FISHERIES & AQUACULTURE
PIRSA

# ECOLOGICALLY SUSTAINABLE DEVELOPMENT (ESD) RISK ASSESSMENT OF THE SOUTH AUSTRALIAN COMMERCIAL MARINE SCALEFISH FISHERY

JULY 2011

growing sustainable regions

Government of South Australia
Primary Industries and Regions SA

# TABLE OF CONTENTS

# LIST OF FIGURES

# LIST OF TABLES

# 1 INTRODUCTION

Ecologically Sustainable Development (ESD) principles are the basis of fisheries and aquatic resource management in South Australia. Within the South Australian *Fisheries Management Act 2007*, ESD is described as "*the use, conservation, development and enhancement of the aquatic resources of the State in a way, and at a rate, that will enable people and communities to provide for their economic, social and physical well-being".*

The Fisheries and Aquaculture Division of Primary Industries and Resources South Australia (PIRSA) is responsible for fisheries management under the Act and must:

- sustain the potential of aquatic resources of the State to meet the reasonably foreseeable needs of future generations;
- safeguard the life-supporting capacity of the aquatic resources of the State; and
- avoid, remedy or mitigate adverse effects of activities on the aquatic resources of the State.

Similar ESD-based management objectives are now widely accepted as the foundation of Australian State and Commonwealth fisheries and environmental management legislation, and ESD principles also underpin key international fisheries treaties and agreements. These include the United Nations Convention on the Law of the Sea (UNCLOS), and the Food and Agriculture Organisation (FAO) Code of Conduct for Responsible Fisheries.

ESD principles also drive key fisheries aspects of the Australian Government's overarching *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). This legislation requires that all Commonwealth, State and Territory fisheries that export some or all of their catch are assessed against fishery sustainability criteria before being licensed for export. This EPBC Act assessment process is focussed on the ecological impacts of fishing to ensure that management outcomes avoid overfishing and recover overfished stocks; maintain biodiversity; and minimize adverse impacts on ecosystem structure, function, and productivity.

Achieving strong ESD outcomes for commercial fisheries is a complex balancing act. It requires careful integration of immediate, medium, and long term resource use priorities with the full range of environmental, economic and social considerations facing business and communities. South Australia's commercial and recreational fisheries are a significant part of the State's identity and are very important both economically and culturally. The commercial wild catch fishing sector has an annual production value of $202 million (Knight and Tsolos 2011) and it is estimated that around 236,000 South Australians enjoy recreational fishing each year (Jones 2009). The viability of these important commercial and recreational activities relies on healthy and productive ecosystems, supported by an efficient regulatory and business framework.

## 1.1 Fishery Management Plans and ESD Reporting

The *Fisheries Management Act 2007* has been in place since 1 December 2007. Since then, the Fisheries Council of South Australia has been established and is the peak advisory body to the Minister for Fisheries. The primary functions of the Fisheries Council are to prepare fisheries management plans under the *Fisheries Management Act 2007* and to advise the Minister for Fisheries on key aspects of fisheries and aquatic resource management.

To coincide with these changes, Fishery Management Committees (FMCs) were discontinued from 1 July 2007 and PIRSA Fisheries and Aquaculture has signed communication protocols with the relevant representative industry association(s) for each commercial fishery sector. For the Marine Scalefish Fishery the industry association is the Marine Fishers Association (MFA).

Management plans are significant instruments, guiding decisions on annual catch or effort levels, the allocation of access rights, and establishing the tenure of valuable commercial licences.

The *Fisheries Management Act 2007* also describes the nature and content of fishery management plans including mandatory requirements. Among other things, management plans must describe the biological, economic and social characteristics of a fishery. Management plans must also include a risk assessment of the impacts or potential impacts of the fishery on relevant ecosystems. These risk assessments are then used to develop management strategies that will best pursue fishery-specific ESD objectives. The broad process is outlined in Figure 1.

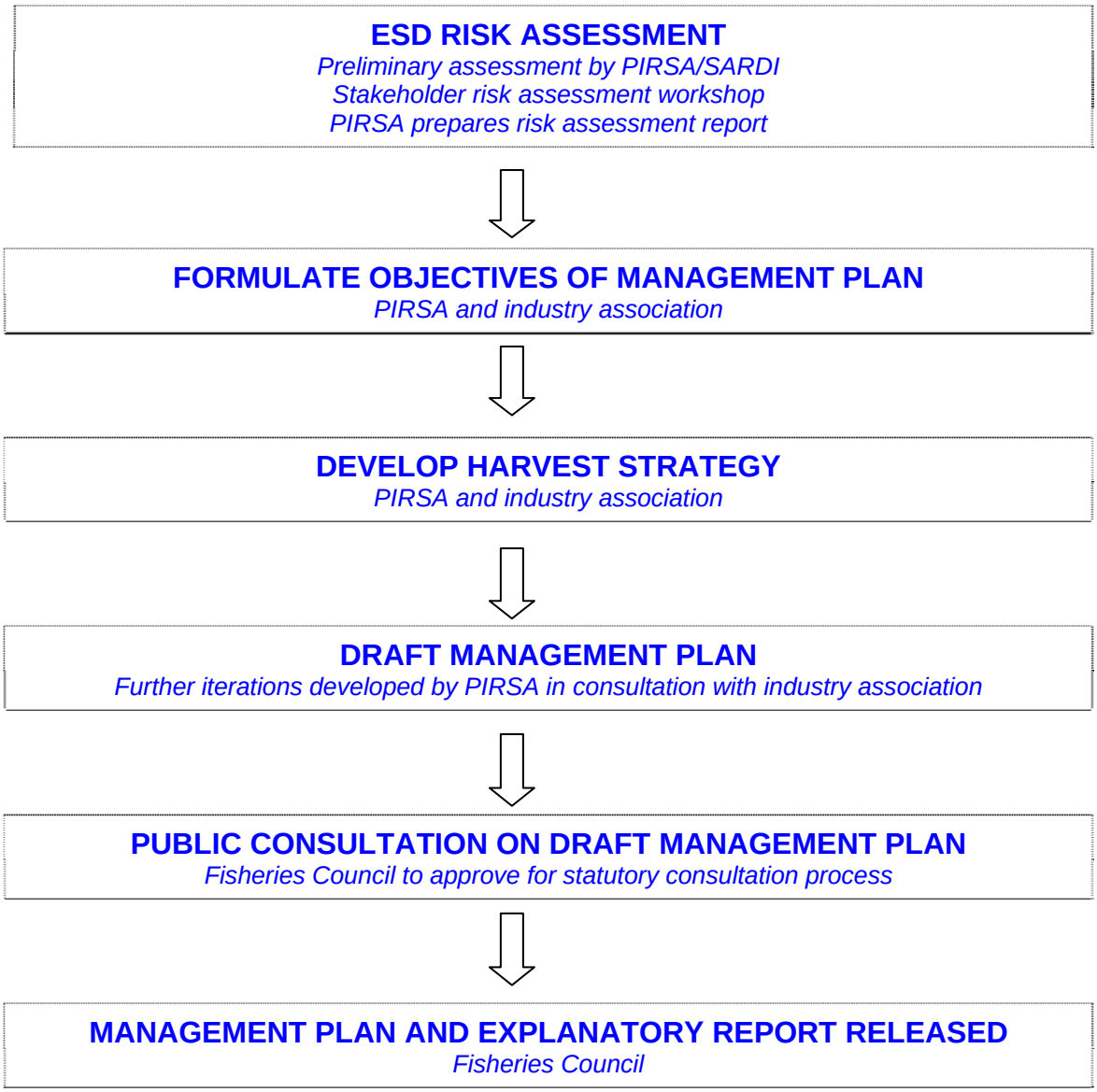


Figure 1. Process for preparing a fishery management plan

The *Fisheries Management Act 2007* specifies that management plans may remain in force for up to 10 years from commencement. For developmental fisheries they may remain in force for up to 3 years. To ensure that management plans remain relevant, efficient, and focussed on the legislative and policy objectives of the day, the Fisheries Council must conduct a detailed review of the operation of a management plan soon after five years of commencement. This process will include a review of the ESD risk assessment.

## 1.2 The ESD Risk Assessment and Reporting Process

To efficiently meet its ESD accountabilities under both State and Commonwealth legislation, PIRSA Fisheries and Aquaculture has adopted the

National ESD Reporting Framework for Fisheries[1]. This approach, developed in Australia, has been extensively used to analyse and report on the ESD performance of commercial fisheries, and has the potential to drive substantial performance improvements. When applied appropriately the national framework will:

- substantially improve knowledge about the environmental, economic, and social issues relevant to the ESD performance of a fishery;
- enable consistent and comprehensive analysis and reporting of the current and strategic operating environment for fisheries (this may also usefully inform industry strategic and business planning initiatives);
- engage industry, key fishery stakeholders, managers and scientists in a proven, transparent, and clearly defined collaborative process to understand and improve fisheries management performance; and
- improve the efficiency and quality of performance reporting against a range of public and private sector accountabilities (such as the EPBC Act Strategic Assessment process, or industry business planning initiatives).

In April 2011, PIRSA Fisheries and Aquaculture arranged an ESD risk assessment workshop with key Marine Scalefish Fishery stakeholders. An independent facilitator was engaged to run the workshop process. The workshop built upon earlier scoping work by the fishery manager, scientists, and industry to identify the major management issues facing the fishery and to start the process of developing detailed fishery-specific ESD component trees. The key steps undertaken at the broader stakeholder workshop are outlined below:

1. The generic ESD component trees were modified, through an iterative process with stakeholders, into a set of trees specific to the fishery. This process was used to identify all of the issues relevant to the ESD performance of the fishery.

2. A risk assessment of the identified issues (or components) was completed based on the likelihood and consequence of events that may undermine or alternatively contribute to ESD objectives. This was an iterative process involving managers, scientists, industry and key stakeholders.

3. Risks were then prioritised according to their severity. For higher level risks a detailed analysis of the issue, associated risks, and preferred risk management strategies was completed. For low risk issues, the reasons for assigning low risk and/or priority were recorded.

4. For higher level risks a full ESD performance report in the context of specific management objectives was prepared. This includes operational objectives,

[1] The National ESD Reporting Framework was initially developed under the Standing Committee for Fisheries and Aquaculture. The framework was then finalised under FRDC Project 2000/145. See Fletcher et al. (2002); or www.fisheries-esd.com for details.

indicators, data required, performance measures, and preferred management responses.

5. A detailed fishery-specific background report was also prepared to guide the identification of issues, risks and management strategies. This report includes the history of the fishery and its management, the areas of operation and their biological and physical characteristics, target species and by-product and bycatch species, and other relevant information.

The full ESD reporting process outlined above provides a logical framework for managers and stakeholders to identify, prioritise, and efficiently manage risks to achieve agreed ESD objectives. Where there are substantial knowledge gaps, the process informs cost effective and efficient research strategies targeted to high risk areas.

# 2 BACKGROUND

## 2.1 Description of the Marine Scalefish Fishery

### 2.1.1 Location of the Fishery

The South Australian Marine Scalefish Fishery (MSF) includes all South Australian coastal waters including gulfs, bays and estuaries (excluding the Coorong estuary) from the Western Australian border (129°E longitude) to the Victorian border (141°E longitude) (Figure 2).

With the exception of the mud cockle fishery, the Blue Swimmer Crab fishery, there are no zones or area restrictions placed on licences. A licence holder may choose to operate in any or all waters of the fishery. Specific mud cockle fishing zones exist in the Port River, Coffin Bay, Smoky Bay, Streaky Bay and Venus Bay, which restricts the commercial harvest of mud cockles to those that hold cockle quota. Similarly the take of Blue Swimmer Crabs in both Gulf St. Vincent and Spencer Gulf is limited to blue crab quota holders.

Historically the vast majority of fishing effort has been concentrated in the gulfs, i.e. Spencer Gulf and Gulf St. Vincent. With the exception of King George Whiting, the majority of catches of the major target species including Southern Garfish, Snapper and Southern Calamari, come from the two gulfs. For King George Whiting however, areas west of Spencer Gulf have historically accounted for over 40% of the total commercial catch.

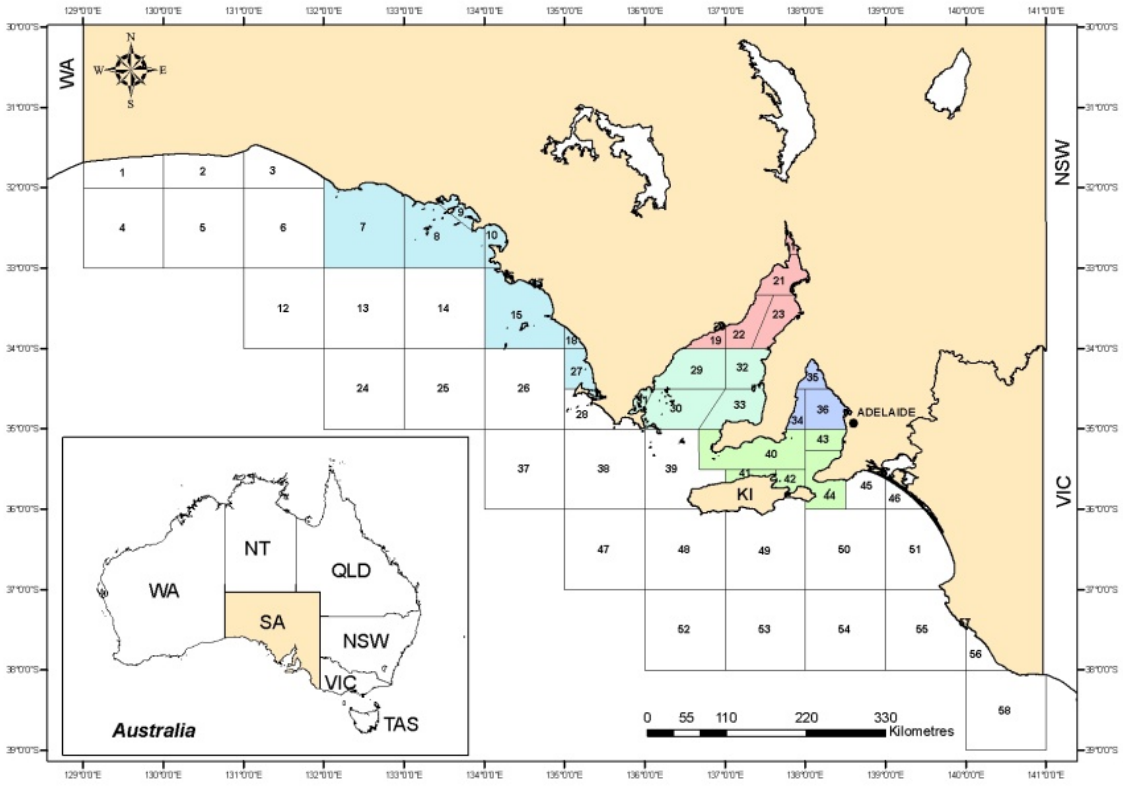


Figure 2. Area of the SA Marine Scalefish Fishery.

### 2.1.2 Access to the Fishery

The Marine Scalefish Fishery as constituted in the *Fisheries Management (Marine Scalefish Fishery) Regulations 2009* (the Regulations) includes holders of a Marine Scalefish Fishery licence or a Restricted Marine Scalefish Fishery licence. The Regulations preclude the Director of Fisheries from granting any additional fishing licences in the fishery.

As of 1st April 2011 there were a total of 331 Marine Scalefish and 12 Restricted Marine Scalefish Fishery licences in existence in the fishery. A licence amalgamation scheme governs the transferability of licences and is a management tool aimed at reducing the total number of licences (and therefore effort) in the fishery. Under the scheme licences are allocated a certain number of points, and provided that the combined point's value is higher than a determined threshold, two un-amalgamated licences may be amalgamated and transferred to third party. Restricted Marine Scalefish Licences are allocated the lowest points value and a minimum of 3 restricted licences are required to be amalgamated to enable transferability under the amalgamation scheme.

In addition to marine scalefish licence holders, licence holders from the Southern and Northern Zone Rock Lobster fisheries, the Lakes and Coorong Fishery and the Miscellaneous Fishery have varying levels of access to the waters and species of the Marine Scalefish Fishery.

The Regulations also provide the management framework for the sardine (*Sardinops sagax*) fishery. Whilst sardine fishery operators are required to hold a Marine Scalefish Fishery licence, the fishery has operated under a separate management plan since 2005. A separate risk assessment and management plan will be developed for this component of the fishery.

### 2.1.3 Fishing Methods

The Marine Scalefish Fishery has a diverse range of gear types and fishing methods which have been developed to target the broad range of permitted species within the fishery. In all there are a total of 21 different gear types that can be registered on MSF licences. Of these, the dominant gear types are hook and line, longline, haul nets, mesh nets and jigs. Various regulations and licence conditions govern the use of fishing gear for targeting different species. Impacts of these gear types are assessed in Section 4.3.

### 2.1.4 Retained Species

The fishery is based on the capture and retainment of over 50 individual species. For assessment and management purposes, these species have been classified as primary, secondary and tertiary species. The four primary species are King George Whiting, Snapper, Southern Garfish and Southern Calamari. Catch and value information for these and some of the secondary species are shown below (Figure 3). Table 1 lists all species that are permitted to be taken in the Marine Scalefish Fishery in accordance with the *Fisheries Management (Marine Scalefish Fishery) Regulations 2009*.

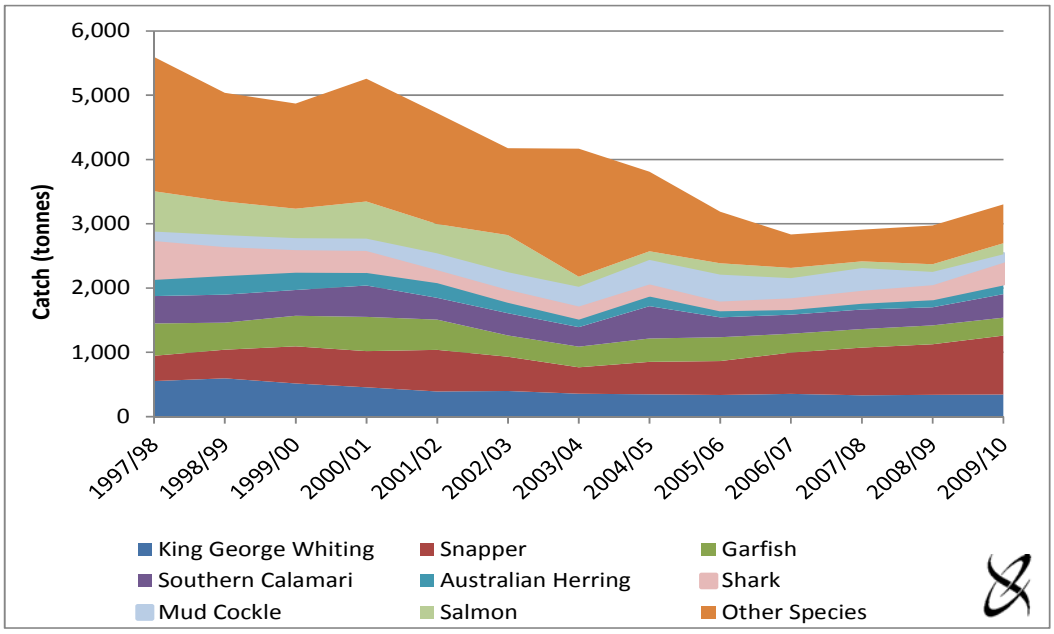


Figure 3. Catch of higher volume species in the Marine Scalefish Fishery, 1997/98 to 2009/10.

Source: Econsearch (2010)

### 2.1.5 Non-Retained Species

Each of the main gear types used within the MSF has their own associated bycatch species. Whilst many of these 'non-target' species are retained as by-product, there are also a number of others that are returned to the water either because they are not permitted to land them (undersize, non-permitted species, out of season) or because of market reasons. Under current reporting requirements, commercial MSF licence holders are not required to record details of species that are not retained, other than for threatened, endangered and protected species (TEPS).

TEPS are protected under State and/or Commonwealth legislation. However if these species are taken incidentally during part of normal fishing operations and the interaction is recorded in logbooks, the fisher is unlikely to be deemed to have committed an offence. Recording of interactions with TEPS is also a requirement of the Australian Government Department of Sustainability, Environment, Water, Population and Communities (SEWPaC) condition for export approval as approved under Part 13A of the *Environmental Protection and Biodiversity Conservation Act 1999*.

Table 1. Permitted species in the Marine Scalefish Fishery

| **Annelids** |
|---|
| Beachworm (Class Polychaeta) |
| Bloodworm (Class Polychaeta) |
| Tubeworm (Class Polychaeta) |
| **Crustaceans** |
| Blue Swimmer Crab (*Portunus pelagicus*) |
| Sand Crab (*Ovalipes* spp) |
| Velvet Crab (*Nectocarcinus tuberculosus*) |
| **Molluscs** |
| Southern Calamari (*Sepioteuthis australis*) |
| Cockle (Suborder Teledonta) |
| Cuttlefish (*Sepia* spp) |
| Mussel (*Mytilus* spp) |
| Octopus (*Octopus* spp) |
| Oyster (Family Ostreidae) |
| Scallop (Family Pectinidae) |
| Gould's Squid (*Notodarus gouldi*) |
| **Scalefish** |
| Australian Anchovy (*Engraulis australis*) |
| Barracouta (*Thyrsites atun*) |
| Black Bream (*Acanthopagrus butcheri*) |
| Cod of all marine species (Family Moridae) |
| Dory (Family Zeidae) |
| Flathead (Family Platycephalidae) |
| Flounder (Family Bothidae or Pleuronectidae) |
| Southern Garfish (*Hyporhamphus melanochir*) |
| Bluespotted Goatfish (*Upeneichthys vlamingii*) |
| Australian Herring (*Arripis georgianus*) |
| Yellowtail Kingfish (*Seriola lalandi*) |
| Leatherjacket (Family Monacanthidae) |
| Pink Ling (*Genypterus blacodes*) |
| Blue Mackerel (*Scomber australasicus*) |
| Common Jack Mackerel (*Trachurus declivis*) |
| Morwong (Family Cheilodactylidae) |
| Mullet of all species (Family Mugilidae) |
| Mulloway (*Argyrosomus hololepidotus*) |
| Redfish (*Centroberyx affinis*) |
| Bight Redfish (*Centroberyx gerrardi*) |
| West Australian Salmon (*Arripis truttaceus*) |
| Australian Sardine (*Sardinops sagax*) |
| Snapper (*Pagrus auratus*) |
| Snook (*Sphyraena novaehollandiae*) |
| Southern Sole (*Aseraggodes haackeanus*) |
| Sea Sweep (*Scorpis aequipinnis*) |
| Swallowtail (*Centroberyx lineatus*) |
| Blue-eye Trevalla (*Hyperoglyphe antarctica*) |
| Trevally (*Caranginae* spp) |
| Whiting (Family Sillaginidae) |
| Bluethroat Wrasse (*Notolabrus tetricus*) |
| **Sharks** |
| Rays of all species (Class Elasmobranchii) |
| Shark of all species (Class Elasmobranchii) other than White Shark (*Carcharodon carcharias*) |
| Skate of all species (Class Elasmobranchii) |

A study to quantify the species composition, catch rates and rates of discarding in the MSF was recently undertaken by Fowler et al.(2009). This study was restricted in that only three main gear types were examined; handlines, haul nets and longlines, and the area of operation was restricted to Gulf St. Vincent (GSV) and Spencer Gulf (SG). Nevertheless it provides a significant insight into the catch and bycatch issues in the fishery.

This study demonstrated that bycatch and discard rates are heavily influenced by gear type, area of operation, season, and mode of operation which are all largely dependent upon target species.

For handlines a total of 62 species were captured. When targeting King George Whiting, retention rates were 87.2% and 77.5% of total numbers caught in GSV and SG respectively. When targeting Snapper retention rates were 79.6% and 98.9% of the total numbers caught in GSV and SG, respectively (Fowler et al. 2009).

For longlines a total of 39 species were captured, with an overall retention rate of 82.8% of total numbers caught. However there were notable differences between hook sizes, with small hooks resulting in a lower retention rate, largely due to the release of undersize snapper (Fowler et al. 2009).

For haul nets a total of 50 species were captured. Retention rates generally exceeded 65%, except for sinking haul nets with a 5cm mesh size where retention rates dropped as low as 25.7% in GSV. Retention rates were relatively high compared to similar net fisheries in south-eastern Australia (Fowler et al. 2009).

This study also provided qualitative assessment of the condition of fish that were released. Fish condition varied significantly across the different gear types, mode of capture within gear types and between species. For example longlines using small hooks resulted in a greater proportion of fish being released in ‘poor’ condition compared to large hooks. For haul nets, condition of fish varied depending on whether fish were enmeshed in the net wings or whether they were retained within the bunt, and not meshed.

The bycatch study demonstrated that there is a variety of factors influencing bycatch and discarding. This study examined the three main gear types and determined that each has its own set of interactions and consequences for target and non-target species.

## 2.2 Summary of Management Arrangements and Objectives

### 2.2.1 History of the Fishery

Noell et al. (2006) provide a detailed history of the commercial MSF in the previous management plan. Commercial scalefish fishing commenced almost simultaneously with the arrival of European settlers, as means of providing food for the new colony. Fish became the first export of the new colony when three

barrels of salted fish were shipped to Tasmania by the South Australian Company in 1836 (Noell et al. 2006). Fishing for scalefish increased with the demise of the whaling industry in the 1840's. The nature of the fishery and the gear types used were influenced by the arrival of immigrants from the United Kingdom, Scandinavia and during the 1870's and 1880's from Greece and Italy.

When licensing was first introduced in 1904, 476 people applied for and received licences. However during the Depression in the 1930's fishing licences were issued as a means of addressing rising unemployment, and in 1934 a total of 1463 licences were issued.

The capacity of the fishing fleet has not only been influenced by the number of licences issued, but also by technological advances in powered vessels (engines), refrigeration and processing. The introduction of engines began in the early 1900's and came into general use by the 1930's. Ice boxes were also an innovation that altered the way fish were kept and brought to market. Between the early to mid 1900's ice boxes replaced wells, carrying capacity increased and catches could be stored at sea for longer. The first fish cannery opened in the 1890's on Kangaroo Island, where King George Whiting were the main fish processed. Further canneries were opened in Port Lincoln and other west coast towns during the mid 1900's for the purpose of preserving catches of Australian Salmon and Australian Herring (tommy rough). The Port Lincoln cannery was still operation in the early 1960's, however production had switched from marine scalefish species to Southern Bluefin Tuna, a species managed by the Australian Government (Noell et al. 2006).

Modern day fisheries management began in the late 1970's when there was a freeze on issuing new licences, and entry into the fishery was capped. Since then there have been continued management changes aimed at reducing overall effort in the fishery, particularly on key target species.

### 2.2.2 Legislation

The *Fisheries Management Act 2007* provides the broad statutory framework to provide for the conservation and management of South Australia's aquatic resources. In the administration of the Act, the Minister for Agriculture, Food and Fisheries must pursue the following objectives, outlined in Section 7 of the Act:

(1) An object of this Act is to protect, manage, use and develop the aquatic resources of the State in a manner that is consistent with ecologically sustainable development and, to that end, the following principles apply:

(a) proper conservation and management measures are to be implemented to protect the aquatic resources of the State from over-exploitation and ensure that those resources are not endangered;

(b) access to the aquatic resources of the State is to be allocated between users of the resources in a manner that achieves optimum utilisation and equitable distribution of those resources to the benefit of the community;

(c) aquatic habitats are to be protected and conserved, and aquatic ecosystems and genetic diversity are to be maintained and enhanced;

(d) recreational fishing and commercial fishing activities are to be fostered for the benefit of the whole community;

(e) the participation of users of the aquatic resources of the State, and of the community more generally, in the management of fisheries is to be encouraged.

(2) The principle set out in subsection (1)(a) has priority over the other principles.

(3) A further object of this Act is that the aquatic resources of the State are to be managed in an efficient and cost effective manner and targets set for the recovery of management costs.

(4) The Minister, the Director, the Council, the ERD Court and other persons or bodies involved in the administration of this Act, and any other person or body required to consider the operation or application of this Act (whether acting under this Act or another Act), must—

(a) act consistently with, and seek to further the objects of, this Act; and

(b) insofar as this Act applies to the Adelaide Dolphin Sanctuary, seek to further the objects and objectives of the *Adelaide Dolphin Sanctuary Act 2005*; and

(c) insofar as this Act applies to the River Murray, seek to further the objects of the *River Murray Act 2003* and the *Objectives for a Healthy River Murray* under that Act; and

(d) insofar as this Act applies to areas within a marine park, seek to further the objects of the *Marine Parks Act 2007*.

(5) For the purposes of subsection (1), *ecologically sustainable development* comprises the use, conservation, development and enhancement of the aquatic resources of the State in a way, and at a rate, that will enable people and communities to provide for their economic, social and physical well-being while—

(a) sustaining the potential of aquatic resources of the State to meet the reasonably foreseeable needs of future generations; and

(b) safeguarding the life-supporting capacity of the aquatic resources of the State; and

(c) avoiding, remedying or mitigating adverse effects of activities on the aquatic resources of the State,

(taking into account the principle that if there are threats of serious or irreversible damage to the aquatic resources of the State, lack of full scientific certainty should not be used as a reason for postponing measures to prevent such damage).

The regulations that govern management of the Marine Scalefish Fishery are the *Fisheries Management (Marine Scalefish Fishery) Regulations 2009* for the commercial fishery and the *Fisheries Management (General) Regulations 2007* for the recreational fishery.

### 2.2.3 Management Arrangements

**Commercial Fishery**

The commercial MSF is managed using a complex mix of input and output controls aimed at matching harvesting capacity with resource availability and controlling growth in aggregate harvesting capacity. 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 assist fishing operations, legal minimum size limits and in some cases individual transferable quotas. The broad management objectives of the MSF are outlined in the management plan.

The purpose of the management plan is to provide a strategic policy framework that aims to ensure ecologically sustainable management of the fishery. There are four goals outlined, they are:

1. *Sustainable harvest of marine scalefish fish stocks*
2. *Minimise adverse impacts of all fishing operations on the ecosystem upon which the Marine Scalefish Fishery depends*
3. *Optimal utilisation of Marine Scalefish Fishery resources within the constraints of sustainability imperatives.*
4. *Good governance of the Marine Scalefish Fishery.*

One of the key issues in managing the commercial MSF and achieving the goal of sustainable harvest is the total potential effort in the fishery. Many MSF species are already fished at levels at or near full capacity, and some have been fished beyond optimum levels. Whilst fishing effort is at or near capacity, significant numbers of licences are not fished, or are fished well below their capacity. The potential activation of this ‘latent’ effort creates an issue when trying to match harvesting capacity to resource availability. Historically a number of species have been overfished as a result of management arrangements failing to sufficiently restrict fishing effort.

The existing management plan for the fishery recognises that there is excess potential (latent) effort in the fishery. One of the existing, and long-running management strategies contained within the management plan is to reduce the number of MSF licences through the licence amalgamations scheme. Furthermore latent effort can be exacerbated with increases in fishing efficiency gained through advances in technology, which results in greater potential effort with the same number of licences/gear.

The goals and objectives of the fishery will be reviewed as part of the development of the management plan for the commercial MSF under the requirements of the Act in 2011/12.

**Recreational Fishery**

Recreational fishing is an extremely popular activity; with an estimated 236,463 South Australian residents aged 5 years or older fishing at least once in the 12 months prior to October 2007 (Jones 2009). Marine scalefish species make up a significant proportion of the total recreational catch. Among the most popular recreational target species were; King George Whiting, Southern Garfish, Southern Calamari and Snapper. Other popular species include; Australian Herring, Australian Salmon, Snook, Yellow-eye Mullet, and Razorfish.

There are numerous species targeted by the recreational sector and a variety of fishing methods used to catch them. The most common gear type is rod and line which includes the use of baited hooks, lures and jigs. Other methods include, hoop nets, spears, rakes and hand collection. Recreational fishing is conducted from a variety of different platforms including privately owned vessels, shore-based (e.g. beach, rock platform, jetty) and from commercial charter fishing vessels. For some species the recreational catch forms a significant contribution to the total catch. For example the recreational take of King George Whiting is almost equal to that of the commercial sector (approximately 49%).

The current Marine Scalefish Fishery Management Plan prescribes the management objectives for both the commercial and recreational components of the fishery. However in accordance with the *Fisheries Management Act 2007*, the management goals and strategies for commercial and recreational marine scalefish activities must be set out separately under new management plans for each sector. The development of these management plans is currently underway.

### 2.2.4 Aboriginal Traditional Involvement in the Fishery

Aboriginal communities fished South Australia's coastal waters for at least 6,000 years prior to European settlement (Nance and Speight 1986). They utilised a range of different fishing gears including nets, fish traps and spears as well as hand collection of a variety of fish, bivalves and gastropods (Noell et al. 2006).

Many Aboriginal communities have strong connections with the sea and its resources and these links have been maintained since European settlement. Each community's fishing activities and cultural practices are distinct. Information about these activities and practices will be described in each Aboriginal Traditional Fishing Management Plan. These plans are currently being developed through the South Australian Government process of negotiating Indigenous Land Use Agreements (ILUAs) with the native title claimants. These will be available as the plans are finalised. This process will help in quantifying the level of Aboriginal fishing across all fisheries in South Australia.

### 2.2.5 Catch and Effort Reporting

Catch and effort data are collected through compulsory monthly logbook returns. A separate logbook exists for the quota managed mud cockle component of the fishery. SARDI Aquatic Sciences maintains a comprehensive catch and effort database for the fishery using data collected from these returns. Areas of the fishery are divided into individual fishing blocks, to provide area-based catch and effort information. Data provided includes: catch, effort (man days, number of hooks, net length), location (fishing block), species targeted, species caught (kg), and port of landing. Discard information is not recorded in logbooks.

## 2.3 Biology of Species

### 2.3.1 Biology of Target Species

**Snapper *(Pagrus auratus)***

Snapper are a member of the family Sparidae, occurring throughout the warm, temperate and sub-tropical waters of the Indo-Pacific region, including Japan, the Philippines, India, Indonesia, as well as Australia and New Zealand (Kailola et al. 1993). They are found in a broad range of habitats from shallow, coastal, demersal areas to the edge of the continental shelf across a depth range from 1 – 200 m. The broad distribution is thought to be divisible into a number of separate stocks, including a division between Victorian and South Australian stocks in the vicinity of the mouth of the River Murray. Snapper can also form separate stocks at spatial scales smaller than the regional geographic scale, however there is little evidence for any finer-scale genetic differentiation amongst Snapper captured from the remaining SA waters.

Spawning in Northern Spencer Gulf commences in late November, peaking in December and declining in January before finishing in early February. The timing appears to be approximately one month later in the Southern Spencer Gulf (Fowler et al. 2010a). Snapper are multiple batch spawners that spawn over several consecutive days. While spawning seems to occur widely through SA, the main nursery areas are thought to be in the northern parts of both gulfs, particularly Spencer Gulf (Fowler et al. 2010a). Mature adults form large

aggregations in preferred spawning areas. Spawning generally occurs in waters less than 50m deep (Kailola et al. 1993).

Snapper eggs are pelagic and hatch after approximately 36 hours at 21°C. The larvae are also pelagic and take 20-30 days to develop before they become demersal juveniles (Fowler et al. 2010a). Studies on the distribution patterns of eggs are limited but they have patchy distribution patterns, which suggest distinct spawning hotspots. Recruitment of Snapper is highly variable (Fowler et al. 2010a). The life history model for Snapper suggests that the majority of fish remain resident to their region whilst a lower proportion of fish are migrants (Fowler et al. 2010a)

Snapper are long-lived and slow-growing fish; the oldest estimate of age obtained so far from SA is 36 years. The age structures of Snapper from different regions of SA show the presence of strong and weak year classes (Fowler et al. 2010a). Age at first maturity also varies throughout their distribution. Snapper from New South Wales are, on average, 3 years old and 30 cm fork length at first maturity. Snapper in Port Philip Bay first breed when they are about 4 years old and 27 cm total length, while those from Southern Australian waters are about 28 cm total length at first maturity. In New Zealand, some juvenile Snapper change sex from female to male but all such changes are completed by the onset of maturity. There have been no investigations of sex reversal in Australian Snapper populations (Kailola et al. 1993).

Snapper in Victorian waters feed primarily on crustaceans, bivalve molluscs and small fish. Juveniles and small adults in South Australia feed on King Prawns (*Penaeus latisulcatus*) while larger fish also feed on thick shelled animals such as Blue Swimmer Crab (*Portunus pelagicus*) and Mussels (Mytilidae). Bronze Whaler Shark (*Carcharhinus brachyurus*) are known to accompany spawning aggregations of Snapper but their significance as a predator is unknown (Kailola et al. 1993).

### King George Whiting (*Sillaginodes punctatus*)

King George Whiting are a member of the family Sillaginidae and is endemic to the shelf waters of southern Australia ranging from Port Jackson on the east coast through Bass Strait and west to Jurien Bay on the west coast of Australia (Kailola et al. 1993). Juveniles occur in shallow waters to depths of 20m, whilst adults are found in a range of habitats and depths from sandy patches in seagrass meadows to more exposed waters along coastal beaches and reef areas in the continental shelf waters to depths of 50m and greater (Kailola et al. 1993). The nursery areas for King George Whiting are shallow, protected bays where the post-larvae arrive during the winter and spring each year (Fowler et al. 2008a).

Spawning in South Australia occurs at the offshore grounds to which fish migrate, including Investigator Strait along the north coast of Kangaroo Island and south-eastern Spencer Gulf around Corny Point and Wardang Island (Fowler et al. 2008a). Spawning typically occurs between March and May. King George Whiting are serial batch spawners, yet the number of spawnings in a

season is unknown. Batch fecundity increases as the female fish grow; from an average of 100 000 eggs at 34 cm total length to 800 000 eggs at 45 cm (Kailola et al. 1993).

King George Whiting eggs are buoyant and the larvae are planktonic. The larvae move inshore to sheltered areas and settle out of the plankton between 60 and 150 days old and 15-18mm long, depending on when spawned. Juveniles remain in protected waters for 2-3 years. King George Whiting greater than 25 cm total length generally move to deeper water, particularly during winter (Kailola et al. 1993) (Fowler & McGarvey 2000).

A maximum age of 22 years and a maximum size of 72 cm total length and 4.8 kg have been recorded. Growth rates vary from region to region, depending on the water temperature. King George Whiting grow rapidly in the summer months of December to March. They typically reach 31 cm in 3-4 years (Kailola et al. 1993).

Maturity is attained at 3 or 4 years of age when males are between 27 cm and 32 cm total length and females between 32 cm and 36 cm total length. The sex ratio at that time is even but among older fish (greater than 50 cm total length) females are 4 times more numerous than males (Kailola et al. 1993).

Juvenile King George Whiting feed on benthic amphipods and other crustaceans. As they grow larger their diet expands to include polychaete worms, molluscs and peanut worms (Sipuncula). Adult King George Whiting are preyed upon mostly by sharks, whilst juveniles are eaten by other fish such as flathead (Platycephalidae), Australian Salmon (Arripis species) and Barracouta (*Thyrsites atun*).

**Southern Calamari (*Sepioteuthis australis)***

Southern Calamari is from the family Loliginidae and is endemic to southern Australian and New Zealand waters (Steer et al. 2006). Its southern Australian range is from Dampier in Western Australia to Moreton Bay in Queensland, including Tasmania. Southern Calamari is found in coastal waters, usually in depths less than 70 m (Winstanley et al. 1983).

Southern Calamari is a short lived species, living for an estimated maximum of 280 days (Triantafillos 2001). There is considerable variability in growth during the short life span; with males generally growing faster and attaining larger sizes (Triantafillos 2001) and individuals spawned in spring growing faster than those spawned in autumn (Steer et al. 2006). Such variability in growth rates is common among cephalopods and is suggested to be governed by a combination of factors including temperature, prey availability, population density, sexual maturation and genetics (Steer et al. 2006).

Southern Calamari, like all cephalopods, have separate sexes. Their courtship and reproductive behaviour is complex and involves the transfer of mature spermatophores from the male to the female using a modified arm (hectocotylus). Females store sperm inside their buccal membrane

(spermathecae) and are capable of mating multiple times with numerous males before fertilising the eggs and spawning (Steer et al. 2006). Females are serial spawners and spawning occurs throughout the year. Fertilised eggs are 'laid' in an egg mass attached to the substrate. The egg mass consists of numberous individual fingers that hold up to 10 longitudinally- aligned eggs (Steer et al. 2006). Evidence suggests that eggs are preferentially attached to seagrass (e.g. Amphibolis spp.) and macroalgae (e.g. *Cystophora* spp., *Sargassum* spp.) (Steer et al. 2006) however they are also known to lay eggs on low relief rocky reefs and on sand (Triantafillos 2001).

Once laid the eggs undergo direct embryonic development to hatch as structurally and functionally adept 'paralarvae' (Steer et al. 2002). The embryos hatch at night and swim to the surface where they remain for an unknown period of time before they become benthic, at around 8mm mantle length (Steer et al. 2006). Juveniles are generally found in the deeper offshore areas such as the middle of the gulfs. As they grow, the sub-adults move inshore where they reach maturity and aggregate to commence spawning on shallow seagrass habitats and low profile rocky reefs.

Southern Calamari populations are believed to follow a generalised anti-clockwise pattern of spawning behaviour within Gulf St Vincent (Steer et al. 2006). Spawning in late spring occurs in Kangaroo Island, continuing in a clockwise direction to Edithburgh where spawning occurs in late winter.

**Southern Garfish *(Hyporhamphus melanochir)***

Southern Garfish are from the family Hemiramphidae, which are characterised by having a distinct beak protruding from the lower jaw, hence the colloquial name 'halfbeaks'. Garfish are a schooling species and found in shallow, inshore marine waters throughout southern Australia from Shark Bay in Western Australia to Eden in southern New South Wales, including Tasmania (Kailola 1993). Southern Garfish are particularly abundant in the two gulf regions of South Australia.

The association with sheltered seagrass habitat is linked to a dietary basis, a hypothesis first proposed over 50 years ago (Ling 1958). This has been supported by several more recent studies in both Victoria and South Australia. The study undertaken in north eastern Gulf St. Vincent confirmed that Zosteracean seagrasses were consumed in relatively large quantities during the day, followed by a switch to hyperbenthic invertebrates in lower volumes at night (McGarvey et al. 2009).

The estimated $L_{50}$ for female Southern months of Garfish in South Australia is 21.5cm (total length), equivalent to 17.5 age (Ye et al. 2002b), which is smaller than for fish in both Victoria and Western Australia. This, along with other evidence, suggests that the size and age of first maturity have decreased over time, possibly as a result of a high exploitation rate (McGarvey et al. 2009). Southern Garfish are serial spawners with asynchronous oocyte development that occurs simultaneously in reproductively-active gonads. Spawning throughout the SA gulfs extends from October to March and during the summer

of 1997/98 there appeared to be two spawning peaks, one during November/December and the other in February (McGarvey et al. 2009).

Commercial catch samples taken during the 1990s were aged for a study on age and growth (Ye et al. 2002a). Seven age classes were present in the catch, from 0+ to 6+ age classes. However the catches were dominated by 1+ and 2+ fish which accounted for 88.8% of all fish sampled. Similar breakdowns in age classes were shown in recent ageing work from the northern parts of the two gulfs (Fowler et al. 2008b). This age structure demonstrates that a single year class dominates the fishery for approximately 12 months before it is fished down and replaced by the following year class. Under such circumstances fishery productivity is driven by inter-annual variation in recruitment (McGarvey et al. 2009).

The age structure described above has not altered in recent years but differs from that recorded in the 1950s. This historical comparison suggests that the fished populations of the upper gulfs are now significantly truncated with respect to size and age, consistent with high, long-term exploitation rates that the Southern Garfish populations have been subject to (McGarvey et al. 2009).

### 2.3.2 Current Status

Detailed stock assessment reports are published once every 3 years for three of the primary species; Snapper, King George Whiting and Southern Garfish. In addition an annual stock status report provides a yearly assessment of fishery performance based on agreed performance indicators and limit reference points. A detailed examination of the biological status is given for each species in the discussion regarding their risk ratings in Section 4.1, where the available biological and general performance indicators are assessed for each species.

In addition to the published species assessments and fishery status reports, PIRSA Fisheries and Aquaculture have also produced a whole of fisheries report titled *South Australian Fisheries Resources: Current Status & Recent Trends*. The first of these was published in 2006, and provided an assessment of the biological status of all fisheries based on catch and effort data collected during 2004/05. A second edition of this production was in preparation in August 2011 and provides an update of biological status based on catch and effort information collected during 2009/10. A summary of the fishery status of key marine scalefish species is provided in Table 2.

Table 2. Fishery status of key marine scalefish species in 2004/05 and 2009/10.

| **Species** | | **Status 2004/05** | **Status 2009/10** |
|---|---|---|---|
| Snapper | | Sustainably fished | Sustainably fished |
| King George Whiting | | Over fished | Sustainably fished |
| Southern Calamari | | Sustainably fished | Sustainably fished |
| Southern Garfish | | Over fished | Over fished |
| Mud cockles | West Coast | Na | Under fished |
| | Port River | Na | Over fished |
| | Coffin Bay | Na | Sustainably fished |

## 2.4 Major Environments

### 2.4.1 Physical Environment

The MSF extends through all South Australian coastal waters including gulfs, bays and estuaries (excluding the Coorong estuary) from the Western Australian border (129°E longitude) to the Victorian border (141°E longitude). The majority of fishing activity takes place in the inshore waters which are dominated by the two gulfs; Gulf St. Vincent and Spencer Gulf.

The more southern waters of the gulfs are of oceanic character whilst salinity increases reaching 48 parts per thousand in the most northern reaches. This rising salinity is brought about by the decreasing water depth and higher summer water temperatures causing high evaporation rates (PIRSA 2007). These environmental conditions are optimal for some species of more tropical distribution (e.g. Blue Swimmer Crab and prawns).

Primary production in the more sheltered parts of the gulfs as well as embayment's off the west coast of Eyre Peninsula and the north coast of Kangaroo Island, is dominated by a number of seagrass species that occur at depths to about 20 m in clearer waters but about 10 m in the gulfs.

The natural and artificial reefs in the gulfs provide high quality habitats for a number of species including juvenile and adult Snapper, which form spawning aggregations during the summer spawning season.

The gulf waters and protected bays and inlets provide important habitat for all life history stages of each of South Australia's primary marine scalefish species (Table 3).

Table 3. Critical habitat types associated with life history stages of primary MSF species.

| **Life stage** | **King George Whiting** **(Jackson & Jones, 2000; McGarvey et al., 2003)** | **Snapper** **(Fowler, 2002; Jones & Luscombe, 1993)** | **Southern Garfish** **(Noell, 2004)** | **Southern Calamari** **(Triantafillos, 2002)** |
|---|---|---|---|---|
| Early juveniles (0+ age group), i.e. nursery areas | Sheltered bays, tidal creeks, with seagrass patches. | Fine mud substrate, deeper gulf waters. | Sheltered bays, tidal creeks, seagrass beds of both gulfs. | Bare sand substrate in deeper waters of both gulfs |
| Sub-adults | Seagrass beds (patchy to dense). | Natural and artificial reefs. | Not applicable | Not applicable |
| Adults, i.e. spawning or feeding areas | Offshore low profile reefs, sponge/bare sand. | Natural and artificial reefs, inshore mud substrate. | Seagrass and algal beds. | Seagrass and algal beds, low profile reefs. |

Source: Adapted from Noell et al. (2006)

### 2.4.2 Socio-Economic Environment

Detailed economic information for the MSF has been collected regularly since 1997/98, providing a valuable reference regarding the economic status and trends of the commercial marine scalefish fishery. Social information is not currently collected, however a number of the economic variables may provide some indication of social performance of the fishery. Measurement of the social aspects of fishery management is a developing science in itself and there are a number of national initiatives currently underway which aim to assist management agencies to collect and monitor relevant social data.

**Gross value of production (GVP)**

The total catch in the MSF in 2008/09 was 3,080 tonnes with a total gross value of production (GVP) of over $22.5 million (EconSearch 2010, Figure 4).

Since 1994/95 the total catch has steadily declined from over 6,000 t per annum to just over 3,000 t where it appears to have stabilised over the past few years. Despite the decline in catches, the GVP has been variable, but not shown any long-term trends, largely due to increased value of key target species (Figure 4).

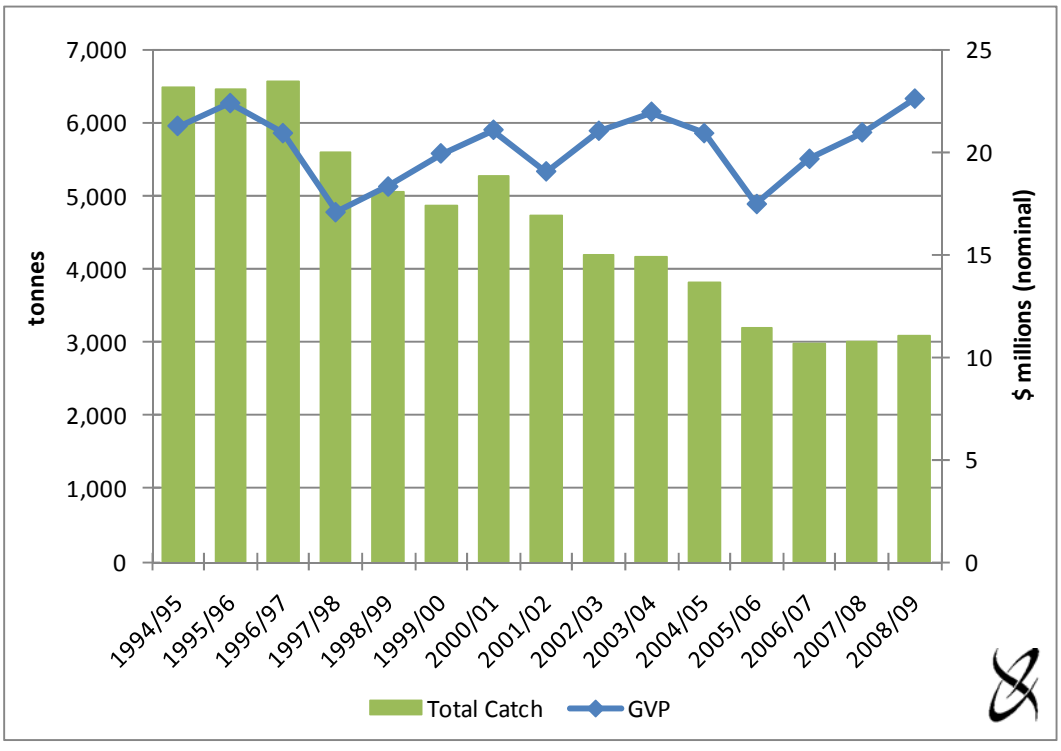


Figure 4. Catch and gross value of production (GVP) of all marine scalefish species, South Australia, 1994/95 to 2008/09.

Source: EconSearch (2010)

The highest value species has historically been King George Whiting, however the recent increased catches of Snapper has resulted in this now being being the highest valued species since 2007/08, with an estimated value of $5.7m in 2008/09. Southern Calamari and Southern Garfish, the third and fourth most valuable species are each worth over $2.0m in 2008/09 (Table 4).

Table 4. Marine Scalefish Fishery catch and value of catch in SA, 2003/04 to 2008/09[a].

| Species | 2003/04 | | | 2004/05 | | | 2005/06 | | | 2006/07 | | | 2007/08 | | | 2008/09 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | catch '000 kg | value $,000 | avg value $/kg | catch '000 kg | value $,000 | avg value $/kg | catch '000 kg | value $,000 | avg value $/kg | catch '000 kg | value $,000 | avg value $/kg | catch '000 kg | value $,000 | avg value $/kg | catch '000 kg | value $,000 | avg value $/kg |
| King George whiting | 355 | 4,239 | $11.94 | 347 | 3,507 | $10.11 | 336 | 4,033 | $12.00 | 361 | 4,707 | $13.04 | 329 | 4,536 | $13.79 | 339 | 5,074 | $14.97 |
| snapper | 413 | 3,915 | $9.48 | 504 | 4,614 | $9.16 | 529 | 3,376 | $6.38 | 644 | 4,309 | $6.69 | 741 | 5,253 | $7.09 | 780 | 5,724 | $7.34 |
| southern calamari | 303 | 2,586 | $8.54 | 504 | 2,852 | $5.66 | 311 | 2,200 | $7.07 | 297 | 2,882 | $9.70 | 303 | 2,727 | $9.00 | 281 | 2,729 | $9.71 |
| garfish | 321 | 2,536 | $7.90 | 364 | 2,673 | $7.34 | 369 | 2,139 | $5.80 | 293 | 1,929 | $6.58 | 290 | 2,137 | $7.37 | 294 | 2,006 | $6.82 |
| shark | 204 | 583 | $2.86 | 190 | 595 | $3.13 | 152 | 585 | $3.85 | 181 | 680 | $3.76 | 203 | 925 | $4.56 | 235 | 916 | $3.90 |
| salmon | 158 | 435 | $2.75 | 133 | 360 | $2.71 | 177 | 338 | $1.91 | 157 | 254 | $1.62 | 105 | 174 | $1.66 | 120 | 222 | $1.85 |
| sand crabs | 96 | 382 | $3.98 | 148 | 534 | $3.61 | 142 | 539 | $3.80 | 83 | 378 | $4.56 | 63 | 275 | $4.37 | 98 | 400 | $4.08 |
| oceanjacket | 498 | 1,345 | $2.70 | 308 | 980 | $3.18 | 149 | 185 | $1.24 | 54 | 61 | $1.13 | 32 | 40 | $1.25 | 0 | 0 | $0.00 |
| yellowfin whiting | 163 | 910 | $5.58 | 138 | 764 | $5.54 | 130 | 805 | $6.19 | 85 | 687 | $8.08 | 82 | 722 | $8.81 | 111 | 904 | $8.14 |
| Goolwa cockle | 3 | 3 | $1.00 | 37 | 47 | $1.27 | 1 | 1 | $1.00 | 5 | 10 | $2.00 | 2 | 8 | $4.00 | 32 | 221 | $6.90 |
| blue crabs | 53 | 253 | $4.77 | 0 | 0 | $0.00 | 0 | 0 | $0.00 | 0 | 0 | na | 0 | 0 | na | 0 | 0 | na |
| Australian herring (tommy ruff) | 152 | 315 | $2.07 | 183 | 367 | $2.00 | 126 | 318 | $2.52 | 105 | 333 | $3.17 | 122 | 394 | $3.23 | 143 | 466 | $3.26 |
| mud cockle | na | na | na | 346 | 1,225 | $3.54 | 385 | 1,250 | $3.25 | 282 | 1,227 | $4.35 | 320 | 1,673 | $5.23 | 171 | 1,389 | $8.12 |
| snook | 81 | 279 | $3.45 | 83 | 254 | $3.06 | 61 | 171 | $2.80 | 64 | 226 | $3.53 | 82 | 266 | $3.24 | 70 | 253 | $3.61 |
| yelloweye mullet | 44 | 110 | $2.50 | 50 | 116 | $2.32 | 38 | 100 | $2.63 | 36 | 102 | $2.84 | 29 | 90 | $3.11 | 30 | 105 | $3.50 |
| leatherjackets | na | na | na | na | na | na | na | 0 | na | na | 0 | na | na | 0 | na | 0 | 0 | na |
| mulloway | na | na | na | 5 | 32 | $6.40 | 5 | 28 | $5.60 | 5 | 39 | $7.80 | 6 | 45 | $7.50 | 4 | 31 | $7.75 |
| cuttlefish | na | na | na | 9 | 17 | $1.89 | 7 | 21 | $3.00 | 11 | 21 | $1.91 | 6 | 14 | $2.33 | 4 | 19 | $4.75 |
| other species | 921 | 4,025 | $4.37 | 461 | 1,941 | $4.21 | 268 | 1,358 | $5.07 | 315 | 1,789 | $5.68 | 287 | 1,637 | $5.70 | 368 | 2,092 | $5.68 |
| **TOTAL [b]** | **4,168** | **21,916** | **$5.26** | **3,810** | **20,878** | **$5.48** | **3,186** | **17,446** | **$5.48** | **2,978** | **19,635** | **$6.59** | **3,002** | **20,917** | **$6.97** | **3,080** | **22,551** | **$7.32** |

[a] SARDI estimates of GVP for 2003/04 to 2008/09 have been re-valued to reflect price differentials between Adelaide, interstate and local markets.

[b] Does not include sardines. Includes marine scalefish species harvested by all licence holders and could include catch taken by Rock Lobster licence holders who have access to marine scalefish gear. Estimates of catch and GVP for the Marine Scalefish Fishery for the period 1998/99 to 2003/04 include blue crabs caught by marine scale licence holders. To prevent double counting, estimates of catch and GVP for 2004/05 to 2008/09 do not include any blue crab catch.

Source: Econsearch 2010

## Cost of management

PIRSA collects licence fees from commercial operators under the South Australian Government's cost recovery policy for the management of commercial fisheries. Licence fees contribute to the costs of management, compliance and research (Table 5).

Table 5. Cost of management of the Marine Scalefish Fishery from 1996/97 to 2009/10[a].

| | Licence Fee | Gross Value of Production | Fee/GVP | Catch | Fee/Catch | Licence Holders [a] | Fee/Licence Holder |
|---|---|---|---|---|---|---|---|
| | ($'000) | ($'000) | (%) | (tonnes) | ($/kg) | (No.) | ($/licence) |
| 1996/97 | $1,419 | $20,879 | 6.8% | 6,563 | $0.22 | 535 | $2,652 |
| 1997/98 | $1,646 | $17,049 | 9.7% | 5,594 | $0.29 | 513 | $3,209 |
| 1998/99 | $1,559 | $18,293 | 8.5% | 5,036 | $0.31 | 492 | $3,169 |
| 1999/00 | $1,706 | $19,897 | 8.6% | 4,869 | $0.35 | 463 | $3,188 |
| 2000/01 | $1,718 | $21,042 | 8.2% | 5,255 | $0.33 | 450 | $3,244 |
| 2001/02 | $1,655 | $19,027 | 8.7% | 4,722 | $0.35 | 428 | $3,287 |
| 2002/03 | $1,557 | $20,994 | 7.4% | 4,175 | $0.37 | 408 | $2,986 |
| 2003/04 | $1,799 | $22,756 | 7.9% | 4,168 | $0.43 | 397 | $3,521 |
| 2004/05 | $1,891 | $20,878 | 9.1% | 3,810 | $0.50 | 394 | $3,728 |
| 2005/06 | $1,994 | $17,446 | 11.4% | 3,186 | $0.63 | 384 | $4,028 |
| 2006/07 | $2,014 | $19,635 | 10.3% | 2,978 | $0.68 | 349 | $4,184 |
| 2007/08 | $2,047 | $20,917 | 9.8% | 3,002 | $0.68 | 343 | $4,423 |
| 2008/09 | $1,962 | $22,551 | 8.7% | 3,080 | $0.64 | 340 | $4,215 |
| 2009/10 | $1,900 | n.a. | - | n.a. | - | 334 | $4,281 |

[a] Indicates the licence holder numbers at the beginning of the financial year, which may be different to the end of the financial year due mainly to amalgamation of licences. The number of licence holders for 2008/09 is the number at the end of the financial year.

Source: EconSearch (2010)

The total cost of management in 2008/09 was $1.96 million, which was 4 % lower than the previous year. As a percentage of GVP, the total cost of management fell to 8.7 % in 2008/09 compared to 9.8 % in the previous year, which reflects an increase in gross value of production in the fishery and a slight decrease in total licence fees (Econsearch 2010).

Whilst the total cost of management has remained steady or declined in recent years the average fee per licence has generally increased, as a direct result of the reduction in licence numbers through natural attrition within the Restricted Marine Scalefish Fishery and through licence amalgamations.

## Financial performance

The management plan sets out a number of economic indicators that are to be used as a measure of the economic performance of the fishery. These include; GVP, gross income, costs, cash operating surplus, return on investment and licence values.

Based on the results of a survey of licence holders conducted in 2007 and changes in catch size and value between 2007/08 and 2008/09, it was estimated that the average gross income per surveyed boat in the Marine Scalefish Fishery in 2008/09 was approximately $112,000, an increase of 9 % over the previous year (Econsearch 2010).

It was estimated that average total boat cash costs increased by 4 % between 2007/08 and 2008/09 (Econsearch 2010).

For the Marine Scalefish Fishery as a whole, the average rate of return to total capital was 0.4 % in 2008/09 (–0.9 % in 2007/08). For fishers with net and line entitlements the rate of return to total capital was 5.6 % and for line only fishers it was –5.0 % (Econsearch 2010).

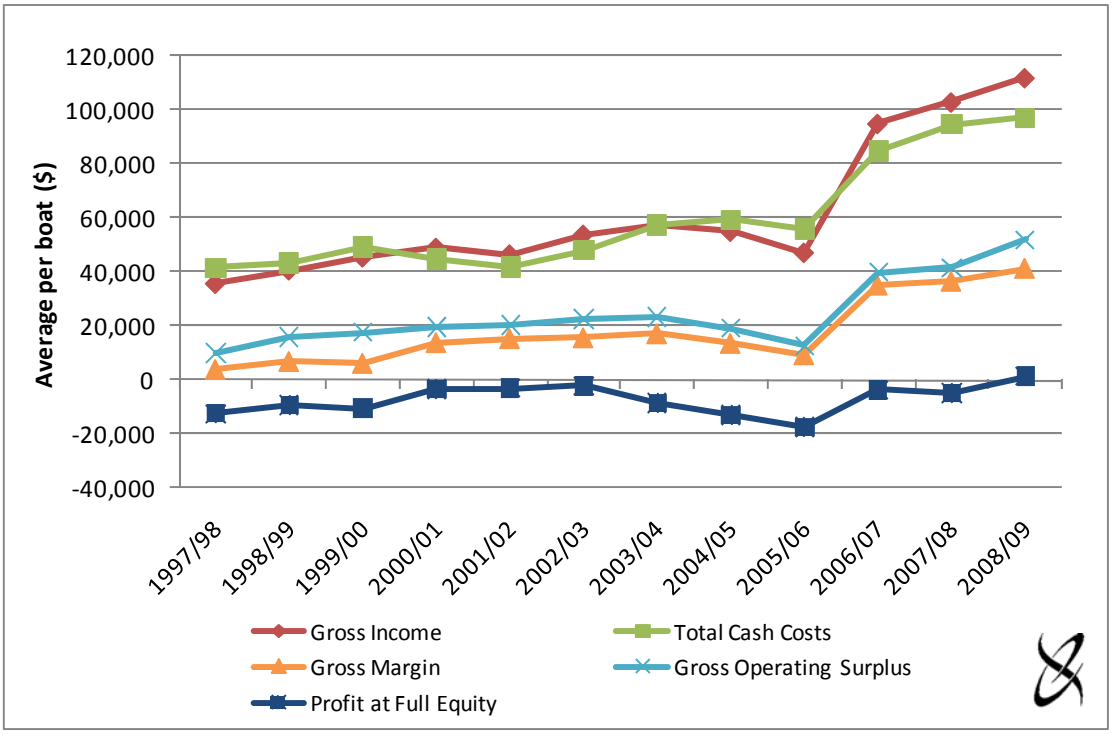


Figure 5. Average income and profit per boat in the Marine Scalefish fishery, 1997/98 to 2008/09 [a]

[a] Estimates of income and profitability measures are expressed in nominal terms.

Source: EconSearch (2010)

## 2.5 Research Strategy

### 2.5.1 Recent / Current Research

The research framework for the MSF is clearly laid out in the existing management plan[2] (Noell et al. 2006). The management plan outlines the research objectives, research themes, prioritisation of research and stock assessment reporting. The objectives and the framework for research were developed by a Research Working Group, and ratified by the Marine Scalefish Fishery Management Committee (MSFMC) (Noell et al. 2006).

Research costs for the fishery are largely funded through the cost-recovery process whereby the costs of managing the fishery, including research are covered through the collection of annual licence fees.

**Identification and prioritisation of research**

Given the large number of commercially and recreationally exploited marine scalefish species, it is not feasible to undertake detailed stock assessments for them all. In July 2003, the Research Working Group prioritised 30 species for research and stock status reporting, based on key information including:

- Commercial harvest weights and values as recorded in SARDI wild fisheries production reports;
- Recreational harvest numbers from the 2000/01 National Recreational and Indigenous Fishing Survey (Henry & Lyle 2003); and
- Community values through a consensus view from community representatives of the Research Working Group and the broader community.

Four species were prioritised as primary species, which were (in order of priority): 1. King George Whiting, 2. Southern Calamari, 3. Snapper and 4. Southern Garfish.

The order of priority for the remaining 25 species is as follows:

5. Australian Herring (tommy ruff)
6. Australian Salmon
7. Snook and mulloway
8. Sand Crabs, ocean leatherjacket, wrasses and State-managed sharks
9. Yellowfin Whiting, mud cockles, cuttlefish, leatherjackets and black bream
10. Razorfish, Western Blue Groper, mullet, trevally, red mullet, rays and annelid worms
11. Western striped grunter (trumpeter), weedy Whiting, sweep, flathead and yellowtail kingfish.

[2] The current management plan guides the management of both the commercial and recreational sectors of the fishery, so whilst this risk assessment relates solely to the commercial component, the research objectives described apply to both sectors.

## Objectives

Based upon this classification and prioritisation of species, the research objectives of the MSF, as identified in the management plan are:

- To undertake biological research on primary and secondary species, with special reference to key parts of their life history and their associated habitat and oceanographic dependencies;
- To undertake ongoing stock assessment on primary and secondary species, incorporating general fishery and biological reference points for monitoring by the MSFMC. To identify key economic reference points for monitoring by the MSFMC;
- To undertake fish community studies, with special reference to trophic dynamics of primary species and relationships between fish communities and habitat; and
- To undertake or support studies that quantify the impacts or potential impacts of the activities of other sectors (fishing and non-fishing) on the Marine Scalefish Fishery.

## Research Plan

The annual research priorities are outlined in a five-year research plan. The plan provides for regular on-going detailed stock assessments for three of the four primary species, ongoing collection of biological data for primary species and an annual status report that also covers the other secondary and tertiary species.

A detailed stock assessment, including estimates of biological performance of the fishery is undertaken once every three years for Snapper, King George Whiting and Southern Garfish. The stock assessment provides model-derived estimates of biological indicators such as recruitment, biomass and age structure as well as fishery dependent information such as commercial catch, effort and catch per unit effort (CPUE).

Market-based catch sampling for the three primary species is undertaken in two of the three years to provide up-to-date information on size and age structure as well as other biological condition such as stage of reproductive maturity.

For primary and secondary species an annual status report provides details on the status of the fishery on each species at the State-wide scale based on commercial fishing statistics. Catch, effort and CPUE for the most recent year are measured against limit reference points in order to detect changes in fish abundance and fishing effort.

Provision is also made within the research plan to undertake a discretionary project annually. This discretionary project is used to address key management issues and in the past has funded such projects as: examining the development of stock assessment and monitoring tools for Southern Calamari; examining fleet dynamics; providing fishery independent

assessment and quantification of bycatch; and mesh selectivity analysis in the Southern Garfish fishery.

The cost-recovered funding through licence fees is not the only stream of funding from which research relevant to the management of the fishery is undertaken. External sources such as the Fisheries Research and Development Corporation (FRDC) and Universities also provide opportunities.

### 2.5.2 Research projects

**Recent and Current**

Some recently completed and current research directly related to the management of the MSF includes:

- Stock assessments for primary species including Snapper (Fowler et al. 2010a), Southern Garfish (McGarvey et al. 2009), King George Whiting (Fowler et al. 2008a) and Southern Calamari (Steer et al. 2007);
- Stock status reports (Fowler et al. 2010b, 2009b and 2008c);
- Management strategy evaluation for Snapper (McGarvey et al. 2010).
- Biology of marine fish species of conservation or management concern (Saunders et al. 2010);
- Dynamics of fishing effort between species of the MSF (Steer 2009);
- A major bycatch study (Fowler et al. 2009a); and
- Stock structure and movement of garfish (Steer et al. 2009).

Other research projects including student projects that relate to the MSF include:

- A PhD study by Richard Saunders, *The reproductive biology and recruitment dynamics of Snapper (Pagrus auratus)*;
- An honours study by Matthew Lloyd, *Spatial variation in growth of Snapper (Pagrus auratus) in South Australian gulf waters: investigation of diet as a contributing factor*.

Research projects currently underway include:

- Market sampling of King George Whiting and Snapper;
- Stock assessment for Southern Garfish;
- Movement and stock structure of Snapper.

# 3 METHODOLOGY

The current series of PIRSA ESD performance reports have been prepared to ensure that South Australian fisheries management is both effective and efficient in the context of achieving ESD outcomes. In addition to meeting the statutory requirements of the *Fisheries Management Act 2007*, and national environmental legislation, this approach will also provide the fishing industry, key stakeholders, and the broader community with an ongoing opportunity to contribute to, and influence, fisheries management outcomes.

The reports will also provide the basis for the development of statutory management plans required under the *Fisheries Management Act 2007*. On behalf of the SA Fisheries Council, PIRSA Fisheries and Aquaculture has used the comprehensive issue identification and subsequent risk assessment and priority setting process to collaboratively develop more effective management arrangements under the new Act. Where necessary this may include development of fishery-specific harvest strategies, and related research and monitoring programs for each fishery assessed.

The issue identification, risk assessment, and reporting process described in detail below, as well as the final report format, is closely based on the National ESD Framework *How To Guide* (see www.fisheries-esd.com), as well as the Department of Fisheries Western Australia ESD performance reports pioneered by Dr Rick Fletcher and other WA Fisheries staff.

## 3.1 Scope

The present ESD report describes "the contribution of the South Australian commercial Marine Scalefish Fishery to ESD" in the context of South Australian Fisheries legislation and policy. The report is based on preliminary scoping and issue identification work by PIRSA Fisheries and Aquaculture staff in conjunction with Marine Scalefish Fishery industry representatives. This initial scoping was then refined and validated through a broader stakeholder workshop on 18 April 2011.

The scope of the assessment was contained to issues relevant to the commercial Marine Scalefish Fishery. The recreational catch will be assessed separately through an ESD assessment of South Australian recreational fishing.

The assessment process examined an extensive range of issues, risks and opportunities identified by stakeholders. The identification of issues was informed by the generic ESD component tree approach with each fishery component tree refined specifically for the Marine Scalefish Fishery. Each major component tree reflects the primary components of ESD, and the ESD report assesses the performance of the fishery for each of the relevant ecological, economic, social and governance issues facing the fishery (Table 6). The process also identifies where additional (or reduced) management or research attention is needed, and identifies strategies and performance criteria to achieve management objectives to the required standard.

Table 6. Primary ESD Components

| | |
|---|---|
| Retained Species<br>Non-Retained Species<br>General Ecosystem | *Ecological Wellbeing* |
| Community Wellbeing<br>Aboriginal Community | *Human Wellbeing* |
| Governance<br>External Factors Affecting Fishery Performance | *Ability to Achieve* |

## 3.2 Overview

The steps followed to complete this report were:

1. A set of "Generic ESD Component Trees" were modified through an iterative process with stakeholders into a set of trees specific to the fishery. This process identified the issues relevant to ESD performance of the fishery under the categories described in Table 6 above.

2. A risk assessment of the identified issues (or components) was completed based on the *likelihood* and *consequence* of identified events that may undermine or alternatively contribute to ESD objectives. This was an iterative process involving managers, scientists, industry, and key stakeholders.

3. Risks were then prioritised according to their severity. For higher level risks, where an increase in management or research attention was considered necessary, a detailed analysis of the issue, associated risks, and preferred risk management strategies was completed. For low risk issues, the reasons for assigning low risk and/or priority were recorded.

4. For higher level risks, a full ESD performance report was prepared (Section 4 of the current report). This was completed in the context of specific management objectives and includes operational objectives, indicators and performance measures.

5. A background report providing context and necessary supporting information about the fishery was also prepared to guide the identification of issues, risks and management strategies. The current report includes the history of the fishery and its management, the areas of operation and their biological and physical characteristics, target species and by-product and bycatch species, and other relevant information.

The process is illustrated in Figure 6 below.

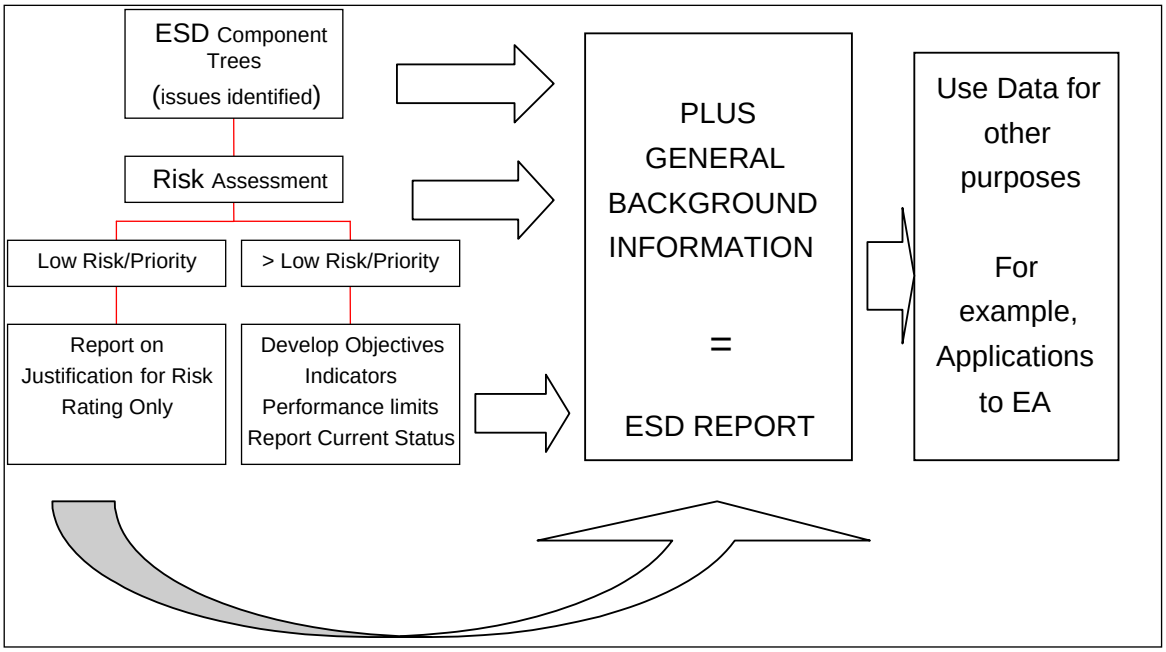


Figure 6. Summary of the ESD reporting framework processes
Source: ESD Reporting *How To Guide*; Fletcher et al. (2002)

## 3.3 Issue Identification (component trees)

The Marine Scalefish Fishery ESD reporting component trees are a refined version of the generic trees suggested in the National ESD Reporting Framework (see Table 6, Section 3.1). The generic trees and the issues that they encompass were the result of extensive consideration and refinement during the initial development of the National Fisheries ESD approach. The trees were designed to be very comprehensive to ensure that all conceivable issues facing a fishery would be considered during the workshop process. The fishery-specific component trees developed after expert and stakeholder consideration provide a more realistic and practical illustration of the issues facing a particular fishery.

The generic component trees have been used as the starting point to ensure thorough, consistent, and rigorous identification and evaluation of ESD issues across all of the South Australian Fisheries being assessed. When developing each of the major fishery-specific component trees, each primary component is broken down into more specific sub-components for which operational objectives can then be developed.

For example, the component tree identifying ‘retained species’ during the MSF risk assessment workshop is shown below.


Figure 7. Example of a component tree specific to the Marine Scalefish Fishery.

## 3.4 Risk Assessment and Prioritisation of Issues

Once the fishery-specific component trees were developed and reviewed by stakeholders, the focus moved to the assessment and prioritisation of risks and opportunities facing the fishery. These have been considered in the context of the specific management objectives for each fishery being assessed. The higher level management objectives and desired ESD outcomes are those described in the *Fisheries Management Act 2007*. Risks and opportunities are also evaluated against more detailed fishery-specific objectives, such as those articulated in the fishery's management plan.

The risk assessment of issues identified for the MSF has been done on the basis of existing management of risks to the fishery. Hence the risk assessment conducted during the stakeholder workshop considered the residual risk after the existing risk treatments were taken into account. For example, PIRSA's current compliance program for the Marine Scalefish Fishery is itself based on a separate compliance risk assessment process. This process identifies compliance risks in the context of the fishery's management objectives, and then develops and applies strategies to mitigate those risks. The ESD assessment and reporting process works across the full suite of fishery ESD objectives in a similar way.

Risk assessment applied under the national ESD framework has been designed to be consistent with the Australian and New Zealand Standard AS/NZS 4360:1999 for Risk Management. Subject matter experts and key fishery stakeholders consider the range of potential consequences of an issue, activity, or event (identified during the component tree development process) and how likely those consequences are to occur. The estimated consequence of an event is multiplied by the likelihood of that event occurring to produce an estimated level of risk.

What is Risk Analysis?

***"****Risk analysis involves consideration of the sources of risk, their consequences and the likelihood that those consequences may occur."*

Australian and New Zealand Standard (AS/NZS) 4360 – 1999

(NB. AS/NZS 4360-1999 has since been superseded by AS/NZS 4360:2004, which was then superseded by AS/NZS ISO 31000:2009)

ESD workshop participants worked methodically through each component tree from the top down and conducted a qualitative risk assessment of each issue. An estimate of the consequence level for each issue was made and scored from 0–5, with 0 being negligible and 5 being catastrophic/irreversible (see Appendix 1 for details of the risk consequence tables). The consequence estimate was based upon the combined judgement of workshop participants who had considerable expertise in the issues being assessed.

The level of consequence was estimated at the appropriate scale and context for the issue in question. For the target species the consequence assessment was based at the population not the individual level. Killing one fish is catastrophic for the individual but not for the population. Similarly, when assessing possible ecosystem impacts this was done at the level of the whole ecosystem or at least in terms of the entire extent of the habitat, not at the level of an individual patch or individuals of non-target species[3].

The likelihood of that consequence occurring was assigned to one of six levels from remote (1) to likely (6). This was based on a judgement about the probability of the events - or chain of events - occurring that could result in a particular adverse consequence. This judgement about conditional probability was again based on the collective experience and knowledge of workshop participants. See Appendix 1 for details of the likelihood table.

From the consequence and likelihood scores, the overall risk value (Risk = Consequence x Likelihood), was calculated. On the basis of this risk value each issue was assigned a Risk Ranking within one of five categories (see Table 7).

Table 7. Risk ranking definitions

| RISK | Rank | Likely Management Response | Reporting |
|---|---|---|---|
| Negligible | 0 | Nil | Short Justification Only |
| Low | 1 | None Specific | Full Justification needed |
| Moderate | 2 | Specific Management Needed | Full Performance Report |
| High | 3 | Possible increases to management activities needed | Full Performance Report |
| Extreme | 4 | Likely additional management activities needed | Full Performance Report |

Where a more detailed and/or quantitative risk assessment and management process was in place for the fishery - such as a robust quantitative stock assessment for a target species - the resultant risk score could be expected to be moderate to low. The risk score in this example reflects the fact that the risk is being managed effectively through existing arrangements.

[3] These descriptions and detailed guidance about developing consequence and likelihood scores for fishery issues are provided in the ESD *How To Guide* at www.fisheries-esd.com.

The national ESD reporting framework suggests that only those issues scored at moderate, high and extreme risk, which require additional management attention, need to have full ESD performance reports completed. This is the approach that has been used in the current ESD report. The rationale for scoring other issues as low or negligible risk has also been documented and forms part of the current report. This approach encourages transparency and should help stakeholders to understand the basis for risk scores and the justification for no further management, or for additional management action if necessary. The process is summarised earlier in this section (Table 7).

## 3.5 Performance Reports for Higher Risk Issues

As noted above, a comprehensive ESD performance report has only been prepared for higher risk/priority issues that require additional management attention (see Section 4). The content of these performance reports is based on the standard subject headings recommended in the ESD Framework's *How To Guide*.

The full performance report for the Marine Scalefish Fishery was developed by PIRSA Fisheries and Aquaculture largely from the discussions during the ESD workshop held in Adelaide on 18 April 2011. A preliminary draft ESD report was sent to industry members and other stakeholders for review before finalisation.

## 3.6 Overview Table

The following table provides a summary of the material presented in the performance reports (see Section 4).

Table 8. Overview of the ESD Risk Assessment for the Marine Scalefish Fishery

N = Negligible; L = Low; M = Moderate; H = High; N/A = Not applicable; H (M) indicates discrepancy at the workshop; * = Review under new Management Plan, scheduled for 2013; ** = Review at next major ESD assessment, *** = Review currently underway. Coloured cells reflect final risk ratings from the ESD risk assessment workshop (see Section 4).

| Issue | Risk / Priority | Objective Developed | Indicator Measured | Performance Measure | Current Performance | Robustness | Actions |
|---|---|---|---|---|---|---|---|
| **Retained Species** | | | | | | | |
| Snapper | H | Yes | Yes | Yes | Uncertain | High | *** |
| King George Whiting | L | Yes | Yes | Yes | Acceptable | High | ** |
| Southern Calamari | L | Yes | Yes | Yes | Acceptable | High | ** |
| Southern Garfish | H | Yes | Yes | Yes | Not acceptable | High | *** |
| Yellowfin Whiting | L | Yes | Yes | Yes | Acceptable | Medium | ** |
| Australian Herring | L | Yes | Yes | Yes | Acceptable | Medium | ** |
| Bronze & Dusky Whaler Shark | M | Yes | Yes | Yes | Uncertain | Medium | * |
| Sand Crab | L | Yes | Yes | Yes | Acceptable | Medium | ** |
| Blue swimmer crab (West coast) | L | Yes | No | No | Acceptable | Low | ** |
| Ocean jackets | L | Yes | Yes | Yes | Acceptable | Low | ** |
| Mud cockles | M | Yes | Yes | Yes | Acceptable | High | *** |
| Australian Salmon | L | Yes | Yes | Yes | Acceptable | Medium | ** |
| Snook | L | Yes | Yes | Yes | Acceptable | Medium | ** |
| Yellow-eye Mullet | L | Yes | Yes | Yes | Acceptable | Low | ** |
| Wrasse spp (parrotfish) | L | Yes | Yes | Yes | Acceptable | Low | ** |
| Octopus | L | Yes | Yes | Yes | Acceptable | Low | ** |
| Cuttlefish | L | Yes | Yes | Yes | Acceptable | Low | ** |
| Bloodworms | L | Yes | Yes | No | Acceptable | Low | ** |
| Pipi (Gunyah beach) | M | Yes | Yes | No | Not acceptable | Low | *** |
| Razorfish | M | Yes | Yes | No | N/A | N/A | ** |
| Gummy Shark | L | Yes | Yes | Yes | N/A | N/A | ** |
| School Shark | L | Yes | No | No | N/A | N/A | ** |
| Whiskery Shark | L | Yes | No | No | N/A | N/A | ** |

| Issue | Risk / Priority | Objective Developed | Indicator Measured | Performance Measure | Current Performance | Robustness | Actions |
|---|---|---|---|---|---|---|---|
| Broadnose Shark | L | Yes | No | No | N/A | N/A | ** |
| Red Mullet | N | Yes | No | No | N/A | N/A | ** |
| Western Striped Grunter | N | Yes | Yes | Yes | Acceptable | Low | ** |
| Trevally | N | Yes | Yes | Yes | Acceptable | Low | ** |
| Leatherjacket spp | N | Yes | Yes | Yes | Acceptable | Low | ** |
| Flathead | N | Yes | No | No | N/A | N/A | ** |
| Mulloway | N | Yes | No | No | N/A | N/A | ** |
| Other schedule 1 spp | N | Yes | No | No | N/A | N/A | ** |
| Non-schedule 1 spp | N | Yes | No | No | N/A | N/A | ** |
| **Non-Retained Species** | | | | | | | |
| Cormorants | N | Yes | Yes | No | Acceptable | Medium | ** |
| Little penguin | N | Yes | Yes | No | Acceptable | Medium | ** |
| Pacific gull | N | Yes | Yes | No | Acceptable | Medium | ** |
| Shearwater | N | Yes | Yes | No | Acceptable | Medium | ** |
| Silver gull | N | Yes | Yes | No | Acceptable | Medium | ** |
| Australian fur seal | N | Yes | Yes | No | Acceptable | Medium | ** |
| New Zealand fur seal | N | Yes | Yes | No | Acceptable | Medium | ** |
| Dolphins | N | Yes | Yes | No | Acceptable | Medium | ** |
| Australian sea lion | M | Yes | Yes | No | Uncertain | Medium | *** |
| White Shark | M | Yes | Yes | No | Acceptable | Medium | ** |
| Turtles | N | Yes | Yes | No | Acceptable | Medium | ** |
| Western Blue Groper | L | Yes | No | No | N/A | N/A | ** |
| Blue Swimmer Crab (gulf waters) | N | Yes | No | No | N/A | N/A | ** |
| Other crab spp | N | Yes | No | No | N/A | N/A | ** |
| Port Jackson Shark | N | Yes | No | No | N/A | N/A | ** |
| Other shark spp | N | Yes | No | No | N/A | N/A | ** |
| Other scalefish spp | N | Yes | No | No | N/A | N/A | ** |
| Other sea birds | N | Yes | Yes | No | N/A | N/A | ** |
| Whales | L | Yes | Yes | No | Acceptable | High | ** |
| Sygnathids | N | Yes | Yes | No | Acceptable | Medium | ** |
| **General Ecosystem Impacts of Fishing** | | | | | | | |
| Fishing – Marine | M | Yes | No | N/A | N/A | N/A | ** |
| Ghost fishing | N | Yes | No | N/A | N/A | N/A | ** |
| Discarding (bycatch) | N | Yes | No | N/A | N/A | N/A | ** |

| Issue | Risk / Priority | Objective Developed | Indicator Measured | Performance Measure | Current Performance | Robustness | Actions |
|---|---|---|---|---|---|---|---|
| Introduced marine pests / aquatic diseases | M | Yes | No | N/A | N/A | N/A | ** |
| Habitat disturbance – Haul netting, cockle raking, bait fork/spade, razorfish tongs | L | Yes | No | N/A | N/A | N/A | ** |
| Habitat disturbance – gill netting, purse seining, hooking/jigging, longline & drop lining, cockle raking (pipi), fish traps, octopus traps, crab, hoop & drop nets, mussel dredge | N | Yes | No | N/A | N/A | N/A | ** |
| Habitat disturbance – lost gear | N | Yes | No | N/A | N/A | | ** |
| Habitat disturbance – vehicular | L | Yes | No | N/A | N/A | N/A | ** |
| Habitat disturbance – anchoring | L | Yes | No | N/A | N/A | | ** |
| Air quality – Greenhouse gas / carbon emissions | N | Yes | No | N/A | N/A | N/A | ** |
| Water quality – Rubbish / debris | N | Yes | No | N/A | N/A | N/A | ** |
| Water quality – Fuel, oil and bilge discharge | N | Yes | No | N/A | N/A | N/A | ** |
| **Community** | | | | | | | |
| Profit (fishing industry) | H | Yes | Yes | Yes | Acceptable | Medium | ** |
| Employment | M | Yes | Yes | Yes | Acceptable | Medium | ** |
| OHS&W | M | Yes | Yes | Yes | Acceptable | Medium | ** |
| Relationship with community | H | Yes | Yes | Yes | Acceptable | Low | ** |
| Asset value | H | Yes | Yes | Yes | Acceptable | Medium | ** |
| Lifestyle | M | Yes | No | No | N/A | N/A | ** |
| Employment (regional centres) | M | Yes | No | No | N/A | N/A | ** |
| GRP and GSP | L | Yes | No | No | N/A | N/A | ** |
| Re-Investment (regional) | M | Yes | No | No | N/A | N/A | ** |
| Social capital (regional) | M | Yes | No | No | N/A | N/A | ** |
| Tourism (regional) | L | Yes | No | No | N/A | N/A | ** |
| Infrastructure (regional) | L | Yes | No | No | N/A | N/A | ** |
| Economic value (city) | N | Yes | No | No | N/A | N/A | ** |
| Health / food (city) | L | Yes | No | No | N/A | N/A | ** |

| Issue | Risk / Priority | Objective Developed | Indicator Measured | Performance Measure | Current Performance | Robustness | Actions |
|---|---|---|---|---|---|---|---|
| Social capital (city) | L | Yes | No | No | N/A | N/A | ** |
| Infrastructure (city) | N | Yes | No | No | N/A | N/A | ** |
| **Governance** | | | | | | | |
| Minister | H | Yes | No | No | N/A | N/A | ** |
| Management plan (Fish Council) | H | Yes | No | No | N/A | N/A | ** |
| Allocation (Fish Council) | H | Yes | No | No | N/A | N/A | ** |
| Consultation (Fish Council) | M | Yes | No | No | N/A | N/A | ** |
| Management effectiveness (PIRSA) | H | Yes | No | No | N/A | N/A | ** |
| Resources (PIRSA) | H | Yes | No | No | N/A | N/A | ** |
| Strategic policy (PIRSA) | H | Yes | No | No | N/A | N/A | ** |
| Research / information (PIRSA) | H | Yes | No | No | N/A | N/A | ** |
| Compliance (PIRSA) | H | Yes | No | No | N/A | N/A | ** |
| Legal framework (PIRSA) | M | Yes | No | No | N/A | N/A | ** |
| Consultation (PIRSA) | H | Yes | No | No | N/A | N/A | ** |
| Reporting (PIRSA) | H | Yes | No | No | N/A | N/A | ** |
| SA Govt: DENR | H | Yes | No | No | N/A | N/A | ** |
| Aust Govt: SEWPaC | M | Yes | No | No | N/A | N/A | ** |
| AFMA/DAFF | L | Yes | No | No | N/A | N/A | ** |
| DTEI | M | Yes | No | No | N/A | N/A | ** |
| FRDC | L | Yes | No | No | N/A | N/A | ** |
| Codes of Conduct (Industry) | H | Yes | No | No | N/A | N/A | ** |
| Communication/participation (Industry) | H | Yes | No | No | N/A | N/A | ** |
| Industry association | H | Yes | No | No | N/A | N/A | ** |
| Access security | H | Yes | No | No | N/A | N/A | ** |
| Marine park issues | H | Yes | No | No | N/A | N/A | ** |
| Owner operator | M | Yes | No | No | N/A | N/A | ** |
| Conservation Organisations | H | Yes | No | No | N/A | N/A | ** |
| SARFAC | M | Yes | No | No | N/A | N/A | ** |
| Other NGO's | M | Yes | No | No | N/A | N/A | ** |
| **External factors affecting performance of the fishery** | | | | | | | |
| Physical | E | Yes | No | No | N/A | N/A | ** |
| Climate change | N | Yes | No | No | N/A | N/A | ** |

| Issue | Risk / Priority | Objective Developed | Indicator Measured | Performance Measure | Current Performance | Robustness | Actions |
|---|---|---|---|---|---|---|---|
| Diseases | H | Yes | No | No | N/A | N/A | ** |
| Effluent | M | Yes | No | No | N/A | N/A | ** |
| Agricultural runoff | L | Yes | No | No | N/A | N/A | ** |
| Stormwater | L | Yes | No | No | N/A | N/A | ** |
| Hyper salinity (desalination) | L | Yes | No | No | N/A | N/A | ** |
| Illegal artificial reef | L | Yes | No | No | N/A | N/A | ** |
| Illegal dumping | L | Yes | No | No | N/A | N/A | ** |
| Development | L | Yes | No | No | N/A | N/A | ** |
| Dredging | L | Yes | No | No | N/A | N/A | ** |
| Recreational boating | L | Yes | No | No | N/A | N/A | ** |
| Commercial shipping | L | Yes | No | No | N/A | N/A | ** |
| Exotic species | M | Yes | No | No | N/A | N/A | ** |
| Fuel price | H | Yes | No | No | N/A | N/A | ** |
| Other fisheries (market demand) | M | Yes | No | No | N/A | N/A | ** |
| Marketing | M | Yes | No | No | N/A | N/A | ** |
| Labour (availability/cost) | M | Yes | No | No | N/A | N/A | ** |
| Other fishing costs | M | Yes | No | No | N/A | N/A | ** |
| Interest rates | M | Yes | No | No | N/A | N/A | ** |
| Illegal take | H | Yes | No | No | N/A | N/A | ** |
| Marine parks (access) | H | Yes | No | No | N/A | N/A | ** |
| Recreational fishers | H | Yes | No | No | N/A | N/A | ** |
| Aquaculture | L | Yes | No | No | N/A | N/A | ** |
| Eco-tourism | N | Yes | No | No | N/A | N/A | ** |
| Non-extractive users | N | Yes | No | No | N/A | N/A | ** |
| Shipping | L | Yes | No | No | N/A | N/A | ** |
| Artificial reefs | N | Yes | No | No | N/A | N/A | ** |
| **Aboriginal community** | | | | | | | |
| Yet to be undertaken | | | | | | | |

# 4 PERFORMANCE REPORTS

Red, pink and yellow boxes indicate that the issue was considered of high enough risk/priority at the April 2011 workshop to warrant having a full report on performance. Green and blue boxes indicate that the issue was rated as a low risk or negligible risk, respectively, and no specific management is required – only a justification is presented.

Background information and workshop discussion points on the rankings of each species and/or issue assessed have been recorded in this report and are summarised with each of the risk ratings.

Where applicable, reporting against performance indicators, including breaches of limit reference points has been included for each species/issue. In cases where performance indicators are not used, this has been recorded.

## 4.1 Retained Species


Figure 8. Component Tree for Retained Species

### 4.1.1 Primary Species

A total of twenty species were identified as 'primary species' for the purposes of the risk assessment workshop (Figure 8). These species were considered primary species as they are specifically targeted or have specific gear types associated with their capture.

For three of the primary species i.e., Snapper, King George Whiting and Southern Garfish, fishery models are used to assess the fishery's biological status, through biological estimates of variables such as biomass and recruitment. Specific performance indicators have been developed and are therefore reported on in addition to general performance indicators that are used across all species.

**Snapper**

**Objective**

- Ensure the Snapper resource is harvested within ecologically sustainable limits

Meeting this objective should ensure sufficient spawning stock to continue recruitment at levels that will replenish what is taken by fishing, predation and other environmental factors, and thereby maintain the spawning stock at or above a level that minimizes the risk of recruitment over-fishing.

**ERA Risk Rating: Impact on breeding population (HIGH)**

The commercial Snapper (*Pagrus auratus*) fishery encompasses most of the state's inshore marine waters, with the majority of catches coming from Spencer Gulf and Gulf St Vincent. Long term catches have fluctuated between 400 and 600 tonnes annually between 1983/84 and 2005/06. However catches have increased considerably since 2003/04 to a record high level of over 900 tonnes in 2009/10. This recent increase in catch has also been seen in Victoria and New South Wales suggesting an increasing biomass trend throughout south east Australia.

Comprehensive fishery assessment reports are produced every three years for Snapper, with the most recent completed in July 2010 (Fowler et al. 2010a). This assessment includes catch and effort data up to the end of 2008/09.

**Performance indicators (biological):** The most recent Snapper fishery assessment report assessed performance indicators at a State-wide and regional level and examined biological and fishery dependent data trends. The model estimated a downward trend in biomass estimates from Southern Spencer Gulf, due to lower levels of recruitment during the 2000's. However biomass was estimated to be increasing and was at record high levels in Northern Spencer Gulf and Gulf St Vincent. Based on that assessment, Snapper stocks were assessed as being healthy with no immediate stock sustainability issues.

**Performance indicators (general):** A number of reference points were breached in 2009/10, as detailed in the annual stock status report (Fowler et al. 2010b). These breaches related to total catch and targeted longline effort as well as the highest targeted longline CPUE (Table 9). The sharp rise in longline effort and longline catch in 2009/10 is unprecedented, with catch and effort well above historical levels. Despite the positive indicators, there are concerns that the current levels of effort cannot be sustained. The reduced fishing effort in Southern Spencer Gulf may be an indication that parts of the fishery are already experiencing a decline.

Reflecting the view that current management arrangements are not optimal, PIRSA have cautioned against industry investment in the fishery, pending the outcomes of a management review taking place during 2011.

It was felt that the current level of take of Snapper would be having a **severe (C3)** consequence on the population and that this will **occasionally (L5)** occur into the future. The risk rating was therefore **HIGH (15)**.

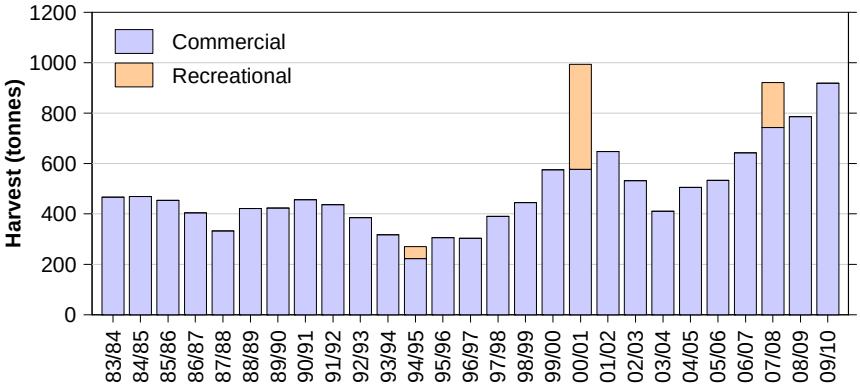


Figure 9. Total State-wide commercial and recreational catches of Snapper.
Source: Fowler et al. (2010b)

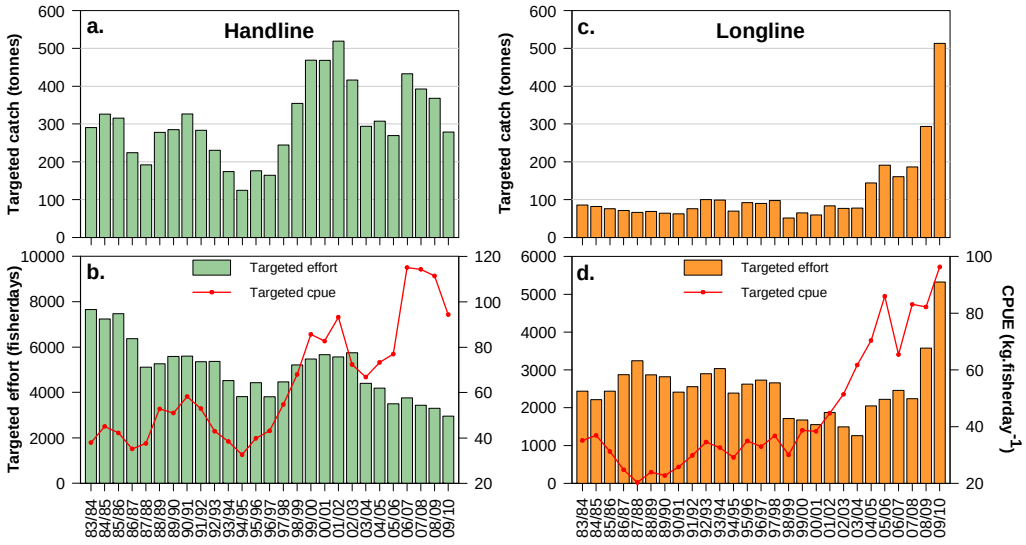

Figure 10. (a) Targeted handline catch of Snapper; (b) Targeted handline effort and CPUE; (c) Targeted longline catch; (d) Targeted longline effort and CPUE.
Source: Fowler et al. (2010b)

Table 9. Performance indicators and current status levels for Snapper 2009/10.
(Yellow shading breach of limit reference point, either positive or negative)

| Performance Indicator | Limit Reference Point | Breached? | Details |
|---|---|---|---|
| A. Total commercial catch | 3rd lowest/3rd highest | **Yes** | **Highest** |
| | Greatest interannual change (±) | **Yes** | **Highest increase** |
| | Greatest 5-year trend (±) | **Yes** | **Highest** |
| B1. Targeted handline effort | 3rd highest | No | |
| | Greatest interannual change (±) | No | |
| | Greatest 5-year trend (±) | No | |
| B2. Targeted longline effort | 3rd highest | **Yes** | **Highest** |
| | Greatest interannual change (±) | **Yes** | **Highest increase** |
| | Greatest 5-year trend (±) | **Yes** | **Highest increase** |
| C1. Targeted handline CPUE | 3rd lowest/3rd highest | No | |
| | Greatest interannual change (±) | No | |
| | Greatest 5-year trend (±) | No | |
| C2. Targeted longline CPUE | 3rd lowest/3rd highest | **Yes** | **Highest** |
| | Greatest interannual change (±) | No | |
| | Greatest 5-year trend (±) | No | |

Source: Fowler et al. (2010b)

## King George Whiting

### Objective

- Ensure the King George Whiting resource is harvested within ecologically sustainable limits

Meeting this objective should ensure sufficient spawning stock to continue recruitment at levels that will replenish what is taken by fishing, predation and other environmental factors, and thereby maintain the spawning stock at or above a level that minimizes the risk of recruitment over-fishing.

### ERA Risk Rating: Impact on breeding population (LOW)

King George Whiting (*Sillaginodes punctaus*) is an iconic South Australian species, highly regarded as a table fish and keenly sought by recreational fishers. The fishery includes all SA coastal waters, but is largely confined to waters form Gulf St. Vincent westwards to Denial Bay. King George Whiting has traditionally been the most valuable marine scalefish species in terms of total production, however it has recently been eclipsed with the expansion of the Snapper fishery and development of the sardine fishery. King George

Whiting remains the highest valued species by unit weight.

The fishery is largely based on the targeting of young adult fish as they migrate southwards out of the two gulfs during autumn and winter each year (Fowler et al. 2010a). These fish move out of the inshore nursery areas into the offshore waters at around age 3-4 when they have reached fishable size. There is also a deep water offshore component of the fishery which tends to target fish during spawning time. These fish tend to be larger and older, with some up to 18 years of age (Fowler et al. 2010a). Commercial fishers target King George Whiting with three main gear types, handlines, haul nets and gillnets.

A number of management changes have been introduced in recent times in response to declining catches and catch rates during the late 90's and early 2000's. In 2004, the size limit was increased from 30cm to 31cm in all waters east of longitude 136°, at the same time the recreational bag limit was reduced from 20 to 12. In addition, significant rationalisation of the net sector of the fishery took place during 2005 with a buy-back scheme resulting in the permanent removal of over 50% of netting endorsements. Additional permanent spatial netting closures were also implemented. Together these initiatives removed approximately 45% of net fishing effort.

Since these management measures have been implemented targeted fishing effort has remained at all time low levels, and consequently catches have also remained low. However since 2005 catch per unit effort (CPUE) for the handline sector has shown an upward trend, indicating a significant turnaround from the downward trend experienced between 1999 and 2002 (Fowler et al. 2010a).

As a priority species for management, a dedicated stock assessment for this species is undertaken every three years. The most recent report was published in August 2008. This assessment report indicated a number of positive signs for the fishery. The next report is due in August 2011.

**Performance indicators (biological):** The fishery mode estimated increasing trends in fishable biomass across all regions, breaching limit reference points (+/- 10% of previous 5-yr average). Limit reference points were also breached with significant increasing trends in pre-recruit abundance across all regions. Exploitation rates were within limit reference points and there were no signs of significant changes to the age structure over the previous 5 years (Fowler et al. 2010a).

**Performance indicators (general):** Annual stock status reports have continued to report on the general performance indicators of the fishery and indications are that the stocks remain in a healthy state and are continuing to re-build from the low period experienced almost 10 years ago. The only reference point breached in 2009/10 was targeted handline CPUE, which was the second highest on record (Fowler et al. 2010b) (Table 10).

It was noted during the workshop that almost 50% of the total catch of King

George Whiting was taken by the recreational sector and there was some concern that a risk analysis of the commercial take alone may not be truly representative of the fishery.

Given that; (1) current catches appear to be limited by the available effort, (2) CPUE is increasing and (3) historical catches have been considerably higher it was felt that the current take of King George Whiting would be having a **minor (C1)** impact on the fishery and is **likely (L6)** to continue into the future. The risk rating was therefore **LOW (6)**. There was some concern that a species for which there is so much interest and value that the overall rating should have been higher.

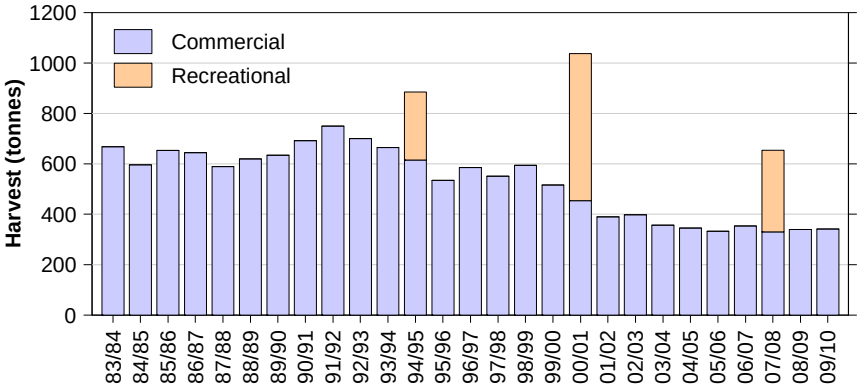


Figure 11. Total State-wide commercial and recreational catches of King George Whiting.
Source: Fowler et al. (2010b)

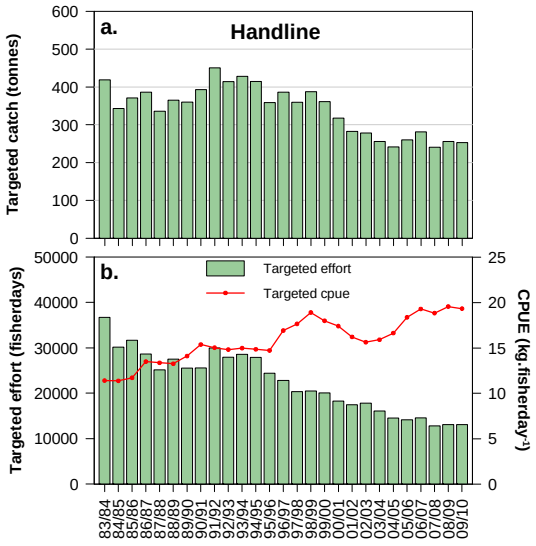


Figure 12. (a) Targeted handline catch of King George Whiting; (b) Targeted handline effort and CPUE.
Source: Fowler et al. (2010b)

Table 10. Comparisons between performance indicators and limit reference points for King George Whiting 2009/10.
(Yellow shading breach of limit reference point, either positive or negative)

| Performance Indicator | Limit Reference Point | Breached? | Details |
|---|---|---|---|
| A. Total commercial catch | 3rd lowest/3rd highest | No | |
| | Greatest interannual change (±) | No | |
| | Greatest 3-year trend (±) | No | |
| B1. Targeted handline effort | 3rd highest | No | |
| | Greatest interannual change (±) | No | |
| | Greatest 3-year trend (±) | No | |
| C1. Targeted handline CPUE | 3rd lowest/3rd highest | **Yes** | **2nd highest** |
| | Greatest interannual change (±) | No | |
| | Greatest 3-year trend (±) | No | |

Source: Fowler et al. (2010b)

## Southern Calamari

### Objective

- Ensure the Southern Calamari resource is harvested within ecologically sustainable limits.

Meeting this objective should ensure sufficient spawning stock to continue recruitment at levels that will replenish what is taken by fishing, predation and other environmental factors, and thereby maintain the spawning stock at or above a level that minimizes the risk of recruitment over-fishing.

### ERA Risk Rating: Impact on breeding population (LOW)

Southern Calamari (*Sepioteuthis australis*) is found throughout the entire range of the MSF. It is a short lived species, living for an estimated maximum of 280 days (Triantafillos 2001). They are serial spawners and spawn throughout the year, and are believed to follow a generalised anti-clockwise pattern of spawning behaviour within Gulf St Vincent (Steer et al. 2006). Spawning in late spring occurs in Kangaroo Island, continuing in a clockwise direction to Edithburgh where spawning occurs in late winter. Spawning occurs in shallow water habitats with egg masses being attached to seagrass, macro algae as well as low profile rocky reef and sand. Reproductive behaviour is dependent upon visual cues and is therefore thought to be impacted by environmental conditions such wind strength, rainfall and turbidity.

Commercial catch and effort is concentrated in the waters of the gulfs, which account for approximately 90% of the total commercial catch. The remainder of the catch is taken in waters adjacent to Kangaroo Island and the far west coast. Jigs account for over 65% of the total commercial catch, however prior to 1992, jigs accounted for 50% and the other 50% was taken by haul nets. This increase reflects the development of the fishery which has changed significantly since the early 1980's. The switch to targeted jig fishing was

driven by the increase in demand for Southern Calamari and reflects the efficiency and low costs associated with jigging. In addition to the MSF, a significant commercial catch is taken by the prawn trawl fisheries that operate in both gulfs. Through a combination of fishery-independent trawl surveys and commercial catch and effort data, it is conservatively estimated that approximately 35% of the total catch (in numbers) is taken by the prawn fisheries. By weight, this take is estimated to be 7.5% of the total catch (Steer et al. 2007).

The unique life history characteristics of Southern Calamari make a formal stock assessment of the species quite difficult. Steer et al. (2007) examined a number of methods to estimate pre-recruit abundance to predict the health/biomass of the coming year class. This included an assessment of environmental proxies such as wind strength and sea surface temperature, egg surveys and pre-recruit surveys (both fisheries dependent and independent). Whilst there were some strong correlations between pre-recruit abundance and commercial catch rates in the following 'season' the benefit of undertaking regular monitoring that provides a forecast 2 months ahead is limited under the current harvest strategy.

The most complete and informative data to assess the status of the stocks are the regional estimates of catch and effort and the subsequent estimates of CPUE, noting they too have limitations (Steer et al. 2007).

The workshop discussions centred on the ability for Southern Calamari to continue to withstand the current levels of fishing effort from all sectors. There were some concerns that localised areas were being depleted through sustained fishing pressure. The scientific view on localised depletion expressed at the workshop, was that it would be extremely hard to fish out an entire area given the highly mobile nature of the species. What often happens is that if fish are removed from a spawning area on one day, new fish will move into the area the next day. So whilst there is a period where fish are not available, it's unlikely that the stock has been permanently depleted.

**Performance indicators:** No limit reference points were breached during 2009/10; however commercial MSF catches increased in 2009/10 to its highest level since 2004/05.

The view of the workshop was that Southern Calamari is a highly resilient species with life history characteristics that allow it to cope well with high levels of exploitation. Therefore it was agreed that the current take of Southern Calamari would have a **minor (C1)** impact on the fishery which is **likely (L6)** to continue into the future. The risk rating was therefore **LOW (6)**.

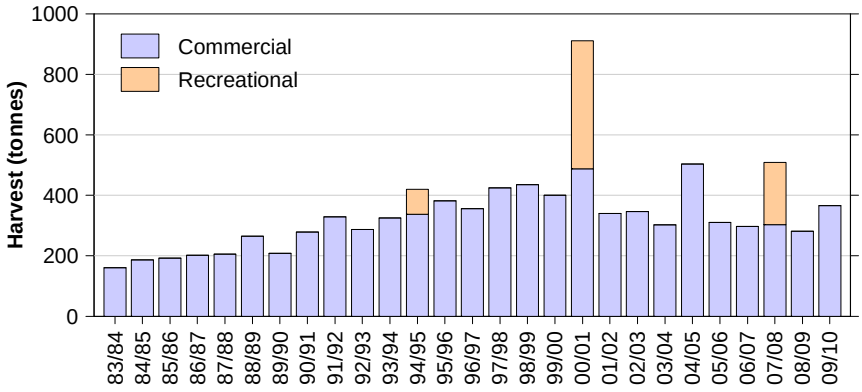


Figure 13. Total State-wide commercial and recreational catches of Southern Calamari.
Source: Fowler et al. (2010b)

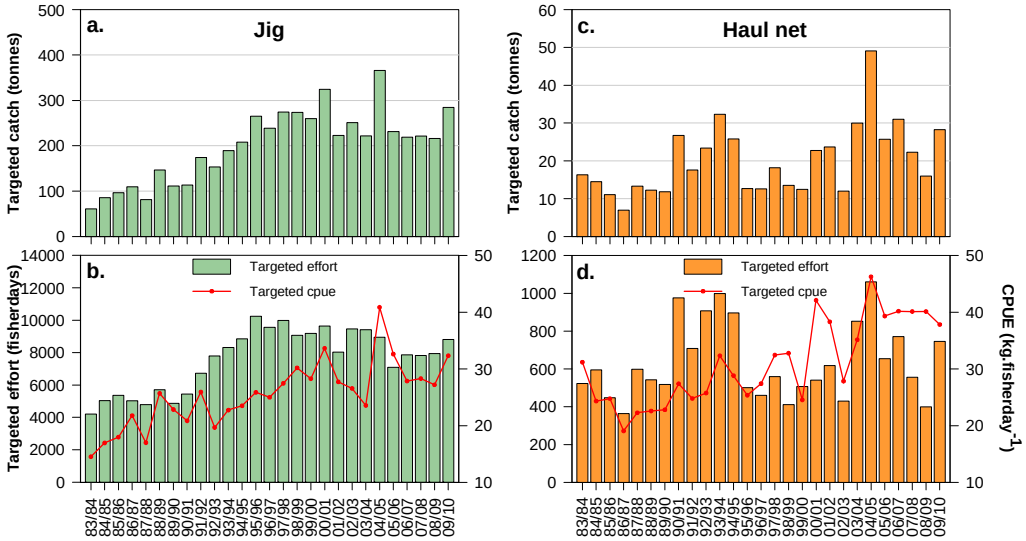


Figure 14. (a) Targeted jig catch of Southern Calamari; (b) Targeted jig effort and CPUE; (c) Targeted haul net catch; (d) Targeted haul net effort and CPUE.
Source: Fowler et al. (2010b)

## Southern Garfish

### Objective

- Ensure the Southern Garfish resource is harvested within ecologically sustainable limits

Meeting this objective should ensure sufficient spawning stock to continue recruitment at levels that will replenish what is taken by fishing, predation and other environmental factors, and thereby maintain the spawning stock at or above a level that minimizes the risk of recruitment over-fishing.

**ERA Risk Rating: Impact on breeding population (HIGH)**

Southern Garfish (*Hyporhamphus melanochir*) are principally harvested in the upper regions of both Spencer Gulf and Gulf St. Vincent. The commercial catch is largely taken by haul nets, with approximately 10% taken by dab nets.

Since 1983/84 the fishery has experienced a consistent decline in fishing effort. Catches have fluctuated over this time, but in the last few years have stabilised at the lowest levels on record. Significant management changes designed to address concerns relating to Southern Garfish, specifically for the haul net sector, have been implemented over the last 15 years. The licence amalgamation scheme was introduced in 1994 and continues today in a somewhat altered format. This scheme has resulted in a steady decline in licence numbers and subsequent reduction in exploitation on most targeted marine scalefish species (McGarvey et al. 2009). This decline was accelerated in 2005 with the voluntary net buy-back, which resulted in the permanent removal of over 50% of netting endorsements from the fishery. In addition to effort reduction significant netting area closures were introduced in 2005. Furthermore in 2001 the minimum legal size limit was increased from 21cm to 23cm for both recreational and commercial fishers. No changes to mesh size restrictions were made at the time of the size limit increase.

Despite these management initiatives, concerns are still held for the status of Southern Garfish stocks. Much of the concern relates to the age structure of the commercial catch. Market sampling of commercial catch indicate that the populations consist primarily of one and two year old fish. Whilst this structure was evident in samples collected through the late 1990's, they are different from those in the 1950's. The data indicates that the Southern Garfish populations in the gulfs are now significantly truncated with respect to size and age, likely to be a result of continued, high levels of exploitation (McGarvey et al. 2009).

**Performance indicators (biological):** The GarEst fishery model which was assessed in 2009 and presented in the garfish fishery assessment report, estimated exploitation rates to be at an average of 70% and 72% in Spencer Gulf and Gulf St. Vincent over the last five years (McGarvey et al. 2009), well above the international standard of 32%. The model estimated a total of 5 performance indicator breaches across two geographical assessment regions. Two related to exploitation rate (harvest fraction) as discussed above, two related to low egg production measured as a percentage of pristine egg production and the final breach related to recruitment in Spencer Gulf, with the estimated value of 14% lower than the average of the previous 5 years.

**Performance indicators (general):** Regarding the general performance indicators reported in the annual stock status report, only one limit reference point was breached during the 2009/10 year. The breach related to total commercial catch, which was the lowest on record (Figure 15) (Table 11).

There has been significant discussion between PIRSA, SARDI and industry regarding the status of Southern Garfish and the need for management action. A Garfish Working Group has been formed and a gear selectivity trial

is underway which will provide recommendations about increasing the minimum mesh size for haul nets in line with the legal minimum length for garfish. In addition the spatial netting closures have resulted in further concentration of fishing effort in the northern parts of the gulfs which may be having impacts on stock structure which are unknown. However it is widely agreed that garfish stocks are under pressure and management changes are required.

It was felt that the current level of take of Southern Garfish would be having a **severe (C3)** consequence on the population and that this will **occasionally (L5)** continue into the future. The risk rating was therefore **HIGH (15)**.

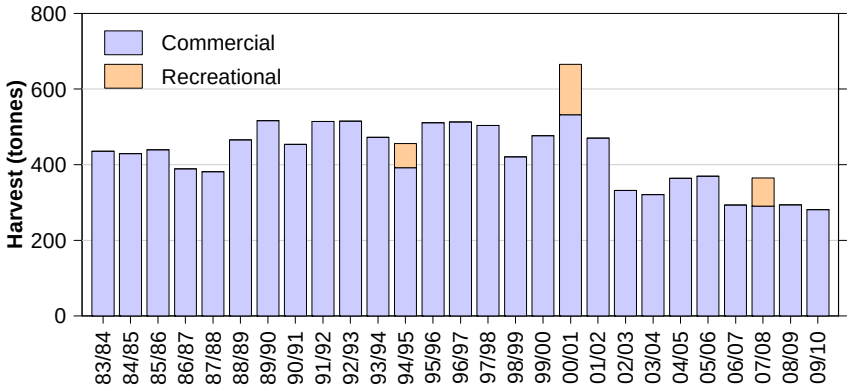


Figure 15. Total state-wide commercial and recreational catches of Southern Garfish.
Source: Fowler et al. (2010b)

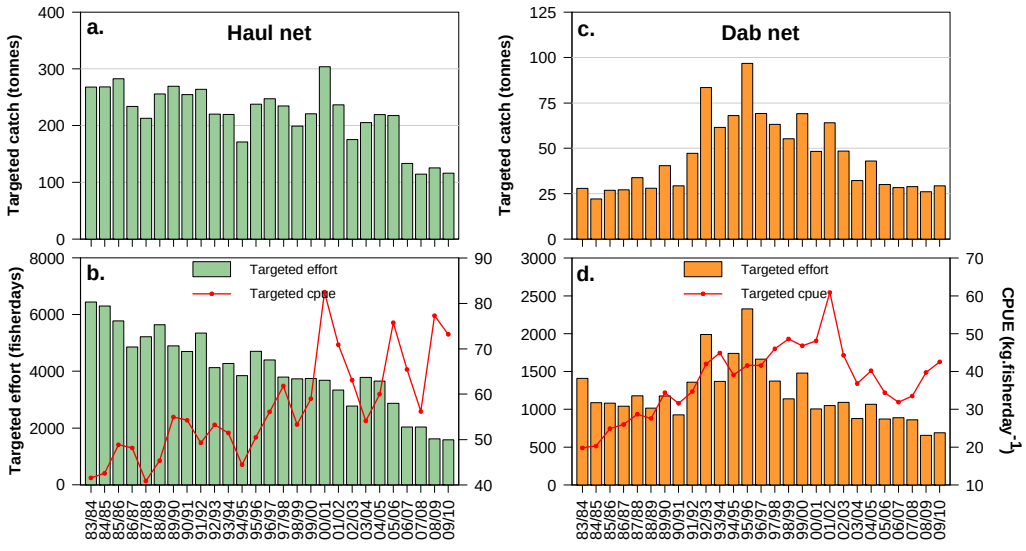


Figure 16. (a) Targeted haul net catch of Southern Garfish; (b) Targeted haul net effort and CPUE; (c) Targeted dab net catch; (d) Targeted dab net effort and CPUE.
Source: Fowler et al. (2010b)

Table 11. Comparisons between performance indicators and limit reference points for Southern Garfish 2009/10.
(Yellow shading breach of limit reference point, either positive or negative)

| Performance Indicator | Limit Reference Point | Breached? | Details |
|---|---|---|---|
| A. Total commercial catch | 3rd lowest/3rd highest | **Yes** | **Lowest** |
| | Greatest interannual change (±) | No | |
| | Greatest 3-year trend (±) | No | |
| B1. Targeted haul net effort | 3rd highest | No | |
| | Greatest interannual change (±) | No | |
| | Greatest 3-year trend (±) | No | |
| B2. Targeted dab net effort | 3rd highest | No | |
| | Greatest interannual change (±) | No | |
| | Greatest 3-year trend (±) | No | |
| C1. Targeted haul net CPUE | 3rd lowest/3rd highest | No | |
| | Greatest interannual change (±) | No | |
| | Greatest 3-year trend (±) | No | |
| C2. Targeted dab net CPUE | 3rd lowest/3rd highest | No | |
| | Greatest interannual change (±) | No | |
| | Greatest 3-year trend (±) | No | |

Source: Fowler et al. (2010b)

## Bronze & Dusky Whaler Shark

### Objective

- Ensure the Bronze Whaler and Dusky Whaler Shark resources are harvested within ecologically sustainable limits.

Meeting this objective should ensure sufficient breeding stock to continue recruitment at levels that will replenish what is taken by fishing, predation and other environmental factors, and thereby maintain the spawning stock at or above a level that minimizes the risk of recruitment over-fishing.

### ERA Risk Rating: Impact on breeding population (MODERATE)

Bronze Whaler (*Carcharhinus brachyurus*) and Dusky Whaler Shark (*C. obscurus*) are both taken in the marine scalefish fishery. However given difficulties in identification, both species are often recorded as bronze whalers, and so are considered together for the purposes of this report.

Both species are globally distributed through warm temperate waters usually between 20° and 40° latitude in both hemispheres (Jones 2008). Whilst current knowledge on stock structure in Australia is limited, populations of both species are found in South Australia and Western Australia (WA). Tagging studies have demonstrated that individuals move between the two States, however the level of connectivity is unknown (Huveneers, SARDI Aquatic Sciences, pers comm). One hypothesis is that they are part of the same stock (McAuley 2005) however this is yet to be broadly accepted.

Whaler sharks are subject to fishing mortality from a range of South Australian fisheries and are also taken as bycatch in Commonwealth managed fisheries operating within and adjacent to South Australian coastal waters.

An examination of catch and effort data shows two distinct and sharp increases in catch and effort over the last 10 years. The first occurred between 2000 and 2002, the years immediately following changes to the management of the school and gummy shark fisheries, for which management responsibility was transferred to the Australian Fisheries Management Authority (AFMA). The second increase was in 2009/10 which saw catches more than double. What has driven the most recent increase is unknown, but it coincides with significant increases in longline effort targeted at Snapper in Gulf St. Vincent.

The concerns surrounding whaler sharks relate to the biology of this species and the significant increase in targeted catch and effort. Like most shark species, whaler sharks are long-lived, slow-growing and have low fecundity. There are concerns regarding the status of the dusky whaler shark in WA following the cumulative impacts of sustained fishing pressure across the species range during the 1990's which has led to recruitment failure (McAuley, 2005). The status of Bronze Whaler Shark in WA is unknown. Knowledge gaps in distribution, stock structure, basic biology (reproduction, age and growth) and spatio-temporal dynamics complicate any fishery assessments of the South Australian whaler shark fisheries.

**Performance indicators:** The recent increases in targeted catch and effort triggered a total of nine limit reference points in the 2009/10 stock status report. These include breaches in total commercial catch, targeted longline effort, targeted shark net effort and targeted shark net CPUE as shown in Table 12.

Targeted effort has increased significantly in the last 12 months. It was felt that the current level of take of whaler sharks would be having **severe (C3)** consequences on the population and that it is **possible (L4)** to continue into the future. The risk rating was therefore **MODERATE (12)**.

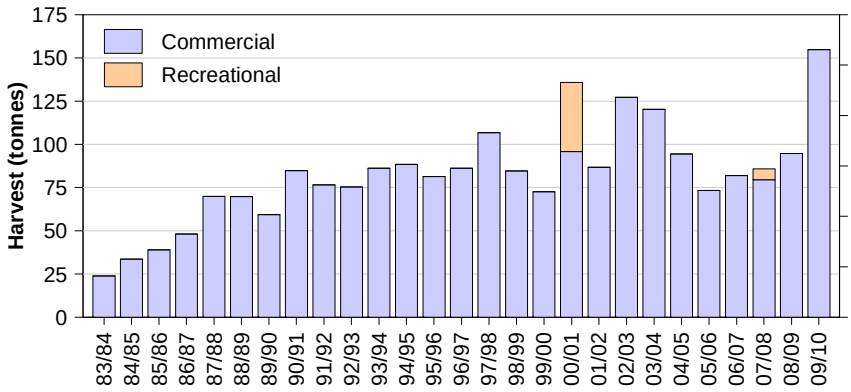

Figure 17. Total State-wide commercial and recreational catches of whaler sharks.

Source: Fowler et al. (2010b)

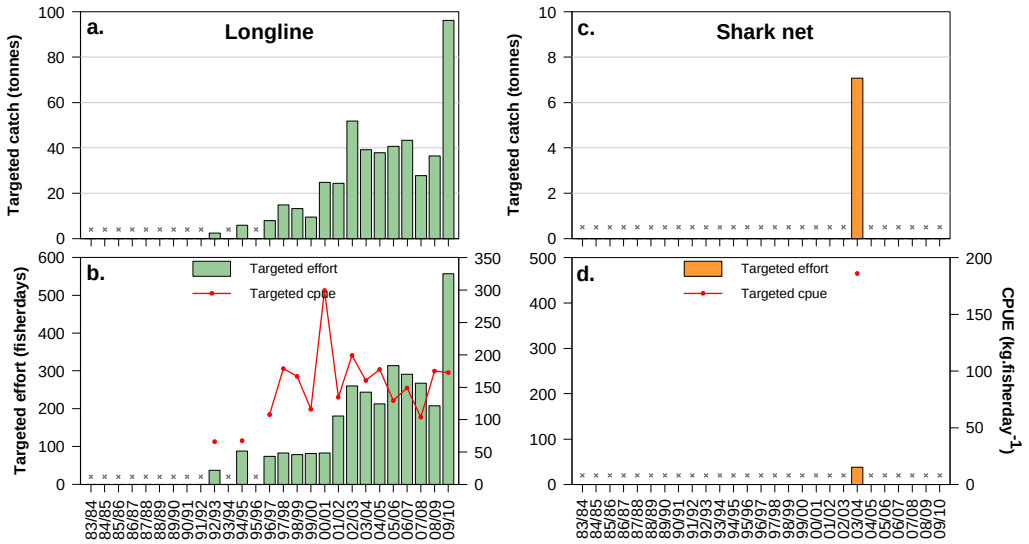


Figure 18. (a)Targeted longline catch of whaler sharks; (b) Targeted longline effort and CPUE; (c) Targeted shark net catch; (d) Targeted shark net effort and CPUE.
(Grey crosses indicate confidential data (<5 fishers))

Source: Fowler et al. (2010b)

Table 12. Comparisons between performance indicators and limit reference points for whaler sharks 2009/10.
(Yellow shading breach of limit reference point, either positive or negative)

| Performance Indicator | Limit Reference Point | Breached? | Details |
|---|---|---|---|
| A. Total commercial catch | 3rd lowest/3rd highest | **Yes** | **Highest** |
| | Greatest interannual change (±) | **Yes** | **Highest** |
| | Greatest 3-year trend (±) | **Yes** | **Highest** |
| B1. Targeted longline effort | 3rd highest | **Yes** | **Highest** |
| | Greatest interannual change (±) | **Yes** | **Highest** |
| | Greatest 3-year trend (±) | **Yes** | **Highest** |
| B2. Targeted shark net effort | 3rd highest | **Yes** | **2nd highest** |
| | Greatest interannual change (±) | No | |
| | Greatest 3-year trend (±) | **Yes** | **Highest** |
| C1. Targeted longline CPUE | 3rd lowest/3rd highest | No | |
| | Greatest interannual change (±) | No | |
| | Greatest 3-year trend (±) | No | |
| C2. Targeted shark net CPUE | 3rd lowest/3rd highest | **Yes** | **3rd highest** |
| | Greatest interannual change (±) | No | |
| | Greatest 3-year trend (±) | No | |

Source: Fowler et al. (2010b)

## Mud cockles

### Objective

- Ensure the mud cockle resource is harvested within ecologically sustainable limits.

Meeting this objective should ensure sufficient spawning stock to continue recruitment at levels that will replenish what is taken by fishing, predation and other environmental factors, and thereby maintain the spawning stock at or above a level that minimizes the risk of recruitment over-fishing.

### ERA Risk Rating: Impact on breeding population (MODERATE)

The commercial mud cockle fishery is based on the take of three species of mud cockle from the genus *Katelysia*. All three species are distributed throughout the sheltered bays and coasts across the entire range of the MSF.

Traditionally the mud cockle fishery was exploited by commercial marine scalefish fishers for use as bait and berley when fishing for King George Whiting. The main fishing areas were in the Port River and Kangaroo Island. However the fishery experienced a period of rapid expansion with the establishment of the human consumption market. The fishery catch first exceeded 50 tonnes in 1995/96, following which the fishery rapidly expanded to a peak of 375 tonnes in 2005/06. The majority of this catch was coming from the Port River and Coffin Bay. It was widely acknowledged that this level of expansion was not sustainable in the medium to long term.

A quota management system was implemented in 2008 which limited access and restricted catches in 5 locations and three management zones; (1) the Port River, (2) Coffin Bay, and (3) the West Coast (consisting of Smoky Bay, Streaky Bay and Venus Bay).

The quota management framework has now provided the ability to directly restrict catches. In an assessment of the fishery, Gorman et al. (2010) provided biomass estimates of each of the quota-managed zones and PIRSA has established a formal procedure for setting the total allowable catch (TAC) on an annual basis (Craig Noell, PIRSA, pers comm). Since the introduction of quota and in response to continued concern for stocks, catches have reduced significantly since 2007/08.

**Performance indicators:** There were two breaches of limit reference points recorded in 2009/10; the greatest decrease in the 3-year trend of catch and effort.

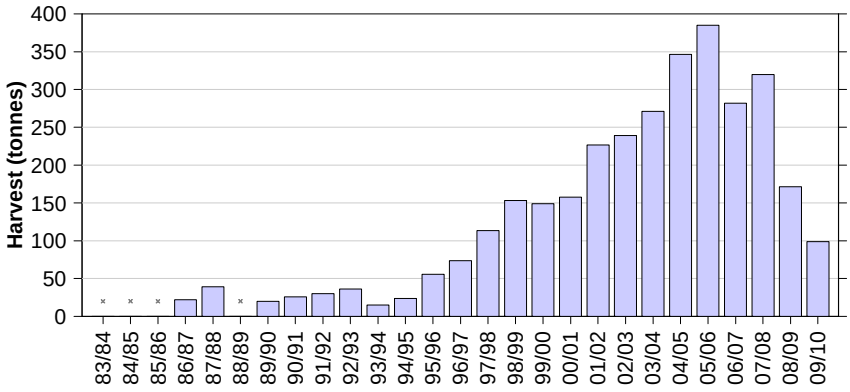


Figure 19. Total State-wide commercial catch of Mud Cockles.
(Grey crosses indicate confidential data (<5 fishers))
Source: Fowler et al. (2010b)

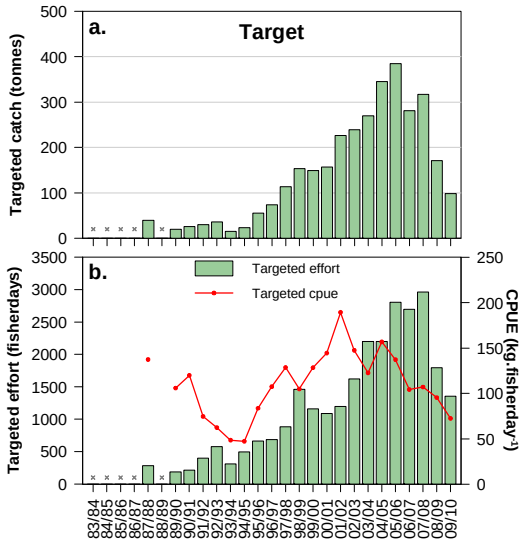


Figure 20. (a) Total Targeted catch of mud cockles; (b) Total targeted effort and CPUE.
(Grey crosses indicate confidential data (<5 fishers))
Source: Fowler et al. (2010b)

It was considered that the recent management initiatives had arrested the decline of the fishery and that recovery of the stocks was taking place based upon quantitative fishery independent assessments. The current level of take of mud cockles was assessed as having a **moderate (C2)** consequence on the population and that this is **likely (L6)** to continue into the future. The risk rating was therefore **MODERATE (12)**.

## Pipi (outside the Coorong beach)

### Objective

- Ensure the pipi resource is harvested within ecologically sustainable limits.

Meeting this objective should ensure sufficient spawning stock to continue recruitment at levels that will replenish what is taken by fishing, predation and other environmental factors, and thereby maintain the spawning stock at or above a level that minimizes the risk of recruitment over-fishing.

### ERA Risk Rating: Impact on breeding population (MODERATE)

Pipi or Goolwa cockle, *Donax deltoides*, is found on surf beaches from southern Queensland to Eyre Peninsula in SA (Kailola et al. 1993). The population found in the Coorong along the Sir Richard and Younghusband Peninsulas is likely to represent the largest population of the species found in Australia (King 1976).

The Coorong population is managed as a self-recruiting population under the Lakes and Coorong Fishery and is distinct from other stocks distributed throughout other South Australian ocean beaches (Sloan 2005). The populations outside the Coorong have historically had little or no management other than general restrictions on commercial fishing effort and fishing gear as well as recreational bag and boat limits which have historically been derived from limits determined for the Coorong fishery.

Specific localised concerns have arisen relating to a population of pipi found on Gunyah Beach on the west coast of Eyre Peninsula, and the same issues are relevant to other beaches where significant localised populations exist.

From a commercial marine scalefish perspective, the risks of over exploitation are mitigated to some extent by food safety laws that restrict the harvest of bivalve molluscs for human consumption from waters that are subject to regular monitoring. However, given the increasing cost of bait there is still commercial incentive to harvest this species particularly when available in high densities.

This issue has been identified within the local recreational and commercial fishing community and a number of actions have been agreed to, but are yet to be implemented. Reductions in the recreational possession limit and a commercial bait collection limit are considered sufficient to address the current concerns (Lianos Triantafillos, PIRSA, pers comm).

**Performance indicators:** There are no performance indicators for pipis.

As the proposed management changes had not been implemented, the assessment was based on current restrictions. Therefore, the current level of take of pipis (outside of the Coorong) was assessed as having a **severe (C3)** consequence on the population that is **possible (L4)** to continue into the future. The risk rating was therefore **MODERATE (12)**.

## Razorfish

### Objective

- Ensure the razorfish resource is harvested within ecologically sustainable limits.

Meeting this objective should ensure sufficient spawning stock to continue recruitment at levels that will replenish what is taken by fishing, predation and other environmental factors, and thereby maintain the spawning stock at or above a level that minimizes the risk of recruitment over-fishing.

### ERA Risk Rating: Impact on breeding population (MODERATE)

Razorfish (*Pinna bicolor)* is the largest bivalve found along Australia's south coast (Edgar 1997). Razorfish are distributed throughout tropical Australia down the west coast to the gulfs of South Australia and down the east coast to New South Wales. Razorfish predominantly inhabit shallow, intertidal seagrass beds, but are also found in subtidal seagrass habitats. The shells of razorfish are typically colonised by marine algae, sponges and other invertebrates.

Razorfish are a popular recreational target species, harvested predominantly for their meat, which is not unlike that of a scallop, for human consumption. Commercial MSF licence holders are permitted to harvest Razorfish, but they cannot be sold. Commercial fishers use razorfish as bait and berley when fishing for King George Whiting. In recent years commercial catches have exceeded 10 tonnes.

The sedentary nature of Razorfish and their preference for shallow, sheltered seagrass and soft sediments mean that they are readily accessible by both commercial and recreational fishers. There are concerns that high effort in some areas has caused localised depletion of stocks.

In 2007, PIRSA conducted a review of the fishery which resulted in a reduction of the recreational bag limit from 50 to 25 and the boat limit from 150 to 75 (when three or more people are on board). At the same time, long standing exemptions issued to commercial fishers allowing them to exceed the daily limit of 50 razorfish were removed.

**Performance indicators:** There are no performance indicators for razorfish.

It was acknowledged that whilst management action has helped reduce fishing pressure, this species is still susceptible to overfishing. It was agreed that the current take of razorfish would be having a **moderate (C2)** consequence on the population and that this will **occasionally (L5)** continue into the future. The risk rating was therefore **MODERATE (10)**.

## Australian Herring and Australian Salmon

### Objective

- Ensure the Australian Herring and Australian Salmon resources are harvested within ecologically sustainable limits.

### ERA Risk Rating: Impact on breeding population (LOW)

Both Australian Herring (*Arripis georgianus*) (also known as tommy rough) and Australian Salmon (*Arripis truttaceus*) are part of stocks that extend from WA to SA. Both species are targeted by both recreational and commercial fishers, with the majority of commercial catch being taken by haul nets and specialised Salmon (or purse seine) nets.

Australian Herring are understood to reside in SA coastal waters as juveniles before returning to WA to spawn. The catch and effort levels are strongly linked to availability. There has been a significant reduction in netting effort and available waters for haul netting since the early 2000's.

Australian Salmon catches have declined significantly since 2002/03. This is largely due to individual licence holders exiting the fishery and is also linked to areas of productive fishing grounds being closed to commercial net fishing.

**Performance indicators:** General performance indicators and reference points are in place for both species. The only breaches reported in 2009/10 related to targeted haul net CPUE for Australian Salmon which was the highest on record, was the greatest inter-annual change and was also the highest 3-year trend in CPUE.

The take of both Australian Herring and Australian Salmon was considered to be **minor (C1)** compared to the overall population size and that this level of take is **likely (L6)** to continue into the future. The risk rating was therefore **LOW (6)**.

## Yellowfin Whiting, Snook, Yellow-eye Mullet and wrasse spp.

### Objective

- Ensure the Yellowfin Whiting, Snook, Yellow-eye Mullet and wrasse resources are harvested within ecologically sustainable limits.

### ERA Risk Rating: Impact on breeding population (LOW)

Yellowfin Whiting (*Sillago schomburgkii*), Snook (*Sphyraena novaehollandiae*), Yellow-eye Mullet (*Aldrichetta forsteri*) and wrasse (*Notolabrus* spp.) are all harvested at relatively low levels. For both Snook and Yellow-eye Mullet much of the catch is non-targeted reflecting the lower demand and relatively low market value for these species. The recent low catches are mirrored in low levels of effort. Yellowfin Whiting are a higher

value species and are opportunistically targeted by haul net fishers when in sufficient abundance. There is a relatively small window of opportunity to target Yellowfin Whiting and catches are considered to be strongly linked with effort. A small but relatively stable fishery for wrasse (parrot fish) has been established since the late 1990's. Wrasse, predominantly blue throat (*Notolabrus tetricus*), are sold live for the Asian restaurant markets in Sydney and Melbourne where they can obtain a premium price. Some concern has been raised regarding the low minimum legal size limit and it is acknowledged that there is potential for depleting localised populations given the site attachment behaviour to reefs. However across the range of the fishery it was considered that fishing was having a minimal effect of the population.

**Performance indicators:** The following breaches of limit reference points were recorded in 2009/10:

- 2nd highest targeted haul net CPUE for Yellowfin Whiting;
- 3rd lowest total commercial catch of Snook; and
- The lowest commercial catch of mullet;

The take of Yellowfin Whiting, Snook, Yellow-eye Mullet and wrasse was considered to be **minor (C1)** compared to the overall population size and that this level of take is **likely (L6)** to continue into the future. The risk rating was therefore **LOW (6)**.

## Ocean Jackets

### Objective

- Ensure the ocean jacket resource is harvested within ecologically sustainable limits.

### ERA Risk Rating: Impact on breeding population (LOW)

Ocean Jackets (*Nelusetta ayraud*) are a common species of leatherjacket (family *Monacanthidae*) distributed throughout southern Australia. Juveniles are found inshore in sheltered bays and estuaries; however large adults restricted to deep water habitats (Edgar 1997). A specialised, deep water fish trap fishery has developed within the marine scalefish fishery, which is limited to a small number of licence holders.

The workshop participants noted that catches are largely driven by economic factors such as fuel price and market value. Market value has historically been subject to depression as a result of large volumes of Ocean Jackets from the Great Australian Bight Trawl Fishery.

**Performance indicators:** No limit reference points were breached.

The take of Ocean Jackets is considered to be **minor (C1)** compared to the overall population size and that this level of take is **likely (L6)** to continue into the future. The risk rating was therefore **LOW (6)**.

## Sand Crab and Blue Swimmer Crab (west coast)

### Objective

- Ensure the Sand Crab and blue swimmer crab (west coast) resources are harvested within ecologically sustainable limits.

### ERA Risk Rating: Impact on breeding population (LOW)

Sand Crab (*Ovalipes australiensis*), are distributed throughout the range of the marine scalefish fishery jurisdiction, although the majority of catch has traditionally come from the coffin bay region.

Blue Swimmer Crab (*Portunus pelagicus*) are permitted to be taken by MSF licence holders outside of gulf waters. The fishery outside gulf water is largely confined to the west coast, particularly Streaky Bay.

Effort controls appear to be effective at constraining effort in these two sectors where catch is strongly linked to effort.

**Performance indicators:** No limit reference points were breached for Sand Crab; however there are no performance indicators for Blue Swimmer Crab (west coast).

The take of Sand Crab and Blue Swimmer Crab (west coast) was considered to be **minor (C1)** compared to the overall population size and this level of take is **likely (L6)** to continue into the future. The risk rating was therefore **LOW (6)**.

## Octopus and cuttlefish

### Objective

- Ensure the octopus and Cuttlefish resources are harvested within ecologically sustainable limits.

### ERA Risk Rating: Impact on breeding population (LOW)

There are low levels of catch and effort directed at both octopus (Family *Octopodidae*) and Cuttlefish (*Sepia apama*). There is some targeting of octopus using shelter or habitat pots which are largely unbaited and rely upon the target species to use the pot as a shelter or as a home. Cuttlefish were taken in significant quantities during the mid-late 1990's, however this effort was concentrated on the spawning aggregation at Point Lowly, the largest known aggregation of its kind. The majority of this area is now fully protected from commercial and recreational fishing for squid and cuttlefish.

**Performance indicators:** No limit reference points were breached for

cuttlefish; however there are no performance indicators for octopus.

The take of octopus and Cuttlefish was considered to be **minor (C1)** compared to the overall population size and that this level of take is **likely (L6)** to continue into the future. The risk rating was therefore **LOW (6)**.

**Bloodworms**

**Objective**

- Ensure the Bloodworm resources are harvested within ecologically sustainable limits.

**ERA Risk Rating: Impact on breeding population (LOW)**

Bloodworms are harvested by marine scalefish and miscellaneous fishery licence holders for personal use and are also sold as recreational bait. Bloodworms have a limited time where they are susceptible to commercial harvest, generally associated with the new moon during winter, the worms aggregate to spawn and can be found in very high densities on the surface when they are then caught using dab nets. The majority of the catch is taken from the Port River, which is well known for its Bloodworm 'run' by commercial and recreational fishers. Bloodworms are also taken by recreational fishers. Whilst there is some concern about localised depletion, their availability for capture is considered very limited, providing adequate stock protection. The majority of catch is taken by miscellaneous fishery licence holders.

During the workshop it was noted that similar Bloodworm spawning activity occurs in a number of other areas across the state.

**Performance indicators:** There are no performance indicators for Bloodworms.

The take of Bloodworms was considered to be **minor (C1)** compared to the overall population size and that this level of take is **likely (L6)** to continue into the future. The risk rating was therefore **LOW (6)**.

### 4.1.2 Secondary and by-product species

Due to the variety of gear types, target species and habitats fished, a variety of by-product species are also captured in the MSF. These include rays, skates, sharks, and a number of finfish species. Workshop participants noted that a number of these species were not regarded as by-product, but as a species to target when fish were available and market conditions were favourable. Therefore the heading was amended to *Secondary and by-product species*.

## Sharks, skates & rays

### Objective

- Ensure the shark, skate and ray resources are harvested within ecologically sustainable limits.

### ERA Risk Rating: Impact on breeding population (NEGLIGIBLE)

A number of species of shark, skate and rays are taken within the fishery. A significant fishery for Gummy Shark (*Mustelus antarcticus*) and School Shark (*Galeorhinus galeus*) existed as a state-managed fishery until management was transferred to the Australian Fisheries Management Authority (AFMA) under a Memorandum of Understanding between the Commonwealth of Australia and the States of South Australia, Tasmania and Victoria in December 2000. The take of these species by state fishery licence holders is managed as a bycatch fishery with daily limits in place for both species. Other species taken include Whiskery Shark (*Furgaleus macki*), Broadnose (seven gill) Shark (*Notorynchus cepedianus*), Hammerhead Shark (*Hphyrna zygaena*), Wobbegong (*Orectolobus ornatus*) and Eagle Ray (*Myliobatis australis*).

**Performance indicators:** There are performance indicators for Gummy Shark that relate to total catch. However these indicators are largely irrelevant for monitoring stock status given the minor take by SA licence holders in comparison to the AFMA managed fishery. Rays and skates are collectively reported on and indicators relating to total catch are reported on. No reference points relating to sharks, skates and rays were breached in 2009/10.

The take of other sharks, skates and rays was considered to be **negligible (C0)** compared to the overall population sizes and that this level of take is **likely (L6)** to continue into the future. The risk rating was therefore **NEGLIGIBLE (0)**.

## Western Striped Grunter, trevally, leatherjackets and Mulloway

### Objective

- Ensure the Western Striped Grunter, trevally, leatherjacket and Mulloway resources are harvested within ecologically sustainable limits.

### ERA Risk Rating: Impact on breeding population (NEGLIGIBLE)

There are a number of secondary target and by-product finfish species targeted opportunistically and taken as bycatch of other targeted fishing activities. Western Striped Grunter *(Pelates octolineatus)*, Silver Trevally *(Pseudocaranx georgianus)*, leatherjackets *(*Family Monacanthidae*)* and Mulloway *(Argyrosomus japonicus)* are four of these species which are also reported on in the annual stock status report.

**Performance indicators:** Performance indicators for these species relate to

total catch only. The only breach recorded in 2009/10 was for the 3rd lowest total commercial catch of leatherjackets.

The take of these species was considered to be **negligible (C0)** compared to the overall population sizes and that this level of take is **likely (L6)** to continue into the future. The risk rating was therefore **NEGLIGIBLE (0)**.

## Red mullet and flathead

### Objective

- Ensure the Red Mullet and flathead resources are harvested within ecologically sustainable limits.

### ERA Risk Rating: Impact on breeding population (NEGLIGIBLE)

Red mullet (*Upeneichthys lineatus*) and flathead (Family Platycephalidae) are taken incidentally during fishing operations targeted at other species such as King George Whiting. A number of different flathead species are likely to be taken including Sand Flathead (*Platycephalus bassensis*), Rock Flathead (*Platycephalus laevigatus*) and Dusky Flathead (*Platycephalus fuscus*). All are retained, and in the case of flathead can return good prices.

**Performance indicators:** There are no performance indicators for red mullet and flathead.

The take of these species was considered to be **negligible (C0)** compared to the overall population sizes and that this level of take is **likely (L6)** to continue into the future. The risk rating was therefore **NEGLIGIBLE (0)**.

## Other schedule 1 and non-schedule 1 species

### Objective

- Ensure all other fish resources are harvested within ecologically sustainable limits.

### ERA Risk Rating: Impact on breeding population (NEGLIGIBLE)

A number of other species are permitted to be harvested commercially and a number of species not listed in Schedule 1 are taken infrequently within the fishery. These species are sometimes landed as by-product.

**Performance indicators:** There are no performance indicators for these species.

The take of these species was considered to be **negligible (C0)** compared to the overall population sizes and that this level of take is **likely (L6)** to continue into the future. The risk rating was therefore **NEGLIGIBLE (0)**.

## 4.2 Non-Retained Species

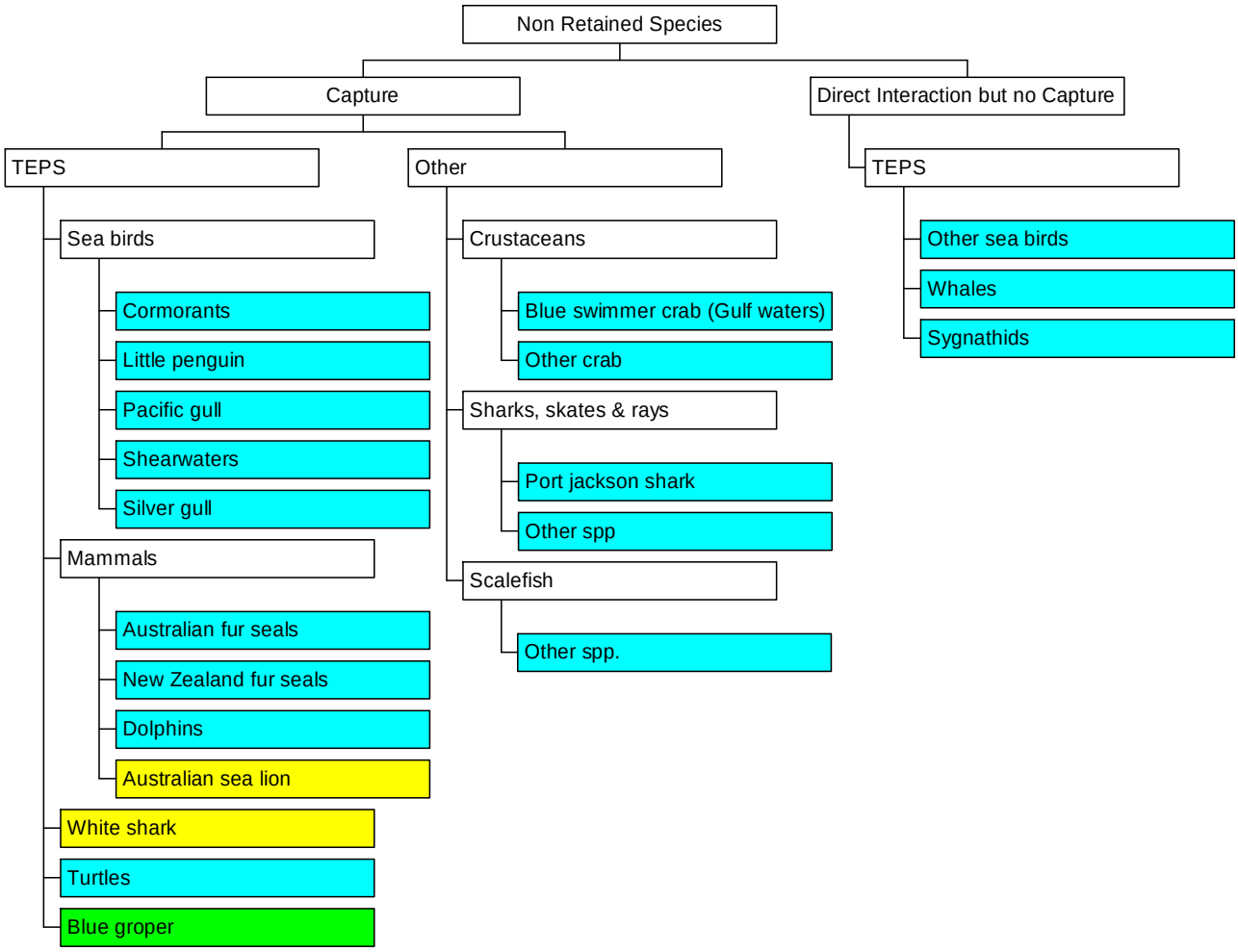


Figure 21. Component tree for non-retained species
(TEPS = Threatened, Endangered and Protected Species)

### 4.2.1 Captured by Gear

**Threatened, endangered and protected species**

There are a number of threatened, endangered and protected species (TEPS) listed under State and/or Australian Government legislation. These species are not permitted to be taken and must be released immediately if accidental capture occurs, in addition all interactions must be reported.

All licence holders in South Australian commercial fisheries are required to record interactions with TEPS using a 'wildlife interaction' logbook, which are then provided to SARDI Aquatic Sciences.

**Cormorants, Little Penguin, Pacific Gull, Short-tailed Shearwater, Australian Fur Seal, New Zealand Fur Seal, dolphins and turtles**

**Objective**

- Minimise fishery interactions with threatened, endangered, and protected species.

**ERA Risk Rating: Impact on breeding populations (NEGLIGIBLE)**

A number of different TEPS are captured in the marine scalefish fishery. Whilst the majority of captures result in the release of the animal alive, a small number of mortalities have been recorded (Knight 2009). Species that are known to be taken by fishing gear include; cormorants (Family Phalacrocoracidae), Little Penguin (*Eudyptula minor*), Pacific Gull (*Larus pacificus*), Short-tailed Shearwater (*Puffinus tenuirostris),* Silver Gull (*Larus novaehollandiae*), Australian Fur Seal (*Arctocephalus pusillus*), New Zealand Fur Seal (*Arctocephalus forsteri*), dolphins (Family Delphinidae) and marine turtle, i.e Leatherback Turtle (*Dermochelys coriacea*).

**Performance indicators:** There are no performance indicators for these species, however all interactions are required to be recorded in the TEPS logbook.

Given the number of interactions is very low, and mortalities are rare, the impact on these species' populations was considered to be **negligible (C0)** and that this will **occasionally (L5)** occur into the future. The risk rating was therefore **NEGLIGIBLE (0)**.

**Australian Sea Lion**

**Objective**

- Minimise fishery interactions with threatened, endangered, and protected species.

**ERA Risk Rating: Impact on breeding populations (MODERATE)**

Australian Sea Lions (*Neophoca* cinerea) as with other pinnipeds are susceptible to capture in gear used within the commercial marine scalefish fishery, particularly large mesh gill nets. Australian Sea Lions (ASL) are listed as a *Threatened* species under the category of *Vulnerable* under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The shark gillnet sector of the AFMA-managed Southern and Eastern Scalefish and Shark Fishery (SESSF) was identified as a fishery that poses the greatest risk to ASL populations given the significant overlap with areas fished and the foraging range of ASL (Goldsworthy et al. 2007). Goldsworthy et al. (2009) published a report to the Australian Government Department of the Environment, Water, Heritage and the Arts (DEWHA) detailing the risks to the ASL populations from a variety of natural and anthropogenic factors,

including the SA Marine Scalefish Fishery. The elevated concern for the viability of ASL populations relates to their unique population structuring and low reproduction rates. It is estimated that even slightly elevated levels of mortality through fishing pressure may result in a quasi extinction of some sub populations (Goldsworthy et al. 2007).

The MSF allows the use of similar gear as the gillnet fishery of the SESSF (large mesh nets, mesh size >15cm). However the MSF is considered to be a lesser risk that that of the SESSF. With the loss of school and gummy shark as target species in 2000, large mesh gillnet effort has declined dramatically.

Industry members present at the workshop expressed some concern regarding the modelling used by Goldsworthy, and considered natural mortality from White Sharks would be higher than that of commercial fishing effort from the marine scalefish fishery.

**Performance indicators:** There are no performance indicators for this species, however all interactions are required to be recorded in the TEPS logbook. No interactions were recorded in recent years.

Given the species characteristics and the potential fishery impacts, the impact on the population was considered to be **major (C4)** and that the likelihood of this occurring into the future was **rare (L2)**. The risk rating was therefore **MODERATE (8)**.

## White Shark

### Objective

- Minimise fishery interactions with threatened, endangered, and protected species.

### ERA Risk Rating: Impact on breeding populations (MODERATE)

White Shark (*Carcharodon carcharias*), are distributed throughout temperate and sub-tropical regions in both northern and southern hemispheres. However, it appears to be relatively scarce compared to most other widely distributed species, being most frequently reported from South Africa, the Great Australian Bight, northern California and north eastern United States (Last and Stevens, 1994).

Significant measures have been taken to ensure the conservation of White Shark worldwide and are fully protected in Australia. The White Shark is listed on Appendix II on the Convention on International Trade in Endangered Species of Fauna and Flora (CITES), which aims to prevent the highly lucrative illegal trade in White Shark products such as teeth, jaws and fins. In 2002 White Shark was listed on Appendices I and II of the Convention on Migratory Species (CMS). Furthermore a recovery plan for this species was implemented in 2002 in accordance with the guidelines for recovery plans

under the EPBC Act. This recovery plan is currently being reviewed and the new plan will be released shortly.

Interactions with White Sharks and the SA MSF continue today with unintentional capture and interactions being recorded in association with longline and handline fishing activities. Interactions are likely to continue or perhaps increase as White Shark numbers increase in line with the recovery plan. The majority of interactions do not result in capture or animals are released alive, however mortalities have been recorded in recent years.

Fisheries Officers have detected illegal fishing activities in recent years, resulting in a number of successful prosecutions. It appears there is still a demand for White Shark products such as teeth and jaws.

There are some industry reports that White Sharks are becoming more common and interactions are likely to continue. However the workshop noted that progress had been made in regard to gear design in order to allow escape of captured shark.

**Performance indicators:** There are no performance indicators for this species, however all interactions are required to be recorded in the TEPS logbook. Low levels of interactions were recorded in recent years.

Given the high conservation status of this species and the increasing trend of longline effort, the impact on the population was considered to be **moderate (C2)** and that this will **occasionally (L5)** occur into the future. The risk rating was therefore **MODERATE (10)**.

## Western Blue Groper

### Objective

- Minimise fishery interactions with threatened, endangered, and protected species.

### ERA Risk Rating: Impact on breeding populations (LOW)

Western Blue Groper (*Achoerodus gouldii*) is a species of wrasse (Family Labridae) which is found from Western Australia to Victoria (Edgar 1997). Western Blue Groper has an elevated conservation status in SA; commercial fishers are not permitted to take this species and there are significant area closures for the recreational sector. Despite the fact that Western Blue Groper are not permitted to be taken, small quantities are consistently taken by commercial fishers.

**Performance indicators:** There are no performance indicators for Western Blue Groper.

Despite the illegal take, the impact of fishing Western Blue Groper was considered to be **minor (C1)** compared to the overall population size and that

this level of take is **likely (L6)** to continue into the future. The risk rating was therefore **LOW (6)**.

**Other species – crustaceans, sharks, skates, rays and other scalefish species**

**Objective**

- Minimise fishery impacts on bycatch species.

**ERA Risk Rating: Impact on breeding populations (NEGLIGIBLE)**

A number of other species are captured and released in the MSF, including crabs, sharks, skates, rays and other scalefish species. Blue Swimmer Crabs (*Portunus pelagicus*) are encountered by haul nets in Spencer Gulf and Gulf St. Vincent where commercial take is restricted to quota holders and can only be taken by lift nets and specialised blue crab pots. However in most cases captured blue crabs are easily released alive with little damage. Sharks, skates and rays are encountered with numerous different gear types, however these species including Port Jackson Shark are readily released alive and in good condition. Other species of scalefish such as toadfish (*Tetractenos* spp.) are also taken but discarded.

**Performance indicators:** There are no performance indicators for these species.

The level of interactions with crabs, sharks, skates, rays and other scalefish species are likely to have minor levels of unintentional mortalities however those mortalities in the context of the entire populations are considered minor. As such the interaction with these species was considered to be **negligible (C0)** and that this is **likely (L6)** to occur into the future.

### 4.2.2 Direct Interaction but no capture

Sometimes there may be a direct interaction, but no capture of a TEPS. All licence holders in South Australian commercial fisheries are required to record all interactions with TEPS using a 'wildlife interaction' logbook, however in some cases the interaction may not be observed as that interaction occurs underwater or at a distance from the immediate fishing operation.

**Other seabirds, whales and syngnathids**

**Objective**

- Avoid fishery interactions with threatened, endangered and protected species.

**ERA Risk Rating: Impact on breeding populations (NEGLIGIBLE)**

There are a variety of seabirds that may encounter fishing vessels and gears of the marine scalefish fishery; however no capture of these species has been recorded. Similarly with whales, there may be close encounters with vessels, however there is no capture. Syngnathids (seahorses, pipefish, pipehorses and seadragons) are known to occur in sheltered seagrass and algal habitats throughout the range of the Marine Scalefish Fishery, particularly in gulf waters where they are sometimes taken as bycatch in prawn trawl nets. It is likely that haul net operations would encounter a number of species of syngnathids, however these have not been recorded in TEPS logbooks, and no captures were recorded during a recent bycatch study (Fowler et al. 2009a).

**Performance indicators:** There are no performance indicators for these species.

It was considered that the impact on other seabirds, whales and syngnathid populations was **negligible (C0)** and that this is **likely (L6)** continue into the future. The risk rating was therefore **NEGLIGIBLE (0)**.

## 4.3 General Ecosystem Impacts of Fishing

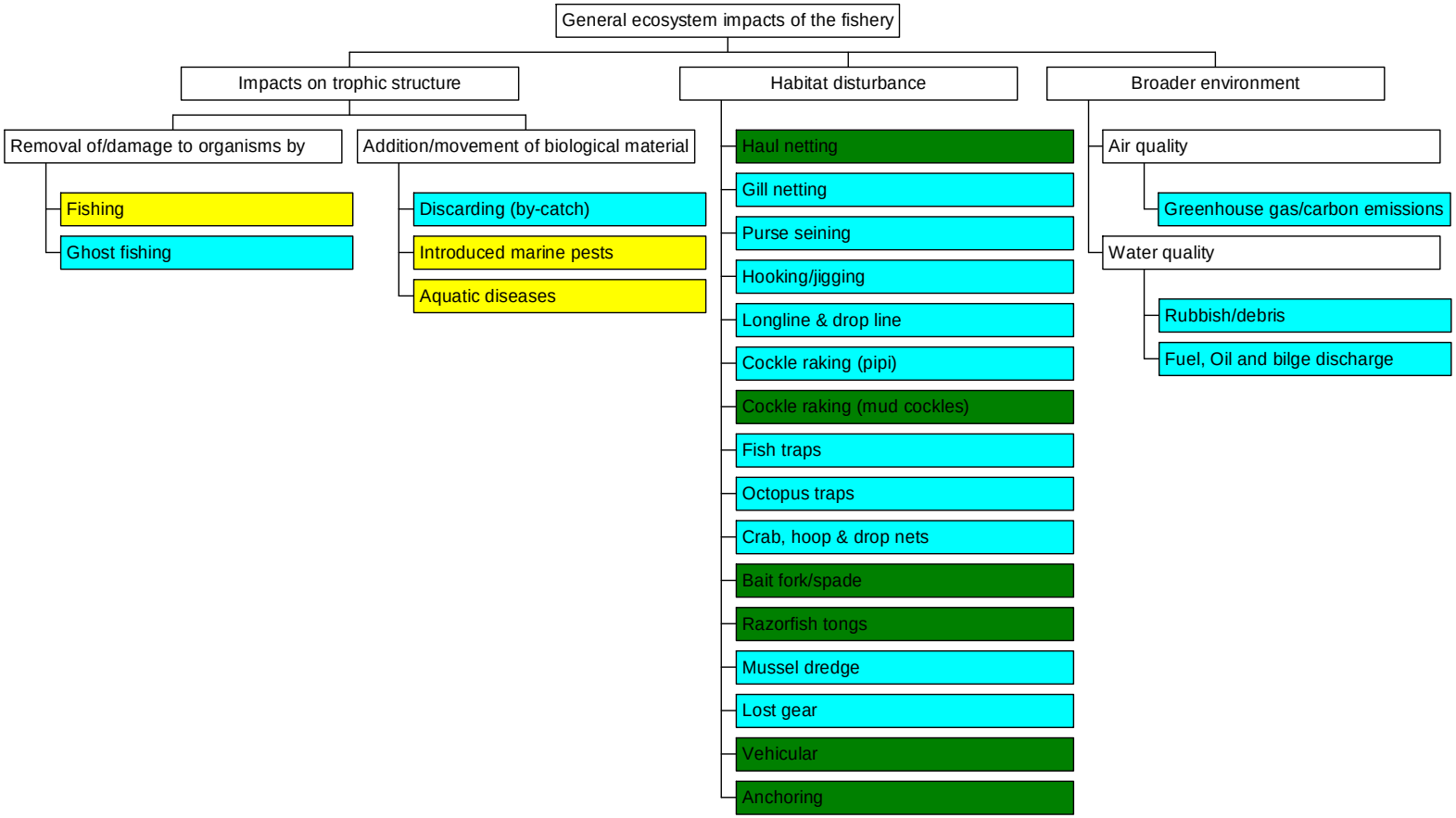


Figure 22. Component tree for general ecosystem impacts of fishing

### 4.3.1 Impacts on Trophic Structure

**Objective**

- Minimise fishery impacts on the ecosystem.

In some fisheries there may be trophic impacts caused by the removal of high volumes of certain species. Research on trophic structure related to South Australian fisheries (including the MSF) is not readily available.

Performance indicators have not been developed to monitor fishery impacts on the trophic structure, and are therefore not reported in this section.

**Removal of/damage to organisms by fishing**

**ERA Risk Rating: Fishery impacts on ecosystems (MODERATE)**

As knowledge of the trophic structure of the marine ecosystem of which marine scalefish species are a part is minimal, assessing the risk is problematic. A range of species are taken from top order predators, to filter feeding bivalves. It is acknowledged that the biomass of target species and some non-target species have been reduced due to fishing pressure. However it is difficult to determine whether this has affected the function of the ecosystem.

Workshop participants were somewhat divided on this issue. The majority believed that the fishery has had a **moderate (C2)** consequence on the ecosystem and that this was **likely (L6)** to continue into the future; giving a risk rating of **MODERATE (12)**. Some participants believed that the fishery has had a **severe (C3)** consequence on the ecosystem and that it was **possible (L4)** that this would continue in the future; giving a risk ranking of **MODERATE (12)**.

**Removal of/damage to organisms by ghost fishing**

**ERA Risk Rating: Fishery impacts on the ecosystem from ghost fishing (NEGLIGIBLE)**

The impacts of the continued fishing of lost gear or ‘ghost fishing’ may be significant in some fisheries and is often difficult to quantify. Industry members stated that gear loss is minimal in the fishery, and what gear is lost would not have the ability to continue fishing for any considerable period.

It was agreed that the consequence of ghost fishing on the ecosystem is **negligible (C0)** and this will **likely (L6)** occur into the future. Thus the risk rating was **NEGLIGIBLE (0)**.

**Addition / movement of biological material caused by discarding bycatch**

**ERA Risk Rating: Fishery impacts on the ecosystem from discarding of bycatch (NEGLIGIBLE)**

Bycatch discarding does occur in the MSF and there are observed interactions with bird species and other predators and scavengers. However, based on industry knowledge and some recent bycatch work in the fishery (Fowler et al. 2009b) the current level of bycatch discarding is considered minor. It was considered that the impact on the ecosystem from bycatch discarding was **negligible (C0)** and that it is **likely (L6)** to continue into the future. The risk rating was therefore **NEGLIGIBLE (0)**.

**Addition / movement of biological material caused by the introduction of marine pests / aquatic diseases**

**Objective**

- Minimise potential for introduction/translocation of exotic plants and animals by the fishery.

**ERA Risk Rating: Fishery impacts on the ecosystem by the introduction of marine pests / aquatic diseases (MODERATE)**

The likelihood of fishing vessels introducing or translocating marine pests or aquatic diseases is low; however the spatially unrestricted nature of the fishery poses a heightened risk. The use of imported bait was noted as a potential risk by workshop participants. It was considered that the impact on the ecosystem due to the introduction of marine pests or aquatic diseases by the MSF could be **severe (C3)** but that under current practices and circumstances this is **unlikely (L3)** to occur. The risk rating was therefore **MODERATE (9)**.

### 4.3.2 Habitat disturbance

**Habitat disturbance**

**Objective**

- Minimise fishery impacts on ecosystem through habitat disturbance.

**ERA Risk Rating: Fishery impacts on the marine ecosystem from habitat disturbance by haul netting, cockle raking (mud cockles), bait digging (bait spade/fork), Razorfish collection (razorfish tongs), vehicular access and anchoring (LOW)**

It was recognised that the listed gear types have the potential to alter and disturb the environments in which they are operated in. Vehicular access on

beaches and in the intertidal zone impacts on benthic invertebrates and also on seagrasses and other algae. The collection of Razorfish was considered as impacting on habitat as Razorfish provide suitable habitat for numerous species which colonise the hard shell surface below and above the benthos. Anchoring can also damage habitats such as seagrasses and reefs.

It was agreed that the consequence of habitat disturbance by these actions on the marine ecosystem was **minor (C1)** and that this is **likely (L6)** occur into the future. Thus the risk rating was **LOW (6)**.

**Habitat disturbance**

**Objective**

- Minimise fishery impacts on ecosystem through habitat disturbance.

**ERA Risk Rating: Fishery impacts on the marine ecosystem from habitat disturbance by gill netting, purse seining, hooking/jigging, cockle raking (pipi), fish traps, octopus traps, crab, hoop and drop nets, mussel dredge and lost gear (NEGLIGIBLE).**

None of the various types of fishing gears above were considered to be capable of causing measurable damage to habitats within the marine ecosystem. It was agreed that the consequence of habitat disturbance by these gear types/actions on the marine ecosystem was **negligible (C0)** and that this is **likely (L6)** to occur into the future. Thus the risk rating was **NEGLIGIBLE (0)**.

### 4.3.3 Broader Environment

**Air Quality – greenhouse gas / carbon emissions**

**ERA Risk Rating: Fishery impacts on the air quality of the broader environment from greenhouse gas / carbon emissions (NEGLIGIBLE)**

When considered in the context of manufacturing and other industries the MSF was considered to be an insignificant contributor to reduced air quality and associated issues. It was agreed that the consequence of greenhouse gas / carbon emissions by the MSF on the air quality of the broader environment was **negligible (C0)** and that this is **likely (L6)** to occur into the future. Thus the risk rating was **NEGLIGIBLE (0)**.

**Water Quality - Rubbish / debris**

**ERA Risk Rating: Fishery impacts on the water quality of the broader environment from rubbish / debris (NEGLIGIBLE)**

There are strict regulations regarding dumping at sea, which are generally well adhered to. It was considered that any debris from fishing is likely to have negligible impacts. It was agreed that the consequence of rubbish / debris by the MSF on the water quality of the broader environment was **negligible (C0)** and that this is **likely (L6)** to occur into the future. Thus the risk rating was **NEGLIGIBLE (0)**.

**Water Quality – fuel, oil and bilge discharge**

**ERA Risk Rating: Fishery impacts on the water quality of the broader environment from fuel, oil and bilge discharge (NEGLIGIBLE)**

Due to the relatively small number of operators and the compliance of operators with State legislation on pollution, it was agreed that the consequence of fuel, oil and bilge discharge by the MSF on the water quality of the broader environment was **negligible (C0)** and that this is **likely (L6)** to occur into the future. Thus the risk rating was **NEGLIGIBLE (0)**.

## 4.4 Community

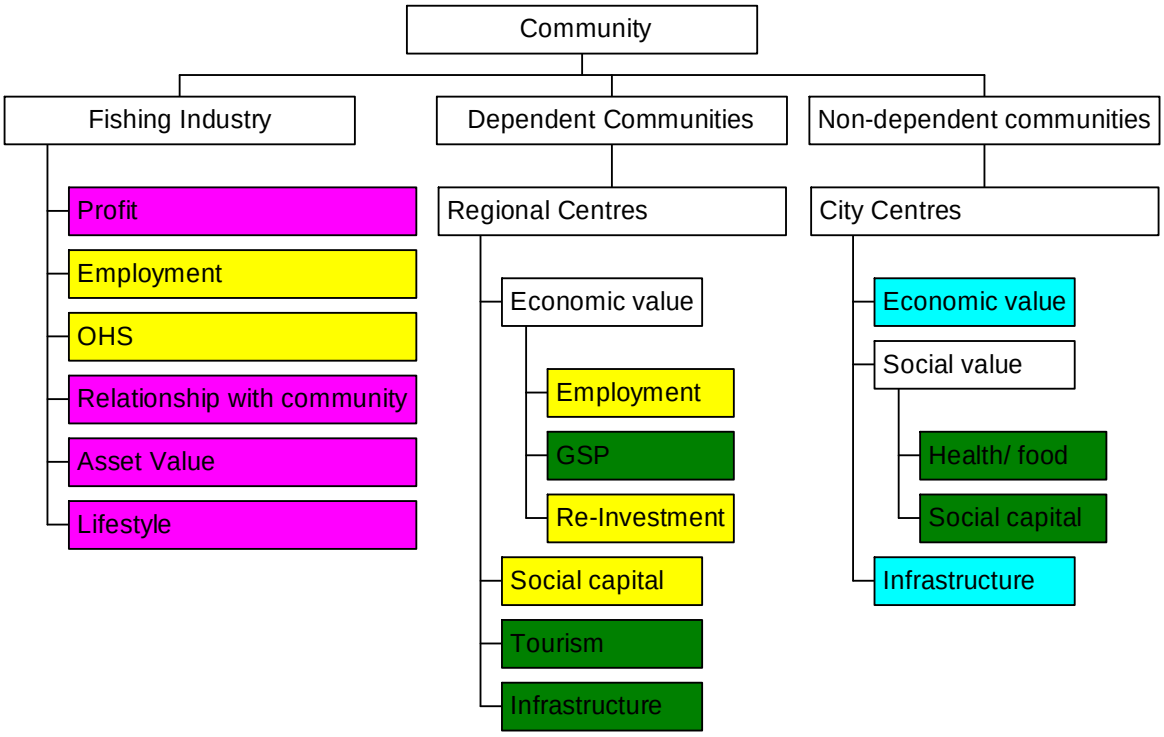


Figure 23. Component tree for community

Due to the nature of the 'Fishing industry' branch of the Community component tree, it was not possible to assign a risk rating to each component using the consequence and likelihood tables. Rather, issues (or components) were assigned a risk rating by industry based upon their overall feel for how important an issue was. Thus, consequence and likelihood values are not shown in Section 4.4.1 below.

Where possible performance indicators are included, however limit reference points are not generally used to monitor these aspects of the fishery.

### 4.4.1 Fishing Industry Community

**Broad objective**

- Maintain a flow of benefit from the fishery to the broader community.

**Profit**

**ERA Risk Rating: The importance of profit to the fishing industry (HIGH)**

Profit is of primary importance to licence holders and is one of the key factors affecting the viability of the fishery; without profit, businesses are not sustainable. EconSearch Pty Ltd conducts annual detailed analyses of the economic status of the MSF. There are a number of ways to measure profitability within the fishery, two measures are provided here; boat business

profit and profit at full equity.

Boat business profit can be defined as total boat income, less total boat cash costs, less depreciation and less owner-operator and unpaid family labour (Econsearch 2010). In 2008/09, fishers with a line entitlement only reported an average boat business profit of around -$19,000 which was 83 % lower than the fishery as a whole. Fishers with both a net and line entitlement reported an average boat business profit that was significantly greater than the fishery average, approximately $22,000 (Econsearch 2010).

Profit at full equity is a measure of the profitability of an individual licence holder, assuming the licence holder has full equity in the operation (EconSearch 2010). It is a useful absolute measure of the economic performance of fishing firms. For all boats profit at full equity in 2008/09 (almost $1,500) was greater than the previous year (-$3,000) (EconSearch 2010).

**Performance indicators:** A report on the economic performance of the fishery is produced annually. The report provides measures of profitability; however no targets are set out in the current management plan other than a limit reference point of '*a declining trend in annual return on investment over a three year period*'.

## Employment

**ERA Risk Rating: The importance of employment to the fishing industry (MODERATE)**

The provision of employment by MSF licence holders is considered important to the fishing industry. Whilst most licence holders operate as owner/operators and dependence upon external employees is limited there are many operators who rely upon employees. Some industry members said finding employees was not that hard, yet others identified the mining sector as competition for suitable employees.

In 2008/09, the MSF was responsible for the direct employment of around 607 full-time equivalent (fte) jobs (EconSearch 2010).

**Performance indicators:** A report on the economic performance of the fishery is produced annually. The report provides measures of employment, both direct and indirect; however no targets are set out in the current management plan other than a limit reference point of '*a declining trend in annual return on investment over a three year period*'.

## Occupational health, safety and welfare

**ERA Risk Rating: The importance of good OHS&W practices to the fishing industry (MODERATE)**

The safety of licence holders and crew during fishing activities is paramount for those involved in the fishery. There are significant occupational, health, safety and welfare (OHS&W) standards and requirements for training, activities and record keeping that is enforced by the Department for Transport, Energy and Infrastructure (DTEI). It is important for the industry to maintain adherence to existing OHS&W requirements and procedures.

## Relationships with community

**ERA Risk Rating: The importance of positive relationships with the community to the fishing industry (HIGH)**

Building and maintaining positive relationships with the broader community was identified as being important for the fishery. Historically commercial fishers have been held in high regard and their sea-going expertise with has been called upon in many search and rescue operations. Industry members stated that they wanted to feel part of the community and be a valued member of the community. It was noted that there are many instances of conflict between commercial and recreational fishers.

**Performance indicators:** No performance indicators are in place for social impacts. A report on the economic performance of the fishery is produced annually which also reports on the time MSF licence holders spend on community-support activities such as conservation, attendance of meetings and community volunteering (Econsearch 2010). This information may provide a measure of social capital for future monitoring.

## Asset value

**ERA Risk Rating: The importance of asset value to the fishing industry (HIGH)**

The importance of maintaining the value of assets was rated highly by the industry. Assets may include fishery licences, vessels, businesses, gear, etc. For many fishers, their assets are their 'superannuation fund'.

Average total investment in fishing gear and licence in the Marine Scalefish Fishery in 2008/09 was estimated to be $342,033 per fisher (EconSearch 2010). This value included the licence holder's estimate of the value of their licence (approximately $210,000) and estimated investment in boats and fishing gear (approximately $130,000 per licence) (EconSearch 2010).

**Performance indicators:** A report on the economic performance of the fishery is produced annually. The report provides measures of profitability; however no targets are set out in the current management plan other than a limit reference point of '*a declining trend in annual return on investment over a three year period'*.

## Lifestyle

**ERA Risk Rating: The importance of lifestyle to the fishing industry (HIGH)**

Industry members considered the lifestyle of a commercial fisher was of high importance, stating that they were unlikely to change professions despite similar or high wages in other employment.

### 4.4.2 Dependent Communities – Regional Centres

**Broad objective**

- Maintain a flow of benefit from the fishery to the broader community.

## Economic value of employment

**ERA Risk Rating: Contribution by the fishery to the economic value of employment in regional centres (MODERATE)**

In 2008/09, the MSF was responsible for the direct employment of an estimated 526 fte jobs, and associated activities created employment for a further 81 fte's State-wide. Flow-on business activity was estimated to generate a further 855 jobs State-wide (EconSearch 2011).

The impact of employment loss would be high in a number of small regional towns, where fishing employs a considerable proportion of the population. However it was noted that those impacts would be lower in places such as Port Lincoln where the MSF is only a minor employer.

**Performance indicators:** A report on the economic performance of the fishery is produced annually. The report provides measures of employment; however no targets are set out in the current management plan other than a limit reference point of '*a declining trend in annual return on investment over a three year period*'.

It was considered that the loss of the MSF would have a **moderate (C2)** consequence on the economic value of employment in regional centres and that this was **likely (L6)** to occur. Thus the risk rating was **MODERATE (12)**.

## Economic value – contribution to Gross State Product (GSP)

**ERA Risk Rating: Loss of fishery contribution to GSP in regional centres (LOW)**

Contribution to GSP is measured as value of output less the cost of goods and services (including imports) used in producing the output. In 2008/09, total marine scalefish fishing industry related contribution to GSP in South Australia was $37.9 million, $8.8 million generated by fishing directly, $4.0 million generated by downstream activities and $25.1 million generated in other sectors of the state economy.

As with employment, the economic impact on the loss of the MSF to regional centres would be greater in small regional towns such as Port Wakefield and Streaky Bay than it would be in larger centres like Port Lincoln.

**Performance indicators:** A report on the economic performance of the fishery is produced annually. The report provides measures of contribution to GSP, including breakdown by regions; however no targets are set out in the current management plan other than a limit reference point of '*a declining trend in annual return on investment over a three year period'*.

Given the overall contribution of the MSF to the GSP, the loss of the fishery would have a **minor (C1)** consequence on the economic value in regional centres, and is considered **likely (L6)** to continue. Thus the risk rating was **LOW (6)**.

## Economic value of re-investment

**ERA Risk Rating: Contribution by the fishery to the economic value of re-investment in regional centres (MODERATE)**

It was acknowledged that the MSF is responsible for re-investment into the regional centres, and in some cases communities were heavily reliant upon investment derived from the MSF. Most re-investment goes into non-fishery areas within the regional centres including; shops, pubs, sporting clubs and real estate.

The loss of the MSF was therefore considered to have a **moderate (C2)** consequence on the economic value of re-investment in regional centres, and that this is **likely (L6)** to continue. Thus the risk rating was **MODERATE (12).**

## Social capital

**ERA Risk Rating: Contribution by the fishery to the social capital of the community in regional centres (MODERATE)**

It was recognised that the commercial MSF licence holders contribute to the social capital of communities in a variety of ways. Their advice and expertise is sought from recreational fishers and general users of the marine environment, although sometimes the sharing of this information is not readily exchanged or recreational anglers observe and follow commercial fishers rather than engage in discussions with them. As previously discussed in

'*Relationship with Community*' commercial fishers are often the first to respond to search and rescue operations. Also the fresh local fish they provide is sold in the community through pubs and clubs benefiting the social wellbeing of the community. Other contributions of the MSF to the social capital of the community were less clear.

**Performance indicators:** No performance indicators are in place for social impacts. A report on the economic performance of the fishery is produced annually which also reports on the time MSF licence holders spend on community-support activities such as conservation, attendance of meetings and community volunteering (Econsearch 2010). This information may provide a measure of social capital for future monitoring.

It was agreed that the loss of the MSF would have a **moderate (C2)** consequence on the social capital of regional communities and that this is **likely (L6)** to continue. Thus the risk rating was **MODERATE (12)**.

**Tourism and Transport infrastructure**

**ERA Risk Rating: Contribution by the fishery to tourism and transport infrastructure in regional centres (LOW)**

The MSF provides fresh seafood which is linked with tourism marketing; however it was acknowledged that marine resource tourism was centred more around recreational fishing and ecotourism. Similarly whilst the MSF contributes to the maintenance of port infrastructure through a levy base, these services would still remain as they would be maintained as public/recreational infrastructure.

The loss of the MSF would have a **minor (C1)** consequence on tourism and transport infrastructure in regional centres and this is likely **(L6)** to continue. Thus the risk rating was **LOW (6)**.

### 4.4.3 Non-Dependent Communities – City Centres

**Broad objective**

- Maintain a flow of benefit from the fishery to the broader community.

**Economic value**

**ERA Risk Rating: Contribution by the fishery to economic value in city centres (NEGLIGIBLE)**

In 2008/09, the total MSF industry-related contribution to GSP in South Australia was $37.9 million (EconSearch 2010). In comparison to South Australia's total Gross State Product for 2009/10 of approximately $80 billion, the contribution by the MSF is relatively minor.

**Performance indicators:** A report on the economic performance of the fishery is produced annually. The report provides measures of contribution to GSP; however no targets are set out in the current management plan other than a limit reference point of '*a declining trend in annual return on investment over a three year period*'.

The loss of the MSF would have a **negligible (C0)** consequence on the economics of city centres and this is likely **(L6)** to continue. Thus the risk rating was **NEGLIGIBLE (0)**.

**Social value – Health / Food**

**ERA Risk Rating: Contribution by the fishery to social value through health / food (LOW)**

The MSF provides a huge diversity of healthy seafood products that provide an important contribution to social value in city centres for those that consume them. However, given the contribution of seafood in most diets and the ability for marine scalefish species to be replaced by imported species, it was agreed the loss of the MSF would have a **minor (C1)** consequence on health and food provision in city centres and this is likely **(L6)** to continue. Thus the risk rating was **LOW (6)**.

**Social capital**

**ERA Risk Rating: Contribution by the fishery to the social capital of the community in city centres (LOW)**

There is a much larger disconnect between the MSF and the community in city centres. As such there is a reduce risk rating in city centres when compared to regional centres. The MSF still contributes to social capital in regard to recreational fishers and marine resource users, but at a greatly reduced level.

**Performance indicators:** No performance indicators are in place for social impacts. A report on the economic performance of the fishery is produced annually which also reports on the time MSF licence holders spend on community-support activities such as conservation, attendance of meetings and community volunteering (Econsearch 2010). This information may provide a measure of social capital for future monitoring.

The impact from the loss of the MSF would have a **minor (C1)** consequence on the social capital of the community in city centres and this is **likely (L6)** to continue. Thus the risk rating was **LOW (6)**.

**Social value – Infrastructure**

**ERA Risk Rating: Contribution by the fishery to social value through infrastructure (NEGLIGIBLE)**

The MSF has contributed little to infrastructure in city centres. Therefore the loss of the MSF would have a **negligible (C0)** consequence on infrastructure in city centres and this is likely **(L6)** to continue. Thus the risk rating was **NEGLIGIBLE (0)**.

## 4.5 Governance

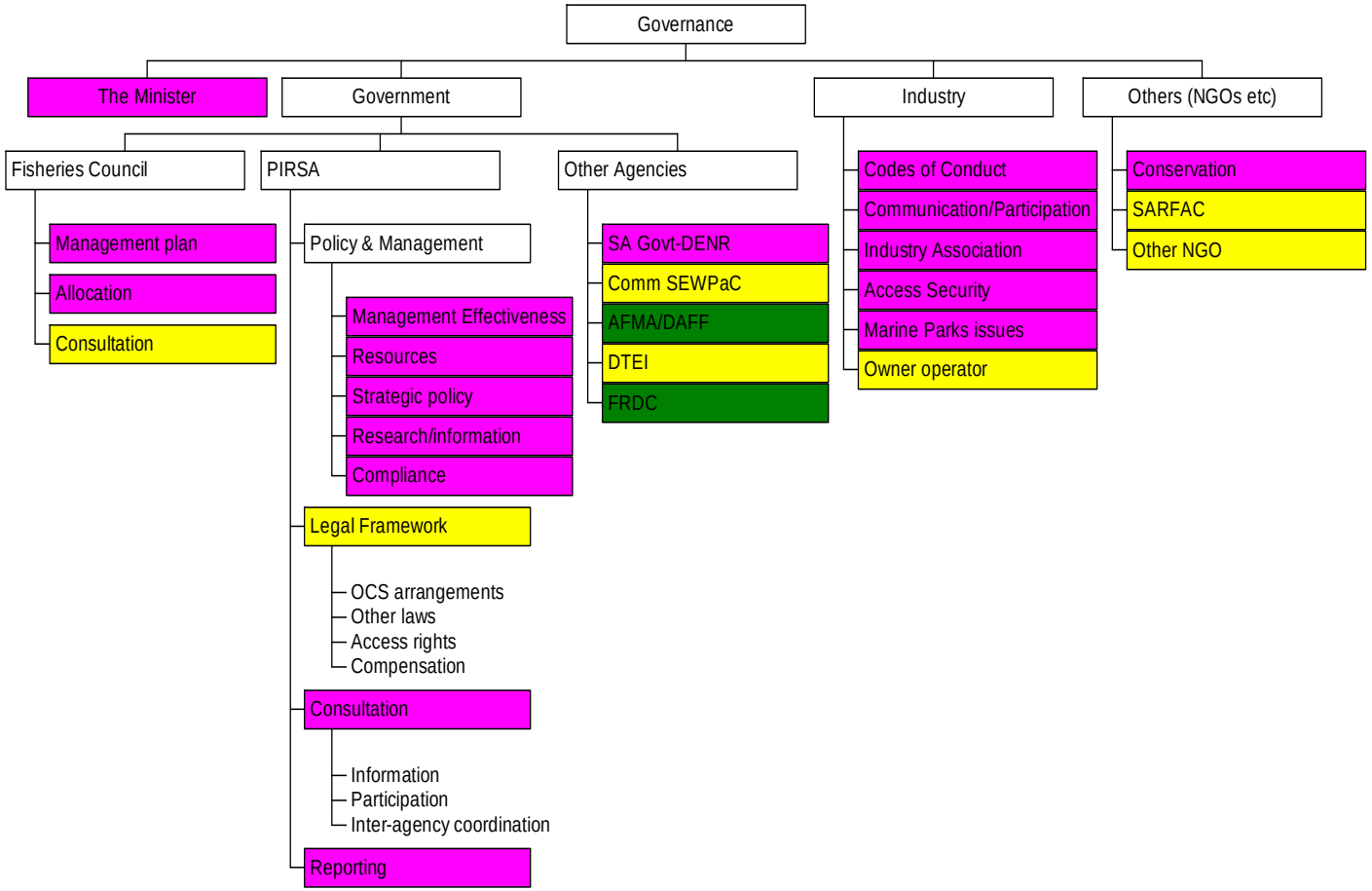


Figure 24. Component tree for governance

Unlike other component trees in the workshop, not every component of the governance tree was assessed for risk. Rather, some components were identified specifically by stakeholders for discussion and risk assessment (i.e., those components highlighted in Figure 19). Furthermore, the usual process of consequence and likelihood assignment was not employed for the risk assessment, but instead industry assigned a risk rating based on the overall importance of the issue.

### 4.5.1 The Minister

**Objective**

- Responsible governance of the Marine Scalefish Fishery by the responsible Minister.

**ERA Risk Rating: Importance of appropriate decision making by the Minister (HIGH)**

Ultimately it is the Minister who is responsible for the management of South Australian fisheries resources. Whilst various positions within PIRSA Fisheries and Aquaculture have been delegated authority under the Act, the Minister still retains responsibility. The Act provides for greater access security for all sectors, which somewhat removes the ability of a Minister to act preferentially to one sector over another in terms of resource allocation. However the Minister is not bound by recommendations from PIRSA or industry, and is free to make decisions as they see fit. The Minister therefore is considered a **HIGH** risk to the governance of the fishery.

### 4.5.2 Fisheries Council

**Fisheries Council – Management plan, Allocation and Consultation**

Under the *Fisheries Management Act 2007* (the Act), the Fisheries Council has a significant involvement throughout the process of developing a new management plan, which includes allocation for all sectors and a public consultation period. The Act requires that fishery management plans explicitly allocate resource shares to the commercial, recreational and Aboriginal traditional sectors of the fishery.

**Objective**

- Responsible governance of the Marine Scalefish Fishery by the Fisheries Council.

**ERA Risk Rating: Importance of the Fisheries Council in delivering outcomes for the MSF Industry (HIGH and MODERATE)**

The current management plan for the MSF was written in 2006 and is due for renewal by end June 2012. The new management plan is a key requirement

for the fishery as it will not only provide a framework for the sustainable management of the resource but it will also give certainty to the industry about how future management decisions will be made. It will also outline the allocation of resources to the various sectors and prescribe a way of managing these shares into the future. The management plan and allocation are considered to be issues of **HIGH** risk.

Consultation by the Fisheries Council when working on delivery of its obligations was considered an issue of **MODERATE** risk.

### 4.5.3 PIRSA – Governance

**Broad objective**

Manage the MSF resource in an efficient and cost-effective manner in pursuit of the objects of the *Fisheries Management Act 2007* and in line with the SA Government's cost-recovery policy.

**PIRSA: Policy & Management - Management effectiveness, Resources, Strategic policy, Research/information and Compliance.**

**Objective**

- Manage the impact of the PIRSA legal framework on the Marine Scalefish Fishery.

**ERA Risk Rating: Importance of appropriate policy and management by PIRSA (HIGH)**

During the workshop, industry participants stated that appropriate fisheries policy and management were the key drivers in how the day to day operations of the fishery were carried out. This includes effective management, adequate resourcing, strategic policy for issues such as the licence amalgamation scheme, and appropriate research and compliance that are targeted to help achieve management objectives. Therefore the importance of PIRSA policy and management is a **HIGH** risk to industry.

**PIRSA: Legal framework**

**Objective**

- Manage the impact of the PIRSA legal framework on the Marine Scalefish Fishery.

**ERA Risk Rating: Importance of PIRSA legal framework to the MSF industry (MODERATE)**

During the workshop, industry noted that the Act provided an improved legal

framework for the fishery including issues surrounding access rights and compensation. The legal framework under PIRSA is considered a **MODERATE** risk to the industry.

**PIRSA: Consultation and Reporting**

**Objective**

- Manage the impact of PIRSA's consultation and reporting practices on the Marine Scalefish Fishery.

**ERA Risk Rating: Importance of PIRSA consultation and reporting to the MSF industry (HIGH)**

Industry members considered consultation and reporting to be essential in delivering good governance of the fishery. It was noted that consultation and reporting is a two way process between management and industry (and other sectors) and that PIRSA and industry should be striving to continually improve these processes. Consultation and reporting is considered a **HIGH** risk to the industry.

### 4.5.4 Other agencies

Other government agencies have governance jurisdiction or interaction with the Marine Scalefish Fishery either directly or indirectly.

**SA Government Department of Environment and Natural Resources DENR)**

**Objective**

- Manage the impact of SA DENR on the Marine Scalefish Fishery

**ERA Risk Rating: Importance of SA DENR to the MSF industry (HIGH)**

During the workshop, industry stated that as DENR were the agency responsible for the introduction of SA marine parks, they had the potential to have significant impacts on the fishery. Industry noted the need to work with DENR to ensure good outcomes for the fishery and licence holders. DENR is considered a **HIGH** risk to the fishery.

**Australian Government of Department of Sustainability, Environment, Water, Population and Communities (SEWPaC)**

**Objective**

- Manage the impact of SEWPaC on the Marine Scalefish Fishery

**ERA Risk Rating: Importance of SEWPAC to the MSF industry**

**(MODERATE)**

During the workshop, industry believed that SEWPaC represented a risk to the MSF as it had direct and indirect interactions with them. All TEPS interactions are required to be reported to SEWPaC as well as mandatory reporting and conditions to be met for export approval under the EPBC Act. SEWPaC are also responsible for Marine Bio-regional planning (Commonwealth marine parks). Industry felt that SEWPAC was a **MODERATE** risk to the fishery.

**Australian Fisheries Management Authority (AFMA), Australian Government Department of Agriculture, Forestry and Fisheries (DAFF) and the Fisheries Research and Development Corporation (FRDC)**

**Objective**

- Manage the impact of AFMA, DAFF and FRDC on the Marine Scalefish Fishery

**ERA Risk Rating: Importance of AFMA, DAFF and FRDC to the MSF industry (LOW)**

It was agreed that AFMA, DAFF and FRDC only have a minor impact on the MSF, including the direction of strategic research and industry research funds through the FRDC. Industry felt that these agencies were a **LOW** risk to the fishery.

**SA Department of Transport, Energy and Infrastructure (DTEI)**

**Objective**

- Manage the impact of DTEI on the Marine Scalefish Fishery

**ERA Risk Rating: Importance of DTEI to the MSF industry (MODERATE)**

It was agreed that through the direct regulation of marine safety, survey requirements and maritime transport DTEI posed a **MODERATE** risk to the fishery.

### 4.5.5 Industry

**Industry governance**

**Objective**

- Manage the impact of industry governance on the Marine Scalefish Fishery

**ERA Risk Rating: Importance of industry governance to the MSF industry (HIGH)**

A number of industry governance issues were identified as being of particular importance to the MSF. These issues include the development of codes of conduct, communication and participation in governance, the need for a strong industry association, access security, and marine parks. All of these issues were rated as a **HIGH** risk to the fishery.

The issue of the owner/operator policy has continued to divide industry and this issue was considered a **MODERATE** risk to industry governance.

### 4.5.6 Other bodies/associations

**Conservation groups**

**Objective**

- Manage the impact of conservation groups on the Marine Scalefish Fishery

**ERA Risk Rating: Importance of conservation interests to the MSF industry (HIGH)**

A number of industry members felt that in the current political and social climate that some conservation groups pose a significant risk to the fishery. It was felt that whilst some conservation sectors were reasonable and shared similar objectives to industry, there remains an element of this sector that does not support commercial fishing in any form. This issue was considered a **HIGH** risk to the industry.

**South Australian Recreational Fishing Advisory Committee (SARFAC) and other Non-government organisations (NGOs)**

**Objective**

- Manage the impact of SARFAC and other NGOs on the Marine Scalefish Fishery

**ERA Risk Rating: Importance of SARFAC and NGO interests to the MSF industry (MODERATE)**

In a similar way that some conservation sector objectives do not align with the aspirations of the MSF, recreational and some NGOs have similar objectives that conflict with those of the MSF. However it was acknowledged that in the co-management framework these sectors needed to be represented and included in the process. These groups were considered a **MODERATE** risk to the industry.

## 4.6 External Factors Affecting Performance of the Fishery

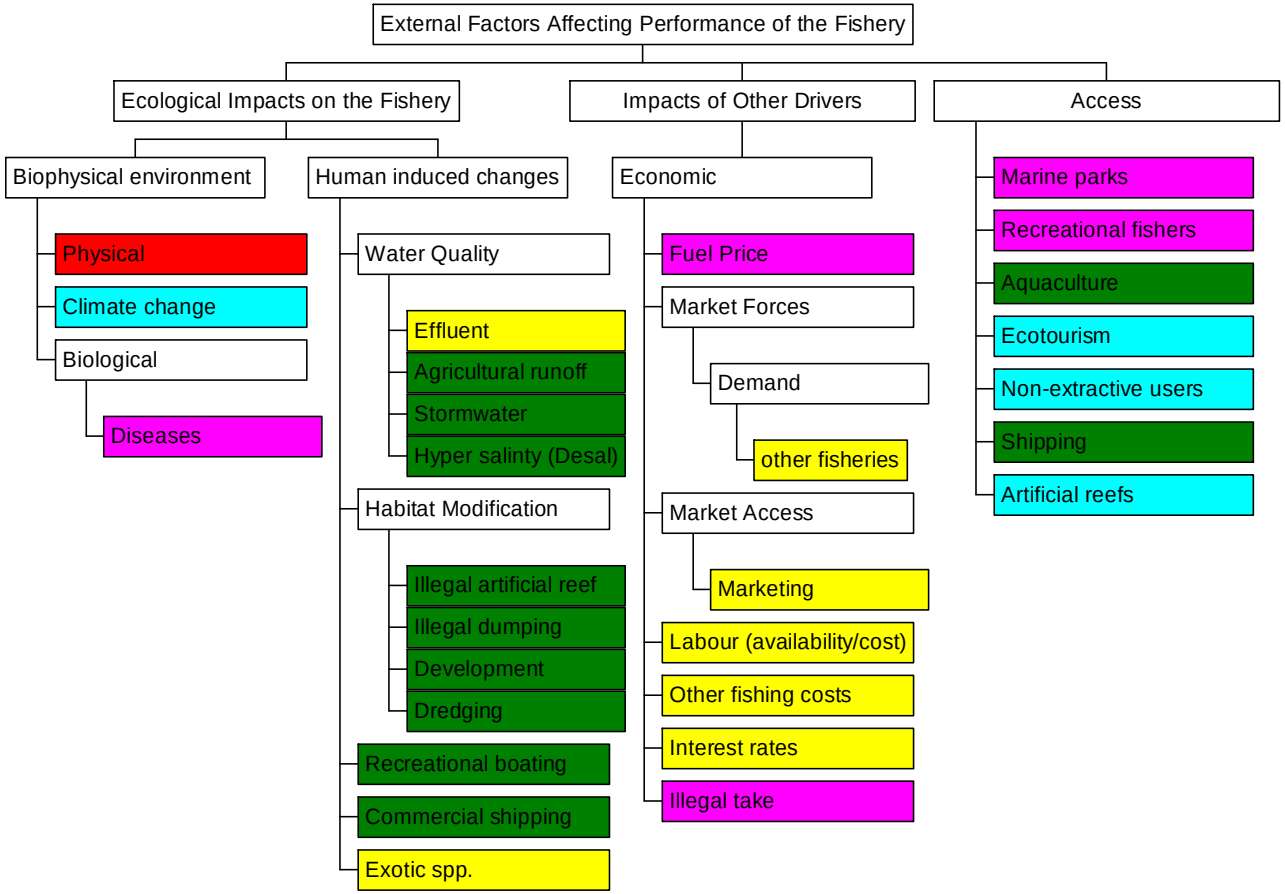


Figure 25. Component tree for external factors affecting performance of the fishery

### 4.6.1 Ecological Impacts on the Fishery – Biophysical Environment

**Broad objective**

- Understand and manage negative impacts on the Marine Scalefish Fishery from external physical and biological influences

**Physical – Oceanographic, temperature, salinity, weather and upwellings**

**ERA Risk Rating: Impact of environmental and physical factors on the MSF (EXTREME)**

During discussions of the various environmental and oceanographic processes that impact on the fishery it became evident that many of these factors were linked, e.g. temperature and salinity. It was therefore decided to group these together under physical impacts affecting the fishery. Whilst the direct linkages between these variables and fish stocks are not fully understood, it is widely accepted that they play a hugely significant role in process such as spawning conditions, larval settlement, recruitment, growth during most if not all life stages of marine scalefish species.

It was considered that physical impacts are likely to have a **major (C4)** consequence and that this was **likely (L6)** to continue in the future. Thus the risk rating was **EXTREME (24)**.

**Physical – Climate change**

**ERA Risk Rating: Impact of climate change on the MSF (LOW)**

The potential exists for climate change to impact on all of the physical processes described above and therefore it is not unreasonable to adopt the same risk rating, however in the context of these consequences happening in the next 5 years, this risk was greatly reduced. It was considered that climate change impacts are likely to have a **major (C4)** consequence and that there was a **remote (L1)** likelihood that this will occur in the future. Thus the risk rating was **LOW (4)**.

**Biological – Diseases**

**ERA Risk Rating: Impact of diseases on the MSF (HIGH)**

The potential always exists for an outbreak of a translocated disease that may damage the commercial fishery. The herpes-like virus that impacted on local sardine populations and more recently the abalone viral ganglioneuritis (AVG) disease that devastated the Victorian abalone fishery are two poignant examples. Workshop participants commented that the consequence of such an outbreak will be dependent on which species are affected; the higher the value, the greater the consequence. It was considered that biological disease

impacts are likely to have a **catastrophic (C5)** consequence; however this was **unlikely (L3)** to occur. Thus the risk rating was **MODERATE (15)**.

### 4.6.2 Ecological Impacts on the Fishery – Human Induced Changes

**Broad objective**

- Understand and manage negative ecological impacts on the MSF from human induced changes

**Water quality – Effluent**

**ERA Risk Rating: Impact of effluent on the MSF (MODERATE)**

Discharge of effluent into the ocean and its catchments has historically had a significant impact on marine ecosystems in localised areas, e.g. loss of seagrass beds adjacent to metropolitan Adelaide. Whilst treatment processes and environmental protection laws have improved, the impact of effluent on the MSF was considered to be **moderate (C2)**, and that it is **likely (L6)** to continue in the future. Thus the risk rating was **MODERATE (12)**.

**Water quality – Agricultural runoff, stormwater and hyper salinity (desalination)**

**ERA Risk Rating: Impact of agricultural runoff, stormwater and hyper salinity on the MSF (LOW)**

The impact on water quality from the desalination process was considered unknown, but likely to be confined to localised areas of hyper salinity. Similarly agricultural runoff and stormwater were considered to be associated with localised impacts but not broader impacts on the MSF. It was therefore considered that the impact of agricultural runoff, stormwater and desalination on the MSF was **minor (C1)**, and that it is **likely (L6)** to continue in the future. Thus the risk rating was **LOW (6)**.

**Habitat modification – Illegal artificial reefs, illegal dumping, development and dredging.**

**ERA Risk Rating: Impact of habitat modification on the MSF (LOW)**

Illegal dumping and the illegal dumping at sea to create artificial reefs were identified as having potential impacts on the broader environment and therefore the MSF. However these impacts were considered minor. Similarly, coastal development and dredging are two processes known to alter natural habitats and water movements. Despite the potentially severe localised impacts overall they were considered to be minor. It was considered that illegal dumping, illegal reefs, development and dredging would be having a

**minor (C1)** impact on the MSF and that this was **likely (L6)** to continue. Thus the risk ranking was **LOW (6)**.

**Recreational boating and commercial shipping.**

**ERA Risk Rating: Impact of recreational boating and commercial shipping on the MSF (LOW)**

Recreational vessels and commercial shipping vessels are present in areas fished by MSF licence holders. Alterations to the environment have occurred through the development of commercial shipping lanes, channel markers and designated anchorages. The increased numbers of recreational vessels poses a greater risk of cumulative impacts associated with fuel and oil discharge and other impacts. However, it was considered that recreational boating and commercial shipping would be having a **minor (C1)** impact on the MSF and that this was **likely (L6)** to continue. Thus the risk ranking was **LOW (6)**.

**Exotic species**

**ERA Risk Rating: Impact of exotic species on the MSF (MODERATE)**

Exotic species can impact on ecosystems and in turn commercial fisheries. Whilst there are a number of exotic species established in SA coastal waters their impacts on the MSF to date has been minimal. However the impact of an exotic species that could out-compete key MSF species would be major. Therefore it was considered that the risk to the MSF posed by exotic species was **severe (C3)** and that this was **unlikely (L3)** to occur in the future. Thus the risk ranking was **MODERATE (9)**.

### 4.6.3 Impacts of Other Drivers – Economic

**Broad objective**

- To minimise the impacts of economic drivers on the Marine Scalefish Fishery

**Fuel prices**

**ERA Risk Rating: Impact of fuel prices on the MSF (HIGH)**

Increasing fuel prices have negatively affected the profitability of many fisheries across SA. The MSF has also been affected, however impacts are somewhat mitigated by the smaller scale nature of the MSF and the adoption of modern, fuel efficient technology. Despite this, fuel price is considered to have a **major (C3)** impact on the economics of the MSF and this is **likely (L6)** to continue in the future. Thus the risk ranking was **HIGH (18)**.

## Market forces – Other fisheries

### ERA Risk Rating: Impact of market forces on the MSF (MODERATE)

The profitability of the MSF can be influenced by fluctuating fish prices that are caused by other fisheries. The importation of a similar species of garfish from Asia is a good example of how markets can be lost or undercut. It was noted that Northern Territory legislation requires the country of origin to be declared at the point of sale (including in restaurants). This has seen increased demand in domestic product. It was agreed that supply from other fisheries is having a **moderate (C2)** impact on the economics of the MSF and this is **likely (L6)** to continue in the future. Thus the risk ranking was **MODERATE (12)**.

## Market access – Marketing

### ERA Risk Rating: Impact of market access on the MSF (MODERATE)

Marketing was considered an important part of the fish production business, and one that has been a deficiency in the past. This is a particular issue for the lower value species. The structure of the fishery and the owner/operator policy has traditionally meant little effort has been directed into marketing. It was agreed that marketing has a **moderate (C2)** consequence on the economics of the MSF and this will **occasionally (L5)** continue in the future. Thus the risk ranking was **MODERATE (10)**.

## Labour (availability / cost), interest rates and other fishing costs

### ERA Risk Rating: Impact of labour availability, fishing costs and interest rates on the MSF (MODERATE)

Increasing costs are a key concern for industry. Like many other fishery sectors in SA, the MSF is competing with other industries (such as mining) to attract and retain employees. Interest rates are an issue faced by most small businesses, and the MSF is no exception. Whilst comparatively the MSF has lower start up costs than many other fisheries, costs are still significant. The costs of fishing are a constant pressure and are likely to continue increasing. Licence fees were also identified by industry members as a key concern.

It was agreed that labour availability, interest rates and other fishing costs all have a **moderate (C2)** consequence on the economics of the MSF and this is **likely (L6)** to continue in the future. Thus the risk ranking was **MODERATE (12)**.

## Illegal take

**ERA Risk Rating: Impact of illegal fishing activities on the MSF (HIGH)**

Illegal fishing activities by unlicensed fishers can have a significant impact, particularly in regional communities were local markets are limited. Unlicensed fishers do not have the costs associated with fishing that licence holders are obliged to pay, which means fish can be sold at lower process, which in turn can impact on prices received by commercial fishers. This type of activity is not considered widespread, but is happening and by its nature it is hard to detect and hard to prevent. It was also noted that such catch was not factored into stock assessments.

It was agreed that illegal take of MSF species has a **severe (C3)** consequence on the economics of the MSF and that this is **likely (L6)** to continue in the future. Thus the risk ranking was **HIGH (18)**.

### 4.6.4 Access

**Objective**

- To minimise the impact of reduced access by marine parks on the Marine Scalefish Fishery.

**Marine parks**

**ERA Risk Rating: Impact of reduced access by marine parks on the MSF (HIGH)**

The South Australian Government proclaimed 19 new marine parks in 2010. All 19 marine parks are located within state waters, generally within 3 nautical miles from the coast including the gulfs and offshore islands. Marine parks will be zoned for multiple-uses, with varying levels of use and conservation. Most activities, such as recreational and commercial fishing, will still be allowed within a marine park. However, some areas will exclude all fishing activity or certain types of activities.

The outer boundaries of the marine parks have been proclaimed but the zones have not yet been determined. Management plans with zoning for each marine park will be developed in consultation with the community and industry during 2011.

All 19 marine parks are within areas currently accessible by the MSF. Therefore it is inevitable that there will be a loss of fishing access. Industry raised a number of associated concerns including; further concentration of haul netting, impacts on available freight with loss of production, the level of compensation. Industry considered the impacts of marine parks to be significant and will be detrimental for some individual operators; however the full impacts of the marine parks on access to the MSF are unknown.

Due to the uncertainty surrounding marine parks, It was considered that marine parks pose has a **severe (C3)** consequence on the MSF and that this

is **likely (L6)** to continue in the future. Thus the risk ranking was **HIGH (18)**.

## Recreational fishers

### ERA Risk Rating: Impact of reduced access by recreational fishers on the MSF (HIGH)

The South Australian recreational fishing sector consists of a large diverse group of people whose participation and interest in the fishery varies greatly. Industry members acknowledge that there is a need to share the fish between sectors and that the Act provides for greater access security in regard to species allocation. However it was noted that recreational fishers were increasing their fishing range and capacity with larger boats and improved technology such as GPS and radar, therefore such areas that were once largely fished by commercial fishers only are being fished by recreational also. It was felt that within the recreational sector there are some that would like to see commercial fishing shut down or excluded from more areas.

Industry considered that the recreational fishing sector poses a **severe (C3)** consequence on commercial access to the fishery and that this is **likely (L6)** to continue in the future. Thus the risk ranking was **HIGH (18)**.

## Aquaculture and shipping

### ERA Risk Rating: Impact of reduced access by aquaculture and shipping on the MSF (LOW)

Aquaculture is a significant industry in South Australia. Aquaculture leases preclude commercial fishers from fishing within their boundaries without the approval of the lease holder. Aquaculture is seen as an important industry, particularly in regional SA, generating employment and downstream benefits and new opportunities are regularly being considered and explored. Aquaculture leases such as oyster racks and fish pens reduce the areas available to fish by MSF licence holders. Shipping lanes and designated anchorages also reduce areas accessible by MSF licence holders.

It was considered that aquaculture and shipping have a **minor (C1)** consequence on commercial access to the fishery and that this is **likely (L6)** to continue in the future. Thus the risk ranking was **LOW (6)**.

## Ecotourism and Non-extractive users

### ERA Risk Rating: Impact of reduced access by ecotourism and non-extractive users on the MSF (NEGLIGIBLE)

There are a number of well established water-based activities that utilise the marine environment without extracting any of the resources (e.g. fish). These

include ecotourism, sailing, boating, swimming and diving. In some cases specific reserves have been set aside for these activities and services and infrastructure have been set up to provide for this use (e.g. dive trails). Despite their popularity, these activities have very little interaction with commercial fishing activities. It was considered that ecotourism and non-extractive users have a **negligible (C0)** consequence on commercial access to the fishery and that this is **likely (L6)** to continue in the future. Thus the risk ranking was **NEGLIGIBLE (0)**.

**Artificial reefs**

**ERA Risk Rating: Impact of reduced access by artificial reefs on the MSF (LOW)**

There are only a small number of legal artificial reefs in SA and it is current Government policy not approve the introduction of such structures for fisheries management purposes. It was noted that artificial reefs have the capacity to aggregate fish and restrict the fishing activities in areas adjacent to reefs. It was also considered that artificial reefs had potential to shift allocations between sectors depending upon how they are managed. It was considered that artificial reefs have a **minor (C1)** consequence on commercial access to the fishery and that this is **likely (L6)** to continue in the future. Thus the risk ranking was **LOW (6)**.

## 4.7 Aboriginal Community

This section will be completed through a separate Aboriginal Traditional ESD workshop.

# 5 REFERENCES


EconSearch. (2010). Economic Indicators for the SA Marine Scalefish Fishery 2008/09. A Report Prepared for Primary Industries and Resources South Australia. EconSearch Pty Ltd, Adelaide.

EconSearch (2011). Preliminary Economic Indicators for the Marine Scalefish Fishery, 2009/10. Unpublished Report Prepared for Primary Industries and Resources South Australia. EconSearch Pty Ltd, Adelaide.

Edgar, G.J., (1997). Australian Marine Life: the Plants and Animals of Temperate Waters, Reed Books, Melbourne, pp. 544.

Fletcher, W.J., Chesson, J., Fisher M., Sainsbury, K.J., Hundloe, T., Smith, A.D.M. and Whitworth, B. (2002) National ESD Reporting Framework for Australian Fisheries: The 'How To' Guide for Wild Capture Fisheries. FRDC Project 2000/145, Canberra, Australia.

Fowler, A. J. (2002). Snapper (*Pagrus auratus*). South Australian Fisheries Assessment Series 01/013. Fishery Assessment Report to PIRSA for the Marine Scalefish Fishery Management Committee. South Australian Research and Development Institute (Aquatic Sciences), Adelaide.

Fowler, A.J., Steer, M.A., McGarvey, R. and Feenstra, J.E. (2007). The South Australian Marine Scalefish Fishery. Stock status report. Report to PIRSA. SARDI Aquatic Sciences Publication No.F2007/000565-2. SARDI Research Report Series No. 255

Fowler, AJ, McGarvey, R & Feenstra, JE (2008a). King George Whiting (*Sillaginodes punctata*) Fishery. Fishery Assessment Report to PIRSA. SARDI Aquatic Sciences Publication No F2007/000843-2. SARDI Research Report Series Number 296. August 2008.

Fowler, AJ, Steer, MA, Jackson, WB and Lloyd, MT (2008b). Population characteristics of southern sea garfish (*Hyporhamphus melanochir*, *Hemiramphidae*) in South Australia. Marine and Freshwater Research, 59: 429-43.

Fowler, AJ, McGarvey, R, Steer, MA & Feenstra, JE (2008c). The South Australian Marine Scalefish Fishery Stock status report. Report to PIRSA. SARDI Aquatic Sciences Publication No.F2007/000565-3. SARDI Research Report Series No.321. December 2008.

Fowler, AJ, Lloyd, M, Schmarr, D (2009a). A preliminary consideration of by-catch in the Marine Scalefish Fishery of South Australia. South Australian

Research and Development Institute (Aquatic Sciences), Adelaide, F2009/000097-1, SARDI Research Report Series No. 365. 79 pp.

Fowler AJ, McGarvey R, Steer MA, Feenstra JE (2009b). The South Australian Marine Scalefish Fishery – Stock Status Report. Report to PIRSA. South Australian Research and Development Institute (Aquatic Sciences), Adelaide, F2007/000565-4, SARDI Research Report Series No. 413. 29 pp.

Fowler AJ, McGarvey R, Burch P, Feenstra JE, and Jackson WB (2010a). Snapper *(Chrysophrys auratus)* Fishery. Fishery Assessment Report to PIRSA. South Australian Research and Development Institute (Aquatic Sciences), Adelaide, F2007/000523-2, SARDI Research Report Series No. 473. Pp 109.

Fowler, A.J., McGarvey, R., Steer, M.A., Feenstra, J.E (2010b). The South Australian Marine Scalefish Fishery – Stock Status Report. Report to PIRSA. (PDF 664.4 kb). South Australian Research and Development Institute (Aquatic Sciences), Adelaide. SARDI Publication No. F2007/000565-5. SARDI Research Report Series No. 507. 29pp.

Goldsworthy, S., Hamer, D., Page, B. (2007). Assessment of the implications of interactions between fur seals & sea lions & the southern rock lobster & gillnet sector of the Southern and Eastern Scalefish and Shark Fishery (SESSF) in SA. SARDI Aquatic Sciences Publication No. F2007/000711. SARDI Research Report Series No. 225

Goldsworthy, S.D., Page, B., Lowther, A., Rogers, P., Peters, K., Shaughnessy, PD. (2009). Pup production assessment of the Australian sea lion *Neophoca cinerea* at Dangerous Reef and English Island, South Australia. South Australian Research and Development Institute March 2009, SARDI Aquatic Sciences Publication Number F2009/000088-1. SARDI Research Report Series No. 338.

Gorman D, Mayfield S, Burch P, Ward TM (2010). Distribution, harvestable biomass and fisheries biology of *Katelysia* spp. in the South Australian commercial mud cockle fishery. SARDI Aquatic Sciences Publication No. F2010/000263-1. SARDI Research Report Series No. 442. 37pp.

Henry, G. W. & Lyle, J. M. (2003). *The National Recreational and Indigenous Fishing Survey*. FRDC Project No. 99/158.

Jackson, G. J & Jones, G. K. (2000). Spatial and temporal variation in nearshore fish and macroinvertebrate assemblages from a temperate Australian estuary over a decade. *Marine Ecology Progress Series* **182,** 253-268.

Jones, K. (2008). Review of the Fishery Status for Whaler Sharks (*Carcharhinus spp*.) in South Australian and adjacent waters. FRDC Project 2004/067. SARDI Aquatic Sciences Publication No. F2007/000721-1, SARDI Research Series No. 154

Jones, K. (2009) South Australian Recreational Fishing Survey. South Australian Fisheries Management Series Paper No 54. PIRSA Fisheries, Adelaide, 84 pp.

Kailola, P.J., Williams, M.J., Stewart, P.C., Reichelt, R.E., McNee, A. and Grieve, C. (Eds). (1993) Australian Fisheries Resources. Canberra, Bureau of Resource Sciences, Department of Primary Industries and Energy and the Fisheries Research and Development Corporation.

King, M., G. (1976). The life history of the Goolwa cockle *Donax (Plebidonax) deltoides* (Bivalvia: Donacidae), on an ocean beach, South Australia. Fisheries Branch, South Australian Department of Agriculture and Fisheries Internal Report (85):16p.

Knight, M.A. and Tsolos, A. (2011) South Australian Wild Fisheries Information and Statistics Report 2009/10. South Australian Research and Development Institute (Aquatic Sciences), Adelaide. SARDI Publication No. F2008/000804-3. SARDI Research Report Series No. 521. 60 pp.

Ling, J. K. (1958). The sea garfish, *Rephorhamphus melanochir* (Cuvier and Valenciennes) (Hemiramphidae), in South Australia: breeding, age determination, and growth rate. Australian Journal of Marfine and Freshwater Research 9, 60-110.

McAuley, R. (2005) Status Report for the Southern and West Coast Demersal Gillnet and Demersal Longline Fisheries and Northern Shark Fisheries. No. 12, September 2005. Appendix 6.3. 26 pp.

McGarvey, R., Fowler, A. J., Feenstra, J. E., Fleer, D. A. & Jones, G. K. (2003). King George Whiting *(Sillaginodes punctata)* fishery. Fishery Assessment Report to PIRSA for the Marine Scalefish Fishery Management Committee. South Australian Research and Development Institute (Aquatic Sciences), Adelaide.

McGarvey R, Fowler AJ, Feenstra JE, Burch P, Jackson WB (2009). Southern Garfish (*Hyporhamphus melanochir*) fishery. Fishery assessment report to PIRSA. South Australian Research and Development Institute (Aquatic Sciences), Adelaide, 82pp. SARDI Publication Number F2007/000720-2. SARDI Research Report Series No. 397.

McGarvey, R., Burch, P. and Feenstra, J.E. (2010). Management Strategy Evaluation for South Australian Snapper. (PDF 340.0 KB). South Australian Research and Development Institute (Aquatic Sciences), Adelaide. SARDI Publication No. F2010/000226-1. SARDI Research Report Series No. 441. 32p.

Noell, C. J. (2004). Early life stages of the southern sea garfish, *Hyporhamphus melanochir* (Valenciennes, 1846), and their association with seagrass beds. PhD Thesis, University of Adelaide.

Noell C, Presser J, Jones K (2006). Management Plan for the South Australian Marine Scalefish Fishery. PIRSA. South Australian Fisheries Management Series No. 45. 68 pp.

PIRSA (2007). South Australian Fisheries Resources — Current Status and Recent Trends 2006. South Australian Fisheries Management Series. Paper number 49. Primary Industries and Resources South Australia.

Saunders, R.J., Bryars, S.R. and Fowler, A.J (2010). Preliminary consideration of the biology of several of South Australia's marine fish species that have conservation or management interest. Report to the Department for Environment and Heritage. (PDF 2.4 MB). South Australian Research and Development Institute (Aquatic Sciences), Adelaide. SARDI Publication No. F2009/000693-1. SARDI Research Report Series No. 426. 41p.

Steer MA (2009). The dynamics of targeted fishing effort between different species in the Marine Scalefish Fishery. Report to PIRSA. South Australian Research and Development Institute (Aquatic Sciences), Adelaide, SARDI Publication No. F2009/000-446-1. SARDI Research Report Series No. 402.

Steer MA, Moltschaniwskyj NA, Gowland FC (2002). Temporal variability in embryonic development and mortality in the southern calamary, *Sepioteuthis australis*: a field assessment. Marine Ecology Progress Series 243: 143-150.

Steer MA, Lloyd MT and Jackson WB (2006). Southern Calamary (*Sepioteuthis australis*) Fishery. Fishery Assessment Report to PIRSA. South Australian Research and Development Institute (Aquatic Sciences), Adelaide, F2007/000528-2.

Steer MA, Lloyd MT and Jackson WB (2007). Southern Calamary (*Sepioteuthis australis*) Fishery. Fishery Assessment Report to PIRSA. South Australian Research and Development Institute (Aquatic Sciences), Adelaide, RD 05/0006–2.

Steer, MA, Fowler, AJ and Gillanders, BM (Editors). (2009) Spatial Management of Southern Garfish (*Hyporhamphus melanochir*) in South Australia – Stock structure and adult movement. FRDC final report Project no. 2007/029. SARDI Publication No. F2009/000018-1. SARDI Research Report Series No. 333.

Sloan, S. (2005) Management Plan for the South Australian Lakes and Coorong Fishery. South Australian Fisheries Management Series Paper No. 44, PIRSA Fisheries, Adelaide, 135 pp.

Steer, M.A., Lloyd, M.T. and Jackson, W.B. (2007). Southern Calamari (*Sepioteuthis australis*) Fishery. Fishery Assessment Report to PIRSA. SARDI (Aquatic Sciences), Adelaide, F2007/000528-2. SARDI Research Report Series No: 229

Triantafillos L, Adams M (2001). Allozyme analysis reveals a complex population structure in the southern calamary, *Sepioteuthis australis*, from Australia and New Zealand. Marine Ecology Progress Series 212: 193-209.

Triantafillos, L. (2002). Population biology of Southern Calamari, *Sepioteuthis australis*, in Gulf St Vincent, South Australia. PhD Thesis, Northern Territory University.

Winstanley RH, Potter MA, Caton AE (1983). Australian cephalopod resources. Memoirs of the National Museum Victoria. 44: 243-253.

Ye, Q., Jones, G.K., McGlennon, D., Ayvazian, S., and Coutin, P.C. (2002a). Chapter 4: Size and age structure of the commercial fisheries and mortality rates. *In*: Fisheries Biology and Habitat Ecology of Southern Sea Garfish (*Hyporhamphus melanochir*) in Southern Australian Waters [eds., Jones, G.K., Ye, Q., Ayvazian, S., Coutin, P.C.], Australian Fisheries Research and Development Corporation Final Report 97/133.

Ye, Q., Noell, C., and McGlennon, D. (2002b). Chapter 5: Reproductive biology of sea garfish. *In*: Fisheries Biology and Habitat Ecology of Southern Sea Garfish (*Hyporhamphus melanochir*) in Southern Australian Waters [eds., Jones, G.K., Ye, Q., Ayvazian, S., Coutin, P.C.], Australian Fisheries Research and Development Corporation Final Report 97/133.

# 6 APPENDICES

## 6.1 Appendix 1: Likelihood and Consequence Tables

Table A1. Likelihood Definitions

| Level | Descriptor |
|---|---|
| Likely (6) | It is expected to occur |
| Occasional (5) | May occur |
| Possible (4) | Some evidence to suggest this is possible here |
| Unlikely (3) | Uncommon, but has been known to occur elsewhere |
| Rare (2) | May occur in exceptional circumstances |
| Remote (1) | Never heard of, but not impossible |

(Source: Fletcher *et al.*, 2002)

Table A2. Consequence categories for the Major Retained/Non-Retained Species

| Level | Ecological (Retained: target/Non-retained: major) |
|---|---|
| Negligible (0) | Insignificant impacts to populations. Unlikely to be measurable against background variability for this population. |
| Minor (1) | Possibly detectable, but minimal impact on population size and none on dynamics. |
| Moderate (2) | Full exploitation rate, but long-term recruitment/dynamics not adversely impacted. |
| Severe (3) | Affecting recruitment levels of stocks/or their capacity to increase. |
| Major (4) | Likely to cause local extinctions, if continued in longer term (i.e. probably requiring listing of species in an appropriate category of the endangered species list (e.g. IUCN category). |
| Catastrophic (5) | Local extinctions are imminent/immediate |

(Source: Fletcher *et al.*, 2002)

Table A3. Consequence categories for the By-Product Species/Minor Non-retained species

| Level | Ecological (RETAINED: By-product/Non-retained: other) |
|---|---|
| Negligible (0) | The area where fishing occurs is negligible compared to where the relevant stock of the species resides (< 1%). |
| Minor (1) | Take in this fishery is small (< 10%), compared to total take by all fisheries and these species are covered explicitly elsewhere. Take and area of capture by this fishery is small, compared to known area of distribution (< 20%). |
| Moderate (2) | Relative area of, or susceptibility to capture is suspected to be less than 50% and species do not have vulnerable life history traits. |
| Severe (3) | No information is available on the relative area or susceptibility to capture or on the vulnerability of life history traits of this type of species.<br>Relative levels of capture/susceptibility suspected/known to be greater than 50% and species should be examined explicitly. |
| Major (4) | N/A Once a consequence reaches this point it should be examined using Table A6. |
| Catastrophic (5) | N/A (See Table A6). |

(Source: Fletcher *et al.*, 2002)

Table A4. Consequence levels for the impact of a fishery on Protected species

| Level | Ecological |
|---|---|
| Negligible (0) | Almost none are impacted |
| Minor (1) | Some are impacted but there is no impact on stock |
| Moderate (2) | Levels of impact are at the maximum acceptable level |
| Severe (3) | Same as target species |
| Major (4) | Same as target species |
| Catastrophic (5) | Same as target species |

(Source: Fletcher *et al.*, 2002)

Table A5. Consequence levels for the impacts of a fishery on habitats

| Level | Ecological (HABITAT) |
|---|---|
| Negligible (0) | Insignificant impacts to habitat or populations of species making up the habitat – probably not measurable levels of impact. Activity only occurs in very small areas of the habitat, or if larger area is used, the impact on the habitats from the activity is unlikely to be measurable against background variability.<br>(*Suggestion- these could be activities that affect < 1% of original area of habitat or if operating on a larger area, have virtually no direct impact)* |
| Minor (1) | Measurable impacts on habitat(s) but these are very localised compared to total habitat area.<br>*(Suggestion – these impacts could be < 5% of the original area of habitat)* |
| Moderate (2) | There are likely to be more widespread impacts on the habitat but the levels are still considerable acceptable given the % of area affected, the types of impact occurring and the recovery capacity of the habitat.<br>*(Suggestion – for impact on non-fragile habitats this may be up to 50% [similar to population dynamics theory] - but for more fragile habitats, to stay in this category the percentage area affected may need to be smaller, e.g. 20%)* |
| Severe (3) | The level of impact on habitats may be larger than is sensible to ensure that the habitat will not be able to recover adequately, or it will cause strong downstream effects from loss of function.<br>*(Suggestion - Where the activity makes a significant impact in the area affected and the area > 25 - 50% [based on recovery rates] of habitat is being removed)* |
| Major (4) | Substantially too much of the habitat is being affected, which may endanger its long-term survival and result in severe changes to ecosystem function.<br>*(Suggestion this may equate to 70 - 90% of the habitat being affected or removed by the activity)* |
| Catastrophic (5) | Effectively the entire habitat is in danger of being affected in a major way/removed.<br>*(Suggestion: this is likely to be in range of > 90% of the original habitat area being affected).* |

(Source: Fletcher *et al.* 2002)

Table A6. Consequence levels for the impact of a fishery on the general ecosystem/trophic levels

| Level | Ecological (ECOSYSTEM) |
|---|---|
| Negligible (0) | General - Insignificant impacts to habitat or populations, Unlikely to be measurable against background variability. Ecosystem: Interactions may be occurring but it is unlikely that there would be any change outside of natural variation. |
| Minor (1) | Ecosystem: Captured species do not play a keystone role – only minor changes in relative abundance of other constituents. |
| Moderate (2) | Ecosystem: measurable changes to the ecosystem components without there being a major change in function. (no loss of components). |
| Severe (3) | Ecosystem: Ecosystem function altered measurably and some function or components are locally missing/declining/increasing outside of historical range &/or allowed/facilitated new species to appear. Recovery measured in years. |
| Major (4) | Ecosystem: A major change to ecosystem structure and function (different dynamics now occur with different species/groups now the major targets of capture). Recovery period measured in years to decades. |
| Catastrophic (5) | Ecosystem: Total collapse of ecosystem processes. Long-term recovery period may be greater than decades. |

(Source: Fletcher *et al.*, 2002)

Table A7. Consequence levels for impacts of management of a fishery at a political level

| Level | SOCIAL - POLITICAL |
|---|---|
| Negligible (0) | No impact - would not have any flow-on impacts to the local community. No fisheries department staff would need to make a statement. |
| Minor (1) | May have minor negative impact on the community (for example, small number of job losses) but these impacts would be easily absorbed. |
| Moderate (2) | Some increase in unemployment and decrease in overall income to which the community will adjust over time. Some community concern, which may translate to some political action or other forms of protest. |
| Severe (4) | Significant reductions in employment and income associated with the fishery. Significant employment and income flow-on effects to other community businesses, as reduced income and increased unemployment in fishing works its way through the local economy. Significant levels of community concern over the future of the community, which may translate to political action or other forms of protest. |
| Major (6) | High level of community impacts which the community could not successfully adapt to without external assistance. Significant level of protest and political lobbying likely. Large-scale employment and income losses in the fishing sector of the local economy. Significant flow-on effects in terms of increasing unemployment and income reductions as a consequence of changes to the fishery. Decline in population and expenditure-based services (e.g. schools, supermarkets, bank). Population declines as families leave the region looking for work. |
| Catastrophic (8) | Large-scale impacts well beyond the capacity of the community to absorb and adjust to. Likely to lead to large-scale rapid decline in community income and increase in unemployment in areas directly and indirectly related to fishing. May lead to large-scale and rapid reduction in population as families leave the region. Likely to lead to high levels of political action, protest and conflict. Significant reduction in access to private and public sector services, as businesses become unviable and target populations needed to attract government and commercial services decline below threshold levels. |

(Source: Fletcher *et al.*., 2002)

Table A8. The General Consequence Table for use in ecological risk assessments related to fishing

| Level | General |
|---|---|
| Negligible (0) | Very insignificant impacts. Unlikely to be even measurable at the scale of the stock/ecosystem/community against natural background variability. |
| Minor (1) | Possibly detectable but minimal impact on structure/function or dynamics. |
| Moderate (2) | Maximum appropriate/acceptable level of impact (e.g. full exploitation rate for a target species). |
| Severe (3) | This level will result in wider and longer term impacts now occurring (e.g. recruitment overfishing). |
| Major (4) | Very serious impacts now occurring with relatively long time frame likely to be needed to restore to an acceptable level. |
| Catastrophic (5) | Widespread and permanent/irreversible damage or loss will occur – unlikely to ever be fixed (e.g. extinctions) |

(Source: Fletcher et al. 2002)