ECOLOGICALLY SUSTAINABLE DEVELOPMENT (ESD) RISK ASSESSMENT OF THE SOUTH AUSTRALIAN COMMERCIAL BLUE CRAB FISHERY

2009

Government of South Australia

Primary Industries and Resources 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 Division of Primary Industries and Resources South Australia (PIRSA) are 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 concepts 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 fisheries 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 around $220 million and it is estimated that 328,000 South Australians enjoy recreational fishing each year. 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 has signed communication protocols with the relevant representative industry association for each commercial fishery sector. For the Blue Crab Fishery the industry association is the South Australian Blue Crab Pot Fishers Association Inc.

Under the *Fisheries Management Act 2007*, the preparation of fishery management plans on behalf of the Minister for Fisheries is a key responsibility of the Fisheries Council. Management plans are a significant instrument, 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 on the following page.

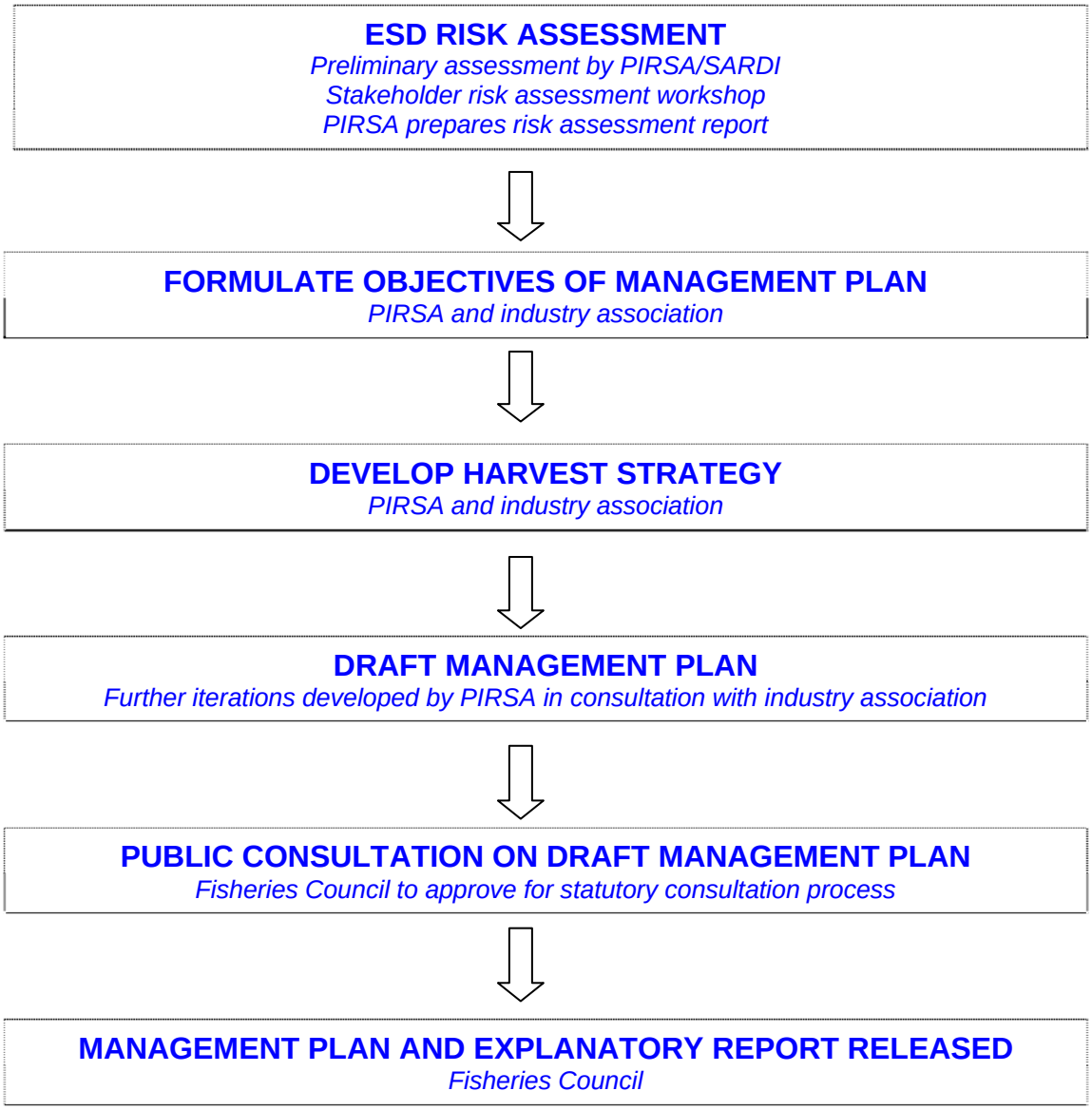

Figure 1. Process for preparing a Fishery Management Plan

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 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 mid May 2009, PIRSA arranged an ESD risk assessment workshop with key Blue Crab Fishery stakeholders, engaging an independent facilitator (Dr Rick Fletcher) to run the workshop process. The workshop built upon earlier scoping work by the fisheries manager, scientists, and industry to identify the majority of 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 that was held to inform the development of the full ESD report 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 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.

[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.

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

2.1.1. Location of the Fishery

Within South Australia, Blue Swimmer Crabs are restricted to the waters of Gulf St Vincent, Spencer Gulf, and the west coast bays off upper western Eyre Peninsula.

The waters in which Blue Crab Fishery licence holders may take Blue Swimmer Crabs are provided in Figure 2 below and are described as follows:

Gulf St Vincent - In the waters of Gulf St Vincent north of the geodesic from the location on Mean High Water Springs closest to 35°03'12.00" South, 137°43'30.45" East to the location on Mean High Water Springs closest to 35°03'12.00" South, 138°30'16.59" East".

Spencer Gulf - In the waters of Spencer Gulf north of the geodesic from the location on Mean High Water Springs closest to 34°26'45.00" South, 136°06'57.58" East to the location on Mean High Water Springs closest to 34°26'45.00" South, 137°24'59.26" East, **with the exception of the following areas**;

- Upper Spencer Gulf – in the waters of Spencer Gulf north of the geodesic from the location on Mean High Water Springs closest to 32°43'45.67" South, 137°47'41.28" East to the location on Mean High Water Springs closest to 32°43'45.67" South, 137°54'11.78" East.

- Whyalla – in the waters of or near False Bay contained within and bounded by a line commencing at Mean High Water Springs closest to 33°04'26.61" South, 137°32'58.50" East, then beginning north-easterly following the line of Mean High Water Springs to the location closest to 32°59'41.12" South, 137°45'31.96" East (Stony Point), then south-westerly to 33°05'12.75" South, 137°34'10.86" East (north-eastern corner of Whyalla-Cowled's Landing Aquatic Reserve), then north-westerly following the boundary of the Whyalla-Cowled's Landing Aquatic Reserve to the point of commencement.

- Port Broughton and Fisherman Bay - in the waters of or near Fisherman Bay contained within and bounded by a line commencing at Mean High Water Springs closest to 33°32'57.56" South, 137°56'27.59" East, then beginning south-easterly following the line of Mean High Water Springs to the location closest to 33°35'40.46" South, 137°55'20.82" East, then northerly to the location on Mean High Water Springs closest to 33°33'27.77" South, 137°55'24.65" East (Shag Island), then north-easterly to the point of commencement.

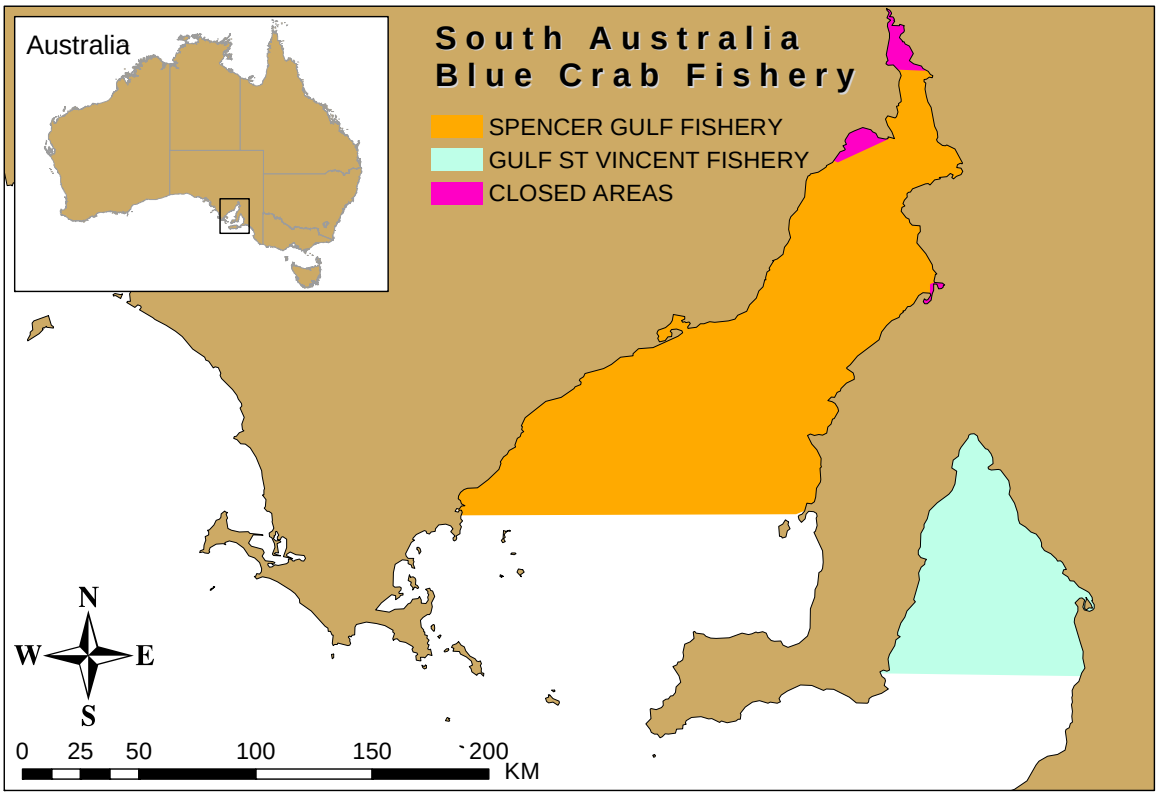

Figure 2. Area of the Blue Crab Fishery
Source: SARDI Aquatic Sciences (Dixon and Hooper, 2009)

Some aquatic reserves also have prohibitions and restrictions on fishing and which species can be taken. The locations and coordinates of the State's aquatic reserves are provided in the *Fisheries Management (Aquatic Reserves) Regulations 2007* or on the PIRSA Fisheries website.

2.1.2. Access to the Fishery

Access to the commercial Blue Crab Fishery is provided through a licence for the Blue Crab Fishery or the Marine Scalefish Fishery. Licences are endorsed with quota units for either the Gulf St Vincent zone or Spencer Gulf zone.

2.1.3. Fishing Methods

Blue Crab Fishery licence holders use crab pots to trap their catch. Crab pots used by the commercial fishery have a diameter of 1.2-1.4 m, a height of 50 cm, and are covered with a 90 mm mesh (Figure 3).

Bait nets are also permitted to be used by licence holders. These nets may be up to 150 m in length and have a mesh size of between 30 mm and 150 mm.

Marine Scalefish Fishery licence holders are restricted to using crab nets, which are hoop nets or drop nets.

Figure 3. Commercial Crab Pot used in the Blue Crab Fishery

2.1.4. Retained Species

The fishery is based on the capture of a single species, *Portunus pelagicus*, although other crustacean species are permitted to be landed and sold as by-product (Note that a recent taxonomic revision has now re-assigned the Blue Swimmer Crab from within South Australia as *Portunus armatus*.) A number of other species are permitted to be taken for use as personal bait, either as incidental catch in crab pots, or by using a bait net.

Rock crabs (*Nectocarcinus integrifrons*) and spider crabs (*Leptomithrax* spp.) may be taken by licence holders. However, as markets have not historically existed for these species they have generally not been retained. Velvet crabs (*Nectocarcinus tuberculosus*) are not captured in the fishery due to the areas they inhabit.

Table 1 lists all species that are permitted to be taken by the *Fisheries Management (Blue Crab Fishery) Regulations 1998*.

Table 1. Permitted Species in the Blue Crab Fishery

	Common Name	Scientific Name
Permitted Species		
Crustaceans	Blue Swimmer Crab	*Portunus pelagicus*
	Rock crab	*Nectocarcinus integrifrons*
	Spider crab	Family Majidae
	Velvet crab	*Nectocarcinus tuberculosus*
Permitted Bait Species		
Molluscs	Octopus	*Octopus* spp
	Gould's Squid	*Nototodarus gouldii*
Scalefish	Australian Anchovy	*Engraulis australis*
	Barracouta	*Thyrsites atun*
	Black Bream	*Acanthopagrus butcheri*
	Cod (marine species)	Family Moridae
	Flathead	Family Platycephalidae
	Flounder	Family Bothidae or Pleuronectidae
	Bluespotted Goatfish	*Upeneichthys vlamingii*
	Eastern Striped Grunter	*Pelates sexlineatus*
	Australian Herring	*Arripis georgianus*
	Yellowtail Kingfish	*Seriola lalandi*
	Leatherjacket	Family Monacanthidae
	Blue Mackerel	*Scomber australasicus*
	Common Jack Mackerel	*Trachurus declivis*
	Morwong	Family Cheilodactylidae
	Mullet of all species	Family Mugilidae
	Mulloway	*Argyrosomus hololepidotus*
	West Australian Salmon	*Arripis truttaceus*
	Australian Sardine	*Sardinops sagax*
	Snook	*Sphyraena novaehollandiae*
	Southern Sole	*Aseraggodes haackeanus*
	Sea Sweep	*Scorpis aequipinnis*
	Trevally	*Pseudocaranx* spp.
	Bluethroat Wrasse	*Notolabrus tetricus*
Sharks	Rays of all species	Class Elasmobranchii
	Shark of all species other than White Shark (*Carcharodon carcharias*)	Class Elasmobranchii
	Skate of all species	Class Elasmobranchii

2.1.5. Non-Retained Species

Generally, no species other than Blue Swimmer Crabs that are captured in crab pots are retained.

Detailed information has been collected on the composition and abundance of bycatch in the fishery through the annual fishery-independent surveys (FIS) since 2002 (refer to Appendix 2). Small mesh pots, designed specifically for surveys, have a diameter of 1.4 m, a height of 50 cm and a smaller mesh covering of 55 mm. Bycatch taken using these pots is significantly and

demonstrably higher than for the commercial pots with larger (90 mm) mesh (Svane and Hooper, 2004).

The FIS research illustrates that bycatch in the Blue Crab Fishery is extremely low and mainly comprises other crab species that can either be retained as by-product or be returned to the water alive (Svane and Hooper, 2004).

The rock crab (*N. integrifrons*) has been found to be the most abundant bycatch species in the FIS, comprising between 80-90% of the total bycatch. Other common bycatch species included the spider crab (*L. gaimardii*) (8%) and the common leatherjacket *Acanthaluteres spilomelanurus* (4%). Most other species were infrequently captured and individually contributed to less than 2% of the total bycatch from both gulfs (Svane and Hooper, 2004).

2.1.6. Bait Usage

The Blue Crab Fishery is permitted to retain a number of species for bait use only pursuant to their own fishing licences and not for sale. Bait may be taken by using a bait net or retained as incidental bycatch in crab pots. Species permitted to be taken as bait are provided in Table 1.

2.2. Summary of Management Arrangements and Objectives

2.2.1. History of the Fishery

Blue Swimmer Crabs were initially taken commercially as incidental catch in the marine scalefish and prawn fisheries. In the late 1970's, the South Australian Department of Fisheries began to investigate the potential for the development of a commercial blue crab fishery.

This investigation lead to the establishment of an experimental blue crab pot fishery in 1983 through a call for expressions of interest from Marine Scalefish Fishery licence holders. Following consideration of applications lodged, 6 permits were issued on an annual basis with no right of renewal.

Those licence holders receiving permits were restricted in their operations to one of the following areas.

- West coast – all waters west of longitude 135° East;
- Gulf St Vincent – all waters north of a line from Stanvac chimney to Oyster point (Stansbury);
- Spencer Gulf – all waters north of a line from Cape Elizabeth to Cape Driver, excluding aquatic reserves.

During the 1985/86 season a total of twelve fishers were offered licences to take Blue Swimmer Crabs in these areas (4 west coast, 6 Spencer Gulf and 2 Gulf St Vincent) for a 2-year period. Those fishers taking up the offer were required to place their marine scalefish licence in abeyance during the trial period.

The west coast fishery collapsed in 1986, due to an environmentally driven recruitment failure. As a result, the four fishers operating in this area

subsequently surrendered their licences. By 1989 a number of operators had forfeited their experimental permits, with two fishers left operating in Gulf St Vincent and four in Spencer Gulf.

In 1996 the South Australian Government established a commercial blue crab pot fishery, implementing management and research strategies to maintain a sustainable and financially viable fishery. Access arrangements to the fishery were determined using historical catches. A number of marine scalefish licence holders who had historically targeted blue crabs in waters adjacent to the Yorke Peninsula using hoop and drop nets were provided access. The fishery was divided into two zones (Spencer Gulf and Gulf St Vincent).

Since the establishment of the fishery an Individual Transferable Quota (ITQ) management system has been in place. At the commencement of the fishery in 1996 total allowable commercial catches (TACCs) were set and divided equally amongst licence holders in each of the zones.

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 Blue Crab Fishery are the *Fisheries Management (Blue Crab Fishery) Regulations 1998* for the commercial fishery and the *Fisheries Management (General) Regulations 2007* for the recreational fishery.

2.2.3. Management Arrangements

Commercial Fishery

The fishery has been managed under a system of ITQ since 1996. The fishery is managed in two separate zones (Spencer Gulf and Gulf St Vincent) with separate quota units for each zone. The TACC is set each year, based on scientific advice about the sustainability of the fishery.

The TACC was initially set at 520 tonnes for the 1996/97 fishing season. Over the next four seasons the TACC gradually increased until it reached 626.8 t in 2000/01. The TACC has been set at 626.8 tonnes every year since 2000/01.

There are 9 licences in the Blue Crab Fishery, which are endorsed with quota units for either the Spencer Gulf or Gulf St Vincent. Blue Crab Fishery licence holders are entitled to fish using crab pots and generally haul their gear once or twice a day during the fishing season.

Blue Crab Fishery licence holders (pot fishers) generally fish in waters deeper than those fished by marine scalefish net fishers and recreational fishers. The ability to access deeper water provides for an extended season as they can access the stocks in waters where they continue to be caught during the cooler months. Pot fishers have developed their operations to make effective use of relatively high catches in order to produce higher returns from the resource. Vessels operating commercial pot licences generally have a skipper and one or two deckhands aboard, with most operators lifting pots on a daily basis.

The total number of pots each Blue Crab Fishery licence holder may use is directly related to the number of quota units endorsed on the licence. This pot to quota unit ratio varies between areas. One pot may be used for every 12.5 quota units in Spencer Gulf and one pot may be used for every 11.5 quota units in Gulf St Vincent. These ratios will continue to be reviewed as consideration is given to allowing fishers to maximise efficiency in the fishery.
Marine Scalefish Fishery licence holders may also hold blue crab quota but may only fish using drop nets or hoop nets, which are hauled every 20 – 30 minutes. Marine scalefish fishers may also take Blue Swimmer Crabs from specified waters on the west coast; however this region is not subject to the quota management system. Seasonal variations in the abundance of Blue Swimmer Crabs present in this area have historically been dependent on environmental conditions. A combined maximum of 10 drop and hoop nets can be used at any one time.

When the Blue Crab Fishery was established in 1996, minimum quota unit holdings were established for Marine Scalefish Fishery licences in order to encourage the efficient use of the resource. These minimum holdings remain at 19 units for original participants who were granted access to the fishery in 1996 and 80 units for all other licence holders.

In 2002, management arrangements were introduced to allow Marine Scalefish Fishery licence holders with blue crab quota to enter the pot fishery. This required forfeiture of the Marine Scalefish Fishery licence in exchange for a Blue Crab Fishery licence. The purpose of implementing this arrangement was to provide the opportunity for those licence holders to expand their Blue Swimmer Crab fishing operations into the Blue Crab Fishery with the higher catching efficiency of crab pots.

The quota management system is monitored through catch disposal records (CDR). CDR forms are formally used to decrement quota, and are submitted by fishers at the time of weighing and consigning the catch.

A commercial closed season is used to protect spawning females and gear restrictions also apply. There are a number of commercial area closures in Spencer Gulf. Berried females are protected and minimum size limits are also in place for both the recreational and commercial fisheries. These management measures are summarised in Table 2.

Table 2. Summary of management controls for the Blue Crab Fishery

Management Tool	Commercial Sector	Recreational Sector
Minimum legal size limit	11 cm carapace length measured from side to side at the base of the largest spines.	
Berried females	Fully protected	
Catch limit	Individual transferable quota system 626.8 tonne TACC	Daily bag limit – 40 Daily boat limit – 120 (combined limits with sand crab)
Seasonal closures	SG: 21 Dec to 19 Feb GSV: 1 Nov to 15 Jan	
Closed areas	SG: Upper Spencer Gulf, Whyalla and Port Broughton / Fishermen's Bay West coast (quota holders only)	
Gear restrictions	SG: 1 pot per 12.5 quota units GSV: 1 pot per 11.5 quota units Crab pot dimensions: max. height of 650 mm, max. diameter of 2 m; min. mesh size of 75 mm or an escape panel that has min. mesh size of 75 mm and is at least 700 mm by 300 mm. Crab net dimensions: max. diameter of 150 cm; max. net extension 30% of hoop diameter; min. mesh size at base of 3 cm. Bait net: max. length 150 m; mesh size between 30 mm and 150 mm.	Max. 10 hoop or drop nets when no other fishing devices used. Max. 3 hoop or drop nets when other fishing devices used.

There are currently four Blue Crab Fishery licences in Gulf St Vincent and five in Spencer Gulf. However, these numbers may change in the future if other Marine Scalefish Fishery licences are forfeited for Blue Crab Fishery (pot) licences. The pot sector now holds 99% of the quota units in the fishery (Table 3).

Table 3. Distribution of Quota in the Blue Crab Fishery

Fishery sector	TACC 2009/2010 (kg)	Unit Value (kg)	No. Of units
Spencer Gulf Pot	377,049.75	57.75	6,529
Spencer Gulf Marine Scalefish	4,620	57.75	80
Gulf St Vincent Pot	241,857	57.75	4,188
Gulf St Vincent Marine Scalefish	3,291.75	57.75	57
Total	**626,818.5**		**10,854**

A draft management plan was developed by the Blue Crab Fishery Management Committee in conjunction with PIRSA Fisheries in 2000. PIRSA Fisheries is currently developing a new management plan following the introduction of the *Fisheries Management Act 2007*.

The primary objectives for the fishery as provided in the draft management plan are:

- Ensure sustainable harvests from the blue crab resource.
- Ensure equitable allocation of the blue crab resource to the commercial and recreational sectors.
- Provide efficient and cost effective management of the fishery.
- Provide for secure access to the resource for each sector.
- Minimise the impact of blue crab fishing on the environment.
- Provide society with a return from the Blue Swimmer Crab resource.

To ensure a robust assessment of the fishery, performance is measured annually against the key fishery indicators defined in the draft plan (Table 4). Performance indicators for the fishery are being reviewed as part of the development of the new management plan.

Table 4. Key performance indicators for the Blue Crab Fishery

Indicator	Interim Target Ref.	Interim Limit Ref.
Catch	TACC	80% of TACC
Relative exploitation rate Gulf St Vincent (% of 1994 level) Spencer Gulf (% of 1990 level)	 50 40	 100 80
Pre-recruit (as % under-size in June and July) Gulf St Vincent Spencer Gulf	 10 30	 5 15
Sex-ratio (% female in June and July) Gulf St Vincent Spencer Gulf	 30 30	 15 15

Recreational Fishery

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

There is no regular assessment of the recreational harvest of Blue Swimmer Crabs in South Australia. McGlennon and Kinloch (1997) estimated a total catch of 161.2 t per year, of which 115.8 t was taken in Gulf St Vincent and 45.4 t in Spencer Gulf. The recreational catch was therefore estimated to be 32.9% in Gulf St Vincent, 10.8% in Spencer Gulf and 20% of the overall statewide catch. The estimate does not include the recreational shore-based fishery, which is considered to be significant (Dixon and Hooper, 2009).

More recently, a National Recreational and Indigenous Fishing Survey (Henry and Lyle, 2003) was conducted between May 2000 and April 2001. The estimated annual catch taken by recreational fishers during this period for South Australia was 389.8 t. This indicated that the recreational harvest was 37.5% of the total catch during 2000/2001. A further 31.7% of the total catch was released after capture (Anon, 2003; Dixon and Hooper, 2009).

PIRSA Fisheries is currently finalising the results of a recreational survey to provide up-to-date estimates of recreational harvest across all South Australian fisheries.

Recreational fishers are subject to some of the same restrictions applied to commercial fishers, including minimum legal size limits and the protection of berried females. However, a closed season does not apply. Maximum daily bag and boat limits are in place for the recreational sector of 40 and 120 Blue Swimmer Crabs per person per day, respectively. Gear restrictions are also in place (refer to Table 2). The catch limits of Blue Swimmer Crab for the Charter Boat Fishery are consistent with the recreational bag and boat limits, except in

cases where there are more than 6 passengers (20 per person per day) or for multi-day trips.

2.2.4. Aboriginal Traditional Involvement in the Fishery

Many Aboriginal communities have a long history of fishing in what are now known as South Australian waters. 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, and 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. SARDI Aquatic Sciences maintains a comprehensive catch and effort database for the fishery using data collected from these returns. To simplify reporting, each gulf is divided into a series of administrative fishing blocks. Data provided includes: fishing block, depth, effort, catch weight, and catch abundance. Fishery logbooks are also used to collect biological data, including the number of undersized crabs, berried females, and the sex-ratio of the catch. These data were first obtained in 1996/97. Historical data from the fishery were recorded into the GARFIS catch and effort database of the South Australian Fisheries Department from 1983/84 (Dixon and Hooper, 2009).

2.3. Biology of Species

2.3.1. Biology of Target Species

Blue Swimmer Crabs have a characteristic last pair of legs that are modified as swimming paddles. They are active swimmers but when inactive, they bury themselves in the sediment leaving only their eyes, antennae, and gill chamber openings exposed. Males are blue and have larger claws than females, which are green-brown in colour (Figure 4) (Dixon and Hooper, 2009).

Figure 4. Male (top) and female (bottom) Blue Swimmer Crabs *Portunus pelagicus*
(Source: SARDI Aquatic Sciences – Dixon and Hooper, 2009)

"Blue Swimmer Crabs are distributed throughout the coastal waters of the tropical regions of the western Indian Ocean and the Eastern Pacific (Kailola *et al*., 1993); they are adapted to a life in warmer waters. In the relatively colder, temperate parts of Australia, the life cycle has evolved to increase growth and reproduction during the warmer part of the year when water temperatures are elevated to those similar to the tropical regions. Activity reduces during the colder winter months.

P. pelagicus occurs in a wide range of algal and seagrass habitats and on both sandy and muddy substrata, from the intertidal zone to at least fifty metres of depth (Williams, 1982; Edgar, 1990). In coastal waters, smaller crabs are found in shallow waters, while adults are found in comparatively deeper waters. Juvenile crabs occur in mangrove creeks and mud flats for eight to twelve months by which time they attain a size of 80 to 100 mm carapace width. Within South Australia, there is a distinct seasonal pattern of adult crab movements into shallow inshore waters during the warmer months of September to April and to deeper offshore waters during the colder months of May to August (Smith, 1982).

Using allozyme markers, Bryars and Adams (1999) determined that the populations of *P. pelagicus* within Spencer Gulf, Gulf St Vincent and the West Coast regions of South Australia, represented separate sub-populations with a limited gene flow. They also found that inter-regional larval dispersal is restricted, and each sub-population must be dependent on its own larval supply.

In a study using microsatellite markers, Chaplin *et al.* (2001) found that the assemblages of *P. pelagicus* in different embayment's in South Australia often constitute genetically different meta-populations. The level of migration

between these populations is probably limited and likely to be determined by local factors.

Male and female *P. pelagicus* generally reach sexual maturity at a size of 70 to 90 mm in carapace width, when they are approximately one year old. The male and female will form a pre-corpula for eight to ten days before ecdysis of the female. After female ecdysis, when the female is soft-shelled, copulation takes place over a six to eight hour period (Meagher, 1971).

The spawning season lasts for 3 to 4 months over the summer/autumn period. The duration of the growing season varies among individuals because those settling in early summer have a longer growing season than those settling in mid-to-late summer. In South Australian waters, crabs close to the minimum legal-size (110 mm) are approximately 14 to 18 months old, sexually mature, and females have produced at least two batches of eggs within one season (Kumar et al., 2000, 2003)."[2]

2.3.2. Current Biological Status

The Blue Crab Fishery is currently classed as fully fished. The stock assessment is considered reliable. The total commercial catch of Blue Swimmer Crab reached a peak of 651.3 t in 1995–96, the year prior to the introduction of quota management in the fishery. The introduction of quota resulted in a 29% reduction in total catch, with 462.4 t being landed in 1996–97. Catches have generally increased each season. In 2007/08, 99.7% of the TACC for the fishery was harvested (Figure 5).

According to Dixon and Hooper (2009), the available data suggest that the Blue Swimmer Crab stock in Gulf St Vincent is being harvested within sustainable limits. In 2007/08 this was evidenced by: stable pre-recruit and legal-size abundance from the FIS; the highest historical catch per unit effort (CPUE) since the introduction of quota in 1997/98, and; the highest level of pre-recruit abundance from commercial logbooks since 1998.

There is conflicting evidence on the status of the resource upon which the Spencer Gulf fishery is based. On a positive note, FIS data indicate that legal-size and pre-recruit abundance during 2007/08 was high. In contrast, fishery-dependent data indicate concern for the resource including: low commercial CPUE; high commercial potlift effort; low pre-recruit abundance from commercial logbooks, and; an increasing proportion of female crabs in the catch (Dixon and Hooper, 2009).

Data were available to assess the fishery's performance against nine of the 11 performance indicators provided by the draft management plan. None of these measures were below the limit reference points. Five of these measures exceeded the target reference (Dixon and Hooper, 2009).

[2] Dixon and Hooper (2009)

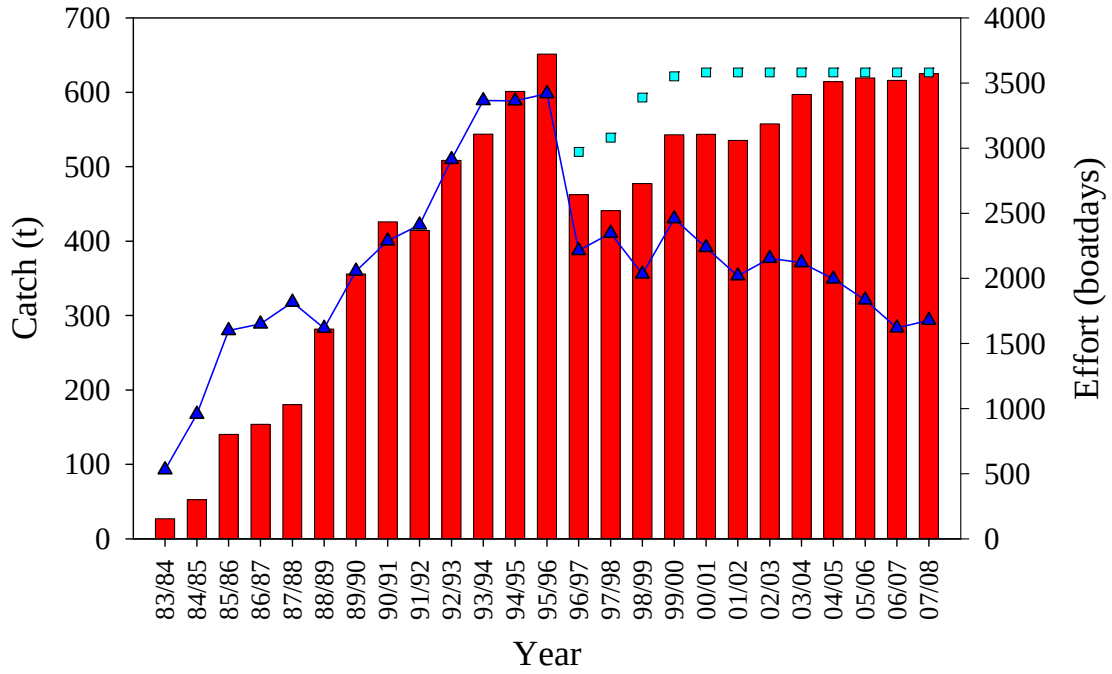

Figure 5. Total commercial catch (vertical bars, t), TACC (squares, t) and fishing effort (line, boat days) for the Blue Crab Fishery from 1983/84 to 2007/08.

(Source: SARDI Aquatic Sciences – Dixon and Hooper, 2009)

2.4. Major Environments

2.4.1. Physical Environment

Spencer Gulf

Spencer Gulf is a unique marine environment in South Australia. It contains the most extensive seagrass meadows in South Australia. The mangrove *Avicennia marina* forms large stands around the coast. Both of these habitats provide vital nursery areas for a large number of fish and crustacean species in the Gulf. Black Point, near Whyalla, provides an important breeding ground for the giant cuttlefish, *Sepia apama*.

Spencer Gulf is considered vulnerable to environmental impacts because its water exchange with the ocean is constrained and the waters are naturally very low in nutrients by world standards. The existing marine communities have evolved to these unique circumstances, and are therefore particularly susceptible to changes in their environment (DEH, 2006).

Gulf St Vincent

Gulf St Vincent lies within the Gulf St Vincent Bioregion. Habitats typical of this region include:

- saltmarshes, mangroves and tidal flats;
- dense seagrass meadows and sandy seafloor; and
- sand and shell grit beaches, tidal creeks and river deltas.

The habitats in the upper Gulf St Vincent area provide critical baselines to measure changes to the State's marine ecosystems that may arise over time from, for example, pollution or climate change.

The coastal wetlands of Gulf St Vincent provide nursery habitats for King George whiting, garfish, mullet, western king prawn and Blue Swimmer Crab. Exposed tidal flats provide important food and resting places for thousands of migratory shorebirds during summer. Species within the region are influenced by the distinctive clockwise circulation of currents within Gulf St Vincent (DEH, 2009).

Environmental Issues

The overall environmental impacts associated with blue crab fishing are considered to be low. The South Australian Blue Crab Fishery was reassessed by the Australian Government Department of Environment and Heritage in 2004 against the 'Guidelines for ecological sustainable management of fisheries', which are set out in the Australian Government *Environment Protection and Biodiversity Conservation Act 1999*. The South Australian Blue Crab Fishery was provided with a five-year exemption from the export controls of the Act, subject to five recommendations.

- Operation of the fishery will be carried out in accordance with the management arrangements for the *Fisheries Management (Blue Crab Fishery) Regulations 1998* and the *Fisheries Management (Marine Scalefish Fisheries) Regulations 2006* in force under the South Australian *Fisheries Management Act 2007.*
- The Department of Primary Industries and Resources, South Australia (PIRSA) to inform the Department of Environment, Water, Heritage and the Arts (DEWHA) of any intended amendments to the Blue Crab Fishery management arrangements that may affect the assessment of the fishery against the criteria on which EPBC Act decisions are based.
- PIRSA to produce and present reports to DEWHA annually as per Appendix B to the Guidelines for the Ecologically Sustainable Management of Fisheries – 2nd Edition.
- PIRSA to ensure that all relevant stakeholders are included in ongoing future consultative processes annually, including industry, recreational, conservation and public representatives.
- PIRSA to:
    - Report on regular surveys, in the annual report, to determine the extent of increased recreational fishing to obtain improved estimates of recreation take; and
    - Ensure all estimates are incorporated into future stock assessments and management arrangements.

2.4.2. Socio-Economic Environment

The total catch of Blue Swimmer Crabs in South Australia increased from 434 tonnes in 1990/91 to 655 tonnes in 1995/96 before decreasing to 467 tonnes in 1999/2000. The total Blue Swimmer Crab catch has trended upward in subsequent years reaching 668 tonnes in 2007/08. Figure 6 illustrates how

the value of the fishery has changed over the seventeen-year period. The total catch in 2007/08 (668 tonnes) was almost 54% above that in 1990/91 (434 tonnes) while the value of the catch was approximately 250% higher, increasing from $1.6 million in 1990/91 to $5.7 million in 2007/08 (Econsearch, 2009).

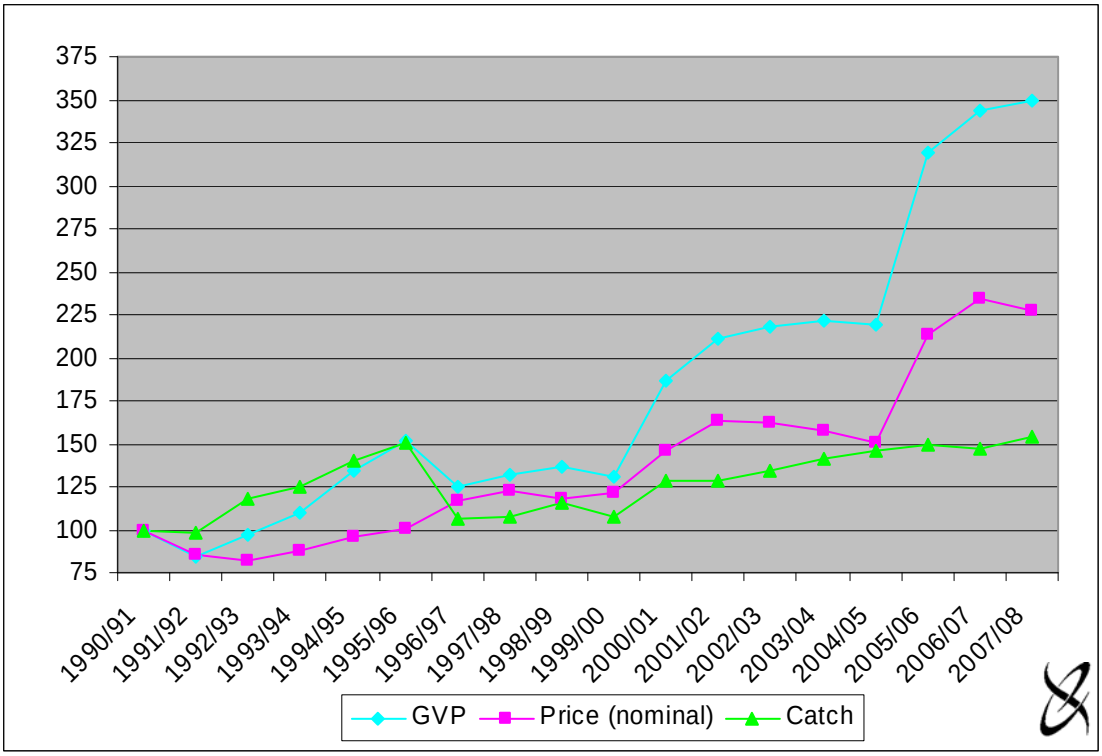

Figure 6. GVP, price and catch indices for the SA Blue Crab fishery (1990/91=100) [3]
(Source: SARDI Aquatic Sciences in Econsearch (2009))

Blue Swimmer Crabs can be stored live in tanks or packed with ice cooked or uncooked before being landed in port. Most of the South Australian commercial catch is sold to the Sydney and Melbourne markets. In 2007/08, a total of 669 tonnes of Blue Swimmer Crabs was harvested from South Australian waters (including the west coast) with an estimated value of $5.7 million (Knight and Tsolos, 2009).

The fishery generates direct and indirect employment, contributes to regional development, and supports many small businesses in direct fishing enterprises as well as various support industries, primarily in regional South Australia (Econsearch, 2009).

PIRSA Fisheries 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. The costs of management of the Blue Crab Fishery are provided in Table 2 below.

[3] SARDI estimates of GVP for 2005/06 to 2007/08 have been re-valued to reflect price differentials between fishery sectors.

Table 2. Cost of management in South Australian commercial fisheries 2007/08

	Licence Fees ($'000)	GVP ($'000)	Fees/ GVP (%)	Catch ('000kg)	Fees/ Catch ($/kg)	Licence Holders (no.)	Fees/ Licence ($/licence)
Abalone	2,530	31,044	8.1%	889	$2.85	35	$72,286
GSV Prawns	302	2,924	10.3%	229	$1.32	10	$30,204
SG & WC Prawns	1,022	32,950	3.1%	2,088	$0.49	42	$24,334
Sth'n Zone Rock Lobster	2,628	75,731	3.5%	1,850	$1.42	181	$14,518
Nth'n Zone Rock Lobster	1,175	15,935	7.4%	459	$2.56	68	$17,287
Blue Crabs - Pots	228	5,423	4.2%	618	$0.37	8	$28,490
Blue Crabs – Marine Scale	11	314	3.4%	50	$0.21	5	$2,126
Lakes and Coorong [a]	282	7,544	3.7%	2,146	$0.13	37	$7,614
Marine Scalefish	2,010	20,917	12.3%	3,002	$0.86	343	$5,968
Sardines	690	16,331	4.2%	29,692	$0.02	14	$49,317
Total SA	10,879	209,113	5.2%	41,023	$0.27	743	$14,641

[a] Excludes the River fishery.

The economic rent generated in the SA Blue Crab fishery over the period 1997/98 to 2007/08 is outlined in Table 3. Economic rent for the fishery as a whole was $1.2 million in 2007/08, approximately 25% lower than the estimate for 2006/07 (Econsearch, 2009).

When economic rent is generated in a fishery and there are transferable licences, the rent represents a return to the value of the licences. The aggregate value of licences in 2007/08 was estimated to be $24.3 million. An annual economic rent of $1.2 million represents a return of 4.8 per cent to the capital value of the SA Blue Crab fishery in aggregate (Econsearch, 2009).

Table 3. Economic rent in the SA Blue Crab fishery, total fishery, from 1997/98 to 2007/08 ($'000)

	Gross Income	Less Labour	Less Cash Costs	Less Depreciation	Less Opportunity Cost of Capital (@10%)	**Economic Rent**
1997/98	2,173	953	821	153	125	**121**
1998/99	2,234	1,012	809	155	127	**131**
1999/00	2,149	1,012	828	159	130	**21**
2000/01	3,067	1,453	922	168	137	**387**
2001/02	3,461	1,696	939	172	141	**512**
2002/03	3,574	1,829	913	179	147	**506**
2003/04	3,638	1,891	981	205	169	**392**
2004/05	4,413	1,098	1,890	385	378	**662**
2005/06	5,236	1,377	1,951	376	370	**1,161**
2006/07	5,629	1,536	1,818	350	347	**1,577**
2007/08	5,564	1,492	2,053	552	291	**1,176**

(Source: Econsearch (2009))

2.5. Research Strategy

2.5.1. Recent / Current Research

"The first report on the South Australian Blue Crab Fishery was published in 1987 by the South Australian Department of Fisheries (Grove-Jones, 1987). The fishery was later reviewed in 1994 by Baker and Kumar (1994). SARDI completed the first stock assessment report for the fishery in 1998, and has since provided annual reports (Kumar, *et al.,* 1998; Kumar, *et al.,* 1999a; Kumar *et al.,* 1999b; Boxshall, *et al.,* 2000; Boxshall, *et al.,* 2001; Hooper and Svane, 2003; Svane and Hooper, 2004; Currie and Hooper, 2006; Currie *et al.*, 2007, Dixon *et al.*, 2008). The Proceedings of the First National Workshop on Blue Swimmer Crab were published in 1997 (Kumar *et al.,* 1997).

Initiated by the Fisheries Research and Development Corporation (FRDC), the Centre for Research on Ecological Impacts of Coastal Cities at the University of Sydney completed an independent review into the research needs of the fishery in February 2001. This report, which was done in consultation with stakeholders, includes comments on the sampling issues for Ecological Sustainable Development (ESD) outcomes, and provides a research review, short-term monitoring advice, and recommendations for a 5-year research program (Scandol and Kennelly, 2001).

A more recent FRDC report (Svane and Cheshire, 2005), reviewed the biology of blue crabs and the key biological determinants for the fishery. This report also provides information on the geographical patterns of post-settlement in juvenile crabs."[4]

[4] Dixon and Hooper (2009)

There are several data sources available for assessment of the fishery, including fishery-dependent commercial logbook data, fishery-dependent pot sampling data, and fishery-independent survey data.

Pot sampling aims to collect fishery-dependent data on abundance and size composition in the fishery throughout the season, to compliment FIS data on recruitment strength and sex-ratio. Pot sampling data have been collected since May 2006 in Spencer Gulf and since July 2006 in Gulf St Vincent. Sampling was voluntarily undertaken from one small mesh pot and one commercial pot each fishing day. Since May 2008, data have been collected from small mesh pots only in each gulf. Data collected include: date, licence number, fishing block, GPS co-ordinates of pot locations, depth, water temperature, and the sex and size of individual crabs (Dixon and Hooper, 2009).

Fishery-independent surveys for the Blue Crab Fishery have been conducted on an annual basis during June/July since 2002. The primary aim of the surveys is to collect data on the spatial abundance and size composition of blue crabs in Spencer Gulf and Gulf St Vincent during winter, when juvenile crabs generally recruit to the fishery. FIS data are the most reliable source of information currently available for the fishery (Dixon and Hooper, 2009).

Although there is sound biological information on Blue Swimmer Crabs in South Australia, there are knowledge gaps that hamper accurate stock assessments. In particular, the lack of robust or representative commercial size-frequency data to reliably detect and quantify significant temporal changes in the mean size, modal size class and the size-frequency distribution of commercially fished crabs increases the uncertainty and limits the assessment of stock status. This is because these data are important given the difficulties associated with using CPUE as a relative index of abundance (Currie and Hooper, 2006).

An annual stock assessment has been produced by SARDI Aquatic Sciences for the Blue Crab Fishery since 1998. These reports undertake an analysis of the catch and effort data from research logbooks and an assessment of data taken as part of the FIS. The most recent stock assessment reports for the Blue Crab Fishery are available on the PIRSA Fisheries website at www.pir.sa.gov.au.

2.5.2. Proposed Future Research

Several research needs have been identified by Dixon and Hooper (2009) to facilitate and augment the current assessment of the Blue Crab Fishery:

- Interpretation of commercial CPUE data;
- Improved data on abundance and size composition through the pot-sampling program;
- Catch and effort data analysis at finer spatial scales;
- Incidental mortality rates; and
- Quantification of the recreational catch.

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 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 of the fisheries 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

This ESD report describes "the contribution of the South Australian commercial Blue Crab 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 staff in conjunction with Blue Crab Fishery industry representatives. This initial scoping was then refined and validated through a broader stakeholder workshop on 14 May 2009.

The scope of the assessment was contained to issues relevant to the commercial Blue Crab Fishery (pot sector). Crab net fishing for Blue Swimmer Crabs by Marine Scalefish Fishery licence holders will be assessed as part of the Marine Scalefish Fishery ESD assessment. The recreational catch of Blue Swimmer Crabs 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 during various blue crab workshops. The identification of issues was informed by the generic ESD component tree approach with each fishery component tree refined specifically for this 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 4). 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 4. Primary ESD Components

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

3.2. Overview

The steps followed to complete this Blue Crab Fishery Report are detailed below:

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 4 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 this 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. 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 process is illustrated in Figure 7 below.

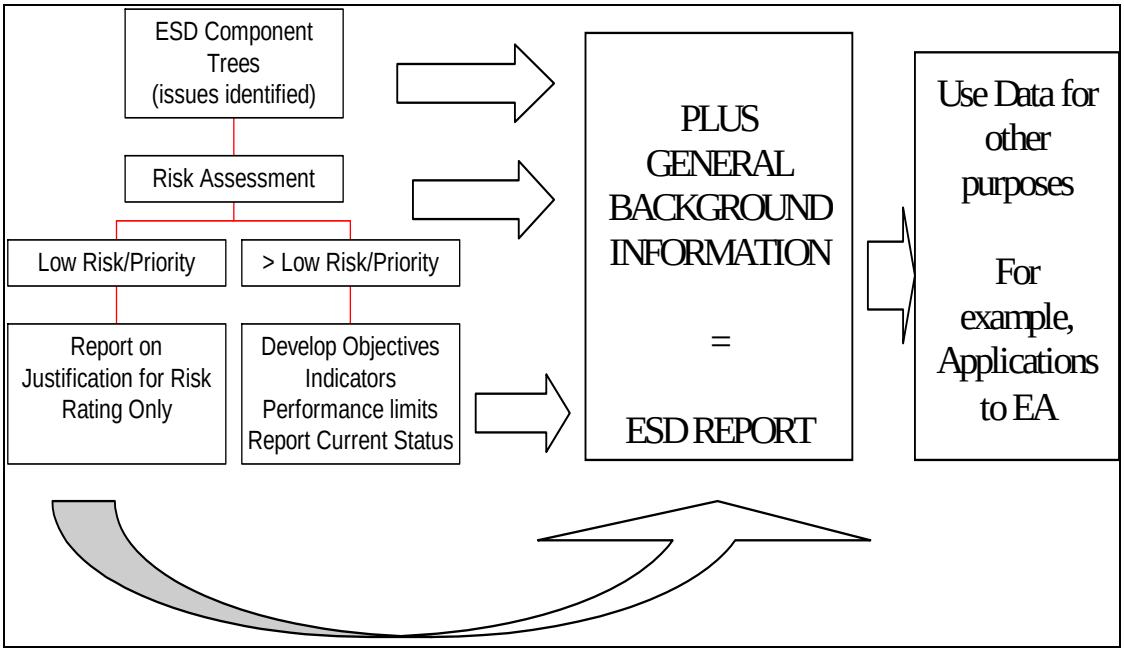

Figure 7. Summary of the ESD reporting framework processes (Source: ESD Reporting *How To Guide*; Fletcher et al., 2002).

3.3. Issue Identification (component trees)

The Blue Crab Fishery ESD reporting component trees are a refined version of the generic trees suggested in the National ESD Reporting Framework (see Table 4 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 of the 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 *external factors affecting ESD performance of the fishery* that was refined during the stakeholder workshop for the Blue Crab Fishery is reproduced below.

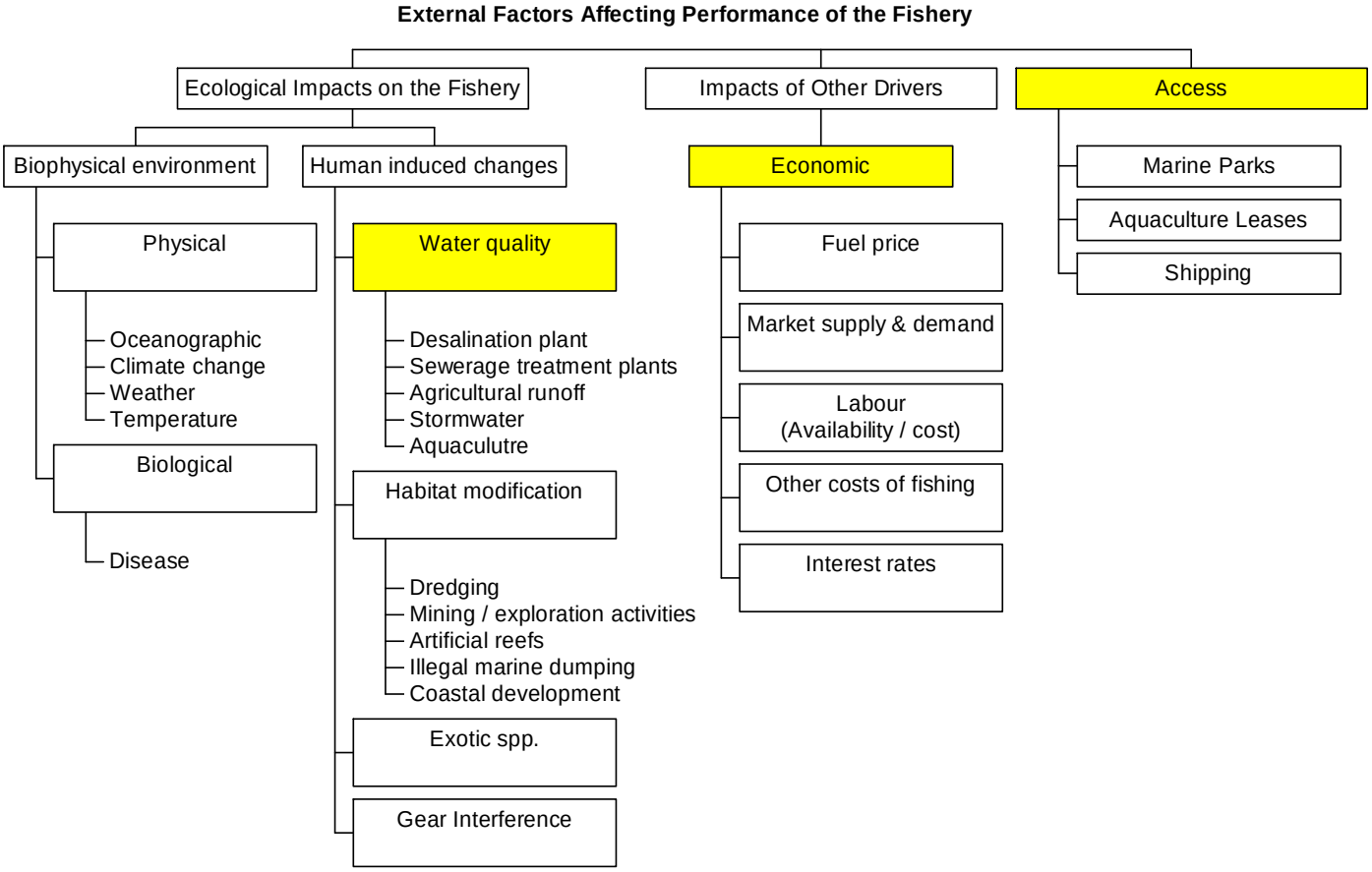

Figure 8. Blue Crab Fishery Component Tree Structure

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 Blue Crab Fishery has been done on the basis of existing management which is currently managing risks to the fishery. Hence the risk assessment conducted during stakeholder workshops considered the residual risk after the existing risk treatments were taken into account. For example, PIRSA's current compliance program for the Blue Crab 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

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 (Blue Swimmer Crabs) the consequence assessment was based at the population not the individual level. Killing one crab 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[5].

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

[5] 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.

Table 8).

Table 5. 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.

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 PIRSA ESD reports. The rationale for scoring other issues as low or negligible risk has also been documented and form part of these reports. This 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 (Figure 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 (Section 4 of this Blue Crab Fishery Report). The content of these reports is based on the standard subject headings recommended in the ESD Framework's *How To Guide*.

The full performance report for the Blue Crab Fishery was developed by

PIRSA Fisheries, informed by the initial consultation with industry and then broader stakeholders at PIRSA's Adelaide ESD workshop on 14 May 2009. A preliminary draft ESD report was sent to industry members and other stakeholders for review. This publication is the final ESD report for the Blue Crab Fishery in support of the draft Management Plan released for public comment in February 2010.

3.6. Overview Table

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

Table 6. Overview of the ESD Risk Assessment for the Blue Crab Fishery

Issue	Risk / Priority	Objective Developed	Indicator Measured	Performance Measure	Current Performance	Robustness	Actions
Retained Species							
Blue Swimmer Crab – Spencer Gulf population	M	Yes	CPUE; Legal size abundance; Pre-recruit abundance	Yes	Acceptable	Medium	TACC reviewed every year
Blue Swimmer Crab – Gulf St Vincent population	M	Yes	CPUE; Legal size abundance; Pre-recruit abundance	Yes	Acceptable	Medium	TACC reviewed every year
Permitted species list	L	N/A – low risk	N/A	N/A	N/A	N/A	Review at next major assessment in 5 years
Bait	N	N/A – negligible risk	N/A	N/A	N/A	N/A	Review at next major assessment in 5 years
Non-Retained Species							
Capture	N	Yes but negligible risk	N/A	N/A	N/A	N/A	Review at next major assessment in 5 years
Direct interaction but no capture	N	Yes but negligible risk	N/A	N/A	N/A	N/A	Review at next major assessment in 5 years
General Ecosystem Impacts of Fishing							
Commercial blue crab fishing	N	N/A – negligible risk	N/A	N/A	N/A	N/A	Review at next major assessment in 5 years
Bait collection	N	N/A – negligible risk	N/A	N/A	N/A	N/A	Review at next major assessment in 5 years
Lost gear	N	N/A – negligible risk	N/A	N/A	N/A	N/A	Review at next major assessment in 5 years

Issue	Risk / Priority	Objective Developed	Indicator Measured	Performance Measure	Current Performance	Robustness	Actions
Discarding	N	N/A – negligible risk	N/A	N/A	N/A	N/A	Review at next major assessment in 5 years
Translocation	M	Yes	Yes	Yes	Acceptable	Medium	Develop code of conduct
Greenhouse gas / carbon emissions	M	Yes	Yes	Yes	Acceptable	Medium	Develop efficiency strategy and determine carbon footprint
Oil discharge	M	Yes	Yes	Yes	Acceptable	Medium	Continue due diligence
Rubbish / debris	L	Yes but low risk	N/A	N/A	N/A	N/A	Review at next major assessment in 5 years
Damage to seagrass	L	Yes but low risk	N/A	N/A	N/A	N/A	Review at next major assessment in 5 years
Damage to soft substratum	N	Yes but negligible risk	N/A	N/A	N/A	N/A	Review at next major assessment in 5 years
Damage to benthic invertebrates	N	Yes but negligible risk	N/A	N/A	N/A	N/A	Review at next major assessment in 5 years
Damage by bait collection	N	Yes but negligible risk	N/A	N/A	N/A	N/A	Review at next major assessment in 5 years
Community							
Profit	M	Yes	Yes	Yes	Acceptable	Medium	Conduct annual economic surveys
Employment	M	Yes	Yes	Yes	Acceptable	Medium	Conduct annual economic surveys
Occupational health, safely and welfare	M	Yes	Yes	Yes	Acceptable	Medium	Periodic review of incidents
Relationships with community	M	Yes	Yes	Yes	Acceptable	-	Maintain positive relationships
Asset value	M	Yes	Yes	Yes	Acceptable	Medium	Maintain asset value
Lifestyle	N	Yes but negligible risk	N/A	N/A	N/A	N/A	Review at next major assessment in 5 years
Regional economic value	L	Yes but low risk	N/A	N/A	N/A	N/A	Review at next major assessment in 5 years
Regional social value	N	Yes but negligible risk	N/A	N/A	N/A	N/A	Review at next major assessment in 5 years

Issue	Risk / Priority	Objective Developed	Indicator Measured	Performance Measure	Current Performance	Robustness	Actions
Regional infrastructure	N	Yes but negligible risk	N/A	N/A	N/A	N/A	Review at next major assessment in 5 years
Economic value	N	Yes but negligible risk	N/A	N/A	N/A	N/A	Review at next major assessment in 5 years
Social value	L	Yes but low risk	N/A	N/A	N/A	N/A	Review at next major assessment in 5 years
Aboriginal community							
*To be completed							
Governance							
Management effectiveness	M	Yes	Yes	Yes	Acceptable	Medium	Develop new management plan under the *Fisheries Management Act 2007*
Research/information	M	Yes	Yes	Yes	Acceptable	Medium	Continue to support research
Allocation	E	Yes	Yes	Yes	Acceptable	Medium	Develop new management plan under the *Fisheries Management Act 2007*
Compensation (other agencies)	E	Yes	Yes	Yes	Acceptable	Medium	To be determined
Industry access security	H	Yes	Yes	Yes	Acceptable	Medium	To be determined
External factors affecting performance of the fishery							
Water quality	M	Yes	Yes	Yes	Acceptable	Low	To be determined
Economic drivers	M	Yes	Yes	Yes	Acceptable	Medium	To be determined
Access	M	Yes	Yes	Yes	Acceptable	-	To be determined

4. PERFORMANCE REPORTS

Red, pink and yellow boxes indicate that the issue was considered of high enough risk/priority at the May 2009 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.

4.1. Retained Species

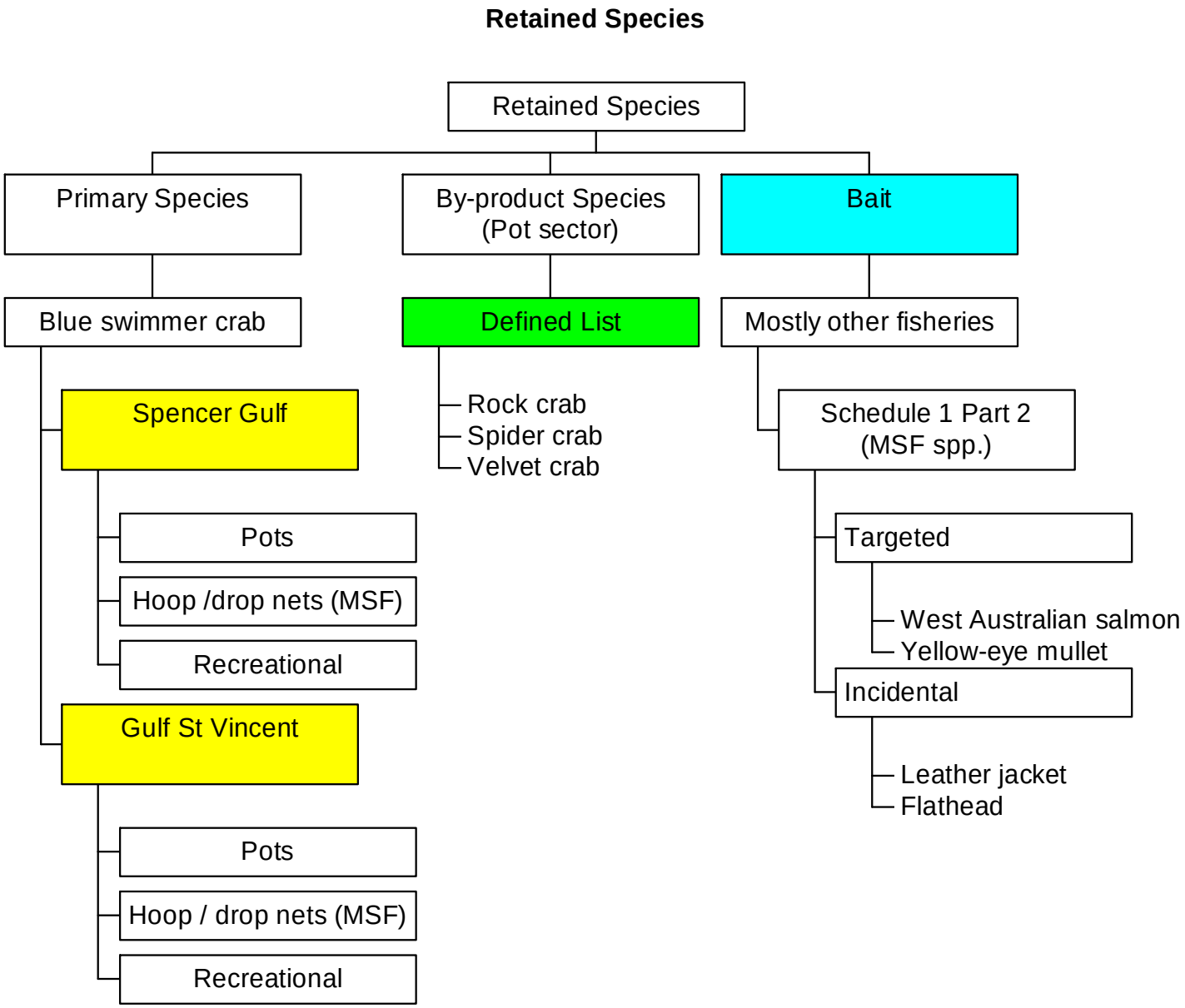

Figure 9. Component Tree for Retained Species

4.1.1. Primary Species

Blue Swimmer Crabs are a short-lived, highly fecund and widespread species. The TACC is the primary tool used in the fishery to control the harvest of Blue Swimmer Crabs in Spencer Gulf and Gulf St Vincent.

There are restrictions to limit the amount of gear that may be used. The regulations require a minimum mesh size for crab pots of 75 mm or an escape panel with 75 mm mesh to prevent the incidental capture of undersize crabs. Industry practice of using 90 mm mesh has further reduced the capture of undersize crabs.

A conservative minimum legal size limit, the protection of berried females and a seasonal closure are also in place to protect the breeding population. Three area closures are in place in Spencer Gulf where the commercial take of Blue Swimmer Crabs is prohibited (Figure 2).

Blue Swimmer Crab – Spencer Gulf population

Objectives

- Ensure the Blue Swimmer Crab resource in Spencer Gulf is harvested within ecologically sustainable limits.
- Maintain the abundance of legal size Blue Swimmer Crabs above the historic 10 year low.

Meeting these objectives should ensure sufficient spawning stock to continue recruitment at levels that will replenish what is taken by fishing, predation and other environmental factors by maintaining the spawning stock of blue crabs at or above a level that minimizes the risk of recruitment over-fishing

ERA Risk Rating: Impact on breeding population (MODERATE)

Available data for the Spencer Gulf pot fishing sector include fishery-dependent data from commercial logbooks and a pot sampling program, as well as fishery-independent survey data. Considerable uncertainty exists in some aspects of the fishery-dependent data and so analyses of CPUE, recruitment and sex-ratio must be interpreted with caution. Fishery-independent survey data have been collected from consistent sites since 2002 and are the most reliable source of information currently available for assessment (Dixon and Hooper, 2009).

According to Dixon and Hooper (2009), there is conflicting information on the status of the resource on which the Spencer Gulf pot fishing sector is based. The most reliable data source, fishery-independent survey, indicates that during 2008 pre-recruit abundance was the second highest recorded (since 2002) (Figure 10) and legal-size abundance was the highest level recorded (Figure 11). These positive observations contradict commercial logbook data from 2008 that suggest pre-recruit abundance was low (Figure 12) and CPUE estimates were at the lowest level since the introduction of quota (Figure 13). These opposing outlooks are not cause for immediate alarm but they warrant careful consideration in future assessments.

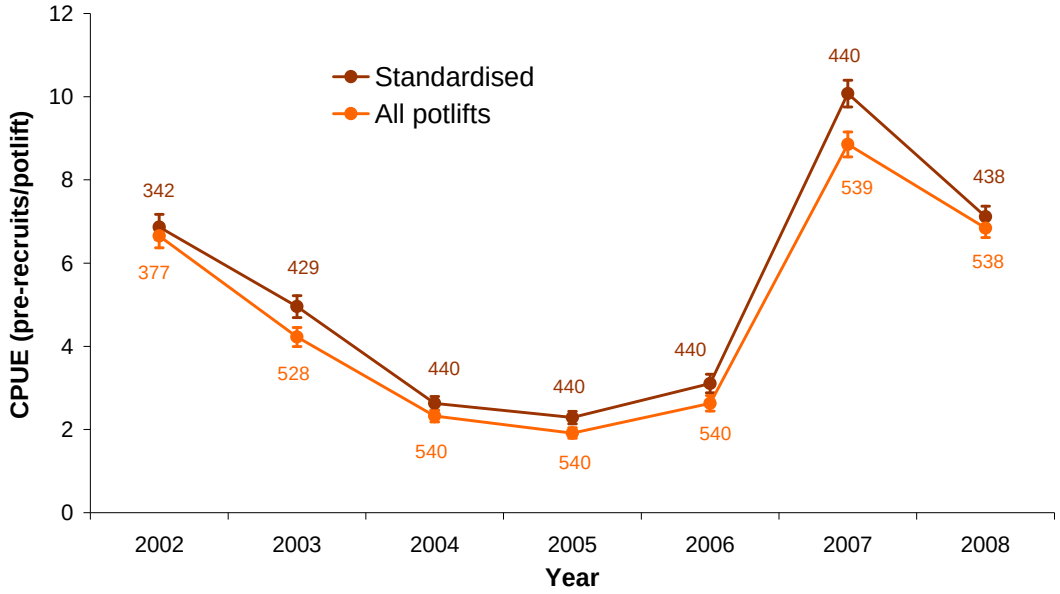

Figure 10. Mean (SE) CPUE (crabs/potlift) of pre-recruit crabs for all potlifts and for standardised potlifts, from fishery-independent surveys conducted in Spencer Gulf between 2002 and 2008[6]

(Source: SARDI Aquatic Sciences – Dixon and Hooper, 2009)

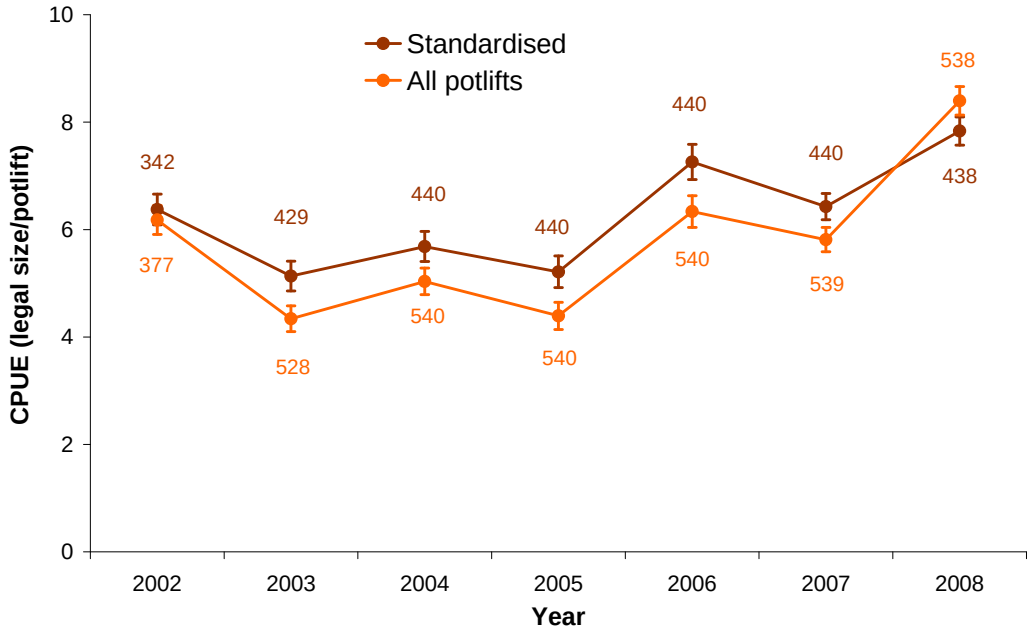

Figure 11. Mean (SE) CPUE (crabs/potlift) of legal-size crabs for all potlifts and for standardised potlifts, from fishery-independent surveys conducted in Spencer Gulf between 2002 and 2008[7]

(Source: SARDI Aquatic Sciences – Dixon and Hooper, 2009)

[6] Labels indicate the number of potlifts.
[7] Labels indicate the number of potlifts.

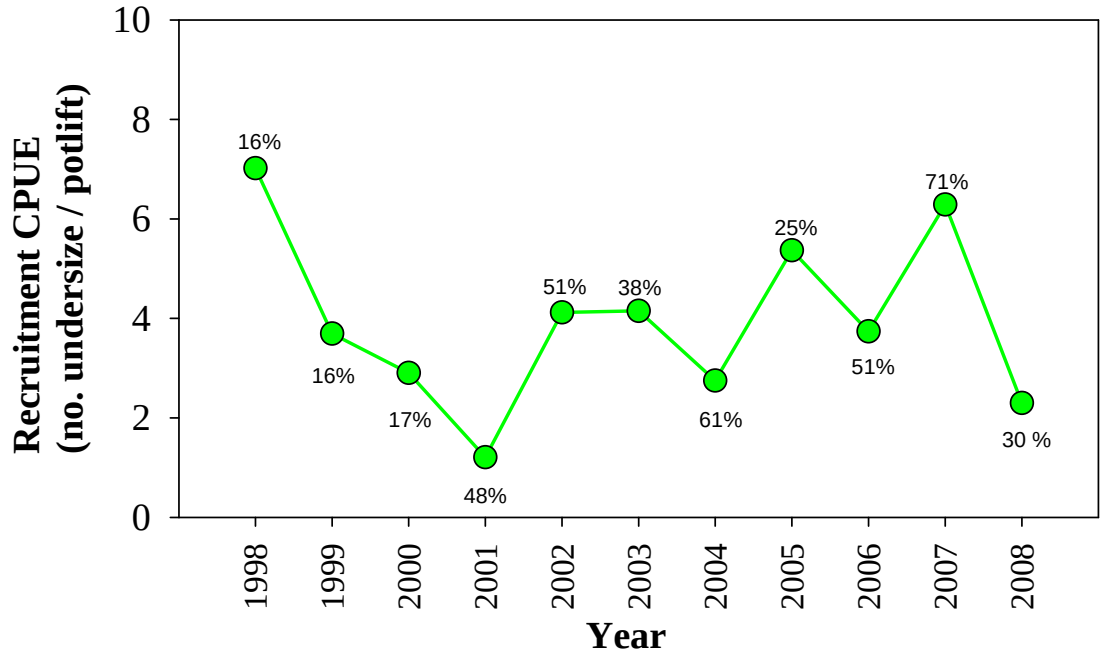

Figure 12. Trends in pre-recruit CPUE (no./potlift) in Spencer Gulf during June/July from 1998 to 2008[8]

(Source: SARDI Aquatic Sciences – Dixon and Hooper, 2009)

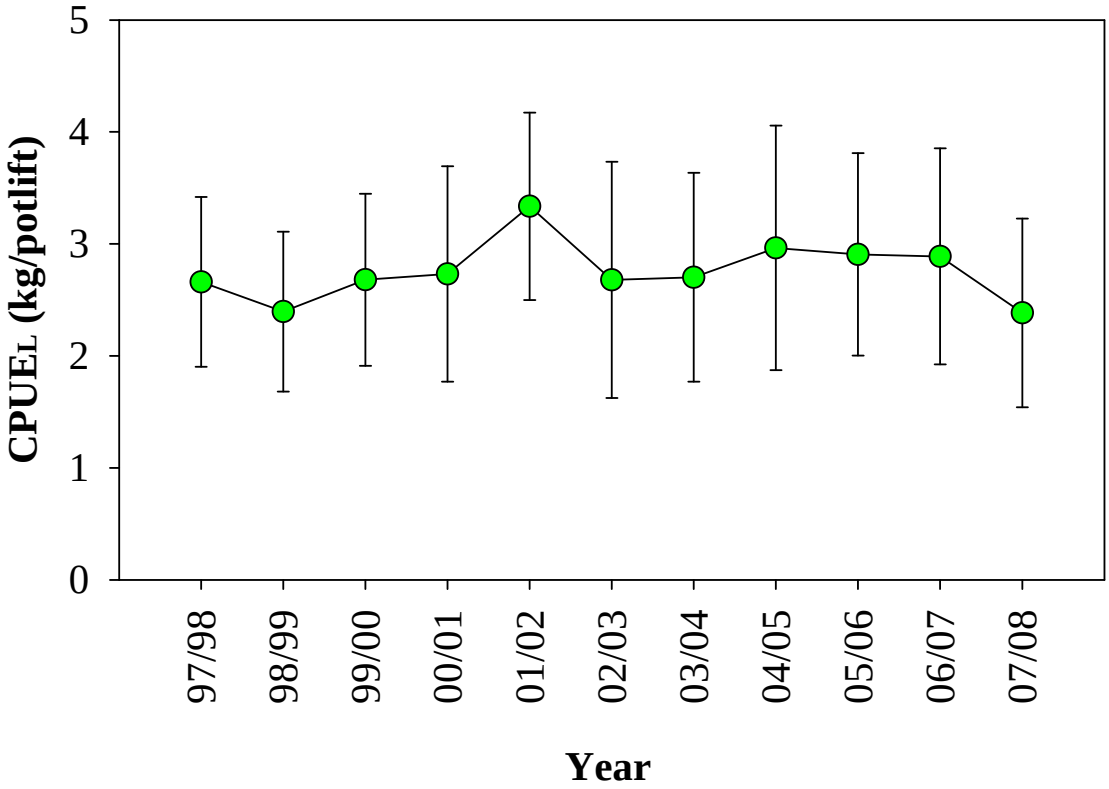

Figure 13. Mean (SD) $CPUE_L$ (kg/potlift) in the commercial Spencer Gulf pot fishing sector from 1997/98 to 2007/08

(Source: SARDI Aquatic Sciences – Dixon and Hooper, 2009)

[8] Labels indicate the % of days where pre-recruit data were recorded in logbooks.

There are two other aspects of the assessment for Spencer Gulf that are also concerning. Firstly, total potlift effort is at its highest recorded level and this is driven by a substantial increase in the number of second potlifts conducted during a day's fishing (Figure 14). Secondly, there appears to be an increasing proportion of female crabs in the total annual catch caused by a shift in the seasonal effort distribution (Figure 15). The consequences of these changes for the long term sustainability of the fishery are currently unknown (Dixon and Hooper, 2009).

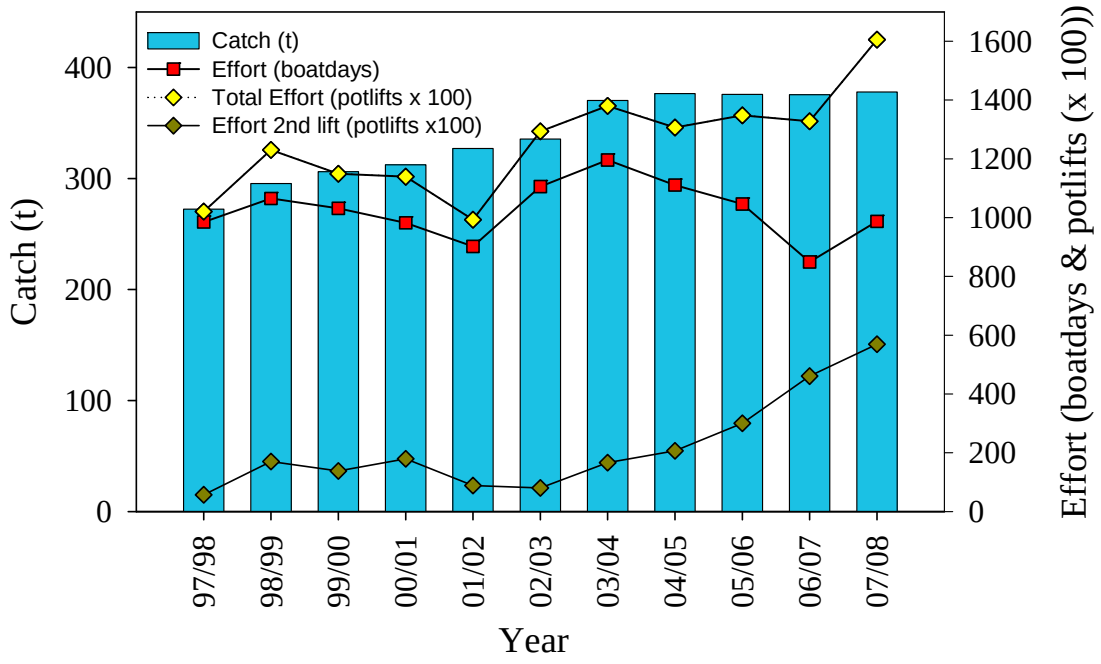

Figure 14. Total catch (t) and effort (boat days, total potlifts and second potlifts) for the commercial pot fishing sector in Spencer Gulf from 1997/98 to 2007/08

(Source: SARDI Aquatic Sciences – Dixon and Hooper, 2009)

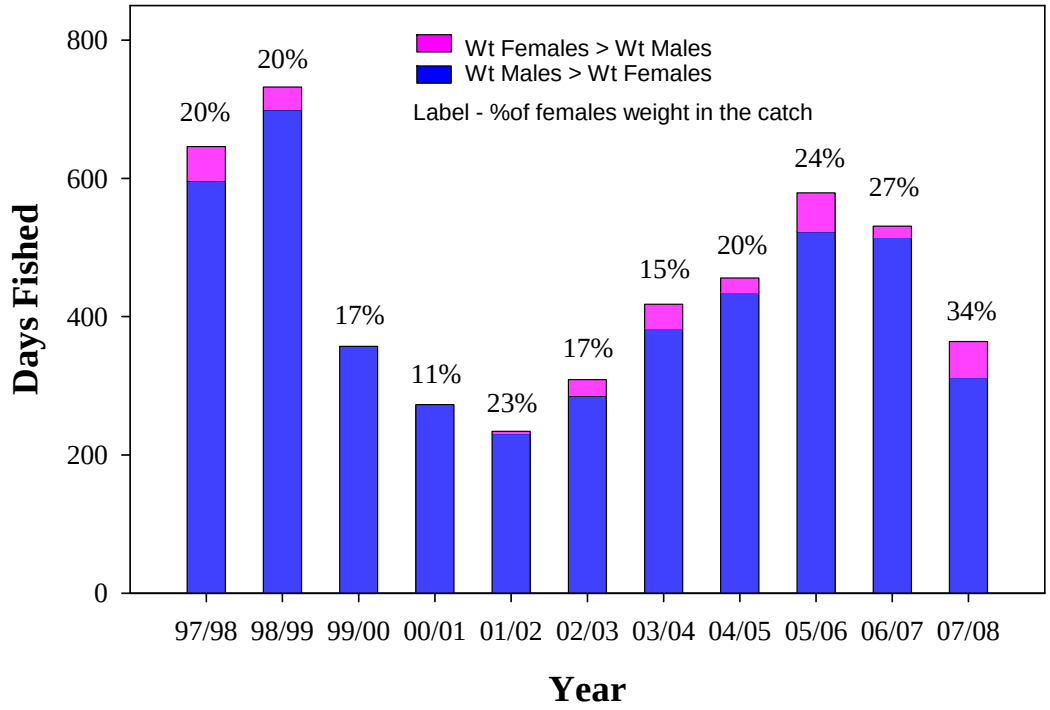

Figure 15. The number of days fished when the retained weight of male crabs exceeded the weight of females (blue bars) and when the retained weight of females exceeded males (pink bars) in Spencer Gulf[9]

(Source: SARDI Aquatic Science – Dixon and Hooper, 2009)

The objective to maintain the abundance of legal size crabs above the historical low is recognised to be an ESD objective, which considers both economic and biological considerations. CPUE is likely to have to drop below this level before the stock and/or its ability to recruit/increase would be affected.

The stock in Spencer Gulf is currently considered to be fully fished and operating in a sustainable way. Therefore the impact on the population was ranked as **moderate (C2)**. The operation of the fishery since the quota management system was introduced in 1996 is considered to have been sustainable and it was considered **likely (L6)** that this existing moderate consequence would continue to occur. This resulted in an overall risk rating of **MODERATE (12)**.

Indicators

- Relative abundance of legal-sized crabs from FIS
- Relative abundance of pre-recruit crabs from FIS
- Commercial CPUE of legal-sized crabs

Performance measures

- Relative abundance of legal size catch is within the upper and lower limit reference points (5 to 8 crabs/potlift)

[9] Labels indicate the percentage of females in the annual catch by weight.

- Relative abundance of pre-recruit catch is within the upper and lower limit reference points (2 to 9 crabs/potlift)
- Commercial CPUE is within the upper and lower limit reference points (2 to 4 kg/potlift)

Blue Swimmer Crab – Gulf St Vincent population

Objectives

- Ensure the Blue Swimmer Crab resource in Gulf St Vincent is harvested within ecologically sustainable limits.
- Maintain the abundance of legal size Blue Swimmer Crabs above the historic 10 year low.

Meeting these objectives should ensure sufficient spawning stock to continue recruitment at levels that will replenish what is taken by fishing, predation and other environmental factors by maintaining the spawning stock of blue crabs at or above a level that minimizes the risk of recruitment over-fishing

ERA Risk Rating: Impact on breeding population (MODERATE)

Available data for the Gulf St Vincent pot fishing sector include fishery-dependent data sources from commercial logbooks and a pot sampling program, as well as fishery-independent survey data. In general, commercial logbook data have been consistently recorded and provide useful information on CPUE and recruitment. In contrast, pot sampling data have been recorded on a low proportion of days fished and are not representative of the catch. Fishery-independent survey data have been collected from consistent sites since 2002 and are the most reliable source of information currently available for assessment (Dixon and Hooper, 2009).

According to Dixon and Hooper (2009), whilst there is some uncertainty in the sources of data available for assessment of the GSV pot fishing sector, all available evidence indicates that the fishery is currently being harvested within sustainable limits. This includes: data from fishery-independent surveys (collected from 2002–2008) that indicate the abundance of pre-recruit and legal-sized crabs in GSV is within historic bounds (Figure 16 and Figure 17); commercial $CPUE_L$ was the highest observed since quota was introduced, and; $CPUE_L$ of recruit sized crabs from commercial logbook data was the highest observed since 1998 (Figure 19).

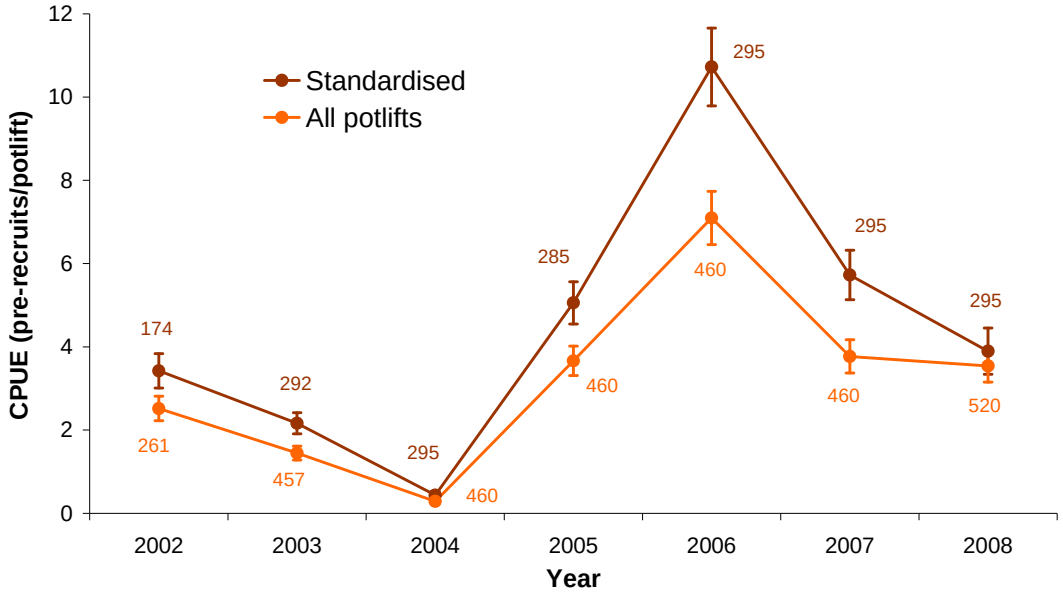

Figure 16. Mean (SE) CPUE (crabs/potlift) of pre-recruit crabs for all potlifts and for standardised potlifts, from fishery-independent surveys conducted in GSV between 2002 and 2008[10]

(Source: SARDI Aquatic Sciences – Dixon and Hooper, 2009)

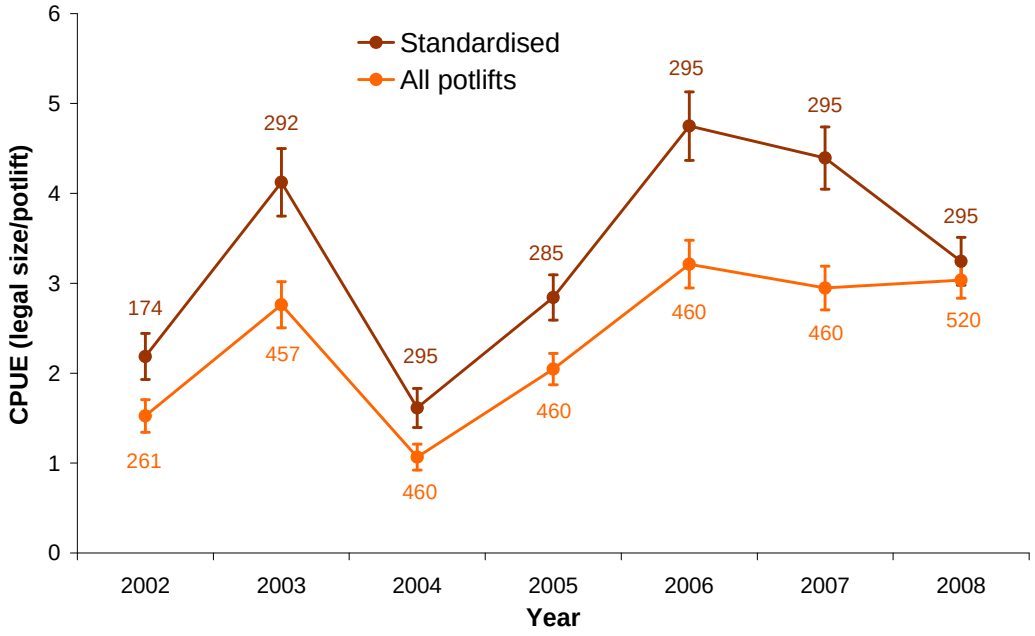

Figure 17. Mean (SE) CPUE (crabs/potlift) of legal-size crabs for all potlifts and for standardised potlifts, from fishery-independent surveys conducted in GSV between 2002 and 2008[11]

(Source: SARDI Aquatic Sciences – Dixon and Hooper, 2009)

[10] Labels indicate the number of potlifts.
[11] Labels indicate the number of potlifts.

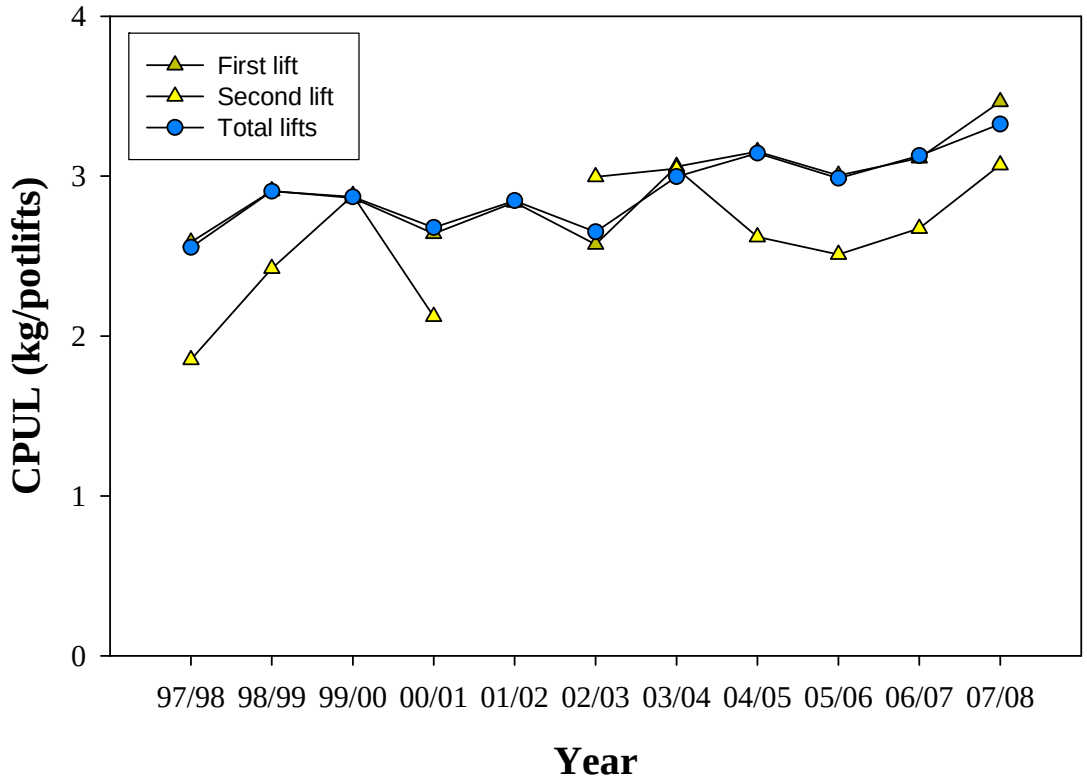

Figure 18. Mean $CPUE_L$ (kg/potlift) in the Gulf St Vincent pot fishing sector for first potlifts, second potlifts and total potlifts from 1997/98 to 2007/08

(Source: SARDI Aquatic Sciences – Dixon and Hooper, 2009)

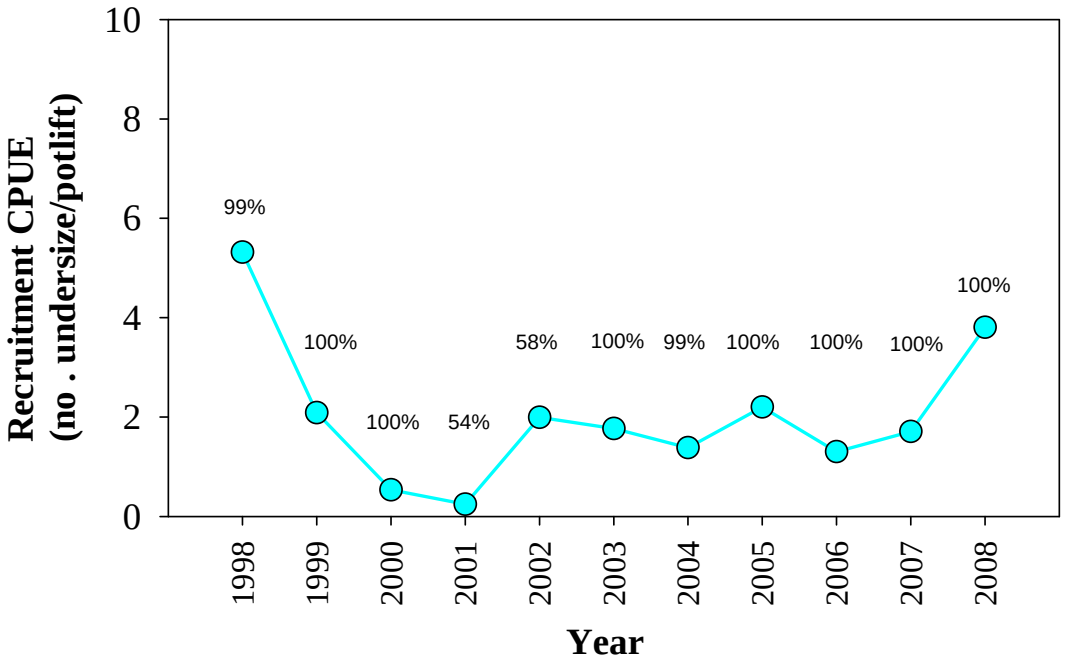

Figure 19. Annual trends in pre-recruit CPUE (no./potlift) in GSV from 1998 to 2008[12]

(Source: SARDI Aquatic Sciences – Dixon and Hooper, 2009)

[12] Labels indicate the % of days where pre-recruit data were recorded in logbooks.

According to Dixon and Hooper (2009), data on pre-recruits were collected consistently in commercial logbooks by Gulf St Vincent fishers from 1998. These data indicate that catch rates of pre-recruit crabs increased substantially during 2008 and were almost double the level of any of the previous nine years. The generally high proportion of data collected suggested that is a robust reflection of the proportion of pre-recruits in the catch. It should be noted that large meshed commercial pots considerably underestimate pre-recruit abundance.

The objective to maintain the abundance of legal size crabs above the historical low is recognised to be an ESD objective, which considers both economic and biological considerations. CPUE is likely to have to drop below this level before the stock and/or its ability to recruit/increase would be affected.

The stock in Gulf St Vincent is currently considered to be fully fished and operating in a sustainable way. Therefore the impact on the population was ranked as **moderate (C2)**. The operation of the fishery since the quota management system was introduced in 1996 is considered to have been sustainable. It was considered **likely (L6)** that this existing moderate consequence would continue to occur. This resulted in an overall risk rating of **MODERATE (12)**.

Indicators

- Relative abundance of legal-sized crabs from FIS
- Relative abundance of pre-recruit crabs from FIS
- Commercial CPUE of legal-sized crabs

Performance measures

- Relative abundance of legal-sized catch is within the upper and lower limit reference points (1.5 to 4 crabs/potlift)
- Relative abundance of pre-recruit catch is within the upper and lower limit reference points (1.5 to 8.5 crabs/potlift)
- Commercial CPUE of legal-sized crabs is within the upper and lower limit reference points (2 to 4 kg/potlift)

4.1.2. By-product Species

Permitted species list

Rock crab (*Nectocarcinus integrifrons*), spider crab (Family Majidae) and velvet crab (*Nectocarcinus tuberculosus*) are permitted to be taken by Blue Crab Fishery licence holders by Schedule 1 Part 1 of the *Fisheries Management (Blue Crab Fishery) Regulations 1998*.

ERA Risk Rating: Impact on breeding population (LOW)

Like Blue Swimmer Crabs, rock crabs also belong to the family Portunidae, commonly known as ‘swimming crabs’. Rock crabs are found in low intertidal

and sublittoral areas from north-eastern Queensland to Spencer Gulf in South Australia and along the lower western coast of Western Australia, to depths of 15 m (DEWHA, 2009).

The rock crab (*N. integrifrons*) has been found to be the most abundant bycatch species in the FIS, comprising between 80-90% of the total bycatch. Other common species collected included the spider crab (*L. gaimardii*) (8%) and the common leatherjacket *Acanthaluteres spilomelanurus* (4%). Most other species were infrequently captured and individually contributed to less than 2% of the total bycatch from both gulfs (Svane and Hooper, 2004).

According to the FIS, rock crab (*Nectocarcinus integrifrons*) is caught as the highest volume bycatch species by the fishery. Although they are a permitted species in the Blue Crab Fishery, rock crabs are not retained because the species has little or no market value. Industry advice is that animals are generally returned to the water alive and unharmed.

The Majidae family is a diverse group of crabs in Australian waters, with 63 genera and some 154 species recorded. They are commonly called `spider crabs' because their swollen bodies and long legs give many species a spider-like appearance. The name `decorator crabs' is also often used as a large number of species decorate the carapace and legs with encrusting invertebrate and algal species. Spider crabs live in a variety of habitats from the low intertidal to the deep sea (DEWHA, 2009). The FIS has recorded spider crab (*Leptomithrax gaimardii*) as the second most abundant bycatch species in the Blue Crab Fishery.

Velvet crabs also belong to the family Portunidae. Their distribution ranges from Port Jackson in New South Wales, across southern Australia to Albany in Western Australia, including Tasmania. It is predominantly subtidal and commonly found on rocky substrate to depths of 40 m (McCartney, 1998). The biology and ecology of the species is poorly understood. Individuals can reach 100 mm CL and weigh up to 600 grams. Although velvet crabs are a permitted species, they have never been recorded as captured in the fishery. This is because the rocky habitat they occupy is dissimilar to Blue Swimmer Crab habitat where fishing effort is targeted. Velvet crab has historically had a low market value.

Current fishing activities are considered to have only a **minor (C1)** impact on the populations of these permitted species. It was **likely (L6)** that this would continue to occur. The resultant risk rating is therefore **LOW (6)**. This assessment may need to be revisited if new markets are developed or any of these species become targeted in the future.

4.1.3. Bait

Bait

The Blue Crab Fishery is permitted to retain a number of species for bait use only pursuant to their own fishing licences and not for sale. Bait may be taken using a bait net or retained as incidental bycatch in crab pots. A list of species permitted to be taken as bait by the *Fisheries Management (Blue Crab Fishery) Regulations 1998* is provided in Table 1.

ERA Risk Rating: Impact on breeding stocks (NEGLIGIBLE)

Industry advised that the take of personal bait by licence holders is very rare because it is quicker and easier to buy bait. Industry also advised that few fish taken in crabs pots are used as bait and most are released alive. Bait used in the fishery is generally sourced from the South Australian Marine Scalefish Fishery.

It was noted that if industry practice changed, the species most likely to be targeted with a bait net would be West Australian salmon and yellow-eye mullet. The most likely species to be retained as incidental catch for bait purposes would be leatherjacket and flathead.

Therefore, it was considered **likely (C6)** that the Blue Crab Fishery is having a **negligible (L0)** impact on the populations of these species. This resulted in a risk rating of **NEGLIGIBLE (0)**.

4.2. Non-Retained Species

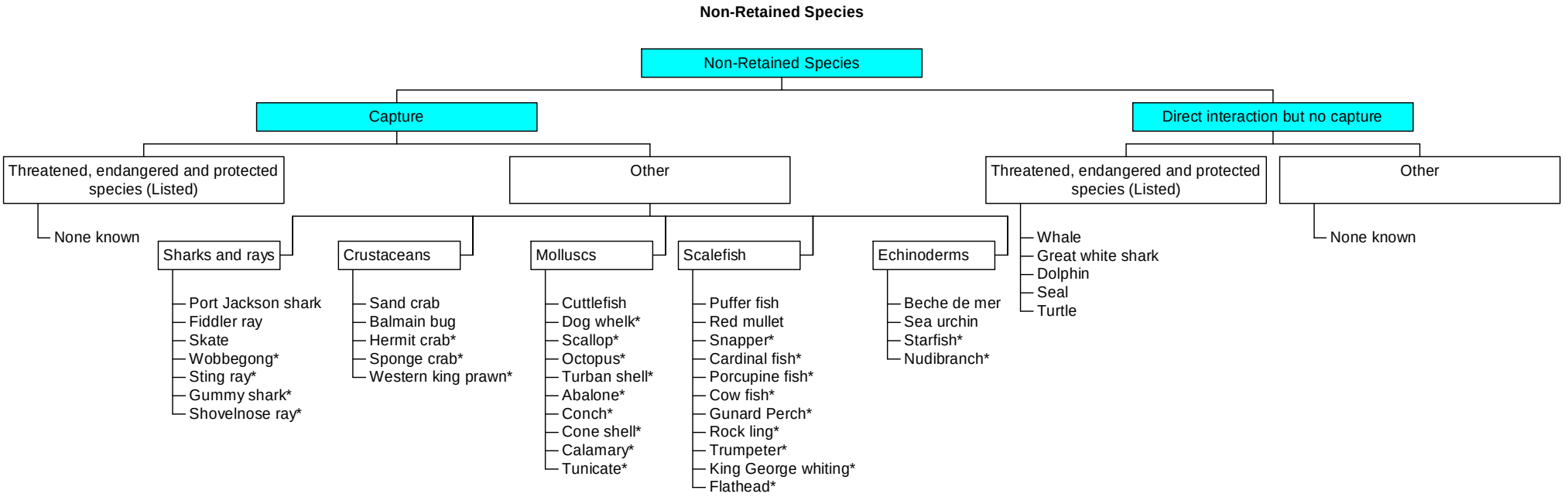

Figure 20. Component Tree for Non-Retained Species

4.2.1. Captured by Gear

Although Blue Crab Fishery licence holders are permitted to retain a number of species for bait use (refer to Table 1), generally no species other than Blue Swimmer Crab is retained.

Objective

- Minimise fishery impacts on bycatch species.

ERA Risk Rating: Impact on populations of species captured in gear (NEGLIGIBLE)

Appendix 1 provides the total abundance and frequency of occurrence of species taken as bycatch during the FIS in Spencer Gulf (Table 15) and Gulf St Vincent (Table 16). These data are a combination of bycatch from both small mesh research pots and commercial pots. For the purposes of the ESD risk assessment, species recorded as captured in commercial pots only have been included in Figure 20. Component Tree for Non-Retained Species It must be noted that many of these species have been recorded in very low numbers. For 'capture' species, those marked with a '*' have been recorded in single digit numbers only, totalled across both gulfs in all years since 2002.

Extensive information on the composition and quantity of bycatch has been collected in the Blue Crab Fishery through the annual FIS. This research illustrates that bycatch in the Blue Crab Fishery is extremely low and mainly comprises other crab species that can either be retained as by-product or be returned to the water alive (Svane and Hooper, 2004).

The small mesh 'research' pots used in the FIS and the fishery-dependent daily pot sampling program have a smaller mesh size of 55 mm. Bycatch taken using these pots is significantly and demonstrably higher than for the commercial pots with larger (90 mm) mesh (Svane and Hooper, 2004).

Aside from the three most abundant bycatch species taken by small mesh pots recorded in the FIS (rock crab, spider crab, and leatherjacket), most other species were infrequently captured and individually contributed to less than 2% of the total bycatch taken from both gulfs. These same relatively rarely taken species also individually occurred in less than 3% of pots fished throughout either gulf (Currie *et al.*, 2007).

Crab pots used by the commercial fishery are considered to be highly selective. Although the regulated minimum mesh size for crab pots is 75 mm (or have an escape panel), industry practice is to use 90 mm mesh. Industry advice and results from the FIS indicate that this larger mesh size has significantly reduced the capture of bycatch species. Industry advice is that almost all bycatch species captured in the gear are released alive.

The impact of the Blue Crab Fishery on populations of species captured in fishing gear is **likely (L6)** to be **negligible (C0)**. This results in a risk rating of

NEGLIGIBLE (0).

4.2.2. Direct Interaction but No Capture

There are a number of species listed as threatened, endangered and protected under State and/or Australian Government legislation. These species are not permitted to be taken and must be released immediately if an interaction occurs.

All licence holders in South Australian commercial fisheries are required to record all interactions with threatened, endangered and protected species using a 'wildlife interaction' logbook, which are provided to SARDI Aquatic Sciences.

Objective

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

ERA Risk Rating: Impact on populations through interaction but no capture (NEGLIGIBLE)

The potential exists for a number of threatened, endangered or protected species to interact with crab pot float lines on rare occasions. These species include whales, dolphins, sharks and seals. The degree to which fishers may encounter each of these species varies temporally and spatially, although this has not been formally quantified. However, the small number of operators and the fact that the Blue Crab Fishery is limited to Spencer Gulf and Gulf St Vincent restrict any interactions that may occur.

Records indicate there have been rare interactions with threatened, endangered or protected species in the fishery. One Southern right whale was recorded tangled in fishing gear and released alive a number of years ago. Industry advice indicated that there has been two great white shark interactions with the fishery during the past 20 years, as well as evidence of chewed pots. Although entanglements have been recorded in the past, none have occurred since gear modifications were made by the industry in 1995/96. There is anecdotal evidence of one dolphin entanglement in the history of the fishery. No other species are known to interact with the fishery.

The fishery is considered **likely (L6)** to have a **negligible (C0)** impact on the populations of these species through direct interaction but no capture. This results in a risk rating of **NEGLIGIBLE (0)**.

4.3. General Ecosystem Impacts of Fishing

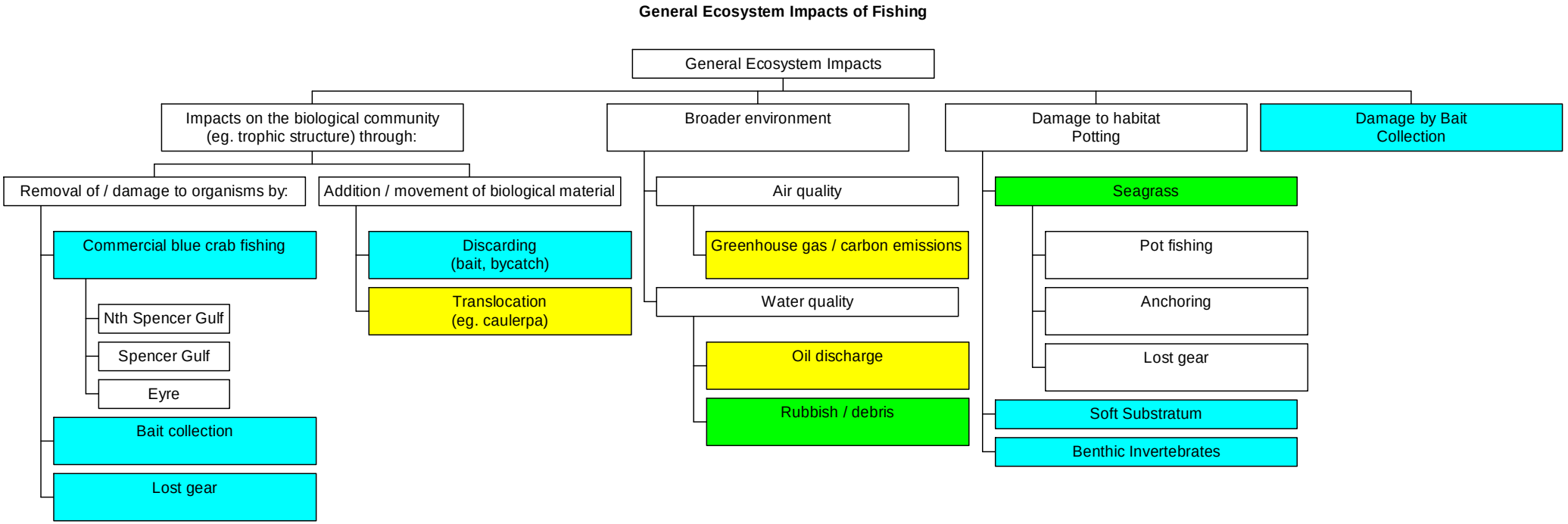

Figure 21. Component Tree for General Ecosystem Impacts of Fishing

4.3.1. Impacts on the Biological Community

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 is not readily available.

Removal of/damage to organisms by commercial blue crab fishing

ERA Risk Rating: Fishery impacts on the ecosystem (NEGLIGIBLE)

The abundance of Blue Swimmer Crabs is highly variable from year to year, despite stable catches in the fishery. The workshop noted that Blue Swimmer Crabs are one of a suite of scavengers in the region.

Studies on the feeding ecology of *P. pelagicus* indicate that it can be either a predator or a scavenger, depending on the local availability of prey species (Patel et al. 1979; Williams 1982; Wassenberg & Hill 1987).

Research undertaken in Western Australia on the feeding behaviour of *P. pelagicus* illustrated that their diet comprised a variety of sessile and slow moving invertebrates, in particular, molluscs and polychaetes and to a lesser extent seagrasses. Small (<50 mm carapace width) crabs mainly foraged on sand flats, whilst larger individuals were most abundant amongst seagrass and non-vegetated habitats further offshore (Edgar 1990). Whilst there is currently no scientific evidence to illustrate the feeding behaviour in waters adjacent to South Australia, it is assumed that the same interactions are occurring.

No predators are known to rely solely on *P. pelagicus* as their only prey. However, little is known about the species that prey on *P .pelagicus*.

Due to the significant variation in abundance caused by environmental factors, it was considered that current commercial harvesting activities are **likely (6)** to be having a **negligible (0)** impact on food chains or ecological communities. This resulted in an overall risk rating of **NEGLIGIBLE (0)**. It was noted however that the management plan may need to include provisions to respond to environmental influences.

Removal of/damage to organisms by bait collection

ERA Risk Rating: Fishery impacts on the ecosystem (NEGLIGIBLE)

Given industry advice that there is no bait collection taking place, it was considered that the impact on the ecosystem was **likely (L6)** to be **negligible (C0)**, resulting in a risk rating of **NEGLIGIBLE**.

Removal of/damage to organisms by lost gear

The impacts of the continued fishing of lost gear or 'ghost fishing' may be significant in some fisheries and is often difficult to quantify.

ERA Risk Rating: Fishery impacts on the ecosystem (NEGLIGIBLE)

There is some uncertainty on the impact of lost fishing gear. The workshop noted the report that there is continued catching by crab pots after gear is lost. The ability of the bait in commercial crab pots to attract species is considered to last a maximum of 5 days. Therefore, should a pot be lost its potential to continue to attract species is limited and the entrance to the pot restricts species from becoming trapped. The workshop also noted industry advice that there is minimal catch with unbaited pots.

The ability for pots to be lost in the area of the fishery is considered to be low, as these gulf waters are generally calmer than the open ocean outside the gulfs. Industry advised that the incidence of lost gear in the fishery is very low; however there is an ongoing problem with interference of commercial gear by recreational fishers[13].

Lost gear in the fishery was considered **likely (L6)** to have a **negligible (C0)** impact on the ecosystem. This results in a risk rating of **NEGLIGIBLE (0)**.

Addition / movement of biological material caused by discarding

The discarding of bait or non-retained bycatch by the fishery results in the addition of biological material that would not usually occur in the ecosystem.

ERA Risk Rating: Fishery impacts on the ecosystem (NEGLIGIBLE)

The workshop noted that there is a very low level of discarding in the fishery by the 9 licence holders and that most bycatch captured in pots is released alive.

Therefore, it was considered **likely (L6)** that the fishery would have a **negligible (C0)** impact on the ecosystem through discarding. This results in a risk rating of **NEGLIGIBLE (0)**.

Addition / movement of biological material caused by translocation

Vessels used in the fishery travel between regions and could potentially translocate exotic species such as *Caulerpa taxifolia*.

Objective

- Minimise potential for translocation of *C. taxifolia* and other exotic plants and animals by the fishery.

[13] This issue is addressed through the 'access' component of the 'Governance' component tree in section 4.6.

ERA Risk Rating: Fishery impacts on the ecosystem (MODERATE)

Caulerpa taxifolia is a marine alga that has been associated with biological invasions with negative environmental and economic effects. *Caulerpa taxifolia* was first detected in South Australia in 2002 and is now considered ineradicable in the Port River system, of which it infests approximately 5.5 km^2. The distribution of the alga has changed little over the past 3 years, with the exception of a new outbreak in North Haven marina in 2008. High densities are associated with thermal and nutrient rich effluent sources in the Port River (Deveney et al., 2008).

Three of the four operators in the Gulf St Vincent zone of the fishery dock in the Port River. A risk was therefore identified in the potential further spread of *C. taxifolia* in Gulf St Vincent or to Spencer Gulf (if a boat was to operate between both gulfs).

PIRSA (through its Biosecurity program) is undertaking targeted fringe control of infested areas, especially where there is known to be a higher risk, such as near boat moorings, around the Torrens Island power station outlet and where tides and currents might deposit *Caulerpa*. PIRSA is also creating risk mitigation plans for construction and dredging sites, such as near the port redevelopment and the opening bridges. Anchoring bans have been placed on all waters of the Port River south of an east west line from Snapper Point to Torrens Island and all waters of the North Arm, Eastern Passage, Angas Inlet, Torrens Reach and Barker Inlet south of an east-west line passing through Middleground Beacon. A major public education campaign is being carried out to inform everyone using the waterway of the problem and how they can help.

It was considered that the impacts of translocation of biological material, such as the further spread of *C. taxifolia*, could be **severe (C3)**. However, this would be **unlikely (L3)** given the low level of impact on the ecosystem that has been observed to date and the management arrangements in place to control its spread. This results in a risk rating of **MODERATE**.

Indicator

- Code of conduct developed to address risks posed by translocation of *Caulerpa taxifolia* and other exotic plants and animals

Performance measure

- Zero translocations of exotic plants and animals

4.3.2. Broader Environment

<u>Air Quality - Greenhouse gas / carbon emissions</u>

Objective

- Minimise the impact of the fishery on the broader environment by reducing carbon emissions.

ERA Risk Rating: Fishery impacts on the broader environment (MODERATE)

There are 9 licences in the fishery. Most licence holders undertake fishing activities on a daily basis, with the average trip ranging from 35 to 60 nm per day.

The industry has been actively reducing its fuel use over the last three years. One operator has moved from using two boats to one more efficient boat and a number of operators have been undertaking longer trips to avoid a higher number of shorter trips. The Blue Crab Fishery has a relatively young fleet with the average age of boats at around 12 or 13 years.

The industry recognises that it will need to be able to demonstrate its impact on the environment in the future as industries everywhere become more accountable for their energy use. For these reasons it was identified as an important issue to address.

The impacts on the broader environment of greenhouse gas / carbon emissions were therefore considered to be **possible (L4)** with a **moderate (2)** consequence. The priory for the fishery to address this issue was therefore rated **MODERATE (8)**.

Indicators

- Industry strategy developed for increasing efficiency of the fleet
- Carbon footprint identified for individual vessels in fleet

Performance measures

- Decrease or stabilise individual carbon footprints of vessels in fleet
- Aim to be carbon neutral by offsetting carbon usage

<u>Water Quality - Oil discharge</u>

Objective

- Minimise the impact of the fishery on the broader environment by effectively managing oil discharge.

ERA Risk Rating: Fishery impacts on the broader environment (MODERATE)

The impacts of harvesting *P. pelagicus* on water quality are considered to be low due to the small number of vessels operating across South Australia relative to the geographic expanse of the fishing grounds.

Blue Crab Fishery licence holders do not discharge oil at sea. Vessels are well maintained and relatively young. There are stringent regulations applied by the Department of Transport and Infrastructure (DTEI) on the management

of oil at sea.

The *Pollution of Waters by Oil and Noxious Substances Act 1987* relates to the protection of the sea and certain waters from pollution by oil and other noxious substances. It also provides for penalties of up to $200,000 for individuals and $1,000,000 for corporations for contravention of the Act.

It was considered **possible (L4)** that an incident in the fishery associated with oil discharge would have a **moderate (C2)** impact on the broader environment with an overall risk rating of **MODERATE (8)**.

Indicator

- Number of reported breaches of regulations

Performance measure

- Zero breaches of regulations

<u>Water Quality - Rubbish / debris</u>

Objective

- Minimise fishery impacts on the ecosystem.

ERA Risk Rating: Fishery impacts on the broader environment (LOW)

The South Australian legislation that is directly relevant for the control of wastes from shipping is:

- *Pollution of Waters by Oil & Noxious Substances Act 1987*
- *Harbors and Navigation Act 1993*
- *Environment Protection Act 1993*

Other legislation that may impact on various aspects of ship waste management is:

- *Public and Environmental Health Act 1987*
- *Water Resources Act 1990*
- *South Australian Ports Corporation Act 1994*

The *Harbors and Navigation Act 1993* provides provisions to regulate the management of harbours, provide special provisions for the storage of dangerous goods, restrict or prohibit the discharge of pollutants into waters or depositing of waste in the vicinity of land or other structures in the harbour. The Act lists 31 South Australian harbours to which it applies.

The *Environment Protection Act 1993* states that a person must not undertake an activity that pollutes, or might pollute, the environment unless the person takes all reasonable and practicable measures to prevent or minimise any resulting environmental harm.

The *Public and Environmental Health Act 1987* provides penalties for persons

who discharge waste into a public place or who pollutes a water supply.

The *Water Resources Act 1990* aims to maintain water quality and preserve wetlands and other ecosystems.

The *South Australian Ports Corporation Act 1994* provides the South Australian Ports Corporation with the right to restrict the use of port waters by regulating the entry of vessels, the operation or use of vessels and aquatic activities.

Operators in the fishery comply with State legislative regulations. They undertake short (generally daily) trips and store all rubbish on board the vessels for disposal on return to port. The fishery does not generate a significant amount of plastic waste in its fishing activities.

It is **possible (L4)** that any rubbish or debris from the fishery would have a **minor (C1)** impact on the broader environment. The overall risk rating is **LOW (4)**.

Damage to seagrass

Objective

- Minimise fishery impacts on the ecosystem.

ERA Risk Rating: Fishery impacts on the broader environment (LOW)

Operators in the Blue Crab Fishery generally set pots over sandy or muddy substratum, where Blue Swimmer Crabs are found. Industry advised that pots are occasionally set near seagrass patches but not in dense seagrass areas. It was noted that some licence holders set pots over a large area and pull the gear twice per day.

Only about half of the boats in the fishery anchor. Industry advised that anchors are set to minimise damage by setting in the sand and avoiding seagrass areas.

There have been no studies in South Australia on damage to the benthic environment caused by pot fishing activities. Results from a Western Australian study showed that pots lift rather than drag when pulled, causing very little damage to the benthos (Moran and Jenke 1989).

It is **possible (L4)** that the fishery has a **minor (C1)** impact on seagrass meadows through pot fishing activities. The overall risk rating is **LOW (4)**.

Damage to soft substratum

Objective

- Minimise fishery impacts on the ecosystem.

‘Soft substratum’ refers to areas of sandy or muddy bottom in the area of the fishery.

ERA Risk Rating: Fishery impacts on the broader environment (NEGLIGIBLE)

Physical interactions do occur when blue crab pots, hoop nets, drop nets and crab nets are placed on the substrate. However, as these fishing devices are passive by nature, the interactions are not considered to be significant.

The stakeholder workshop considered that the pot fishing activities of the Blue Crab Fishery were **likely (L6)** to have a **negligible (C0)** impact on the soft substratum. The overall risk rating is **NEGLIGIBLE (0)**.

Damage to benthic invertebrates

Objective

- Minimise fishery impacts on the ecosystem.

ERA Risk Rating: Fishery impacts on the broader environment (NEGLIGIBLE)

Physical interactions do occur when blue crab pots, hoop nets, drop nets and crab nets are placed on the substrate. However, as these fishing devices are passive by nature, the interactions are not considered to be significant.

The stakeholder workshop considered that the pot fishing activities of the Blue Crab Fishery were **likely (L6)** to have a **negligible (C0)** impact on benthic invertebrates. The overall risk rating is **NEGLIGIBLE (0)**.

Damage caused by bait collection

Objective

- Minimise fishery impacts on the ecosystem.

ERA Risk Rating: Fishery impacts on the broader environment (NEGLIGIBLE)

Bait nets are also permitted to be used by licence holders. These nets may be up to 150 m in length and have a mesh size of between 30 mm and 150 mm.

Given that industry have advised that operators do not currently undertake bait fishing activities, it is **likely (L6)** that the fishery is having a **negligible (C0)** impact on the broader environment due to bait collection. The overall risk rating is **NEGLIGIBLE (0)**.

4.4. Community

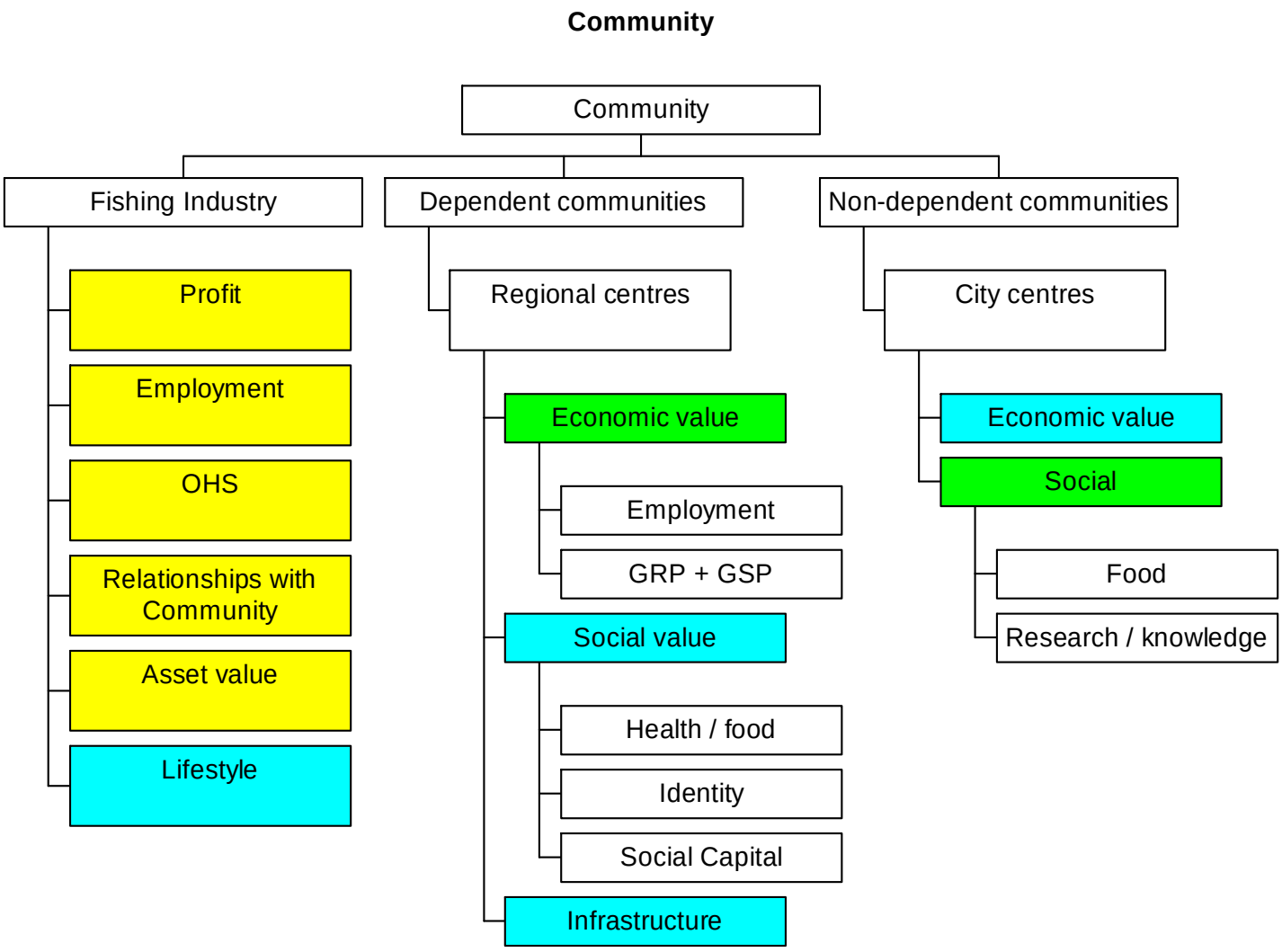

Figure 22. Component Tree for Community

4.4.1. Fishing Industry Community

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 (MODERATE)

Profit is of primary importance to licence holders and is one of the key factors affecting the economic viability of the fishery.

According to Econsearch (2009), gross operating surplus (GOS) was

calculated by excluding imputed wages for operator and family members as a cost item. The aggregate GOS of all boats in 2007/08 was estimated to be approximately $1.6 million.

Boat cash income is measured as gross operating surplus with imputed wages (unpaid labour) included as cash costs. The average boat cash income for the fishery as a whole in 2007/08 was approximately $1.4 million.

Gross operating surplus and boat business profit give an indication of the capacity of the operator to remain in the fishery in the short to medium term. In 2007/08, the total boat business profit was almost $838,000.

Profit at full equity is a measure of the profitability of licence holders in the fishery, assuming that licence holders have full equity in the operation. It is a useful absolute measure of the economic performance of fishing firms. Profit at full equity was $1.5 million in 2007/08 (Econsearch, 2009).

Indicator

- Delivery of annual economic surveys assessing economic performance of the fishery

Performance measure

- Maintain surplus, income and profit at equity levels of 2007/08

Employment

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

The provision of employment to those people directly involved in the fishery is considered to be very important to the fishing industry community itself. In 2007/08, the SA Blue Crab fishery was responsible for the direct employment of around 28 full-time equivalents (fte).

Indicator

- Level of full-time equivalent employment provided by the fishery

Performance measure

- Maintain numbers of fte at level of 2007/08

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 OHS&W standards and requirements for training, activities and record keeping that are enforced by DTEI. It is important for the industry to maintain adherence to existing

OHS&W requirements and procedures

Indicator
- Number of reportable incidents/near misses

Performance measure
- No incidents/near misses

Relationships with community

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

Political lobbying can have significant impacts on the operations of the commercial fishery and the fishing community. A temporary closure of Adelaide metropolitan waters occurred in 2005 as a result of interactions between the commercial fishery and the recreational sector.

Building and maintaining positive relationships with the broader community were identified as being important for the fishery. The fishing community is actively managing their activities to pursue this goal, for example by abiding by a code of conduct relating to fishing activities in Adelaide metropolitan waters.

Indicator
- Level of acceptance of management and fishing arrangements within the community

Performance measure
- General acceptance of the fishery and management arrangements within the community

Asset value

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

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

Blue Crab Fishery licences and quota entitlements are fully transferable. The importance of maintaining the value of assets was rated highly by the industry. Assets may include fishery licences, quota entitlements, vessels, businesses, gear, etc.

According to Econsearch (2009), the total investment in fishing gear and licences in the Blue Crab Fishery in 2007/08 was estimated to be approximately $27.2 million. This includes the licence holder's estimate of the

value of fishing licences ($24.3 million) and estimated investment in boats and fishing gear (approximately $2.9 million).

The licence value for the 1997/98 analysis was based on the then market rate of around $7,000 per tonne of quota or around $5,600 per pot. Since that time there has been considerable interest in 'marginal' units of quota, particularly in the marine scale sector, which has given rise to a substantial increase in the cost of traded quota. It is understood that the demand for quota and the subsequent increase in the price of quota has resulted from operators in other fishing sectors looking to better utilise their existing investments in vessel, gear and available labour. Because the opportunity cost of this 'off-season' capital and labour is low, it enables the operator to offer a higher price for quota than would otherwise be the case (Econsearch, 2009).

Indicators
- Investment in fishing gear and licence
- Licence value
- Value of quota units
- Delivery of annual economic surveys assessing economic performance of the fishery

Performance measure
- Asset value of the fishery remains at 2007/08 levels

Lifestyle

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

The Blue Crab Fishery is a profitable, niche fishery with few operators and a high value product. Operators do not consider themselves lifestyle fishers. The impact on 'lifestyle' as a result of changes in the fishery was not considered to be a threat by the industry.

4.4.2. Dependent Communities – Regional Centres

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

Economic value

ERA Risk Rating: Impact of the Blue Crab Fishery on the community (LOW)

According to Econsearch (2009), contribution to Gross State Product (GSP) is a measure of the net contribution of an activity to the State's economy. Contribution to GSP is measured as value of output less the cost of goods and services (including imports) used in producing the output. It can also be measured as household income plus other value added (gross operating

surplus and all taxes, less subsidies). It represents payments to the primary inputs of production (labour, capital and land).

The value of output generated directly in South Australia by blue crab fishing enterprises summed to $5.7 million in 2007/08, while output generated in South Australia by associated downstream activities (processing, transport, retail/food services and capital expenditure) summed to $3.3 million.

Flow-ons to other sectors of the state economy added another $9.3 million in output. The sectors most affected were the manufacturing ($2.4 million), trade ($1.4 million) and business services sectors ($1.0 million).

In 2007/08, total blue crab fishing industry related contribution to GSP in South Australia was $9.2 million, $3.7 million generated by fishing directly, $1.1 million generated by downstream activities and $4.4 million generated in other sectors of the state economy.

Employment is a measure of the number of working proprietors, managers, directors and other employees, in terms of the number of full-time equivalent (fte) jobs.

In 2007/08, the SA Blue Crab fishery was responsible for the direct employment of around 28 full-time equivalents (fte) and downstream activities created employment of 17 fte jobs state-wide. Flow-on business activity was estimated to generate a further 48 fte jobs state-wide. These state-wide jobs were concentrated in the trade (14), manufacturing (7) and business services sectors (6).

Personal income of $1.5 million was earned in the fishing sector (wages of employees and estimated drawings by owner/operators) and $0.8 million in downstream activities in SA. An additional $2.4 million was earned by wage earners in other businesses in the state as a result of fishing and associated downstream activities. The total household income impact was $4.7 million in South Australia in 2007/08 (Econsearch, 2009).

It was considered that the fishery was **likely (L6)** to have a **minor (C1)** economic impact on the regional communities where it operates, in terms of employment and economic value. This resulted in an overall rating of **LOW (6)**.

Social value

ERA Risk Rating: Impact of the Blue Crab Fishery on the community (NEGLIGIBLE)

The components of social value that were considered for the risk assessment were: health / food; identity; and social capital.

The two regional areas associated with the fishery are Port Broughton (three licence holders) and Port Wakefield (one licence holder). Most product from

the fishery is sold in the Melbourne and Sydney markets and it is generally not sold in the regional areas where the fishery operates. There is therefore little food or health benefit from the fishery in these regional areas. Advice to the stakeholder workshop was that these regional communities did not derive an 'identity' from the operation of the fishery and that there were not significant social capital benefits.

The social value of the fishery in regional communities was considered **likely (L6)** to be **negligible (C0)**, resulting in a risk rating of **NEGLIGIBLE (0)**.

Infrastructure

ERA Risk Rating: Impact of the Blue Crab Fishery on the community (NEGLIGIBLE)

The fishery operates using existing infrastructure such as wharves and boat ramps, etc. and is not considered to have significantly contributed to the investment in new infrastructure in regional areas. Recreational and other commercial fisheries operate from these areas at a larger scale than the Blue Crab Fishery.

It is **likely (L6)** that there is a **negligible (C0)** impact of the fishery on regional infrastructure, resulting in a risk rating of **NEGLIGIBLE (0)**.

4.4.3. Non-Dependent Communities – City Centres

Objective

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

The Blue Crab Fishery is considered a niche fishery with few operators and a high value product. Almost all the product is sold interstate (exported from South Australia). Other than those directly and indirectly employed by the fishery, the main impacts of an interruption to the flow of benefits from the fishery to the community would be lack of availability of product to South Australian and interstate markets.

Economic value

ERA Risk Rating: Impact of the Blue Crab Fishery on the community (NEGLIGIBLE)

In the absence of the fishery, there would be indirect impacts to the community through product unavailability and job losses in the retail, processing and transport industries.

In the context of South Australia's total GSP of $70.9 billion in 2007/08 (ABS, 2009), the economic value of the Blue Crab Fishery was considered **likely (L6)** to have a **negligible (C0)** impact on the broader South Australian community. The overall rating was therefore **NEGLIGIBLE (0)**.

Social value

ERA Risk Rating: Impact of the Blue Crab Fishery on the community (LOW)

Product unavailability would have some impact on the community's ability to buy Blue Swimmer Crabs in Sydney, Melbourne and Adelaide given that the fishery is the major supplier to these markets.

Research supported by the commercial Blue Crab Fishery makes a significant contribution to the knowledge and understanding of the Blue Swimmer Crab resource in South Australia, and therefore the absence of the Blue Crab Fishery would diminish the State's research output.

It was considered **possible (L4)** that the social value of the fishery would have a **minor (C1)** impact on the broader South Australian community with an overall rating of **LOW (4)**.

4.5. Aboriginal Community

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

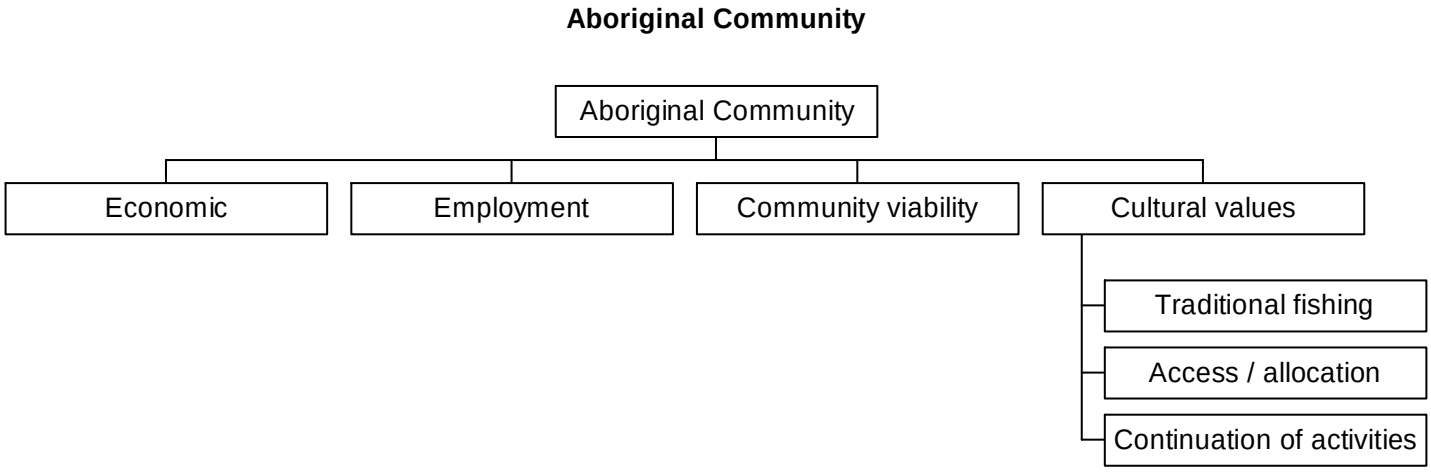

Figure 23. Component Tree for Aboriginal Community

4.5.1. Economic

4.5.2. Employment

4.5.3. Community Viability

4.5.4. Cultural Values

4.6. Governance

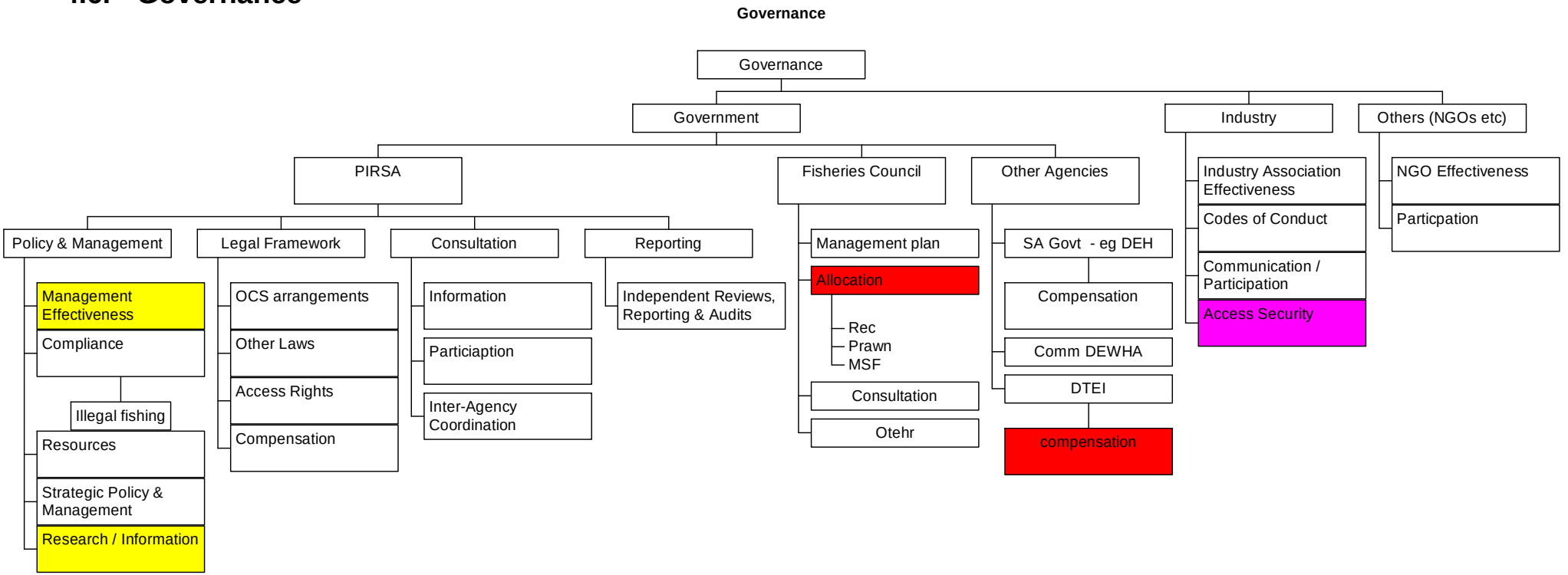

Figure 24. Component Tree for Governance

Note: No generic components have been removed from the tree but only those boxes that are highlighted will be reported on.

This section is not assessed for risks as per the other sections in this report. Rather, the governance structures in place to ensure that the fishery is managed in an ecologically sustainable and efficient manner are described. Issues identified by stakeholders for either further action or identified as current issues are reported on below.

4.6.1. PIRSA Fisheries – Policy and Management

Management effectiveness

Objective

- Ensure the blue crab resource is harvested within sustainable limits.

ERA Risk Rating - Moderate

The workshop considered that it was important for management in the fishery to be proactive to address problems before they arise and adaptive to allow for industry flexibility. The management plan that is currently being developed under the *Fisheries Management Act 2007* is a key requirement for the fishery as it not only provides a framework for the sustainable management of the resource but it also gives certainty to the industry in detailing how future management decisions will be made.

Indicators

- Delivery of fishery management plan
- The extent to which the management plan and supporting documentation address the issues, and have appropriate objectives, indicators and performance measures, along with the planned management responses

Performance measure

- This should be 100%, if all components in the management plan are successful

Research / information

Objective

- Ensure sufficient biological, environmental, economic and social information is collected to inform management decisions.

ERA Risk Rating - Moderate

Annual stock assessment reports are regularly produced by SARDI Aquatic Sciences for the Minister. These reports provide vital information for fisheries managers and are considered during the TACC setting process for the fishery each year. It is important for stakeholders to be able to access and understand key information about the fishery.

Indicators

- License holder participation in daily pot sampling program

- Annual fishery stock assessment report published
- FIS undertaken

Performance measure
- 100% participation in voluntary pot sampling program on 95% of fishing days
-

4.6.2. Fisheries Council of South Australia

Allocation

Objective

- Access to the blue crab resource is explicitly allocated between users in a manner that achieves optimum utilisation and equitable distribution of the resource to the benefit of the community.

ERA Risk Rating: Extreme

The *Fisheries Management Act 2007* requires that fishery management plans explicitly allocate resource shares to the commercial, recreational and Aboriginal traditional sectors of the fishery.

The attitudes of recreational fishers were identified by the industry as an important issue to manage. There have been negative interactions between the recreational and commercial blue crab sectors in the past. The industry association has established a code of conduct to manage commercial fishing operations in Adelaide metropolitan waters in order to minimise such interactions. There were concerns raised by the commercial sector about the incidence of interference with commercial gear and the high level of non-compliance with fishing rules and regulations for Blue Swimmer Crabs in the recreational sector of the fishery.

The bycatch of Blue Swimmer Crabs by the prawn fisheries in Spencer Gulf and Gulf St Vincent were raised as an issue of concern by the blue crab industry. The prawn fisheries collect extensive information on bycatch; however the mortality of Blue Swimmer Crabs as a result of prawn trawling has not been determined.

Indicators
- Delivery of fishery management plan
- Maintain commercial catch limits within the allocation framework
- Develop mechanisms for adjusting shares in the future

Performance measure
- Commercial catch limits remain within the allocation framework

4.6.3. Other Agencies

Compensation

Objective

- To assess the need for compensation for loss of access to resource from other sectors

ERA Risk Rating: Extreme

The extension of areas for shipping around the entrance to the Port River was highlighted. There were concerns from the industry that there was no provision for compensation for loss of access to fishing areas if DTEI closes areas due to shipping activities.

The *Marine Parks Act 2007* provides for compensation to be provided commercial fishers for loss of access as a result of the establishment of marine parks in South Australia.

Indicators

- Delivery of management plan
- Delivery of annual economic surveys

Performance measure

- Fishers are fully compensated for any loss of access due to external management arrangements

4.6.4. Industry

Access security

Objective

- To minimise the impact of external factors (access issues) on the performance of the fishery

ERA Risk Rating: High

The fishery management plan will provide greater certainty of access to the commercial industry through extended tenure of licences, a clear decision-making framework for TACC setting, and explicit allocation between the various sectors of the fishery. Industry participation in developing a robust management plan is very important.

The SA Blue Crab Pot Fishers Association Inc. is the representative body for the Blue Crab Fishery. The association has an elected president and employs an executive officer. All licence holders are members of the association. Adherence to industry codes of practice demonstrates good industry governance.

Indicator

- Certainty of access for the commercial industry to the fishery

Performance measure

- The commercial industry continues to have access
-

4.7. External Factors Affecting Performance of the Fishery

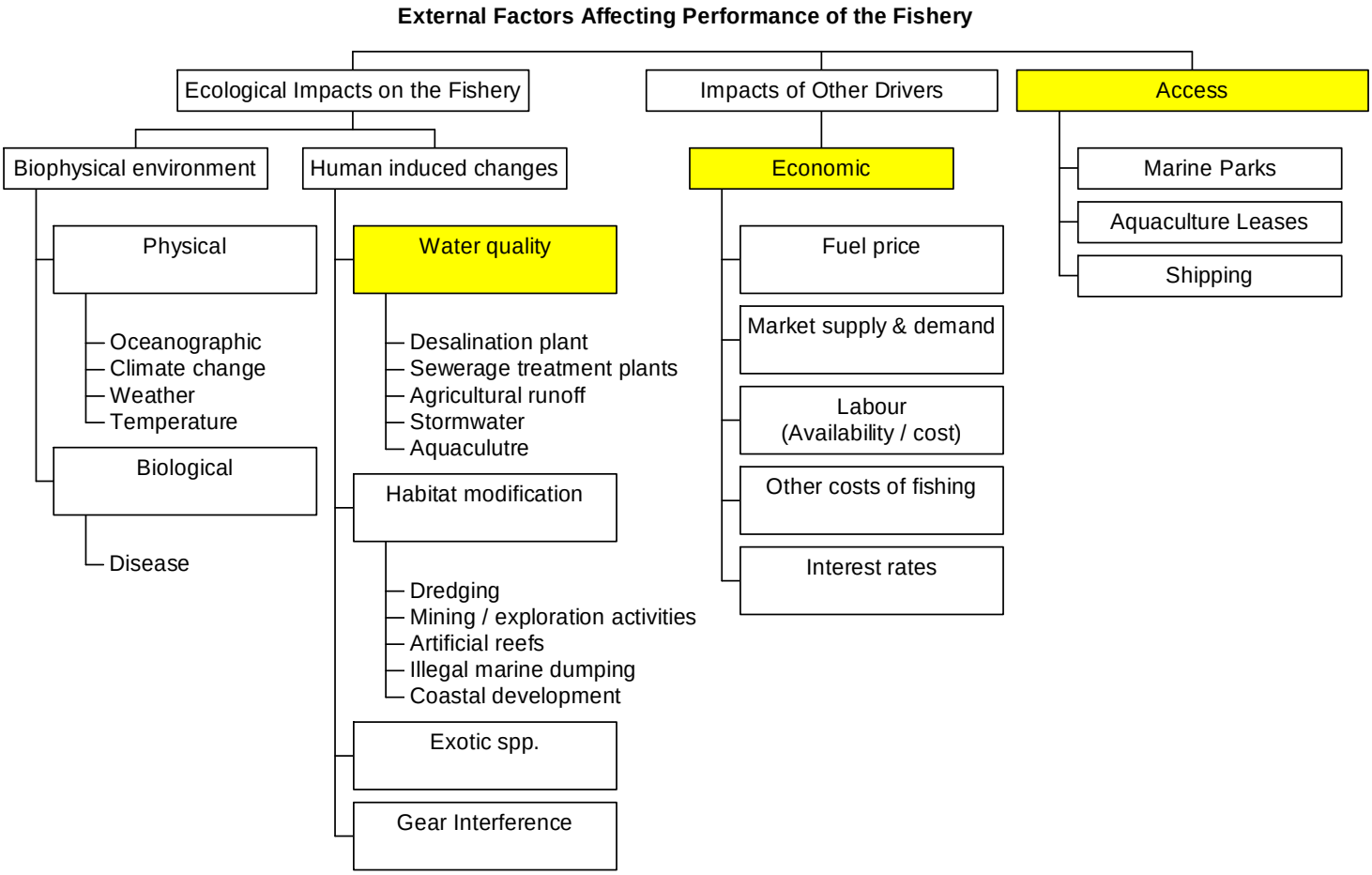

Figure 25. Component Tree for External Factors Affecting Performance of the Fishery

4.7.1. Ecological Impacts on the Fishery – Human Induced Changes

<u>Water quality</u>

Objective

- Minimise negative impacts on the fishery from changes in water quality due to external factors.

ERA Risk Rating: Impact of external factors on performance of the fishery (MODERATE)

There is a risk that impacts from human induced changes to water quality could have negative impacts on the Blue Crab Fishery.

Research has illustrated that throughout both the southern and northern

hemispheres, environmental influences of temperature, salinity and rainfall impact significantly on various species of Blue Swimmer Crab. This impact relates predominantly to the abundance and composition of the species in these areas (Meagher, 1971; Potter et al., 1983).

The proposed development of the desalination plant in Spencer Gulf was raised as a major potential threat to the Blue Swimmer Crab resource and the commercial fishery. There were concerns about the intake of larval/juvenile crabs into the plant as well as the impacts on the broader ecosystem through the expulsion of saline water and chemical pollutants. There was a general concern that the desalination plant could have severe impacts on the gulf system and that the impact assessments conducted were inadequate. Stakeholders suggested that further research and monitoring is required to measure these impacts on the Blue Swimmer Crab population and the broader ecosystem.

Salinity is known to be a constraint on growth and reproduction of Blue Swimmer Crabs. In marine estuarine environments where considerable fluctuations in salinity levels can occur it has been noted that Blue Swimmer Crabs will move to areas of high salinity during winter months. Meagher (1971), noted that *P. pelagicus* prefers salinity levels between 30 and 40ppt. The salinity of seawater is approximately at the midpoint of this range and would explain the species preference for marine environments where *P. pelagicus* frequently passes through its whole lifecycle.

Crustaceans are very sensitive to pesticides, which may enter the gulfs via agricultural runoff.

Acknowledging the uncertainty associated with these potential impacts, it was considered that water quality was **likely (L6)** to have a **moderate (C2)** impact on the Blue Crab Fishery, resulting in a risk rating of **MODERATE (12)**.

Indicator

- Water quality data in fishery areas.

Performance measure

- Water quality (temperature, salinity, nutrients) in fishery areas remaining within threshold levels of various life stages of the species

4.7.2. Impacts of Other Drivers

Economic

Objective

- Minimise negative impacts on the fishery from economic pressures due to external factors and/or drivers.

ERA Risk Rating: Impact of external factors on performance of the fishery (MODERATE)

Economic drivers such as increasing fuel price, the availability and cost of labour, and interest rates have recently been unpredictable and are likely to have an impact on the long term profitability of the fishery. The boom in the mining sector has had a major impact on the availability of labour for a number of commercial fisheries. Market forces and other costs of fishing (such as licence fees, maintenance and equipment costs) also impact on the fishery, to a lesser extent.

Given that these costs were likely to rise in the future, it was considered that economic drivers were **likely (L6)** to have a **moderate (C2)** impact on the Blue Crab Fishery, resulting in a risk rating of **MODERATE (12)**.

Indicator

- Monitoring and reporting in an economic assessment

Performance measure

- Annual monitoring and reporting continues

4.7.3. Access

Objective

- Commercial fishing activities are to be fostered for the benefit of the whole community.

ERA Risk Rating: Impact of external factors on performance of the fishery (MODERATE)

The South Australian Government has committed to establishing 19 new marine parks by 2012, under the South Australian Representative System of Marine Protected Areas (SARSMPA).

Other Australian States, as well as the Australian Government, are also developing systems of marine protected areas that are representative of marine life in other parts of Australia. Collectively, this Australia-wide effort will contribute to the National Representative System of Marine Protected Areas.

All 19 marine parks proposed by the South Australian Government will be located within the State's waters, generally within 3 nautical miles from the coast and including the gulfs and offshore islands.

South Australian marine parks will be zoned for multiple-uses. They will be sectioned into four zones, with varying levels of use and conservation. Most activities, such as recreational and commercial fishing, will still be allowed within a marine park. There will, however, be particular zones or periods of time, where some activities will not be permitted.

Following the introduction of the *Marine Parks Act 2007*, the outer boundaries of the marine parks have been released for public consultation 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 by about mid-2011. Potential impacts of the marine parks on access to State waters by the Blue Crab Fishery are currently unknown.

Potential expansion of aquaculture sites were raised as a risk to access for the commercial fishing sector.

Port Adelaide is the main service point for shipping in South Australia. The extension of areas for shipping around the entrance to the Port River was also identified as a threat to access.

The workshop considered that access issues were **likely (L6)** to have a **moderate (C2)** impact on the Blue Crab Fishery, resulting in a risk rating of **MODERATE (12)**.

Indicator

- Areas of the fishery that are lost due to external factors and management decisions

Performance measure

- Loss of areas is minimised through the marine park consultation process

5. REFERENCES

Australian Bureau of Statistics, South Australia at a Glance (2009) Catalogue 1306.4. http://www.abs.gov.au/

Currie, D. R., Hooper, G. E. and Ward, T. M. (2007) Blue Crab (*Portunus pelagicus*) Fishery 2005/06. Stock Assessment Report to PIRSA Fisheries. South Australian Research and Development Institute (Aquatic Sciences), Adelaide. RD 03/0274-4.

Deveney, M.R., Rowling K.P., Wiltshire, K.H., Manning, C.E., Fernandes, M.B., Collings, G.J. and Tanner, J.E. (2008) *Caulerpa taxifolia* (M. Vahl) C. Agardh: Environmental risk assessment. Prepared for PIRSA Marine Biosecurity. SARDI Aquatic Sciences Publication No. F2008/000854-1. SARDI Aquatic Sciences Adelaide.

DEH (2006) Plan. Coast and Marine Conservation Branch, Natural and Cultural Heritage, Department for Environment and Heritage, Adelaide.

DEH (2009). http://www.environment.sa.gov.au/marineparks/pdfs/MP_Park_Description_14.pdf

DEWHA (2009) Australian Biological Resources Study - Australian Faunal Directory. Department of the Environment, Water, Heritage and the Arts. http://www.environment.gov.au/biodiversity/abrs/online-resources/fauna/afd .

Dixon, C.D. and Hooper, G.E. (2009) Blue Crab (*Portunus pelagicus*) Fishery 2007/08. Stock Assessment Report to PIRSA Fisheries. South Australian Research and Development Institute (Aquatic Sciences), Adelaide. F2007/000729–5.

Econsearch (2009) Economic Indicators for the South Australian Blue Crab Fishery 2007/08: A report prepared for Primary Industries and Resources South Australia. Marryatville, South Australia.

Edgar, G.J. (1990) Predator-prey interactions in seagrass beds. II. Distribution and diet of the blue manna crab *Portunus pelagicus* Linnaeus at Cliff Head, Western Australia. *J. Exp. Mar. Biol. Ecol,* **139**: 23-32.

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.

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

Kailola, P.J., Williams, M.J., Stewart, P.C., Reichelt, R.E., McNee, A. and

Grieve, C. (1993) *Australian* fisheries resources. Bureau of Resource Sciences, Department of Primary Industries and Energy, and the Fisheries Research and Development Corporation. Canberra, Australia.

Meagher, T.D. (1971) Ecology of the crab *Portunus pelagicus* (Crustacea: Portunidae) in south western Australia. Ph.D. thesis, University of Western Australia.

Patel, N.M., Chhaya, N.D., and Bhaskaran, M., (1979) Stomach contents of *Portunus pelagicus* (Linn.) from net catches. *Indian J. Mar. Sci.* **8:** 48-49.

Potter, I.C., de Lestang, S. and Young, G.C. (1998) Influence of the Dawesville Channel on the recruitment, distribution and emigration of crustaceans and fish in the Peel-Harvey Estuary. Murdoch University: School of Biological Science and Biotechnology. Fisheries Research and Development Report 95/042.

Svane, I. and Hooper, G.E. (2004) Blue Swimmer Crab (*Portunus pelagicus*) fishery. Fishery Assessment Report to PIRSA for the Blue Crab Fishery Management Committee. SARDI Aquatic Sciences Publication No. RD03/0274-2.

Wassenberg, T.J. and Hill, B.J. (1987) Feeding by the sand crab *Portunus pelagicus* on material discarded from prawn trawlers in Morton Bay, Australia. *Marine Biology* **95**: 387-393.

Williams, M.J. (1982). Natural food and feeding in the commercial sand crab *Portunus pelagicus* Linneaus, 1766 (Crustacea: Decapoda: Portunidae) in Moreton Bay, Queensland. *J. Exp. Mar. Biol. Ecol.* **59**:165-176.

6. APPENDICES

6.1. Appendix 1: Likelihood and Consequence Tables

Table 7. 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 8. 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 9. 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. 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 11.
Catastrophic (5)	N/A (See Table 11).

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

Table 10. 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 11. 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. (*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. *(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. *(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. *(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. *(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. *(Suggestion: this is likely to be in range of > 90% of the original habitat area being affected).*

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

Table 12. 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 13. 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 14. 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)

6.2. Appendix 2: Bycatch Information from Fishery-Independent Surveys

Table 15. Total abundance and frequency of occurrence (% in brackets) of species taken as by-catch during fishery-independent pot surveys in Spencer Gulf.

Spencer Gulf		2002		2003		2004		2005		2006		
C = Crustacean, F = Fish, E = Echinoderm, M=Mollusc		Lifts = 758		Lifts = 1058		Lifts = 1080		Lifts = 1080		Lifts = 1080		
Common name	**Scientific name**	**No.s**	**Freq**	**No.s**	**Freq**	**No.s**	**Freq**	**No.s**	**Freq**	**No.s**	**Freq**	**Total**
Rock crab (C)	*Nectocarcinus integrifrons*	1035(94.95)	204(26.9)	1749(93.38)	394(37.2)	2122(89.23)	400(37)	1283(80.49)	333(30.8)	2066(87.84)	287(26.6)	8255
Spider crab (C)	*Leptomithrax gaimardii*	3(0.28)	3(0.4)	24(1.28)	21(2)	116(4.88)	57(5.3)	111(6.96)	74(6.9)	42(1.79)	29(2.7)	296
Leatherjacket (F)	*Acanthaluteres spilomelanurus*	13(1.19)	11(1.5)	27(1.44)	19(1.8)	33(1.39)	(0)	57(3.58)	(0)	57(2.42)	44(4.1)	187
Pt Jackson (F)	*Heterodontus portusjacksoni*	3(0.28)	2(0.3)	13(0.69)	10(.9)	7(0.29)	6(0.6)	36(2.26)	28(2.6)	27(2.26)	24(2.2)	86
Cuttlefish (M)	*Sepia apama*	2(0.18)	2(0.3)	3(0.16)	3(.3)	23(0.97)	22(2)	8(0.5)	6(0.6)	27(1.15)	26(2.4)	63
Red Mullet (F)	*Upeneichthys vlamingii*	7(0.64)	7(0.9)	9(0.48)	8(.8)	6(0.25)	5(0.5)	17(1.07)	12(1.1)	18(0.77)	15(1.4)	57
Fiddler (F)	*Trygonorhina fasciata*	4(0.37)	4(0.5)	12(0.64)	12(1.1)	9(0.38)	9(0.8)	7(0.44)	7(.06)	20(0.44)	20(1.9)	52
Cardinal Fish (F)	*Vincentia conspersa*	0(0)	0(0)	11(0.59)	8(.8)	9(0.38)	9(0.8)	11(0.69)	9(0.8)	18(0..76)	13(1.2)	49
Western King Prawn (C)	*Melicertus latisculatus*	4(0.37)	4(0.5)	1(0.05)	1(.12)	8(0.34)	7(0.6)	19(1.19)	15(1.4)	4(0.17)	4(0.4)	36
Trumpeter (F)	*Pelates sexlineatus*	0(0)	0(0)	3(0.16)	3(.3)	7(0.29)	6(0.6)	2(0.13)	2(.2)	19(0.13)	7(0.7)	31
Beche De Mer (E)	*Stichopus mollis*	4(0.37)	3(0.4)	2(0.11)	2(0.2)	13(0.55)	9(0.8)	3(0.19)	3(0..3)	6(0.26)	6(0.6)	28
Puffer Fish (F)	*Torguigener pleurogramma*	1(0.09)	1(0.1)	1(0.05)	1(.12)	4(0.17)	4(0.4)	3(0.19)	3(0..3)	11(0.47)	10(.9)	20
Balmain Bug (C)	*Ibacus peronii*	5(0.46)	4(0.5)	2(0.11)	2(0.2)	4(0.17)	4(0.4)	4(0.25)	4(0.4)	2(0.09)	2(0.2)	17
Sea urchin (E)	*Heliocidaris erythrogramma*	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	1(0.06)	1(0.1)	13(0.55)	11(1.0)	14
Snapper (F)	*Pagrus auratus*	4(0.37)	4(0.5)	0(0)	0(0)	0(0)	0(0)	9(0.56)	4(0.4)	0(0)	0(0)	13
Soldier Fish (F)	*Gymnapistes marmoratus*	1(0.09)	1(0.1)	2(0.11)	2(0.2)	1(0.04)	1(0.1)	3(0.19)	3(0..3)	2(0.09)	1(0.1)	9
Wobbegong (F)	*Orectolobus ornatus*	0(0)	0(0)	0(0)	0(0)	1(0.04)	1(0.1)	3(0.19)	3(0..3)	5(0.19)	5(0.5)	9
Seaweed crab (C)	*Naxiaa spp.*	0(0)	0(0)	0(0)	0(0)	7(0.29)	7(0.6)	0(0)	0(0)	0(0)	0(0)	7
Sand crab (C)	*Ovalipes australiensis*	0(0)	0(0)	3(0.16)	2(0.2)	0(0)	0(0)	2(0.13)	1(0.1)	1(0.04)	1(0.1)	6
Rock ling (F)	*Genypterus tigerinus*	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	5(0.31)	5(0.5)	1(0.04)	1(0.1)	6
Skate (F)	*Raja whitleyi*	0(0)	0(0)	5(0.27)	5(0.5)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	5
Cowfish (F)	*Aracana aurita*	2(0.18)	2(0.3)	0(0)	0(0)	2(0.08)	2(0.2)	0(0)	0(0)	1(0.04)	1(0.1)	5
Flathead (F)	*Platycephalus bassensis*	0(0)	0(0)	0(0)	0(0)	1(0.04)	1(0.1)	1(0.06)	1(0.1)	3(0.09)	3(0.3)	5
Stingray (F)	*Dasyyatis brevicordata*	0(0)	0(0)	0(0)	0(0)	1(0.04)	1(0.1)	1(0.06)	1(0.1)	2(0.06)	1(0.1)	4
Numb Fish (F)	*Hypnos monopterygium*	2(0.18)	2(0.3)	0(0)	0(0)	0(0)	0(0)	1(0.06)	1(0.1)	0(0)	0(0)	3
Gummy shark (F)	*Mustelus antarcticus*	0(0)	0(0)	1(0.05)	1(.12)	0(0)	0(0)	1(0.06)	1(0.1)	1(0.06)	1(0.1)	3
Starfish (E)	*Pateriella brevispina*	0(0)	0(0)	1(0.05)	1(.12)	1(0.04)	1(0.1)	0(0)	0(0)	1(0.04)	1(0.1)	3
Gurnard Perch (F)	*Neosebastes nigropunctatus*	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	1(0.06)	1(0.1)	2(0.06)	1(0.1)	3
Dog Whelk (M)	*Pleuroploca austalasia*	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	1(0.06)	1(0.1)	2(0.09)	2(0.2)	3
Porcupine Fish (F)	*Diodon nicthemerus*	0(0)	0(0)	1(0.05)	1(.12)	1(0.04)	1(0.1)	0(0)	0(0)	0(0)	0(0)	2
Scallop (M)	*Pecten fumatus*	0(0)	0(0)	0(0)	0(0)	1(0.04)	1(0.1)	1(0.06)	1(0.1)	0(0)	0(0)	2
Whiting (F)	*Sillaginodes punctata*	0(0)	0(0)	2(0.11)	2(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	2
Sponge crab (C)	*Dromidiopsis australiensis*	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	1(0.06)	1(0.1)	0(0)	0(0)	1
Flounder (F)	*Ammotretus rostratus*	0(0)	0(0)	1(0.05)	1(.12)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	1
Weedy Whiting (F)	*Haletta semifasciata*	0(0)	0(0)	0(0)	0(0)	1(0.04)	1(0.1)	0(0)	0(0)	0(0)	0(0)	1
Octopus (M)	*Octopus maorum*	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	1(0.06)	1(0.1)	0(0)	0(0)	1
Turban shell (M)	*Turbo torquatus*	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	1(0.06)	1(0.1)	0(0)	0(0)	1
Bait crab (C)	*Liocarcinus corrugatus*	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	1(0.04)	1(0.1)	1
Squid (M)	*Sepioteuthis australis*	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	1(0.04)	1(0.1)	1
Abalone (M)	*Haliotis roei*	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	1(0.04)	1(0)	1
Conch (M)	*unidentified*	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	1(0.04)	1(0.1)	1

(Source: SARDI Aquatic Sciences – Currie *et al.*, 2007)

Table 16. Total abundance and frequency of occurrence (% in brackets) of species taken as by-catch during fishery-independent pot surveys in Gulf St.Vincent.

Gulf St Vincent		**2002**		**2003**		**2004**		**2005**		**2006**		
C = Crustacean, F = Fish, E = Echinoderm, M=Mollusc		Lifts = 538		Lifts = 914		Lifts = 920		Lifts = 880		Lifts = 920		
Common name	**Scientific name**	**No.s**	**Freq**	**No.s**	**Freq**	**No.s**	**Freq**	**No.s**	**Freq**	**No.s**	**Freq**	**Total**
Rock crab (C)	*Nectocarcinus integrifrons*	1922(80.93)	340(63.2)	3994(84.07)	553(60.5)	6648(84.99)	733(79.7)	5844(80.22)	574(65.2)	3442(67.37)	521(56.6)	21850
Spider crab (C)	*Leptomithrax gaimardii*	352(14.82)	134(24.9)	307(6.46)	167(18.3)	440(5.63)	256(27.8)	657(9.02)	262(29.8)	903(17.67)	338(36.7)	2659
Leatherjacket (F)	*Acanthaluteres spilomelanurus*	46(1.94)	22(4.1)	83(1.75)	49(5.4)	368(4.7)	116(12.6)	442(6.07)	122(13.9)	433(8.48)	128(13.9)	1372
Sand crab (C)	*Ovalipes australiensis*	21(0.88)	11(2)	110(2.32)	22(2.4)	227(2.9)	50(5.4)	75(1.03)	23(2.6)	63(1.23)	18(2)	496
Red Mullet (F)	*Upeneichthys vlamingii*	18(0.76)	8(1.5)	134(2.82)	71(7.8)	32(0.41)	19(2.1)	96(1.32)	39(4.4)	22(0.43)	15(1.6)	302
Puffer Fish (F)	*Torguigener pleurogramma*	0(0)	0(0)	1(0.02)	1(0.1)	6(0.08)	4(0.4)	15(0.21)	11(1.3)	95(1.86)	42(4.6)	117
Fiddler (F)	*Trygonorhina fasciata*	4(0.17)	4(.7)	31(0.65)	30(3.3)	16(0.2)	15(1.6)	24(0.33)	23(2.6)	5(0.1)	5(0.5)	80
Cuttlefish (M)	*Sepia apama*	3(0.13)	3(0.6)	12(0.25)	12(1.3)	7(0.09)	6(0.7)	42(0.58)	31(3.5)	12(0.23)	12(1.3)	76
Flathead (F)	*Platycephalus bassensis*	1(0.04)	1(0.2)	6(0.13)	6(0.7)	23(0.29)	19(2.1)	9(0.12)	9(1)	32(0.63)	14(1.5)	71
Pt Jackson (F)	*Heterodontus portusjacksoni*	0(0)	0(0)	7(0.15)	7(0.8)	5(0.06)	5(0.5)	3(0.04)	3(0.3)	38(0.74)	29(3.2)	53
Cardinal Fish (F)	*Vincentia conspersa*	0(0)	0(0)	22(0.46)	16(1.8)	4(0.05)	4(0.4)	14(0.19)	12(1.4)	5(0.1)	5(0.5)	45
Rock ling (F)	*Genypterus tigerinus*	0(0)	0(0)	5(0.11)	5(0.5)	8(0.1)	7(0.8)	11(0.15)	11(1.3)	14(0.27)	13(1.4)	38
Starfish (E)	*Pateriella brevispina*	0(0)	0(0)	4(0.08)	4(0.4)	12(0.15)	8(0.9)	6(0.08)	6(0.7)	7(0.14)	7(0.8)	29
Balmain Bug (C)	*Ibacus peronii*	0(0)	0(0)	1(0.02)	1(0.1)	8(0.1)	8(0.9)	7(0.1)	7(0.8)	11(0.22)	6(0.6)	27
Soldier Fish (F)	*Gymnapistes marmoratus*	2(0.08)	2(0.4)	18(0.38)	18(2)	2(0.03)	2(0.2)	1(0.01)	1(0.1)	4(0.08)	4(0.4)	27
Beche De Mer (E)	*Stichopus mollis*	1(0.04)	1(0.2)	6(0.13)	6(0.7)	5(0.06)	5(0.5)	8(0.11)	8(0.9)	5(0.1)	5(0.5)	25
Trumpeter (F)	*Pelates sexlineatus*	1(0.04)	1(0.2)	0(0)	0(0)	0(0)	0(0)	7(0.1)	4(0.4)	4(0.08)	3(0.3)	12
Skate (F)	*Raja whitleyi*	0(0)	0(0)	2(0.04)	2(0.2)	0(0)	0(0)	5(0.07)	5(0.5)	2(0.04)	2(0.2)	9
Sea urchin (E)	*Heliocidaris erythrogramma*	0(0)	0(0)	3(0.06)	3(0.3)	2(0.03)	2(0.2)	0(0)	0(0)	4(0.08)	4(0.4)	9
Snapper (F)	*Pagrus auratus*	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	2(0.03)	2(0.2)	4(0.08)	2(0.2)	6
Scallop (M)	*Pecten fumatus*	2(0.08)	2(0.4)	0(0)	0(0)	1(0.01)	1(0.1)	1(0.01)	1(0.1)	1(0.02)	1(0.1)	5
Hermit Crab (C)	*Pagguristies frontalis*	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	4(0.05)	4(0.4)	0(0)	0(0)	4
Catfish (F)	*Cnidoglanis macrocephalus*	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	4(0.05)	4(0.4)	0(0)	0(0)	4
Top Shell (M)	*Calliostoma sp.*	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	3(0.06)	3(0.3)	3
Seven Gill shark (F)	*Notoynchus cepedianus*	0(0)	0(0)	1(0.02)	1(0.1)	0(0)	0(0)	2(0.03)	2(0.2)	0(0)	0(0)	3
Turban Shell (M)	*Turbo torquatus*	0(0)	0(0)	0(0)	0(0)	3(0.04)	2(0.2)	0(0)	0(0)	0(0)	0(0)	3
Tunicate (A)	*unidentified*	0(0)	0(0)	0(0)	0(0)	2(0.03)	2(0.2)	0(0)	0(0)	0(0)	0(0)	2
Conch (M)	*unidentified*	0(0)	0(0)	0(0)	0(0)	2(0.03)	2(0.2)	0(0)	0(0)	0(0)	0(0)	2
Weedy Whiting (F)	*Haletta semifasciata*	1(0.04)	1(0.2)	1(0.02)	1(0.1)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	2
Squid (M)	*Sepioteuthis australis*	0(0)	0(0)	1(0.02)	1(0.1)	1(0.01)	1(0.1)	0(0)	0(0)	0(0)	0(0)	2
Shovelnose ray (F)	*Aptychotrema vincentiana*	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	2(0.03)	2(0.2)	0(0)	0(0)	2
Crested Weedfish (F)	*Cristiceps australis*	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	1(0.01)	1(0.1)	0(0)	0(0)	1
Cowfish (F)	*Aracana aurita*	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	1(0.01)	1(0.1)	0(0)	0(0)	1
Gurnard Perch (F)	*Neosebastes nigropunctatus*	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	1(0.02)	1(0.1)	1
Flounder (F)	*Ammotretus rostratus*	1(0.04)	1(0.2)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	1
Stinkfish (F)	*Foetoreepus calauropomus*	0(0)	0(0)	1(0.02)	1(0.1)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	1
Whiting (F)	*Sillaginodes punctata*	0(0)	0(0)	0(0)	0(0)	1(0.01)	1(0.1)	0(0)	0(0)	0(0)	0(0)	1
Octopus (M)	*Octopus maorum*	0(0)	0(0)	1(0.02)	1(0.1)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	1
Gummy shark (F)	*Mustelus antarcticus*	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	1(0.01)	1(0.1)	0(0)	0(0)	1
Wobbegong (F)	*Orectolobus ornatus*	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	1(0.01)	1(0.1)	0(0)	0(0)	1
Abalone (M)	*Haliotis laevigata*	0(0)	0(0)	0(0)	0(0)	1(0.01)	1(0.1)	0(0)	0(0)	0(0)	0(0)	1
Dog Whelk (M)	*Pleuroploca austalasia*	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	1(0.02)	1(0.1)	1
Catshark (F)	*Parascyllium ferrugineum*	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	1(0.02)	1(0.1)	1
Cod (F)	*Pseudophycis bachus*	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	1(0.02)	1(0.1)	1

(Source: SARDI Aquatic Sciences – Currie *et al.*, 2007)