

Commercial catch and effort information provides the primary data on which the biological status of the fishery is assessed and on which the majority of fisheries management decisions are based. Commercial catch and effort are fishery-dependent data collected through daily fishing logbooks.

The other source of fishery-dependent information is derived through a market sampling program. This sampling provides biological information such as age and length data, which is subsequently used in the fishery model to provide estimates on a range of performance indicators.

To monitor changes in the South Australian Southern Garfish population, a stock assessment model was developed (McGarvey and Feenstra 2004). This model covers the fisheries in the two South Australian gulfs, which has accounted for 96% of the statewide Southern Garfish catch over the past five years. The model incorporates age and length samples, along with fishery-dependent catch and effort information to estimate a range of biological output parameters.

Table 104: Harvest strategy components for the South Australian Commercial Southern Garfish Fishery.

Harvest strategy component	Whole of fishery
Objectives	<ul style="list-style-type: none"> > Reduce harvest fraction to $\leq 60\%$ by 2014 > Reduce harvest fraction to $\leq 45\%$ by 2017 > Reduce harvest fraction to $\leq 30\%$ by 2020 > Increase egg production to $\geq 25\%$ of pristine population by 2017 > Increase egg production to $\geq 30\%$ of pristine population by 2020
Performance indicators	<ul style="list-style-type: none"> > Harvest fraction (primary indicator) > Egg production (primary indicator) > Age composition (Secondary indicator) > Total hauling net effort (Secondary indicator) > Total catch, hauling net and dab net CPUE, fishable biomass, recruitment (other indicators)
Limit reference points	No
Target reference points	No
Trigger reference points	Yes
Decision rules	Yes

The primary performance indicators used to assess the performance of the fishery are harvest fraction and egg production derived from the stock assessment. The secondary performance indicators include age composition and total hauling net effort. Other performance indicators include trends in catch, CPUE, fishable biomass and recruitment.

A review of the *Marine Scalefish Fishery Status Report* and *Southern Garfish Stock Assessment Report* is undertaken within the existing co-management framework (principally the Marine Scalefish Fishery Management Advisory Group) within one month of its release. The review considers all information in the report with particular emphasis on the primary and secondary performance indicators and the performance against the trigger reference points and objectives outlined in the harvest strategy.

Current biological status

The current harvest strategy for Southern Garfish does not provide a pre-defined limit reference point that determines when the stock is recruitment overfished. Instead, the performance of the fishery is assessed against the modelled trends in the harvest fraction of the fishable biomass and egg production.

West Coast

A negligible amount of Southern Garfish is landed by the commercial sector on the West Coast, with the statewide contribution rarely exceeding 2% (Figure 59). Consequently, there is insufficient information available to classify the status of this stock.

On the basis of the evidence available the Southern Garfish resource in the West Coast management unit is categorised as **undefined**.

Northern Spencer Gulf

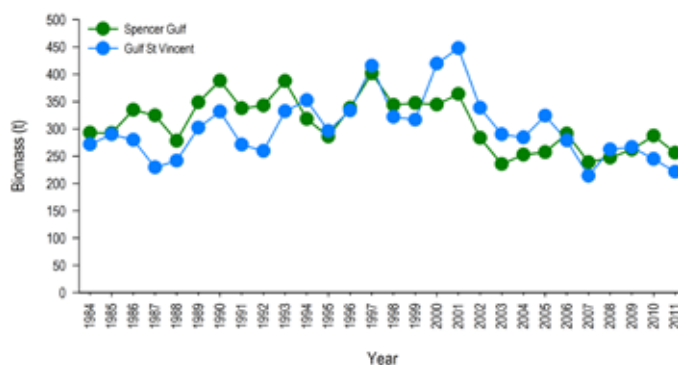
The Northern Spencer Gulf has been the most productive for Southern Garfish in South Australia since 1983, typically contributing more than half of the statewide catch (Figure 59). This stock is exclusively fished by the hauling net sector. The most recent assessment (Steer et al. 2012) assessed three types of performance indicators: commercial catch rates; age-length-frequency distributions; and model-based assessments of harvest fraction, egg production and fishable biomass. Catch rates have trended upwards since 1999. The composition of the commercial harvest is dominated by 1+ and 2+ year old Southern Garfish, continuing to indicate that the population structure has remained truncated as a result of sustained levels of high exploitation (>65%). Despite this, both fishable biomass and egg production have remained relatively stable at moderate levels (from 2003 to 2011), and the stock is not yet considered to be in a recruitment overfished state (Figure 60).

However, the current level of fishing pressure has the potential to cause the stock to become recruitment overfished. The Southern Garfish harvest strategy is being implemented to promote the recovery of the stock by reducing the harvest fraction and increasing egg production through a combination of effort and gear-based restrictions. It is too early to assess the effects of these strategies. The next stock assessment report is due in mid 2015.

On the basis of the evidence available, the Southern Garfish resource in the Northern Spencer Gulf management unit is categorised as **transitional-depleting**.

In response to the status of Southern Garfish in Northern Spencer Gulf seasonal closures in the commercial Garfish Fishery were implemented in 2012, 2013 and 2014 to reduce exploitation. A total of 40 days is now closed to garfish fishing in the peak catching period. In addition, new gear restrictions on hauling nets were implemented in 2013 to minimise and avoid the capture of undersize garfish. An increase to the commercial size limit was also introduced in 2015 to complement the mesh size change and increase the age of the garfish captured in the commercial sector.

Figure 60: Fishable biomass for Southern Garfish in Northern Spencer Gulf and Northern Gulf St Vincent.



Southern Spencer Gulf

A negligible amount of Southern Garfish is landed by the commercial sector in Southern Spencer Gulf, with the statewide contribution rarely exceeding 10%. Consequently, there is insufficient information available to classify the status of this stock.

On the basis of the evidence available, the Southern Garfish resource in the Southern Spencer Gulf management unit is categorised as **undefined**.

Northern Gulf St Vincent

Northern Gulf St Vincent has historically been the second most productive region in the State, accounting for an average of 35% of the annual catch (Figure 59). The most recent assessment (Steer et al. 2012) examined three types of performance indicators; commercial catch rates, age/length-frequency distributions and model-based assessments of harvest fraction, egg production and fishable biomass. The Southern Garfish population in Northern Gulf St Vincent is truncated as a result of sustained levels of exploitation (>60%) and the recent trends in fishable biomass and egg production have remained relatively stable at low levels over the past decade, indicating that the stock is not yet considered to be recruitment overfished (Figure 60).

However, this continued level of fishing pressure has the potential to cause the stock to become recruitment overfished. The Southern Garfish harvest strategy is being implemented to promote the recovery of the stock by reducing the harvest fraction and increasing egg production through a combination of effort and gear-based restrictions. It is too early to assess the effects of these strategies. The next stock assessment report is due in mid 2015.

On the basis of the evidence available, the Southern Garfish resource in the Northern Gulf St Vincent management unit is categorised as **transitional-depleting**.

In response to the status of Southern Garfish in the Northern Gulf St Vincent seasonal closures in the commercial Garfish Fishery were implemented in 2012, 2013 and 2014 to reduce exploitation. A total of 40 days is now closed to garfish fishing in the peak catching period. In addition, new gear restrictions on hauling nets were implemented in 2013 to minimise and avoid the capture of undersize garfish. An increase to the commercial size limit was introduced in 2015 to complement the mesh size change and increase the age of garfish captured in the commercial sector.

Southern Gulf St Vincent

A negligible amount of Southern Garfish is landed by the commercial sector in Southern Gulf St Vincent, with the statewide contribution rarely exceeding 5%. Consequently, there is insufficient information available to classify the status of this stock.

On the basis of the evidence available, the Southern Garfish resource in the Southern Gulf St Vincent management unit is categorised as **undefined**.

South East

A negligible amount of Southern Garfish is landed by the commercial sector in the South East, with the statewide contribution rarely exceeding 0.3%. Consequently, there is insufficient information available to classify the status of this stock.

On the basis of the evidence available, the Southern Garfish resource in the South East management unit is categorised as **undefined**.

Effects of fishing on the marine environment

Hauling nets are the dominant commercial gear type used to target Southern Garfish in South Australia and encountering by-catch and by-product is unavoidable; particularly as these nets sweep over relatively large fishing areas and indiscriminately herd mobile fauna into the net. The nets, however, have been constructed in a way to minimise by-catch issues. They consist of a 'pocket' end and lateral 'wings'. The mesh size of the wings is generally smaller than that of the pocket, typically constructed of different material and specifically designed to herd fish into the pocket of the net rather than enmesh them. Fish herded in the pocket are manually brailled out with a hand-held brailing net.

The herding properties of the net reduce the discard mortality of by-catch as in most instances unwanted catch can be released in good condition, those entangled in the mesh, however, are generally in poor condition (Fowler et al. 2009). Under-size Southern Garfish are the most susceptible to hauling nets as they are too fragile to be handled and discarded alive. Efforts are currently being made to reduce the mortality of small Southern Garfish by increasing the regulated size of the mesh in the pocket of the net. The legal minimum mesh size was increased from 3.0 cm to 3.2 cm in early 2013 and to 3.5 cm in 2015 in response to a study that found that this increase reduces the susceptibility of under-size garfish by approximately 64% (Steer et al. 2011).

The only comprehensive quantitative study of the effects of hauling nets in New South Wales concluded that hauling net fishing did not appear to disrupt the normal life history events and ecological processes of fish and invertebrates that occupy seagrass beds (Otway and Macbeth 1999). Although there has not been any qualitative study carried out in South Australia, there have been several anecdotal reports that have suggested that there are no obvious impacts of nets on *Posidonia spp.* beds that commonly occur in the State's coastal waters (Fowler 2005). The hauling nets that are used to target Southern Garfish are typically light-weight and are designed to float and catch Southern Garfish which inhabit

the surface water. In many cases the skirt of the net lifts up from the bottom during fishing, subsequently providing short-term escape gaps for the encircled fish (Steer et al. 2011).

The Marine Scalefish Fishery has been assessed by the Australian Government Department of the Environment against the *Guidelines for Ecological Sustainable Management of Fisheries*, which are set out in the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999*. The South Australian Marine Scalefish Fishery was provided with an exemption to September 2015 from the export controls of the Act, subject to a number of recommendations and conditions.

An ESD Risk Assessment of the South Australian Marine Scalefish Fishery was undertaken in July 2011, in preparing the *Management Plan for the South Australian Commercial Marine Scalefish Fishery* (PIRSA 2013b). The moderate, high and extreme risks were predominately related to governance and external factors affecting performance of the fishery. Two general ecosystem risks of moderate were identified related to fishing and the introduction of marine pests or aquatic diseases. Southern Garfish was ranked as high risk through this process (PIRSA 2011b). The moderate and high risks have strategies outlined in the management plan to address those risks.

Social and economic information

Commercial and recreationally caught garfish bring economic, social and tourism benefits to a number of coastal fishing communities. The commercial fishery is an owner/operator fishery with fishing undertaken by the licence owner. Garfish is sold domestically as an affordable local seafood product.

Many of the commercial fishers live in small communities. There is a high level of involvement by family and friends in the fishing business (Schirmer and Pickworth 2005). Fishers may fish on a part-time or full-time basis with some defining their fishing operation as a lifestyle that has its own culture and customs.

Key regions for Southern Garfish where there is a high regional impact, in terms of economic spending, membership of community groups and historical links to the local area, include the surrounding towns in the upper gulf regions, and to a lesser extent Yorke Peninsula and the Fleurieu Peninsula.

Recreational fishing contributes to the wellbeing of recreational fishers, particularly for fishers that rate the following aspects as important when fishing; spending time in the outdoors, spending time with family, eating their own catch and getting away from people.

Table 105: Socio-economic information for the South Australian Commercial Southern Garfish Fishery 2012-13 (EconSearch, 2014b).

Socio-economic indicator	Combined sectors
GVP – Garfish (\$ million)	1.8
Contribution to GSP from the Marine Scalefish Fishery (\$ million)*	49.7
Total employment in the Marine Scalefish Fishery (direct and indirect jobs)*	587

* GSP and employment figures are the total contribution of all species from the Marine Scalefish Fishery

Education and awareness, deterrence and enforcement

All compliance checks, monitoring and enforcement for Southern Garfish is undertaken and reported along with other species as part of the Marine Scalefish Fishery. See Table 83 for a full report.

5.8 Yelloweye Mullet (*Aldrichetta forsteri*)

Authors: Jason Earl and Jonathan McPhail



Table 105: Stock status determination for the Yelloweye Mullet Fishery of South Australia.

Management unit	Lakes and Coorong Fishery	Marine Scalefish Fishery
Status	Sustainable	Sustainable
Primary indicator (or weight of evidence)	Weight of evidence	Weight of evidence

Stock structure

Yelloweye Mullet (*Aldrichetta forsteri*) inhabit bays, estuaries and inshore waters in New Zealand and along the southern coast of Australia, from Kalbarri in Western Australia to Newcastle in New South Wales, and around Tasmania. In South Australia, Yelloweye Mullet typically occur in schools in inshore coastal waters from the intertidal zone to depths of at least 20 m, and are also abundant in the Coorong estuary.

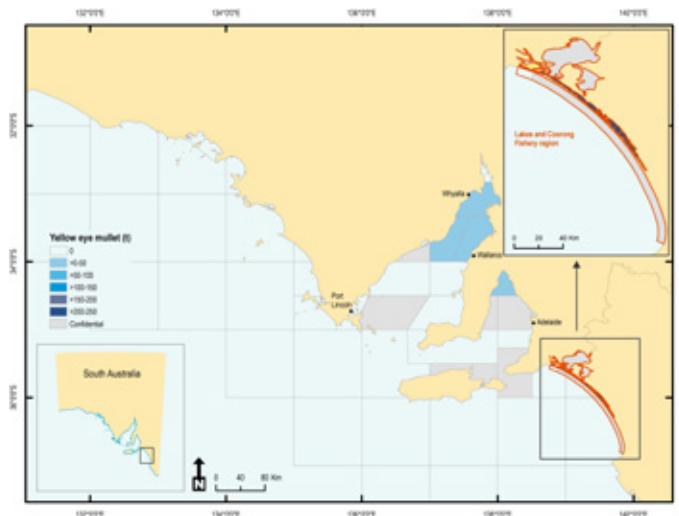
The stock structure of Yelloweye Mullet throughout its distribution is not well understood. It has been suggested that populations in Australia form two discrete stocks, ie. western and eastern stocks, based on morphological differences (Thomson 1957, Pellizzari 2001). However, there is uncertainty around the structure of the stock in South Australia. As such, the assessment of stock status for Yelloweye Mullet is undertaken at the management unit level for both the Lakes and Coorong Fishery and Marine Scalefish Fishery (Figure 61).

Fishery overview

In South Australia, the commercial fishery for Yelloweye Mullet has two main sectors, the Lakes and Coorong Fishery and Marine Scalefish Fishery. The Northern and Southern Rock Lobster fisheries also have access but catch is minimal.

The Lakes and Coorong Fishery is a multi-species, multi-gear fishery that operates in and adjacent to, the River Murray estuary, which comprises Lower Lakes of the River Murray (Lakes Alexandrina and

Figure 61: Distribution of commercial catch of Yelloweye Mullet in the Marine Scalefish Fishery (all State marine waters, except for the Coorong) and Lakes and Coorong Fishery (inset map) in 2012-13.



Note: to avoid disclosure of confidential data, levels of catch are not shown for areas that relate to less than five licences.

Albert), the Coorong lagoons and Coorong coastal waters (Figure 61). Licence holders in the Lakes and Coorong Fishery use mainly small mesh gill nets to target Yelloweye Mullet (Earl and Ferguson 2013) in the Coorong lagoons.

Similar to the Lakes and Coorong Fishery, the Marine Scalefish Fishery is a multi-species, multi-gear fishery. The Marine Scalefish Fishery operates in all coastal waters of South Australia, excluding the River Murray estuary and Coorong (Figure 61). Fishers in the Marine Scalefish Fishery use mainly hauling nets and gill nets to target Yelloweye Mullet.

Yelloweye Mullet are a significant target catch of recreational fishers in nearshore coastal waters of South Australia. Mullet are taken mainly by land-based fishers using rod and line. Recreational fishers can also target Mullet using registered nets in the Coorong lagoons and Lake George in the State's South East. Recreational net fishing is prohibited in all other coastal waters of South Australia.

Table 106: Key biological traits of Yelloweye Mullet.

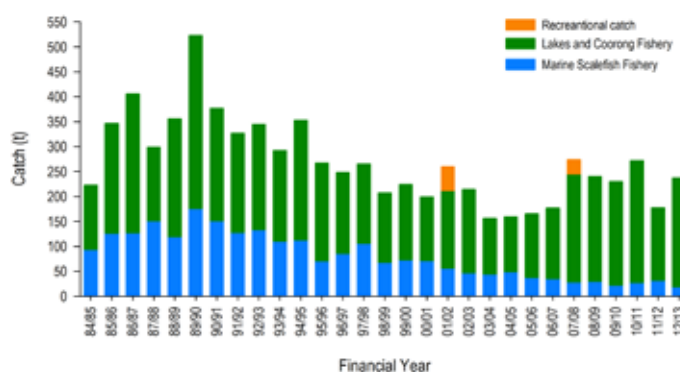
Parameter	Description
Range	Southern coast of Australia from Kalbarri, Western Australia to Newcastle New South Wales, and around Tasmania.
Depth	Intertidal to 20 m
Longevity	10 years
Maximum size	Approximately 40 cm total length
Size at maturity	Females – 24 cm total length; Males – 25 cm total length.
Spawning season	August to April

Catch trends

Estimates of total annual statewide commercial catch of Yelloweye Mullet were first recorded in 1984-85, when 223 t were harvested, 57% of which was taken by the Lakes and Coorong Fishery and 43% by the Marine Scalefish Fishery (Figure 62). Over the following five years, catches for both sectors increased to a combined historical peak of 522 t in 1989-90. From then, catches progressively decreased to a combined low of 156 t in 2003-04. The falling catches reflect declines in targeted fishing effort for the Lakes and Coorong Fishery and Marine Scalefish Fishery. Annual catches for the Marine Scalefish Fishery continued to decline throughout the late 2000s, while those taken by the Lakes and Coorong Fishery increased. In 2012-13, the combined statewide catch of Yelloweye Mullet was 237 t, of which 92% was harvested by the Lakes and Coorong Fishery (Figure 62).

The 2007-08 South Australian Recreational Fishing Survey estimated the recreational catch of Yelloweye Mullet at 28 t, which accounted for approximately 10% of the total annual statewide harvest (Jones 2009).

Figure 62: Annual catch information for the Yelloweye Mullet Fishery of South Australia.



Data for recreational catch (orange) have only been collected in 2000-01 and 2007-08 during recreational fishing surveys.

Management arrangements

Management arrangements for the fishery are provided in the *Management Plan for the Lakes and Coorong Fishery* (Sloan 2005), *Fisheries Management (General) Regulations 2007* and fishery specific regulations are provided in the *Fisheries Management (Lakes and Coorong Fishery) Regulations 2009* and *Fisheries Management (Marine Scalefish Fisheries) Regulations 2011*.

The commercial fishery is largely managed through the use of input controls, which aim to limit the total amount of effort that can be directed into the fishery to ensure the sustainability of the aquatic resources on which the fishery is based. These restrictions are aimed at not only limiting effort but also the impact on the marine ecosystem.

In 2014, 12 licences in the Marine Scalefish Fishery and 2,814 effort days associated with these licences were surrendered through the South Australian Marine Parks: Commercial Fisheries Voluntary Catch/Effort Reduction Program.

The recreational sector is managed through a combination of input and output controls, aimed at ensuring the total catch is maintained within sustainable limits and to ensure that recreational access to the fishery is equitably distributed between recreational participants. A limited number of recreational mesh nets are permitted for use in the Lakes and Coorong and Lake George. These are subject to area restrictions and must meet regulated specifications.

Table 107: Summary of management arrangements for the South Australian Commercial Yelloweye Mullet Fishery in 2013-14.

Management arrangements	Lakes and Coorong Fishery	Marine Scalefish Fishery
Limited entry (number of licences)	36 licences Owner/operator	311 licences 7 - restricted Owner/operator
Minimum legal size limit	21 cm total length	
Commercial gear	<ul style="list-style-type: none"> > Rod and line > Handline > Hauling nets > Gillnets 	<ul style="list-style-type: none"> > Rod and line > Hauling nets > Gill nets
Commercial gear restrictions	<ul style="list-style-type: none"> > Rod and line <ul style="list-style-type: none"> • Number of rod and handlines • Number of hooks > Nets <ul style="list-style-type: none"> • Net length, depth, mesh size, break strain • Restrictions on the use of nets in conjunction with other devices 	<ul style="list-style-type: none"> > Rod and line <ul style="list-style-type: none"> • Number of rod and handlines • Number of hooks > Nets <ul style="list-style-type: none"> • Net length, depth, mesh size • Fish must be retrieved using a brailing net • Restrictions on the use of hauling nets in conjunction with other devices • Gill nets must be set in waters than 5 m or less and must be attended
TACC	No	No
Spatial closures	Yes	
Temporal closures	Yes	
Vessel Monitoring System	No	

Table 108: Summary of management arrangements for the South Australian Recreational Yelloweye Mullet Fishery in 2013-14.

Management arrangements	Management methods
Recreational gear	<ul style="list-style-type: none"> > Fishing rods > Handlines > Mesh nets (Lakes and Coorong and Lake George only)
Recreational gear restrictions	<ul style="list-style-type: none"> > Number of rods and/or handlines > Number of hooks > Registration of mesh nets - 1 per person
Minimum legal size limit	21 cm total length
Recreational bag and boat limits	Bag limit of 60 per person per day Boat limit of 180 per boat per day
Spatial closures	Yes
Temporal closures	Yes
Possession limit	No

Harvest strategy

Lakes and Coorong Fishery

The harvest strategy framework integrates a set of basic environmental management principles into the day-to-day management of the fishery to ensure that management decision-making incorporates critical environmental factors, such as the timing and volume of freshwater flows and barriers to fish passage. This approach aims to ensure that fundamental environmental processes are maintained or, where necessary, restored to maximise benefits for Yelloweye Mullet stocks. Under this integrated approach, instead of simply measuring the performance of individual fish stocks against management objectives, critical environmental drivers are explicitly taken into account when assessing the overall health of the fishery and in decision-making processes. If water flow rates or other key environmental parameters fall outside of reference levels in any given period, a management response is to be initiated to ensure Yelloweye Mullet stocks are managed during periods of low ecosystem health, such as extended periods of drought or low water flow.

A new harvest strategy specific to finfish harvested by the Coorong Fishery is being developed as part of the Lakes and Coorong Fishery Management Plan, due for completion in 2015.

Marine Scalefish Fishery

With more than 60 marine scalefish species harvested annually, developing individual performance indicators and reference points would require significant resources (Noell et al. 2006). Rather, the majority of management and monitoring resources will be targeted on the priority species in the fishery. Yelloweye Mullet are classified

as a secondary species and therefore the harvest strategy for Yelloweye Mullet in the Marine Scalefish Fishery contains broad management objectives and the indicators that will be used to monitor the performance of Yelloweye Mullet over time.

Monitoring and assessment

Fishery-dependent data are collected to monitor the performance of the Yelloweye Mullet Fishery in South Australia. Commercial catch and effort information provides the primary data on which the biological status of the fishery is assessed and the majority of fisheries management decisions are based. Commercial catch and effort data are collected through daily fishing logbooks.

Currently, temporal trends in commercial catch and CPUE data for Yelloweye Mullet are the main indicators of stock biomass in both the Lakes and Coorong Fishery and Marine Scalefish Fishery. These indicators are compared against limit reference points to assess fishery performance and form a weight of evidence approach to the assessment of stock status.

For the Lakes and Coorong Fishery, fishery statistics are augmented by limited data on fish ages that have been collected through sampling of commercial catches. Data on the age composition of the population provide important information on recruitment of young fish to the population and presence/absence of sexually mature individuals within the population.

Previous stock assessment reports for Yelloweye Mullet were undertaken in 2005 (Higham et al. 2005) and 2013 (Earl and Ferguson 2013). Performance indicators were also assessed in the 2014 stock status report for the Lakes and Coorong Fishery (Earl and Ward 2014) and Marine Scalefish Fishery (Fowler et al. 2013a).

Table 109: Harvest strategy components for the South Australian Commercial Yelloweye Mullet Fishery.

Harvest strategy component	Lakes and Coorong Fishery	Marine Scalefish Fishery
Objectives	Maintain the primary performance indicators within limit and target reference points	Maintain the primary performance indicators within limit and target reference points
Performance indicators	<ul style="list-style-type: none"> > Total catch (t) > Commercial CPUE > 4-year total catch trend > 4-year CPUE trend > 4-year net freshwater flows over the barrages 	<ul style="list-style-type: none"> > Total catch (t) > Targeted handline and fishing pole effort > Targeted hauling net and gill net effort > Targeted handline and fishing pole CPUE > Targeted hauling net and gill net CPUE
Limit reference points	Yes	Yes
Target reference points	Yes	Yes
Trigger reference points	No	No
Decision rules	Yes	Yes

Current biological status

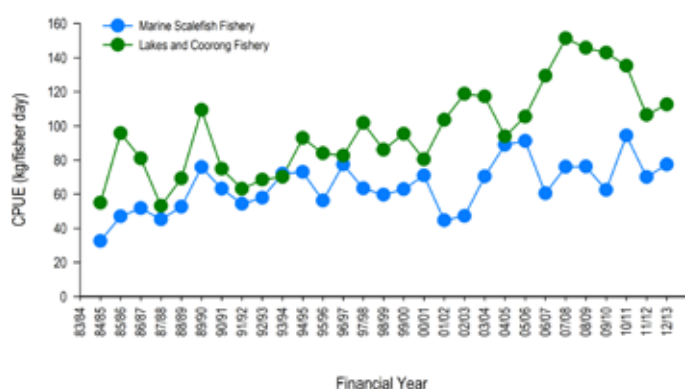
Lakes and Coorong Fishery

The Management Plan for the Lakes and Coorong Fishery does not include fishery performance indicators or limit reference points that are framed around recruitment overfishing (Sloan 2005). Rather, stock assessment for Yelloweye Mullet utilises a weight of evidence approach that involves numerous performance indicators, including commercial catch and CPUE (Earl and Ferguson 2013). These data are augmented by data on fish ages collected through sampling of commercial catches.

Annual catches of Yelloweye Mullet have remained relatively stable since 2007-08, averaging 207 t per year. Annual CPUE increased progressively from about 60 kg/fisher day in the early 1990s, to a historical peak of 151 kg/fisher day in 2007-08 (Figure 63). Despite a recent decline, CPUE was among the highest recorded in the fishery in 2012-13. Age structure analysis undertaken in 2012 revealed numerous strong year classes were present in the population and regular recruitment of young fish to the population over recent years (Earl and Ferguson 2013).

On the basis of the evidence available, the Yelloweye Mullet resource in the Lakes and Coorong Fishery management unit is categorised as **sustainable**.

Figure 63: Annual CPUE for Yelloweye Mullet for the Lakes and Coorong Fishery (small mesh gill nets) and Marine Scalefish Fishery (all gear types) from 1984-85 to 2012-13.



Marine Scalefish Fishery

The management plan for the Marine Scalefish Fishery does not involve fishery performance indicators or trigger reference points that are framed around recruitment overfishing (PIRSA 2013b). Rather, stock assessment for Yelloweye Mullet utilises a weight of evidence approach that involves numerous performance indicators, including commercial catch, targeted effort and CPUE.

Since the late 1980s, there has been a progressive decline in annual catches of Yelloweye Mullet taken by the Marine Scalefish

Fishery (Figure 62). This decline likely relates to historically low levels of targeted effort, rather than a decline in fishable biomass, as catch rates have followed an increasing trend over the same period (Figure 63). In 2012-13, catch rates were among the highest on record. The long-term decline in targeted fishing effort likely relates to the relatively low market value of Yelloweye Mullet taken by the Marine Scalefish Fishery compared to other species targeted by the fishery.

On the basis of the evidence available, the Yelloweye Mullet resource in the Marine Scalefish Fishery management unit is categorised as **sustainable**.

Effects of fishing on the marine environment

Lakes and Coorong Fishery

An ESD Risk Assessment of the Lakes and Coorong Fishery was carried out in 2011. The risk to Yelloweye Mullet in the Lakes and Coorong Fishery was ranked as low and the risk of capture of threatened, endangered and protected species in the Lakes and Coorong Fishery as low for sea birds and Long-nosed fur seals and negligible for all other species. The general ecosystem risks from the impacts of fishing in the Lakes and Coorong were high for the freshwater environment and for the introduction of marine pests and aquatic diseases (PIRSA 2011c).

The overall environmental impacts associated with Yelloweye Mullet fishing in the Coorong estuary are considered to be low. Small mesh gill nets are the dominant gear type used by the Lakes and Coorong Fishery to target Mullet. Overall discarding of by-catch and under-size Yelloweye Mullet from gill nets by the fishery in 2005-06 (Ferguson 2010), was relatively low compared to other fisheries around Australia (Gray 2002; Gray et al. 2004). Discard rates from small mesh gill nets when targeting Yelloweye Mullet were also relatively low compared to other gear types used by the fishery. This may be attributable to the practice of floating the nets, attendance by the fisher during fishing periods, and the legal requirement for a relatively shallow drop (Ferguson 2010).

The South Australian Lakes and Coorong Fishery has been assessed by the Australian Government Department of the Environment against the *Guidelines for Ecological Sustainable Management of Fisheries*, which are set out in the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999*. The South Australian Lakes and Coorong Fishery was provided with an exemption from the export controls of the Act, subject to a number of recommendations and conditions, until February 2016.

The Lakes and Coorong Fishery was assessed against the Marine Stewardship Council environmental standard for sustainable fishing and was certified as sustainable in 2008.

Marine Scalefish Fishery

Hauling nets are the dominant gear type used by the Marine Scalefish Fishery to target Yelloweye Mullet. Haul nets have been constructed in a way to minimise by-catch issues, with mesh size to allow under-size fish to escape and minimise meshing. The mesh size of the wings is generally smaller than that of the pocket, typically constructed of different material and designed to herd fish into the pocket of the net rather than enmesh them. Fish are manually brailled out of the pocket with a hand-held brailing net and are released or retained. The size-selective properties of the hauling net are largely determined by the dimensions and construction of the pocket. The herding properties of the net reduce the discard mortality of by-catch as it can be released from the net pocket alive and in good condition. Those entangled in the mesh, however, are generally in poor condition (Fowler et al. 2009).

Social and economic information

The Yelloweye Mullet fishery is an important contributor to the socio-economic well-being of regional coastal communities in South Australia. The Yelloweye Mullet fishery directly and indirectly contributes to the provision, maintenance and expansion of a number of local and regional services and businesses (EconSearch 2014b, c).

Table 112: Socio-economic information for the South Australian Commercial Yelloweye Mullet Fishery, 2012-13 (source: EconSearch 2014b, c; SARDI unpublished).

Socio-economic indicator	Total Fishery
GVP - Yelloweye Mullet (\$ million)*	0.09
Contribution to GSP from Lakes and Coorong and Marine Scalefish Fishery (\$ million)#	68.5
Total employment from the Lakes and Coorong and Marine Scalefish Fishery #	738

* GVP provided by SARDI (unpublished).

GSP and employment figures are the total contribution of all species in the Lakes and Coorong and Marine Scalefish Fishery.

Education and awareness, deterrence and enforcement

All compliance checks, monitoring and enforcement for Yelloweye Mullet are undertaken and reported along with other species as part of the Lakes and Coorong Fishery. See Table 76 for a full report.

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7 Glossary

Glossary of common fisheries management terms

Abundance A measure of how many fish are in a population or a fishing ground.

Age structure Numbers of fish in each age class from a sample of fish captured during a fishing season. Sometimes sampled separately for retained and discarded catch. An important data input for age-structured fisheries stock assessments.

Allocation Distribution of the opportunity to access fisheries resources, within and between stakeholder groups.

Anabranch A section of a river or stream that diverts from the main channel or stem of the watercourse and rejoins the main stem downstream.

Aquatic reserve An area of water, or land and water, established as an aquatic reserve by proclamation under the *Fisheries Act 1982*.

Bag limit The maximum number of fish of a species that a recreational fisher can legally take in any 24 hour period commencing at midnight.

Benthic Describes animals that live on, in or near the substrate.

Biodiversity The variability among living organisms from all sources (including terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are a part) and includes: (a) diversity within species and between species; and (b) diversity of ecosystems.

Biological reference point An indicator of the status of an exploited stock and a standard for comparison between years. Two types are often used when sufficient biological data are available: those based on fishing mortality and those based on the sustainability of recruitment or biomass. In data-poor fisheries, other estimates of relative biomass may be used (ie. total catch and catch per unit effort). Reference points can be either desirable targets (target reference points) or minimum biologically acceptable limits (limit reference points).

Biological stock Functionally discrete population that is largely distinct from other populations of the same species and can be regarded as a separate entity for management or assessment purposes.

Biomass The total weight or volume of individuals in a fish stock.

Boat limit The maximum number of a species that can be legally taken by persons on a boat per day or per fishing trip, as specified.

By-catch At a broad level, fisheries by-catch includes all material, living and non-living, other than targeted species which is caught while fishing. It includes discards (that part of the catch returned to the water) and also that part of the catch that is not landed but is killed as a result of interaction with fishing gear.

By-product Non-targeted catch that is commercially valuable and retained by fishers.

Carapace length (CL) In prawns, the distance from the posterior margin of the orbit to the mid-caudodorsal margin of the carapace; in lobster, the distance from the tip of the rostrum to the mid-caudodorsal margin of the carapace.

Catch The total amount (weight or number) of a species captured from within a specified area over a given period of time.

Caudal fork length The length of a fish measured from the tip of the snout to the end of the shortest caudal fin rays.

Catch per unit effort (CPUE) The number or weight of fish caught by a unit of fishing effort. Often used as a measure of fish abundance.

Closures Prohibition of fishing during particular times or seasons (temporal closures) or in particular areas (spatial closures), or a combination of both.

Cohort A group of fish spawned during a specified period, usually within a year. A cohort is also referred to as an age class.

Co-management Arrangements between governments and stakeholder groups to allow joint responsibility for managing fisheries resources on a cooperative basis. Co-management arrangements can range from a consultative model, where stakeholders have an advisory role to government, to a delegated model where co-managers have decision-making powers.

Commercial fishing Fishing undertaken for the purposes of trade or business.

Decision rule Pre-determined management actions to achieve operational objectives. Decision rules should be linked directly to the biological, economic and social performance of the fishery relative to reference points.

Ecological risk assessment A tool used to evaluate the likelihood that adverse ecological effects could result from the exposure to a risk.

Ecologically sustainable development Using, conserving and enhancing the community's resources so that ecological processes, on which life depends, are maintained, and the total quality of life, now and in the future, can be increased.

Economic efficiency The maximisation of the value of the net benefits derived from fishery resources.

Ecosystem A dynamic complex of plant, animal, fungal, and micro-organism communities and the associated non-living environment interacting as an ecological unit.

Effort Amount of fishing taking place, usually described in terms of gear type and frequency or period during which the gear is in use; for example, 'hook-sets', 'trawl-hours' and 'searching hours'.

Fishery A term used to describe the collective enterprise of taking fish. A fishery is usually defined by a combination of the species caught (one or several), gear and/or fishing methods used, and area of operation.

Fishery-dependent data Information collected about a fishery or fish stock by the participants of a fishery (eg. catch and effort information from fishery log sheets).

Fishery-independent data Information collected about a fishery or fish stock by researchers, independent of the fishery (eg. scientific surveys, observer reports).

Gear restriction A type of input control used as a management tool to restrict the amount and/or type of fishing gear that can be used by fishers in a particular fishery.

Gross value of production (GVP) A value obtained by multiplying the volume of catch (whole weight equivalent) by the average per unit beach price. In the case of a multispecies fishery, the fishery's GVP is the sum of the GVP of each species.

Habitat The place or type of site in which an organism naturally occurs.

Hyperstable/hyperstability When performance measures remain stable despite changing stock abundance.

Harvest The total number or weight of fish caught and kept from an area over a period of time.

Harvest fraction The total number or weight of fish caught and kept from an area over a period of time as a fraction of the stock.

Individual transferable quota A management tool by which portions of the total allowable catch are allocated among licence

holders (individual fishers or companies) as units of quota. Quota entitlements can be made to be temporarily or permanently transferable between these licence holders.

Input controls A management tool that restrains fishing effort, includes restraints on who fishes (licence limitations), where they fish (closed areas), when they fish (closed seasons) or how they fish (gear restrictions).

Legal size limits A minimum or maximum legal size limit determines the legal size at which a given species can be retained.

Length-frequency An arrangement of recorded lengths of a species of fish, which indicates the number of times each length or length interval occurs in a population or sample.

Limited entry Fishing effort is controlled by restricting the number of operators. It usually requires controlling the number of licences in a fishery. It can also include restrictions on the number and size of vessels, transfer of fishing rights, and replacement of vessels.

Limit reference point Defines the values of an indicator for a fish stock or fisheries management unit that are no longer considered acceptable.

Logbook An official record of catch and effort data made by fishers. In South Australian commercial fisheries licence conditions make the return of logbooks mandatory.

Mantle length The standard measure of length in coleoid cephalopods (eg. squid, cuttlefish and octopus). Usually measured along the dorsal midline from the mantle margin to the posterior tip of the body, excluding long tails, or from a line joining the midpoint of the eyes rather than the mantle margin.

Marine park In South Australia, marine parks are a type of marine protected area proclaimed under the *Marine Parks Act 2007* with the primary aim of protecting and conserving marine biodiversity.

Minimum mesh size The smallest size of mesh permitted in nets and traps; imposed on the basis that smaller individuals will escape unharmed.

Mortality Rate of deaths (usually in terms of proportion of the stock dying annually) from various causes. Comprises (i) natural mortality - deaths in a fish stock from causes except fishing i.e. predation, pollution etc., and (ii) fishing mortality - deaths in a fish stock caused by fishing.

Multi-species fishery A fishery in which fishers' target and/or harvest more than one species. Fishery data from multi-species

fisheries are more difficult to interpret because of uncertainty around the relative targeting of individual species.

Non-target species Any part of the catch, except the target species, and including by-catch and by-product.

Offshore Constitutional Settlement An agreement between the State(s) and the Commonwealth whereby the State or the Commonwealth (or in some cases a Joint Authority) is given jurisdiction for a particular fishery occurring in both coastal waters (low tide mark to 3 nautical miles [nm]) and the Australian Fishing Zone (3 nm to 200 nm). When no OCS agreement has been reached, the fishery remains under the jurisdiction of the State out to 3 nm, and the Commonwealth from 3 to 200 nm.

Output controls Management measures that place restraints on what is caught, including the catch (quota), size limits, sex or reproductive condition of individuals in the catch and species permitted to be taken.

Parameter A 'constant' or numerical description of some property of a population.

Performance indicator A quantity that can be measured and used to track changes in an operational objective.

Population A group of individuals of the same species, forming a breeding unit and sharing a habitat.

Possession limit Possession limits restrict the quantity or total weight of fish that recreational fishers can catch and keep. Possession limits are a useful regulatory tool that prevents recreational fishers taking and stockpiling large quantities of fish.

Quota Amount of catch (weight or numbers of fish) allocated to a fishery as a whole (total allowable catch), or to an individual fisher or company (individual transferable quota).

Quota entitlement The amount of a quota that is allocated to a particular licence that is permitted to be taken pursuant to that licence.

Recreational fishing Non-commercial and non-aboriginal traditional activities of fishers who fish for sport or pleasure whether retaining (e.g. consuming, sharing) or releasing their catches.

Recruitment The addition of new individuals to a stock.

Recruitment overfished The point at which a stock is considered to be recruitment overfished is the point at which the spawning stock biomass has been reduced through catch, so that average recruitment levels are significantly reduced.

Reference point Indicator of the level of fishing (or stock size); used as a benchmark for assessment.

Relative abundance An index of fish population abundance used to compare fish populations from year to year. This does not measure the actual numbers of fish, but shows changes in the population over time.

Sample A proportion or segment of a fish stock which is removed for study, and is assumed to be representative of the whole stock. The greater the effort, in terms of both numbers and magnitude of the samples, the greater the confidence that the information obtained is a true reflection of the status of a stock (level of abundance in terms of numbers or weight, age composition, etc.).

Seasonal closure Closure of a fishing ground for a defined period; used as a management tool, often to protect a particular component of the stock e.g. used to protect a stock during a spawning season.

Selectivity The ability of a type of gear to target and catch a certain size or species of fish.

Settlement Transition from a pelagic larval stage to a substrate-associated juvenile or adult existence.

Shell length A straight-line measurement of molluscs, usually along a straight line at the widest point of the shell.

Size of maturity Length or weight of the fish when it attains reproductive maturity.

Socio-economic Relating to both social and economic considerations.

Spatial closure A method of fisheries management that prevents fishing in a defined area.

Species A group of organisms capable of interbreeding freely with each other but not with members of other species.

Stakeholder An individual or a group with an interest in the conservation, management and use of a resource.

Stock A group of individuals of a species occupying a well-defined spatial range independent of other groups of the same species, which can be regarded as an entity for management or assessment purposes.

Stock assessment A detailed analysis of stock status (abundance, distribution, age structure, etc.) to support the management of the species or fishery.

Target reference point Defines the values of an indicator for a fish stock or fisheries management unit that are desirable or ideal and at which management should aim.

Target species A species that is, or has been, specifically targeted and is, or has been, a significant component of a fishery.

Temporal closure Closure that is implemented to protect fish stocks during specific stages of their life cycle (eg. while spawning).

Threatened Plant or animal species or community considered to be at risk of extinction in the wild.

Total allowable commercial catch (TACC) For a fishery, a catch limit is set as an output control specifically on commercial fishing. The total amount of a species that may be taken by commercial fishing during a specified time period.

Total allowable commercial effort (TACE) For a fishery, an effort limit is set as an input control specifically on commercial fishing. The total amount of fishing effort that may be conducted by a commercial fishery in a specified time period.

Total length (TL) The length from the tip of the snout to the tip of the longer lobe of the caudal fin, usually measured with the lobes compressed along the midline. It is a straight-line measure, not measured over the curve of the body

Traditional fishing Fishing for the purposes of satisfying personal, domestic or non-commercial communal needs, including ceremonial, spiritual and educational needs and utilising fish and other natural marine and freshwater products according to relevant indigenous custom.

Trigger reference point Events or measures that, if they occur or if they reach specified levels, are used to determine when a response should be made. Not usually used as a criterion for over-fishing, but to indicate the need for review of management.

Weight of evidence The systematic consideration of a range of biological and fisheries information for assembly and review of indicators of biomass status and levels of fishing mortality, to support a status determination. Lines of evidence used in the weight of evidence approach include empirical indicators (catch, effort, catch rate, size- or age-based indicators, spatial and temporal distribution of the fishery), risk assessments, fishery-independent surveys, quantitative stock assessment models and harvest strategies.

8 Acronyms

CPUE Catch Per Unit Effort

EPBC *Environment Protection and Biodiversity Conservation Act 1999*

ESD Ecologically Sustainable Development

GPS Global Positioning System

GVP Gross Value of Production

ITQ Individually Transferable Quota

LCF Lakes and Coorong Fishery

MSF Marine Scalefish Fishery

NZRL Northern Zone Rock Lobster Fishery

PIRSA Department of Primary Industries and Regions South Australia, Fisheries and Aquaculture Division

SARDI South Australian Research and Development Institute

SAU Spatial Assessment Unit

SZRLF Southern Zone Rock Lobster Fishery

TACC Total Allowable Commercial Catch

TEPs Threatened, Endangered, Protected Species