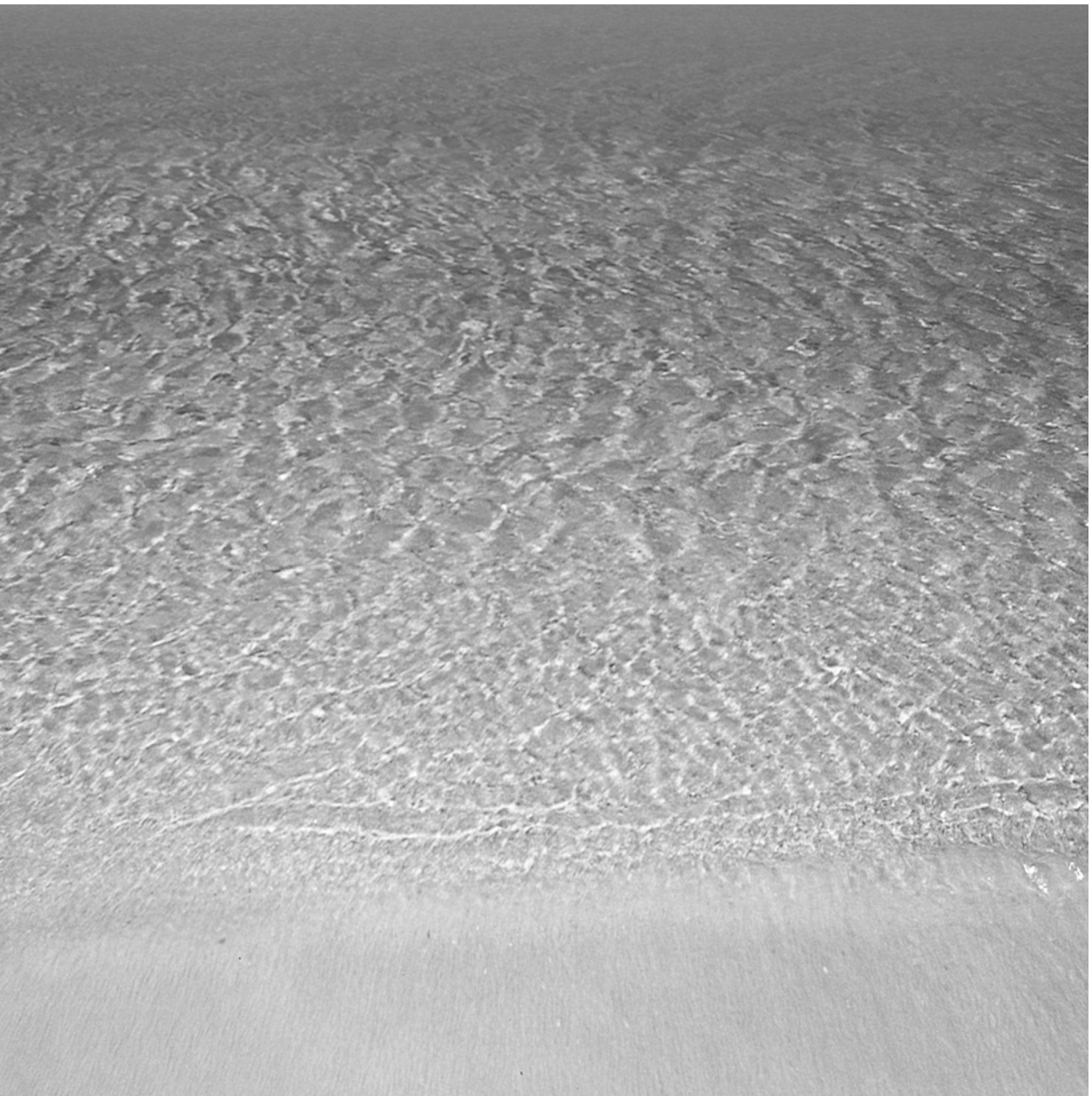
ESD REPORT
SERIES No. 3

Shark Bay Prawn Fishery



Department of Fisheries

Ecologically Sustainable Development
Catching Sustainability
FRDC – Subprogram

Australian Government
Fisheries Research and Development Corporation

Fish for the future

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Published by the Department of Fisheries, Western Australia
ESD Report Series No. 3, January 2006
ISSN: 1448 - 3599 ISBN: 1 877098 38 8

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1.0 Introduction

Ecologically Sustainable Development (ESD) is the concept that seeks to integrate short and long-term economic, social and environmental effects in all decision-making. The Western Australian Government is committed to the concepts of ESD and these principles are implicitly contained in the objectives of the *Fisheries Resources Management Act 1994* (FRMA). More recently, the Minister for Fisheries released a "*Policy for the Implementation of Ecologically Sustainable Development for Fisheries and Aquaculture within Western Australia*" (Fletcher 2002) to articulate, in a practical manner, how the Department of Fisheries can demonstrate to both the government and the broader community that these requirements are being achieved.

A major element of this policy was the requirement for reporting on the progress of each commercial fishery against the major ESD objectives by the end of 2003. This document forms part of this process being the ESD report for the *Shark Bay Prawn Fishery.*

The reporting framework used to generate these ESD reports is the National ESD Framework for Fisheries (see Fletcher et al., 2002 or www.fisheries-esd.com for details). This framework operates by identifying the relevant issues for a fishery within 3 main categories of Ecological wellbeing, Human wellbeing and Ability to achieve completing a risk assessment on each of the identified issues and then providing suitably detailed reports on their status.

Due to recent changes in the Commonwealth environmental legislation (EPBC Act. 1999) administered by Department of Environment and Heritage[1], all export fisheries are now required to have an assessment on their environmental sustainability. As a consequence, the initial series of assessments for fisheries has concentrated on the environmental and governance components of ESD of this fishery. The social and economic elements of ESD will be covered in the next phase of assessments.

The reporting of performance for each fishery is the responsibility of the Department in conjunction with the relevant Management Advisory group and/or associated stakeholders. Consequently, the completion of this report has involved a substantial level of consultation and input from many groups including a public comment period. The list of participants involved in this development is located in Appendix 2.

This material has also been used as the basis to submit an application to Environment Australia to meet the requirements of the Australian Governments' *Guidelines for the Ecologically Sustainable Management of Fisheries*. A copy of the application section of this submission, which was submitted in April 2002, is located in Appendix 6. The Shark Bay Prawn Managed Fishery was awarded an exemption to Part 13A of the EPBC Act for the next five years. A copy of the recommendations imposed for this exemption are located in Appendix 7. Where relevant, these conditions have now been incorporated into the Performance Reports of the fishery (see Section 5).

These ESD reports provide a comprehensive overview of the information pertaining to each fishery. A major element of which is the explicit determination of the operational objectives, performance measures and indicators that will be used to assess performance of the fishery. Most importantly these reports include appropriately detailed justifications for the levels chosen and the methods used. Therefore, the annual *State of the Fisheries* reports on the evaluation of performance of this fishery against these sets of "agreed" objectives/performance measures (ie the full justifications will not be presented in the *SoF* reports). This is summarised in Figure 1.

[1] *During the time this assessment was completed, this department was called Environment Australia (EA). Throughout this document, references to EA should be taken to mean DEH.*

As stated in the Department's ESD policy, it is expected that the ESD report, and therefore the objectives and performance measures, will be reviewed every 5 years to ensure that they remain relevant and appropriate with current scientific protocols, social attitudes and prevailing environmental conditions. This will coincide with the next assessment cycle under the EPBC Act. The material presented here relates to the time of the application, not time of publication.

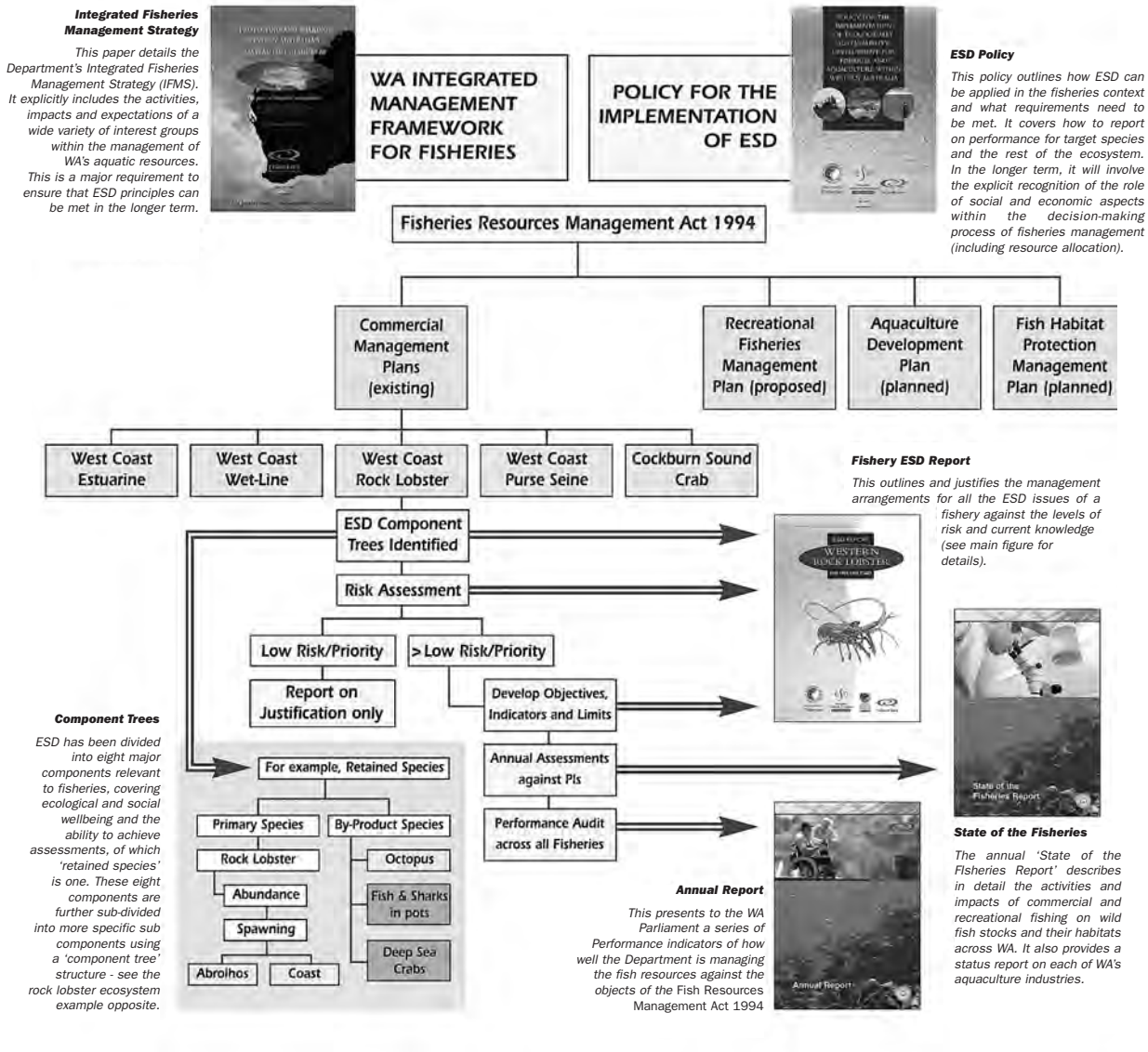

Figure 1. Summary of process for completing ESD reports and their relationship with the Annual Report and State of Fisheries Reports. (Example shown is for the West Coast Bioregion and the Western Rock Lobster fishery.)

2.0 Overview

The western king prawn and the brown tiger prawn are the two major species targeted by this fishery, which is the largest prawn fishery in Western Australia (WA) with a landed value in 2000 of around $40 million. The fishery has operated under a detailed and sophisticated management regime since 1962 with catches over the last 30 years maintained within a range of 1,000-2,300 tonnes per year using a comprehensive set of regulations that include limits on vessel numbers, gear, zoning, closed seasons and closed areas, along with a variety of biological controls. Each of these has been refined through time, and is subject to regular reviews to achieve the overall aim of successful management.

The SBP Plan is the current management plan for the SBP fishery and is a formal statutory document which dictates management measures for the fishery. There is also an Shark Bay Prawn Management Advisory Committee (SBPMAC) which helps to achieve cooperative management of this fishery through the provision of advice for achieving the maximum economic return, maintaining sustainability of the fishery and ensuring cost effective management.

The *Fish Resources Management Act, 1994* (FRMA) provides the legislative framework to implement the management arrangements for this fishery. The FRMA, and the specific management plan for the SBP fishery, adheres to arrangements established under relevant Australian laws with reference to international agreements as documented in Section 5.4.2.

The combination of having a large amount of relevant and accurate information on the biology and recruitment status of the scallop species, the sophisticated suite of management arrangements in place and the proactive management used in the SBP fishery. Each of these has been refined through time, and is subject to regular reviews to achieve the overall aim of successful management, which has resulted in the maintenance of ecologically viable stock levels. In summary these arrangements include:

- Small numbers of vessels and a limited entry fishery with the potential for further reductions
- Fixed seasonal closures (November – March)
- Real time monitoring of fleet dynamics and operations by departmental staff
- Variable spawning/size season closures (areas closed or opened depending upon catch rates and sizes of prawns)
- Permanent area closures to preserve sensitive habitats that are essential nursery areas for prawns and other species
- Time closures- this now includes full moon closures, and due to the habits of prawns, restricts fishing to night hours
- Input controls on gear and vessel equipment (currently, the regulations allow the vessels in this fishery to tow two standard otter trawl nets and one otter trawl try-net but some operators have permits for the trial use of quad gear).

Significant effort is put into ensuring adequate compliance with these regulations. This includes at sea and aerial patrols to ensure closed seasons and closed areas, and operational rules are being adhered to. Since 2000 the use of VMS on the vessels has helped the Department of Fisheries monitor vessel location and speed, thus increasing compliance with closures while decreasing the need for untargeted patrol activities.

Research and monitoring of the SBP fishery has been carried out by the Department of Fisheries since the late 1960s. Catch and effort statistics has been collected for the SBP fishery since 1962. Additionally, voluntary log book information has been collected from fishers at the outset, providing a valuable long-term data set from which stock assessments can be made. Furthermore, this long-term data collection is valuable to the Department because it spans varying effort levels and environmental variations throughout the history of the SBP fishery.

Assessments of current performance demonstrate that all of the target and byproduct prawn species are currently being maintained above levels necessary to maintain ecologically viable stock levels. Thus, in summary:

- The breeding stock level for the tiger prawn stock in Shark Bay is currently above the agreed reference point. Additional protection is now given through complete closure of the main spawning grounds once the threshold catch rate is reached.
- The historical catch and effort trends over the past 40 years indicate that there has been no decline in the production levels for king prawn in Shark Bay, which is consistent with there being sufficient on-going levels of spawning biomass for this species.
- Historical catch and effort trends indicate that there has been no significant decline in the production levels of coral prawns and no recent declining trend in the production levels of endeavour prawns.
- The level of capture of other by-product species by this fishery is too small to have a significant impact on their dynamics.

The fishery has also taken a positive response to minimise wider ecosystem interactions. Bycatch reduction devices and turtle excluding devices are currently being phased-in, which will minimise or, in some cases eliminate, the potential for impacts on other species. Therefore, of the non-retained species identified in this fishery, all of them were ranked as either negligible or low risks.

In the capture category for non-retained species, the assessment concluded that the SBP fishery was only a negligible or low risk to seasnakes, syngnathids, green turtles and loggerhead turtles. The risk to discarded fish was rated as moderate. Following this rating, the Department of Fisheries undertook an assessment of the risk to individual discarded fish species taken in the SBP fishery and will continue to monitor the risk.

For the direct interaction but no capture category for non-retained species, this assessment concluded that the fishery was of negligible or low risk to green and loggerhead turtles and dugongs and cetaceans.

The issues that relate to the broader ecosystem identified for the SBP fishery were also assessed using a formal risk assessment process. Of the seven issues identified for the SBP fishery, three (impact to sand/shell and coral/sponge habitats and discarding fish) were rated as moderate risk, one (trophic interaction) was rated as low and three (impact to seagrass, turbidity and translocation) were rated as negligible.

3.0 Background on SBP fishery

3.1 DESCRIPTION OF THE FISHERY

The SBP fishery is the largest prawn fishery in Western Australia and is located off the mid-west coast of WA (Figure 2). The precise boundaries of the commercial fishery are the waters of the Indian Ocean between 23°24' and 26°30' south latitude and adjacent to WA landwards of the 200 metre isobath, together with those waters of Shark Bay south of 26°30' south latitude (Figure 3). The vessels generally fish out of the port of Carnarvon with the actual areas of operation for these vessels being considerably less than what is described by the regulations.

Figure 2. Locality Map for Shark Bay, Western Australia.

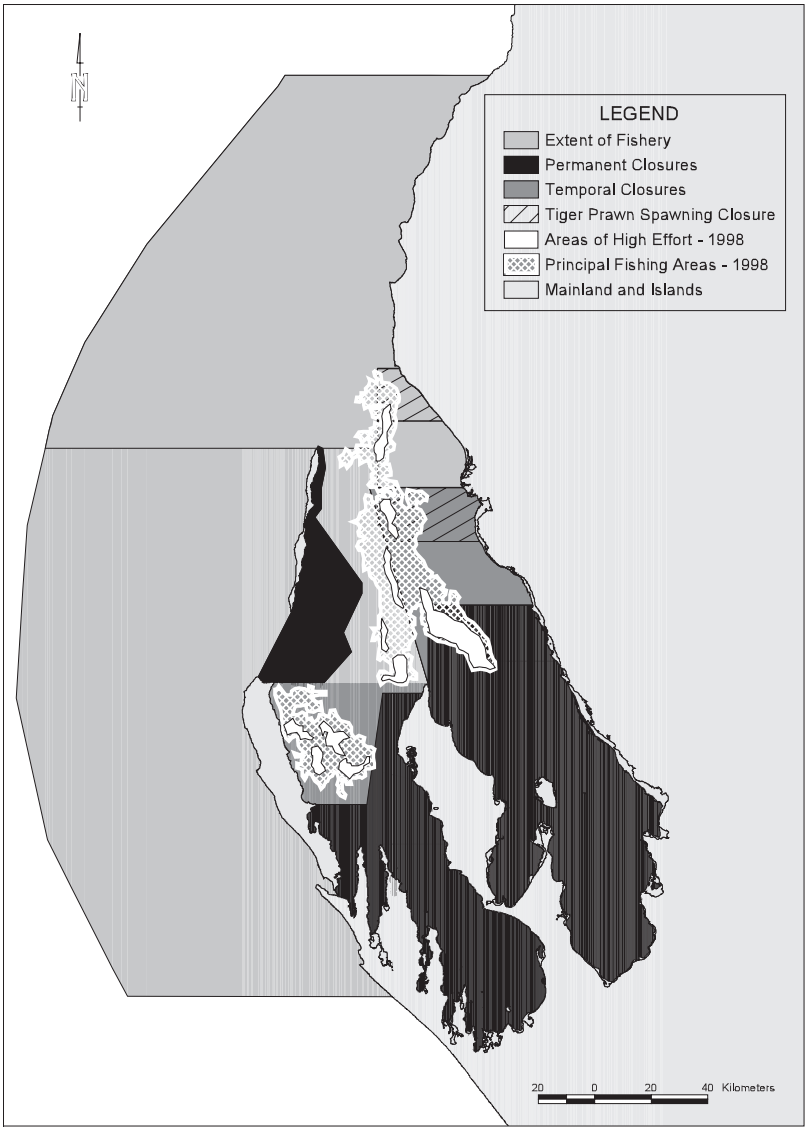

Figure 3. Major Features of SBP fishery including principal fishing areas.

The SBP fishery is an otter-trawl fishery, which began in 1962 with a catch of 152 tonnes of king and tiger prawns by four vessels. The fishery quickly expanded to a maximum of 35 boats in 1976, catching 1,511 tonnes of king and 771 tonnes of tiger prawns (Figure 4). A peak catch of 2,370 tonnes of predominantly king (2,014 t) and tiger (324 t) prawns was landed in 1981. During the period from 1980 to 1989 the annual tiger prawn catch declined to an average of 303 tonnes compared with an average of 649 tonnes during the 1970s. In 1990, a buy-back scheme was introduced, reducing the number of boats to 27, which was the capacity in 2001. The tiger prawn catches have subsequently returned to acceptable levels over 500 tonnes. The catch in 2000 was 2,250 tonnes, which was comprised of 1,555 tonnes of king prawns and 689 tonnes of tiger prawns and valued at around $40 million.

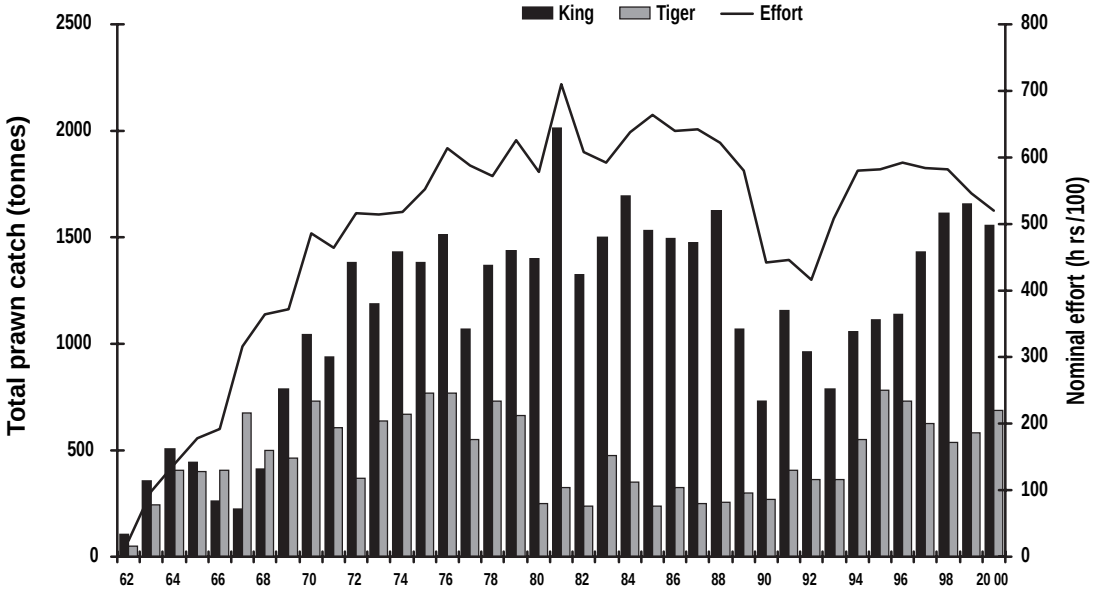

Figure 4. Catch and effort history of king and tiger prawns in the SBP fishery.

Fishing Methods (see Appendix 1 for terminology)

The SBP fishery targets two major species - king and tiger prawns. This affects the types of gear used in the fishery.

The boats in the SBP fishery generally tow two low-opening demersal otter trawl nets (8 fathoms headrope length) and each tow is approximately 60 minutes in duration (see Figure 5). Two otter boards, each 2.44 metres in length and 0.91 metres in height are attached to the extremities of each net at the opening, the height of the fishing gear is set by the height where they are connected to the otter boards. Forces produced by water flowing over the otter boards open the trawl nets laterally. The lateral spread is vital to the catching efficiency of trawl gear and this determines the area swept. Generally, the headrope and ground rope is spread between 60% and 85% of their length. Attached to the footrope is the ground chain, which is limited to 10 mm diameter. The ground chain travels across the sea floor and disturbs prawns and scallops so they rise from the seafloor and into the oncoming net. Low opening nets have the headrope as a lead-ahead, which acts as a net veranda and is set in front of the footrope to ensure that the prawns disturbed by the ground chain do not pass over the headrope. This also maintains the catch efficiency of the nets.

In 2001 the prawn trawlers in Shark Bay were required to fish with one bycatch reduction device (BRD), which includes a turtle excluding frame, and one standard net (Figure 6). As this fishery is managed using the relationship between catch per unit effort and relative abundance, it is crucial for the researchers to understand the impact that the BRDs have on the effective effort exerted by the trawl net. An observer program has been in place since BRDs were introduced to the fishery, to record the catch from the standard nets and BRD nets. This allows a calculation to be made of the difference in effective effort between the two types of nets both in terms of target and non-target species. From 2002, the fishery was required to use two BRD nets, although short-term exemptions will be given in specific areas where high concentration of weeds are present during the fishing season.

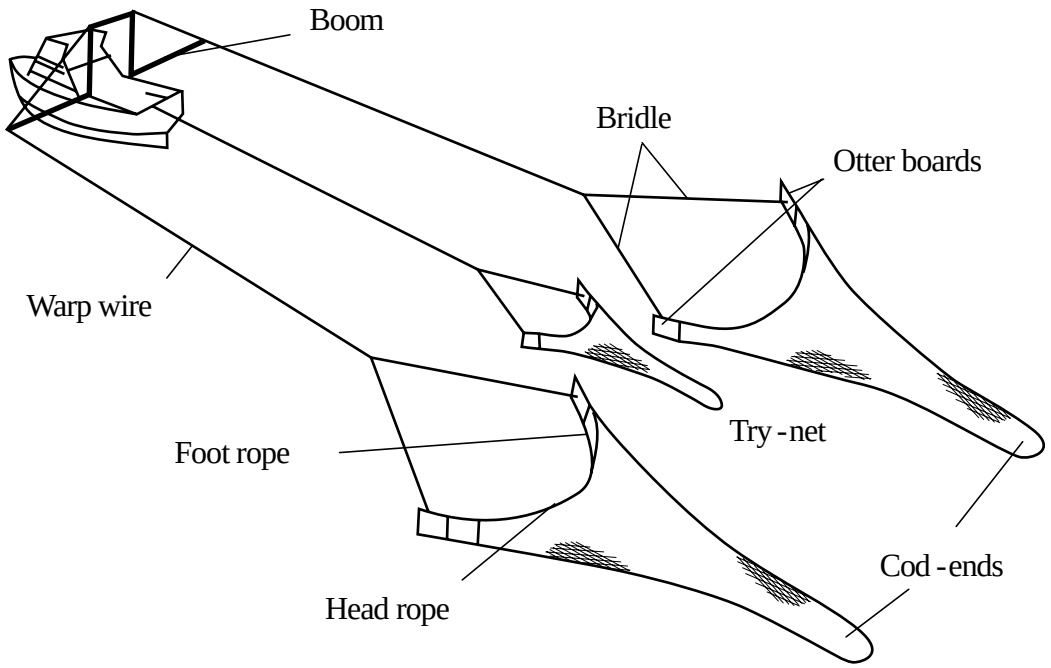

Figure 5. The standard twin otter rig and try gear used by prawn trawlers in Shark Bay.

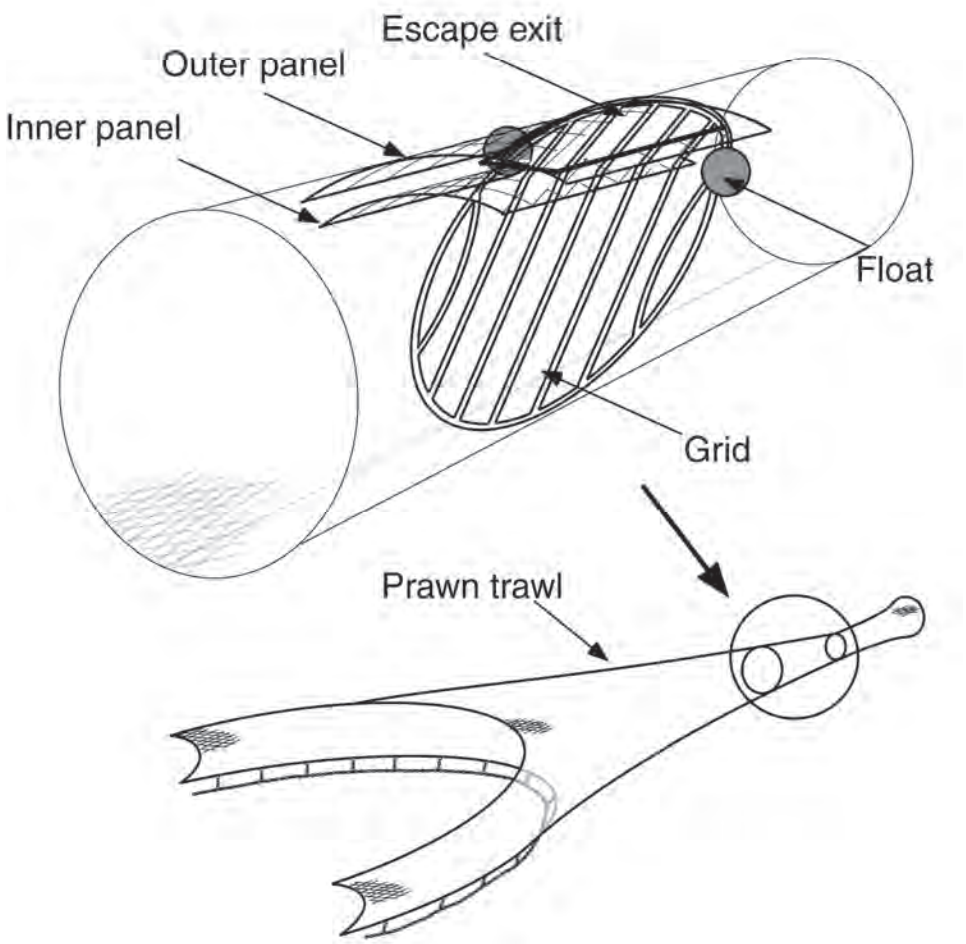

Figure 6. Diagrammatic representation of the type of bycatch reduction device used in Shark Bay, and it's location in the trawl net.

Management

The current management plan for the SBP fishery is a formal statutory document that dictates the management measures for the fishery. The Shark Bay Prawn Management Advisory Committee (SBPMAC) achieves cooperative management of this fishery through the provision of advice to the Minister for Fisheries. The advice provided allows for the management to be better tailored for achieving the maximum economic return from the prawn resource as well as maintaining sustainability of the fishery and ensuring cost effective management.

The SBP fishery is an "input controlled fishery" that has a complex series of management restrictions, including limited entry, boat size and gear controls, and spatial and temporal closures to sustain all of the prawn species, maintain the supporting environment and maximize the size of the prawns at capture. In reality, the fishery is managed under a "constant escapement policy", which is designed to leave a minimum level of tiger prawn spawning stock during their breeding season to maximize recruitment levels the following year.

These management arrangements include:

Limited entry. There are a limited number of vessels operating in the fishery, 27 licences currently. The number has been reduced over time (down from a peak of 35) and may continue to be reduced as effective effort increases with technology.

Seasonal closure. The fishery is closed between November and March each year. The timing of the opening of the season allows juvenile prawns to grow to a harvestable size before they are fished while still allowing the harvest of large residual prawns, which were not caught the previous year.

Area closures. Within the main fishing period, various subsidiary openings and closures occur, which are aimed at protecting prawns from growth and recruitment over fishing based on real-time monitoring of size and catch rates. Parts of Shark Bay are permanently closed to trawling, to preserve seagrass and other sensitive habitats that are essential nursery areas for prawns and other species (Figure 7). Within the fishery, which extends out to the 200m isobath, trawling operates in less than 20% of the licensed fishing area.

Time closures. Prawns are predominantly nocturnal and trawling is only permitted between 1700 hrs and 0800 hrs in the majority of the fishing areas. North of 24°45'18" south latitude, trawling is permitted 24 hours a day for a limited time at the start of the season. Trawling for prawns during the day is generally unproductive because prawns burrow in the sediment and are not disturbed by the ground rope and chains and therefore are not caught. There are also three to seven day closures around each full moon, to increase economic efficiency and avoid capture of moulting soft-shelled prawns, thereby increasing product quality.

Gear controls. These include controls on the mesh size of nets, the length of the head rope, the number of trawls that can be towed, the size of the ground chain, and the dimensions of the otter boards including the metal shoes. Specifications for these controls are part of the Management Plan. Compliance policing is a major part of attaining adherence to the gear controls and closures imposed on this fishery. Sea patrols and radar watches are conducted on a random basis during the season. Aerial compliance checks are also conducted throughout the season. Additionally, the compliance staff conducts license and gear inspections both at sea and in port.

In 2000, the major change in the region was the introduction of the Vessel Monitoring System (VMS) into the SBP fishery. The VMS enables the Department to monitor a vessels location and speed with particular attention paid to the surveillance of nursery areas.

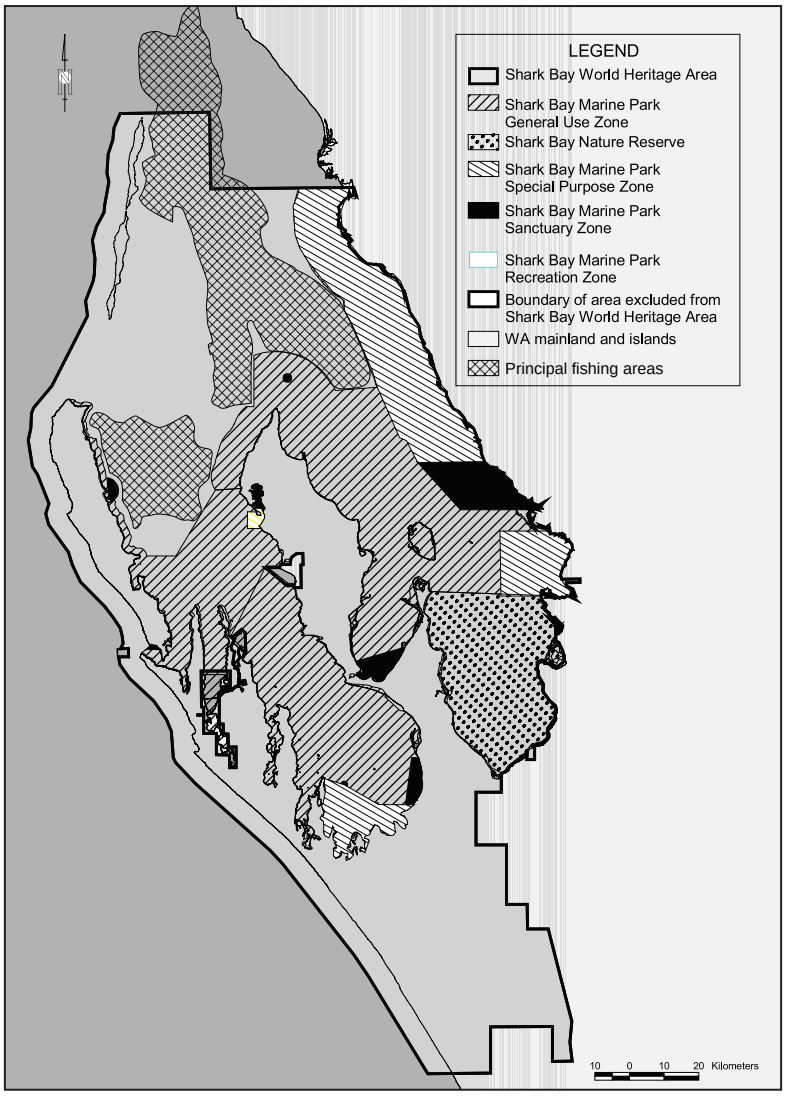

Figure 7. Shark Bay features of the natural environment, marine park zones and principal fishing areas.

Yearly Cycle of Operation

The yearly cycle of operation for the SBP fishery is dynamic and multifaceted. The opening/closing dates vary each year depending on environmental conditions, moon phase and the results of surveys, which predict recruitment dynamics. Intra-seasonal closures are implemented in the fishery to reflect the recruitment pattern of prawns in Shark Bay. Generally, they travel in a northwardly direction, from the shallow hypersaline areas to the deeper oceanic waters. In addition, the Department of Fisheries will open up additional areas throughout the season, which allows the fishing effort to be spread over a wider area as well as between prawn species. The closure system is specifically designed to allow the prawns to grow to reach optimal market sizes in each area before fishing commences.

From the start of the season (mid-March) to the estimated start of recruitment of juveniles into the fishery (mid-April), fishers are restricted to the northern area of Shark Bay and its western gulf (refer to Figure 8). During this period, prawns left over from the previous year's recruitment are fished. While restrictions on fishing further south prevent fishing of juvenile prawns below the market size.

From around mid-April, or when recruitment of marketable-sized prawns has been predicted to take place (now surveyed to confirm), until mid-May, fishers are permitted to trawl in the area within the Carnarvon Line and the extended nursery area north of the Eastern Gulf, in addition to the northern grounds (see to Figure 8). During this period, the western gulf of Shark Bay is closed to trawling.

From mid-April until the beginning of August, Denham Sound is closed as new recruits enter this section of the fishery. In August, when the recruits have reached a marketable size, Denham Sound is re-opened to permit the capture of these prawns (refer to Figure 8).

A closure north of the extended nursery area, designed to protect a portion of the tiger prawn breeding stock during spawning, is generally closed from mid-July (see also Figure 8). This closure period is now determined through catch rate monitoring and surveying of spawning area in June and July.

From the beginning of August until the end of the season (around late October), trawling is permitted in all other areas of the fishery except the permanent and extended nursery areas and the tiger prawn closure area.

From the start of the 2000 SBP fishery season, the arc that formed part of the western and southern boundary of the extended nursery area was re-aligned and straightened and the boundary of the permanent nursery moved one mile north. This realignment facilitates navigation using Global Positioning System (GPS) technology, thus reducing the risk of boats transgressing into non-trawl areas south of the new nursery line. It also provides the opportunity for a more sophisticated fishery closure, which better achieves the aims of protecting the breeding stocks of tiger prawns.

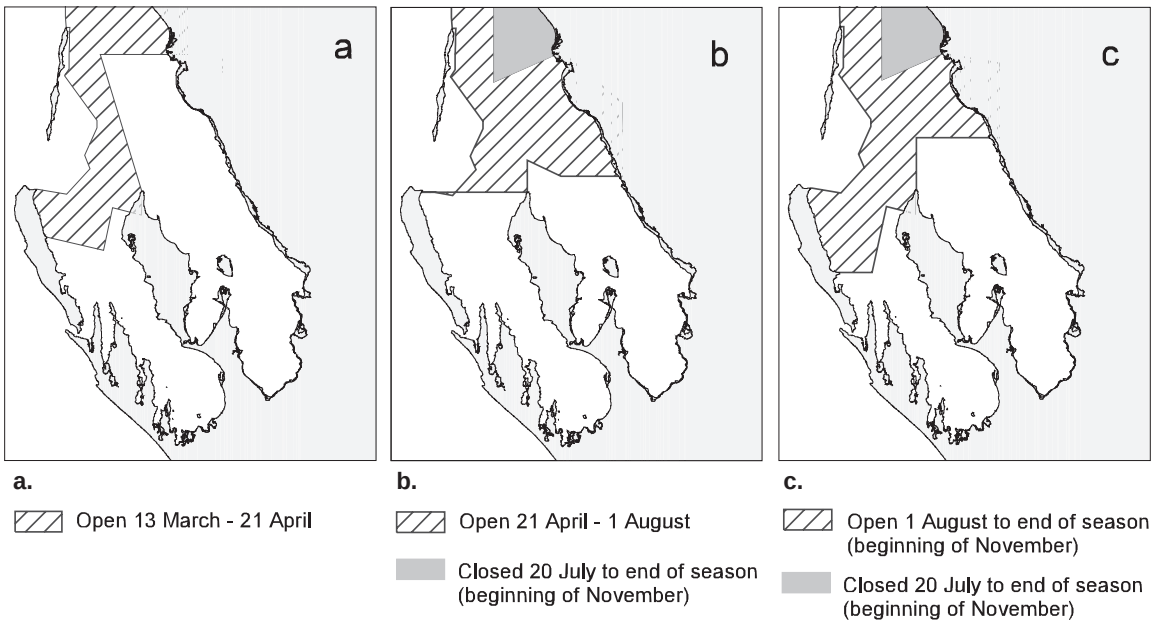

Figure 8. Seasonal (Temporal) closures of the SBP fishery.

Target Species

Western king prawns are the dominant species in the SBP fishery constituting about 65% of the catch. Tiger prawns and a small portion of endeavour and coral prawns as well as a minor amount of other invertebrates and finfish make up the rest of the catch. The non-commercially valuable species are discarded overboard. Prawns and retained by-product species are packed in 12 kg boxes and snap frozen at sea.

The catch history in Shark Bay (Figure 4) indicates that the yield level of king prawns is relatively stable and varies largely according to the effort levels expended towards the species. Tiger prawn catches declined in the 1980s with additional targeting of effort towards king prawns, resulting in increased catch levels of that species. The lower catches between 1989 and 1996 were most likely the result of lower effort levels resulting from the buyback of vessels in 1990 and the increase in abundance of scallops, which corresponded with an unusually weak Leeuwin Current during the extended El Nino Southern Oscillation (ENSO) event (Caputi et. al., 1996). This unusually high abundance of scallops reduced the effort directed towards the catch of king prawns. The catches of king prawns in the last four years have returned to the levels previously seen in the 1980s as a result of the increased effort being targeted on them.

Fishing for tiger prawns developed as an activity secondary to fishing for king prawns but became a major part of the catch in the mid 1960s. During the 1970s, tiger prawn catches increased to an average of 650t per year. Following an increase in effective effort on tiger prawns in the late 1970s as a result of the replacement of vessels and improved targeting on localized areas of high tiger prawn abundance due to their higher value, the catch declined to an average of 300t in the 1980s (Penn et. al., 1997). Research found that when prawns are at reduced levels, recruitment levels of tiger prawns are strongly correlated with spawning stock levels (Penn et. al., 1989). Subsequently, management actions to improve the spawning stock size of tiger prawns were instigated in 1989. The situation was further improved by the removal of eight vessels in 1990 thereby reducing overall effort on tiger prawns and consequently allowing the spawning stock to increase. Recent catches of tiger prawns of around 400-700t indicate stock sizes are back to the levels observed in the 1970s. Changes in the efficiency of the fishing fleet are carefully monitored, to ensure that tiger prawn spawning stocks are not over-exploited.

Non-Retained Species

While target species stocks are relatively well maintained in this fishery, there has been concern in recent years about the fishery bycatch. In particular, precautionary measures were implemented in 2000 to minimise snapper catches. This resulted from concerns about the dramatic decline in two of the three snapper stocks in Shark Bay (eastern and western gulf). This was primarily attributed to the intense recreational fishing pressure on spawning stock aggregations. The prawn trawl fishery responded quickly to implement a range of measures that would minimise any negative effects from the prawn trawl fishery. Consequently in the 2000 season they implemented:

- An additional trawling closure on the east side of Denham Sound;
- An independent Scientific Observer Program as part of the bycatch reduction strategy (and this will aim to quantify the significance of any juvenile snapper in the bycatch);
- All line fishing from trawlers south of Cape Inscription was prohibited, and
- Trawlers south of Cape Inscription were prohibited.

Furthermore, a Draft Bycatch Action Plan has been prepared for this fishery and will be finalised in consultation with the conservation, recreational fishing and commercial fishing sectors. The issues articulated in this plan have been used in the development of this ESD report.

Research

Research and monitoring of the fishery has been conducted since 1962. This data collection provides the Department of Fisheries with an exceptionally detailed database to utilise in the management of the fishery, since it has spanned through varying effort levels by the fishery as well as over numerous

environmental variations. Even so, research activities will continue to focus on stock assessment and monitoring of the status of prawn stocks, particularly tiger prawns. As with all skippers of WA fishing boats, there is a statutory license requirement on those in this fishery to submit monthly returns indicating the level of catch and effort (CAESS). In Shark Bay, trawler skippers also voluntarily (with 100 per cent participation) complete daily log sheets. These data are monitored by the Department's Research Division and are used to calculate the spawning stock index. The fishery-independent data collected is used to gauge the level of recruitment in the SBP Fishery.

In addition, the collection of fisheries-dependent data (voluntary log book program and CAESS and processor unload records) for stock assessment and monitoring of king and tiger prawns will continue. Fishery-independent surveys will be improved and increased to provide recruitment and spawning stock indices. In addition, a pilot program to monitor the commercial size composition of prawn catches will commence during the 2002 season. It is also important that analyses and monitoring are capable of determining the effect of any modified gears on the effective fishing effort of the fleet.

A collaborative project with the industry has been underway for the past two years that is reviewing the impact of trawling on non-target species and evaluating gear modifications to reduce bycatch and improve product quality. Appendix 5 further details the past, present and future research projects for the SBP fishery.

3.2 BIOLOGY OF WESTERN KING PRAWNS

Distribution and Stock Structure

The western king prawn, *Penaeus latisulcatus*, is a decapod crustacean of the family Penaeidae. *Penaeus latisulcatus* has been reported from the Indo-West Pacific region, the Red Sea, and Arabian Gulf in the west, through Malaysia, Korea and Japan to the north and through Indonesia to New Guinea and Australia to the south (Grey et al., 1983). Within Australian waters *P. latisulcatus* has been reported from South Australia (SA), WA, Northern Territory, Queensland and down the east coast to northern New South Wales (Grey et al., 1983). Electrophoretic studies found genetic differences amongst the populations sampled from WA, the Gulf of Carpentaria and SA (Richardson, 1982). Furthermore, this species generally only forms high level stocks in areas associated with the hypersaline waters of marine embayments (Kailola et al., 1993), which are likely to be largely independent of each other in terms of dynamics. This species is the dominant penaeid prawn species in the WA and SA fisheries representing about 65% and 100% of their total catches, respectively.

The juveniles are found inshore where they remain in shallow water nursery grounds for three to six months with the adults moving offshore to spawn. This species is generally found in coastal waters down to a maximum depth of about 80m and commonly caught by trawlers over hard, sand sediment substrates.

Life History

This species can live for up to four years, although animals greater than two years are rarely caught under current harvesting practices. King prawns become mature at six to seven months of age at a size around 25 mm carapace length.

When prawns mate, the male needs to be hard shelled and the female needs to be soft shelled (newly moulted). The male inserts a sperm capsule (spermatophore) into the female. This spermatophore remains inside the female reproductive organ (thelycum) until the female is ready to spawn. The

female's ovary develops rapidly and the eggs are released into the water before the female moults again, normally within a period of about one month (Penn and Stalker, 1979). At spawning, the eggs are released from small pores at the base of the third walking legs (Walker, 1975). Western king prawns have the ability to spawn numerous times throughout the year, producing approximately 100,000 to 700,000 eggs per spawning (Penn, 1980).

The larval development of *P. latisulcatus* has been described by Shokita (1970). During spawning the females swim near the bottom releasing the eggs, which float and usually hatch within 24 hours. After hatching from the egg the larvae called nauplii swim freely in the water column but do not feed. During the nauplii stages the larvae utilise stored food from the egg, completing a series of six moults before developing to the next larval stage (Penn and Stalker, 1979). The larval development continues through several stages: protozoea, mysis and postlarvae. This process generally takes from one to three weeks before the larvae are at the stage where they can settle onto the sea floor. During this period, predators are responsible for high mortality rates of the larvae. If by this time the larvae have drifted to a suitable nursery area (i.e. shallow sand/mud flats) they will settle (at around 10 mm total length) and continue to grow into juveniles. If settlement occurs into unsuitable habitats they are likely to perish (Penn and Stalker, 1979).

Juvenile western king prawns bury during the day into the substrate, which is generally shallow sandy banks. Whilst in the nursery grounds western king prawns are nocturnal and forage at night feeding on small animals and detritus. Juveniles spend about three to six months in nursery grounds allowing them to physically mature to between 107 and 127 mm total length (Penn and Stalker, 1979). At this point, they attain a size, that coincides with them migrating offshore to oceanic waters and subsequently, entering the trawl fishing grounds. This migration takes place in the summer and autumn of each year and is termed recruitment to the fishery.

Western king prawns are mainly detritus feeders but are prey to a wide variety of juvenile and adult fish (Kailola et al., 1993).

3.3 BIOLOGY OF BROWN TIGER PRAWNS

Distribution and Stock Structure

The brown tiger prawn, *Penaeus esculentus*, is a decapod crustacean of the family Penaeidae. *Penaeus esculentus* is generally regarded as an endemic Australian species. They have a distribution around the northern coast of Australia and whilst the electrophoretic study on this species (Mulley and Latter, 1981) found no genetic differences amongst regions, there are a large number of functionally independent stocks. Each of these stocks is associated with relatively sheltered waters where there is a substantial amount of seagrass that forms the main juvenile habitat for this species (and also explains their distinctive colouration).

Given this patchy distribution, there are a number of commercially abundant stocks of *P. esculentus* in Western Australia (Shark Bay, Exmouth Gulf, Onslow, Nickol Bay), Northern Terrritory (the Gulf of Carpentaria, Darwin, Torres Strait), Queensland (Moreton Bay, Yepoon, Mackay, Bowen and Weipa) (see Kailola et al., 1993 for map).

This species is generally found in coastal waters down to approximately 60m but has been recorded to a depth of 200m (Grey et al., 1983) and is commonly found over mud or sandy mud substrates by trawlers (Hall and Penn, 1979). Most spawning females are found in 13-20m of water (Penn et. al., 1995).

Life History

The species can live for over two years although animals greater than two years are rarely caught under current harvesting practices. Brown tiger prawns become mature at six to seven months of age at a size around 25 – 28 mm carapace length.

As for western king prawns, when tiger prawns mate, the male needs to be hard shelled and the female needs to be soft shelled (newly moulted). The male inserts a sperm capsule (spermatophore) into the female. This spermatophore remains inside the female reproductive organ (thelycum) until the female is ready to spawn her eggs. The female's ovary develops rapidly and the eggs are released into the water before the female moults again, which in Queensland is around 27 days (Crocos and Kerr, 1983). Spawning usually occurs at night with the eggs released from small pores at the base of the third walking legs (Walker, 1975). Brown tiger prawns produce approximately 50,000 to 400,000 eggs per spawning. The numbers of eggs being released reaches a small peak during autumn and a larger peak in spring with lower levels of spawning activity (compared to western king prawns) occurring throughout the year (Penn and Stalker, 1979).

The stages of larval development for brown tiger prawns is similar to that of king prawns. At spawning the females swim near the bottom releasing the eggs, which float and usually hatch within 24 hours. After hatching from the egg the larvae, called nauplii, swim freely in the water column but do not feed. During the nauplii stages the larvae utilise stored food from the egg, completing a series of six moults before developing to the next larval stage (Penn and Stalker, 1979). The larval development continues through several stages: protozoea, mysis and postlarvae. This process generally takes from one to three weeks before the larvae are at the stage where they can settle onto the sea floor. During this period, predators are responsible for high mortality rates of the larvae. If by this time the larvae have drifted to a suitable nursery area (i.e. inshore structured habitats which fringe sand flats) they will settle (at around 10 mm total length) and continue to grow into juveniles. If settlement occurs in unsuitable habitats they are likely to perish (Penn and Stalker, 1979). Juvenile *P. esculentus* prefers to inhabit seagrass areas (*Posidonia* spp.) in Shark Bay. The juvenile brown tiger prawn takes on the colour of the seagrass they are living on, becoming green in colour with the normal brown bands. This colouration provides camouflage until the juveniles leave the weed beds (Penn and Stalker, 1979).

Juveniles spend around three to six months in nursery grounds, which allows them to physically mature to between 107 and 127 mm total length (Penn and Stalker, 1979). At this point they attain a size that coincides with them migrating offshore and subsequently, entering the trawl fishing grounds. This usually takes place in summer and autumn each year and is termed recruitment to the fishery.

This species feeds primarily at night and their diet includes small molluscs and polycheate worms (Wassenburg and Hill, 1987). The tiger prawn forms the prey of many species of demersal fish and invertebrates (Salini et al., 1990).

3.4 BIOLOGY OF ENDEAVOUR PRAWNS

Distribution

The endeavour prawn, *Metapenaeus endeavouri*, is a decapod crustacean of the family Penaeidae. *Metapenaeus endeavouri* is restricted to northern Australian waters between northern New South Wales and Shark Bay in Western Australia (Grey et al., 1983).

The species is generally found in coastal waters down to approximately 50m and is commonly trawled over muddy or sand/mud substrates. They are generally found inshore of the main fishing grounds of the tiger and king prawns.

Life History

Endeavour prawns spawn year round and in Queensland spawning peaks in March and September (Courtney et al., 1989). There is little information on larval development in blue endeavour prawns (Kailola et al., 1993). Juvenile blue endeavour prawns are most commonly associated with seagrass beds in shallow estuaries although they are occasionally found in other areas (Staples et al., 1985). They spend a short period of time in nursery areas and at a small size they migrate to adult habitats (Buckworth, 1992). In the Torres Strait, recruitment is mainly in the summer months (Somers et al., 1987).

3.5 BIOLOGY OF CORAL PRAWNS

Coral prawns consist of a number of smaller prawn species but in Shark Bay a large proportion of coral prawns are *Metapenaeopsis crassissima.*

Distribution

Metapenaeopsis crassissima is restricted to Australia and has been recorded from South Australia to Western Australian and north to about Darwin in the Northern Territory. It more commonly occurs down to 30m over softer muddy bottom (Grey et al., 1983).

Life History

Little is known about the life history of *M. crassissima*. In Shark Bay, it appears that spawning may occur throughout the year and it is assumed that nursery areas are inshore sheltered habitats similar to those preferred by king and tiger prawn juveniles. Total length has been recorded at 125 mm for females and 111mm for males. *Metapenaeopsis crassissima* is considered to be one of the largest species of this genus (Racek and Dall, 1965), but it is still much smaller than both the king or tiger prawns.

3.6 MAJOR ENVIRONMENTS

3.6.1 Physical Environment

Shark Bay is in the Gascoyne region of Western Australia. The climate in this region is warm-hot and arid. The waters of Shark Bay cover an area of about 13,000 km^2. It is for the most part a shallow embayment with an average depth of 9 metres and a maximum depth of 29 m. Water depths increase to the north and west where the bay opens into the Indian Ocean reaching a maximum of around 40 metres in the Naturaliste and Geographe Channels.

The rainfall in this region is low; approximately 20 cm per year while the evaporation rate under the influence of the summer trade winds reaches approximately 220 cm per year. The combination of high evaporation rate with the extensive sand banks that slow water movements into the southern bays results in high salinities of up to 60-70 ppt (twice seawater) in areas such as Hamelin Pool. The temperature range in shallow waters can be between 15 (June/July) and 35°C (Feb/Mar) (Penn and Stalker, 1979).

The islands bordering the bay and the seafloor itself are of sedimentary origin, predominantly limestone and sandstones (Logan and Cebulski, 1970). In Shark Bay, water movement is largely influenced by the wind and tide. The waters of the Bay are influenced by semi-diurnal tides (two high water per day), which have a maximum range of about 1.5 metres. Stratification of water due to the different and elevated salinities has resulted from these influences in Shark Bay. The occasional influences from cyclones can cause winds in excess of 50 kts with resultant wave action that can seriously impact on the benthic communities.

The Shark Bay region has a multitude of different habitat types including hard corals, soft corals, seagrass and a variety of soft bottom communities. The prawn fishery operates within the trawlable areas of soft bottom from Cape Peron in the south to the Quobba Point and Koks Island area in the north. In addition, a small separate stock occurs in the northern areas of Denham Sound. These are associated with the deeper parts of the bay most of which were always sandy, even before trawling began.

3.6.2 Economic Environment

Most large king and tiger prawns are exported whole or headless in frozen form to Asia (Japan) and Europe, while the Australian markets take most of the smaller king and coral prawns, cooked or fresh. The fishery has an annual value of around $30-40 million (based on approximately 2,000 tonnes), however the value of the catch fluctuates according to catch levels, the prices of prawns on the world markets and exchange rates.

3.6.3 Social Environment

The fishery has had considerable impact on regional WA. The 27 licensed vessels operate with a maximum of 6 crew members, resulting in a total of 135 skippers and crew employed. In addition, there is also prawn processing and support staff employed at Carnarvon and Fremantle. As a result, the SBP fishery is the major employer in the Gascoyne region providing in excess of 300 direct jobs, including the fishing fleet, processing and fleet maintenance, plus indirect employment for service providers during the season from March-November.

4.0 Outline of Reporting Process

4.1 SCOPE

This ESD report was generated by assessing "***the contribution of the Shark Bay Prawn fishery to ESD".*** This assessment examined the benefits and the costs of the SBP fishery across the major components of ESD (see Table 1). In doing so, it will provide a report on the performance of the fishery for each of the relevant ecological, economic, social and governance issues associated with this fishery. Given the timeframes involved, only the criteria required for the "*Guidelines for the Ecologically Sustainable Management of Fisheries"*, which cover mainly the environmental elements of ESD (outlined below in Table 1) were generated for this report.

Table 1. Main National ESD Reporting Components.

NATIONAL ESD COMPONENTS
Contribution to Ecological Wellbeing
Retained Species*
Non-Retained Species*
Other Environmental Issues*
Contribution to Human Wellbeing
Indigenous Community Issues
Community Issues
National Social and economic Issues
Ability to Achieve
Governance*
Impact of the environment on the fishery

Nb: Only those ESD components in bold* are reported in this report.

4.2 OVERVIEW

There were four steps involved in completing the ESD report for the SBP fishery. It was based upon using the National ESD process, which is outlined in detail in the WA ESD policy paper (Fletcher, 2002) and in the "How to Guide" (Fletcher et al., 2002) located on the fisheries-esd.com website:

1. The issues that needed to be addressed for this fishery were determined at a stakeholder workshop. This process was facilitated by adapting the set of "Generic ESD Component Trees" into a set of trees specific to the SBP fishery.
2. A risk assessment/prioritisation process was completed that objectively determined which of these identified issues was of sufficient significance to warrant specific management actions and hence a report on performance. The justifications for assigning low priority or low risk were, however, also recorded.
3. An assessment of performance for each of the issues with sufficient risk to require specific management actions was completed using a standard set of report headings where operational objectives, indicators and performance measures, management responses etc. were specified.

4. An overview assessment of the fishery was completed including an action plan for activities that will need to be undertaken to enable acceptable levels of performance to continue or, where necessary, improve the performance of the fishery.

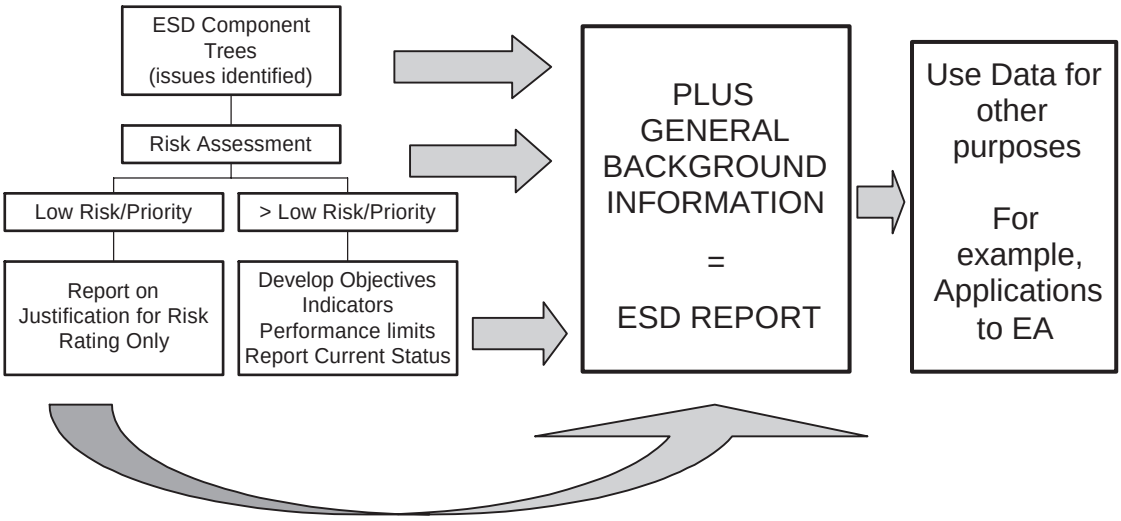

Figure 9. Summary of the ESD reporting framework processes.

4.3 **ISSUE IDENTIFICATION** (COMPONENT TREES)

The National ESD reporting framework has eight major components, which fall into three categories of the "contributions to ecological wellbeing", "contributions to human wellbeing" and "ability to achieve the objectives" (Table 1). Each of the major components is broken down into more specific sub-components for which ultimately operational objectives can be developed.

To maximize the consistency of approach amongst different fisheries, common issues within each of the components were identified by the then SCFA and ESD Reference Groups within each of the major component areas and arranged into a series of "generic" component trees (See Fletcher (2002) (and the www.fisheries-esd.com web site for a full description). These generic trees were used as the starting point for identifying the issues. These trees were subsequently adapted into trees specific to the SBP fishery during an open consultative process involving all stakeholder groups. This was achieved by expanding (splitting) or contracting (removing/lumping) the number of sub-components, as required (see Fig. 10).

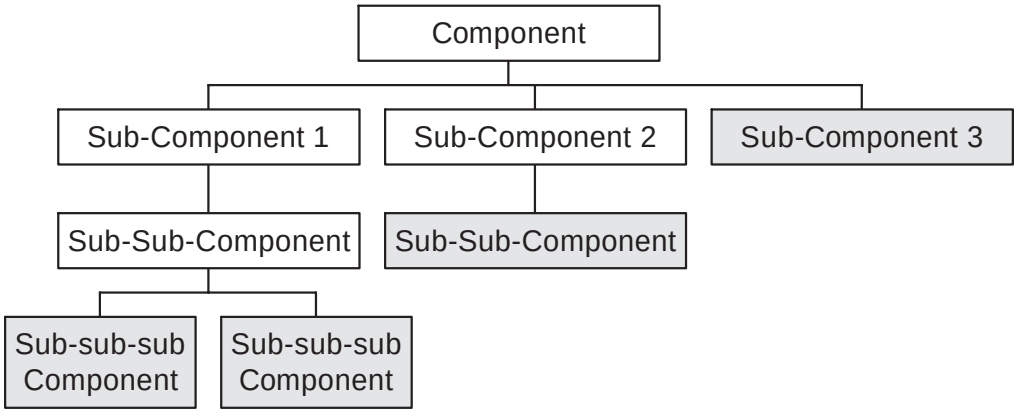

Figure 10. Example of a component tree structure.

The trees for the SBP fishery were developed at a workshop held on June 15, 2001. The stakeholders present during this meeting covered the commercial industry, recreational fishers, environmental groups, local government, Environment Australia, Department of Environmental Protection, Department of Fisheries staff and an independent facilitator (full attendance list in Appendix 2.1)

4.4 RISK ASSESSMENT/PRIORITISATION PROCESS

After the components/issues were identified, a process to prioritise each of these needs was completed using a formal risk assessment process. The risk assessment framework that was applied at the workshop was consistent with the Australian Standard AS/NZS 4360:1999 Risk Management, concentrating on the risk assessment components. The general Risk Assessment process is well documented but in summary, it considers the range of potential consequences of an issue/activity and how likely those consequences are to occur. The combination of the level of consequence and the likelihood is used to produce an estimated level of risk associated with the particular hazardous event/issue in question.

The group collectively made a realistic estimate of the consequence level for each issue. This level was from 0-5, with 0 being negligible and 5 being catastrophic/irreversible (see Appendix 3 for details of consequence tables). This assessment was based upon the combined judgement of the participants at the workshop, who collectively had considerable expertise in the areas examined.

The level of consequence was determined at the appropriate scale for the issue. Thus for target species the consequence of the SBP fishery was based at the population level not at the individual level. Obviously catching one fish is always catastrophic for the individual but not always 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.

The likelihood of a consequence occurring was assigned to one of six levels from remote to likely. In doing so, the workshop group again considered the likelihood of the "hazardous" event (consequence) actually occurring based upon their collective wisdom, which included an understanding of the scale of impact required.

From these two figures (consequence and likelihood), the overall risk value, which is the mathematical product of the consequence and likelihood levels (Risk = Consequence x Likelihood), was calculated. Finally each issue was assigned a *Risk Ranking* within one of five categories: Extreme, High, Moderate, Low and Negligible based on the risk value (see Table 2).

Only the issues of sufficient risk (Moderate, High & Extreme), that require specific management actions need to have a full performance reports completed. Nonetheless, the rationale for classifying issues as low or even negligible risk was also documented and form part of the ESD report. This allows all stakeholders and interested parties to see why issues were given these ratings. This process is summarized in Figure 9 (over).

Table 2. 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

4.5 COMPONENT REPORTS

Only the issues of sufficient risk or priority that require specific management actions have a full performance report completed (this forms sections 5 of this report). Nonetheless, the rationale for classifying issues as low risk/priority was also documented and forms part of the report so that stakeholders can see where all the identified issues have finished.

For each of the lowest level sub-components (assessed as being of sufficient risk/priority to address), a detailed assessment of performance is generated. The then SCFA Working Group in conjunction with the ESD Reference Group has agreed upon a set of 10 standard headings each of which need to be addressed (Table 3). Added to this list is a further heading, "**Rationale for Inclusion**". This specific heading allows for the issues raised within the risk assessment process to be explicitly recorded. A full description of each of these headings is located in the ESD policy (Fletcher, 2002), which is available on the WA Fisheries website.

The completion of these component reports was begun at the initial stakeholder workshop back in June 2001. Progress towards completing these reports was subsequently made by a variety of Departmental staff. When the complete set of draft component reports was completed, a second stakeholder workshop was held in October 2001 where these drafts were discussed with all comments, concerns and suggestions from stakeholders subsequently incorporated within the current document.

Table 3. The National ESD Report headings used in this report.

1. Rationale for Inclusion
2. Operational Objective (+ justification)
3. Indicator
4. Performance Measure (+ justification)
5. Data Requirements
6. Data Availability
7. Evaluation
8. Robustness
9. Fisheries Management Response
   - Current
   - Future
   - **Actions if Performance Limit exceeded**
10. Comments and Action
11. External Drivers

4.6 APPLICATION TO MEET EPBCA REQUIREMENT

The material generated by the ESD reporting process, which is contained with the risk assessment and performance reports was used to meet the requirements of the Commonwealth Environment Protection and Biodiversity Conservation Act (1999). This involved submitting an application that addressed each of the criteria of the Commonwealth guidelines for the assessment of sustainable fisheries. This information is provided in Appendix 6.

4.7 OVERVIEW TABLE

The following table provides a summary of the material presented in the report.

Issue	Objective Developed	Indicator Measured	Performance Measure	Current Performance	Robustness	EA Guidelines Covered	Actions
RETAINED SPECIES (Component Tree)						1.1	
5.1.1.1 Tiger Prawn	Yes	Level of spawning stock present during the spawning season	Above 2 kg/hr, preferred level between 3-4 kg/hr	Acceptable	High	1.1.1 – 1.1.7	Continue and improve current monitoring, management and assessment arrangements
5.1.1.2 King Prawn	Yes	Total catch	Within historical acceptable range of 1,100-1,600 tonnes, given no change in effort	Acceptable	High	1.1.1 – 1.1.7	Continue and improve current monitoring, management and assessment arrangements
5.1.2.1 Coral and Endeavour Prawns	Yes	Total catch	Within historical acceptable range, given no change of effort: Coral – 80-280 tonnes; Endeavour – 1-30 tonnes	Acceptable for both	Medium	1.1.8	Continue current monitoring, management and assessment arrangements
5.1.2.2 Scallops	No	N/A	N/A	N/A	N/A	1.1.8	Addressed under the Shark Bay Scallop Fishery
5.1.2.3 Squid and Cuttlefish	No – Negligible Risk	N/A	N/A	N/A	N/A	1.1.8	Review Risk at Next Major Assessment
5.1.2.4 Crabs	No – Negligible Risk	N/A	N/A	N/A	N/A	1.1.8	Review Risk at Next Major Assessment
5.1.2.5 Sharks	No – Negligible Risk	N/A	N/A	N/A	N/A	1.1.8	Review Risk at Next Major Assessment
5.1.2.6 Mulloway	No – Negligible Risk	N/A	N/A	N/A	N/A	1.1.8	Review Risk at Next Major Assessment
5.1.2.7 Tuna	No	N/A	N/A	N/A	N/A	1.1.8	Addressed under the West Coast Tuna and Billfish Fishery

Issue	Objective Developed	Indicator Measured	Performance Measure	Current Performance	Robustness	EA Guidelines Covered	Actions
RETAINED SPECIES (cont.)						1.1 – 1.8	
5.1.2.8 Other Species	No – Negligible Risk	N/A	N/A	N/A	N/A	1.1.8	To be assessed under the Specimen Shell Fishery
5.1.2.9 Snapper	No – Negligible Risk	N/A	N/A	N/A	N/A	1.1.8	To be assessed under the Shark Bay Snapper Fishery
NON-RETAINED SPECIES (Component Tree)						2.1,2.2	
5.2.1.1 Loggerhead Turtles	Yes – but Minor Risk	Until BRDs fully implemented, survival of turtles should be monitored	90% of turtles captured from non-BRD nets returned alive	Acceptable	High – with Observer Program Low – with fishery dependent means	2.2.2, 2.2.4, 2.2.6	Initiate monitoring of captures
5.2.1.2 Green Turtles	No – Negligible Risk	N/A	N/A	N/A	N/A	2.2.2, 2.2.4, 2.2.6	Review Risk at Next Major Assessment
5.2.1.3 Seasnakes	No – Minor Risk	N/A	N/A	N/A	N/A	2.2.2, 2.2.4, 2.2.6	Review Risk at Next Major Assessment
5.2.1.4 Syngnathids	No – Minor Risk	N/A	N/A	N/A	N/A	2.2.2, 2.2.4, 2.2.6	Review Risk at Next Major Assessment
5.2.1.5 Discarded Fish	Yes	Information on distribution of bycatch species both within and outside the area of trawling	Majority of bycatch species are found in relatively significant numbers outside of trawled areas	Evaluation of issue provided following completion of survey	High	2.2.2, 2.2.4, 2.2.6	Initiate a survey of species within and outside trawl grounds to be conducted
5.2.1.6 Invertebrates	No – Negligible Risk	N/A	N/A	N/A	N/A	2.2.2, 2.2.4, 2.2.6	Review Risk at Next Major Assessment
5.2.2.1 Interaction with Green Turtles	No – Negligible Risk	N/A	N/A	N/A	N/A	2.2.2, 2.2.4, 2.2.6	Review Risk at Next Major Assessment

Issue	Objective Developed	Indicator Measured	Performance Measure	Current Performance	Robustness	EA Guidelines Covered	Actions
5.2.2.2 Interaction with Loggerhead Turtles	No – Minor Risk	N/A	N/A	N/A	N/A	2.2.2, 2.2.4, 2.2.6	Review Risk at Next Major Assessment
5.2.2.3 Interaction with Dugongs and Cetaceans	No – Minor Risk	N/A	N/A	N/A	N/A	2.2.2, 2.2.4, 2.2.6	Review Risk at Next Major Assessment
GENERAL ENVIRONMENT (Component Tree)						2.3	
5.3.1.1 Removal of Prawns and By-products	No – Minor Risk	N/A	N/A	N/A	N/A	2.3.1 – 2.3.5	Review Risk at Next Major Assessment
5.3.1.2 Impact to Sand/Shell	Yes	The % of sand/ shell habitat of the Shark Bay region that is trawled	< 40% of sand/shell habitat in Shark Bay trawled	Acceptable	High	2.3.1 – 2.3.5	Continue management through assurance and compliance with VMS
5.3.1.3 Impact to Coral/Sponge	Yes – But Minor Risk	Amount of coral/sponge habitat within permitted trawl area as a % of total coral/ sponge habitat in Shark Bay	< 20% of the remaining coral/sponge habitat in Shark Bay to be contained within the legally trawled area	Acceptable	Low	2.3.1 – 2.3.5	Development of more detailed and extensive surveys on the spatial distribution of coral and other habitats in Shark Bay
5.3.1.4 Impact to Seagrass	No- Negligible Risk	N/A	N/A	N/A	N/A	2.3.1 – 2.3.5	Review Risk at Next Major Assessment
5.3.2.1 Discarding Fish	Yes	Amount of discards pre-season and ratio of discards to target catch	Reduction in amount of discards and ratio of discards to target catch from pre-catch reduction device levels	Acceptable	Low	2.3.1 – 2.3.5	Introduction of 100% Bycatch reduction devices and initiate research to monitor amount of discards on a five-year basis
5.3.3.1 Turbidity	No – Negligible Risk	N/A	N/A	N/A	N/A	2.3.1 – 2.3.5	Review Risk at Next Major Assessment
5.3.3.2 Translocation	No – Negligible Risk	N/A	N/A	N/A	N/A	2.3.1 – 2.3.5	Review Risk at Next Major Assessment

5.0 Performance Reports

5.1 RETAINED SPECIES

COMPONENT TREE FOR RETAINED SPECIES

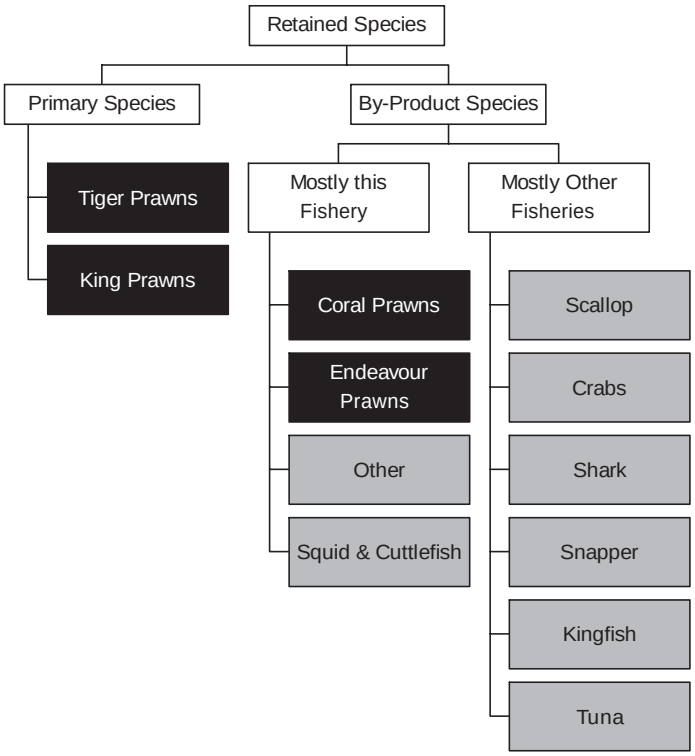

Figure 11. Component Tree for the Retained Species of the SBP fishery.

Black boxes indicate that the issue was considered high enough risk at the June 2001 Risk Assessment workshop to warrant having a full report on performance. Grey boxes indicate the issue was rated as a low or negligible risk and no specific management is required – only the justification for this decision is presented.

5.1.1 Primary species

5.1.1.1 Tiger prawns

Rationale for Inclusion

Tiger prawns are one of the main target species of the fishery. This fishery is capable of taking a relatively large proportion of the stock and therefore it needs to be assessed.

ERA Risk Rating: Impact on breeding population (C3 L5 HIGH)

The potential consequence of fishing on tiger prawns was ranked as '**severe**' with an '**occasional'** likelihood.

Compared to the exploitation of other prawn species in this fishery, this is a relatively high consequence rating. This rating was applied because the recruitment of juvenile tiger prawns is much more climate dependent than other prawn species and there is some ability to overfish them as seen in the early 1980s when the tiger prawn stock in Shark Bay was depleted. Rigorous management controls are now in place to minimise the risk of overfishing (area and seasonal closures etc.). However, due to the higher risk associated with this species a precautionary approach is taken in assigning a **'severe'** level of potential consequence. It was considered that '**occasionally**' that this '**severe**' consequence could occur, given that a stock depletion event has occurred for this species, in this fishery, in the past. This resulted in an overall risk ranking of **'high**'.

Operational Objective

To maintain the spawning stock of tiger prawns at or above a level that minimises the risk of recruitment overfishing.

Justification

Meeting this objective should ensure sufficient spawning stock to continue recruitment at levels that will replenish what is taken by fishing, predation and other environmental factors. This is necessary since there is a relationship between the size of the tiger prawn breeding stock and subsequent levels of recruitment (Caputi, 1993; Penn et al., 1995; Caputi et al., 1998). At high levels of reduction in the breeding stock abundance, and therefore greatly reduced levels of egg production, recruitment levels for the following year are adversely impacted. This phenomenon is defined as recruitment overfishing. Therefore, as a minimum, the breeding stock (or level of egg production) should be maintained at a level above where these adverse impacts are likely to occur.

Indicator

The level of the tiger prawn spawning stock present during the main spawning season (measured as a standardised catch per unit effort index).

Two separate monitoring programs conducted by the Department currently measure estimates of the level of tiger prawn spawning stock:

1. Fishery-dependent Catch Per Unit Effort (CPUE) – Material from voluntary log books provides information on the daily catch (kg) and amount of effort (hours trawled) expended in each fishing area by each boat based on the trawl duration and catch of every shot. From these data the CPUE (kg/hr) is determined for each fishing area (Figure 12). The main spawning period for tiger prawns is in spring with mature female tiger prawns mainly caught in the deep water north east of Bernier Island (ground B) and on the trawl grounds to the west of Carnarvon (ground D) (Penn, 1988). Thus, commercial catch rate information in Area D in July and in Area B in August has provided a good estimate of the abundance of the tiger prawn spawning stock. This method of estimating spawning stock abundance has been in place for many years. In recent years, new trawl closures introduced during the spawning season (July and August) has resulted in the fleet not fishing areas B and D at these times. In the last two years, and until the fishery independent limits are developed, this indicator has been estimated by using the relationships of catch rates in adjacent months and areas to the traditional spawning area catch rates.

2. Fishery Independent Index of Spawning Abundance: As a result of the lack of information available from the commercial fleet (see above), in order to calculate spawning stock abundance, fisheries-independent data are now required. Fisheries independent systematic trawl surveys of the main breeding

grounds commenced in 2001. These fishery independent surveys are carried out using commercial vessels that fish to research specifications. The catch rates (kg/hr) for specific areas are determined and used as an index of spawning stock abundance. As a result of the tiger spawning closure area that was put into effect in 1998, log book data is only available up until 1998. Although a comparison of log book data and surveys can not be completed, the catch rates derived from these surveys are considered to be a good representation of catch rates that would be derived from log books if vessels fished in this area.

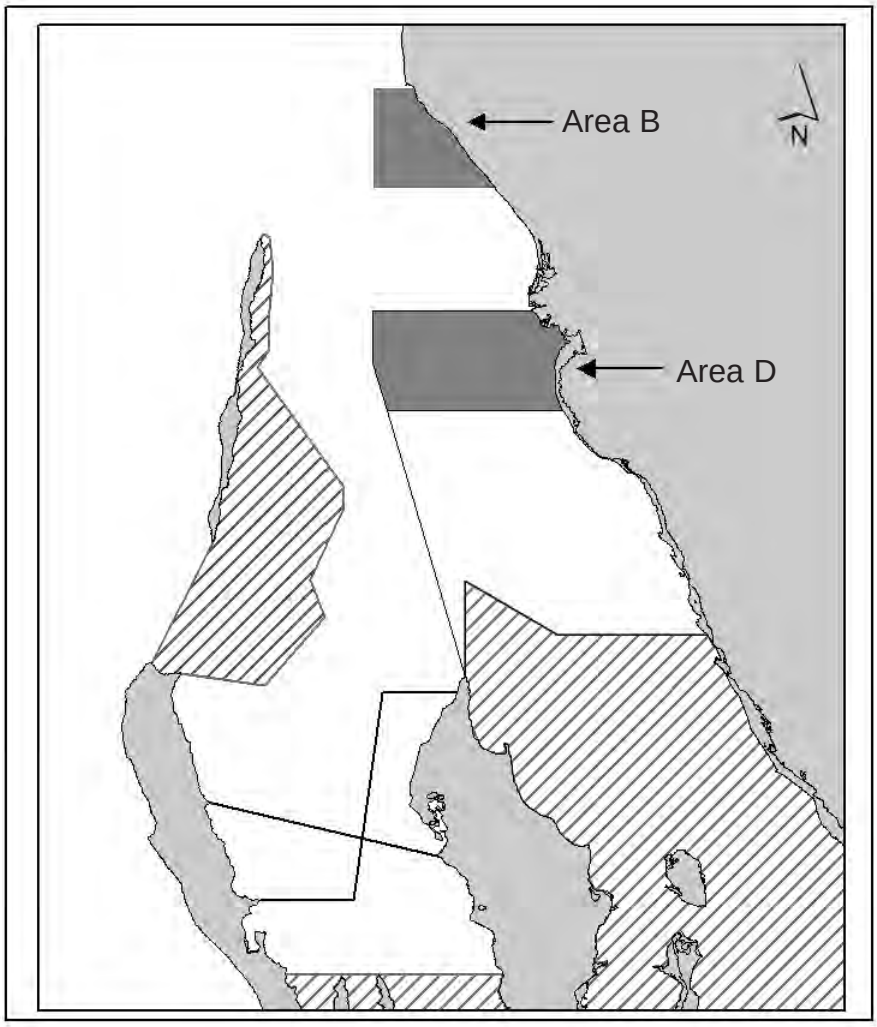

Figure 12. SBP fishery, areas B & D, that are tiger prawn spawning closures and are used in the determination of spawning indices.

Performance Measure

A constant escapement policy is used to manage the fishery for this species. The standardized spawning index, Area B in August and Area D in July, should be above 2 kg/hr (based on the catch and effort rate of the fleet in the 1970s). The preferred level is between 3 – 4 kg/hr.

This performance measure applies only to the fishery-dependent indicator as described above. The performance limit for the fisheries-independent survey index will be developed within the next three years once sufficient data are available.

Justification

Analysis of catch and effort data in the 1970s and 80s (a period when recruitment was found to have been affected by the low spawning stock that were present) provided evidence to develop a stock-recruitment relationship for tiger prawns in Shark Bay (Penn et al., 1995; Caputi et al., 1998). From this the appropriate catch rate, which would equate to leaving sufficient spawning stock to allow for full recruitment potential, has been developed.

The catch rate associated with this performance limit is relatively low, which is appropriate as prawns can be fished to reasonably low abundance levels due to their life history strategies of short life span, high fecundity and high natural mortality (Penn and Stalker, 1979; Dall et al., 1990).

A precautionary approach is now taken with main spawning grounds being closed to fishing once a catch rate threshold of 10kg/hr by the fleet is reached, which is determined to result in their being a 2-4 kg/hr level of tiger prawns left in these areas during the spawning period. This is a constant escapement policy and provides additional protection for the stock and the 10 kg/hr threshold incorporates the increases in fishing power of the fleet since the 1970s.

Data Requirements for Indicator

Data Required	Availability
Catch rate utilising commercial catch and effort information provided through voluntary daily log books completed by 100% of the boats	Yes; available on an annual basis since the 1970s until 1996 when tiger prawn closures came into effect.
Stock Recruitment Relationship	Yes; available on an annual basis since the 1980s
Fishery independent catch rates and spawning status	Yes; available on an annual basis - since 2001

Evaluation

Summary: The current analyses indicate that the tiger prawn fishery breeding stock is above the agreed reference point. Additional protection is now given through complete closure of the main spawning grounds once the threshold catch rate is reached. Consequently, the current performance of the fishery for maintaining a sufficient level of spawning biomass of tiger prawns is meeting the agreed objective. Current management strategies aim to increase the tiger prawn stock levels above the agreed reference point.

Management measures that were put into place in the early 1990s have contributed to relatively high and stable catches of tiger prawns (Figure 13) indicating a relatively stable spawning stock. However, an increasing trend in tiger prawn catches over the last three years has prompted a more precautionary approach for this and future seasons. Closure of key spawning areas has been implemented via a threshold catch rate for tiger prawns, which utilises real-time monitoring. The extent of the closure area was determined from research sampling in June 2001 (and will continue annually). This area will be surveyed in July and August to monitor changes in distribution, abundance and spawning condition of remaining tiger prawns.

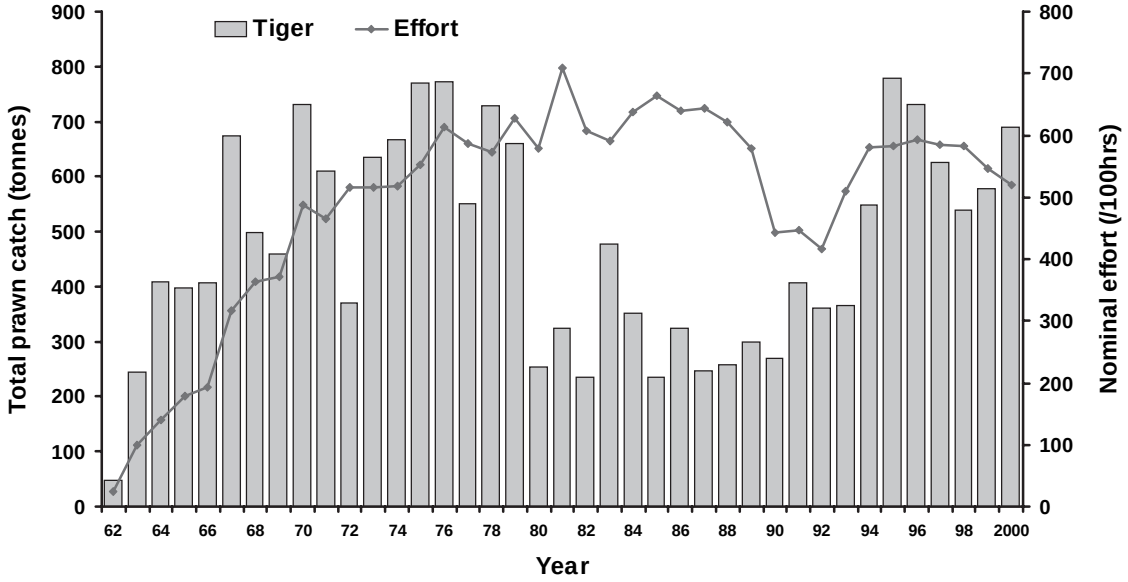

Figure 13. Historical catch (tonne) of tiger prawns and nominal total effort in the SBP fishery.

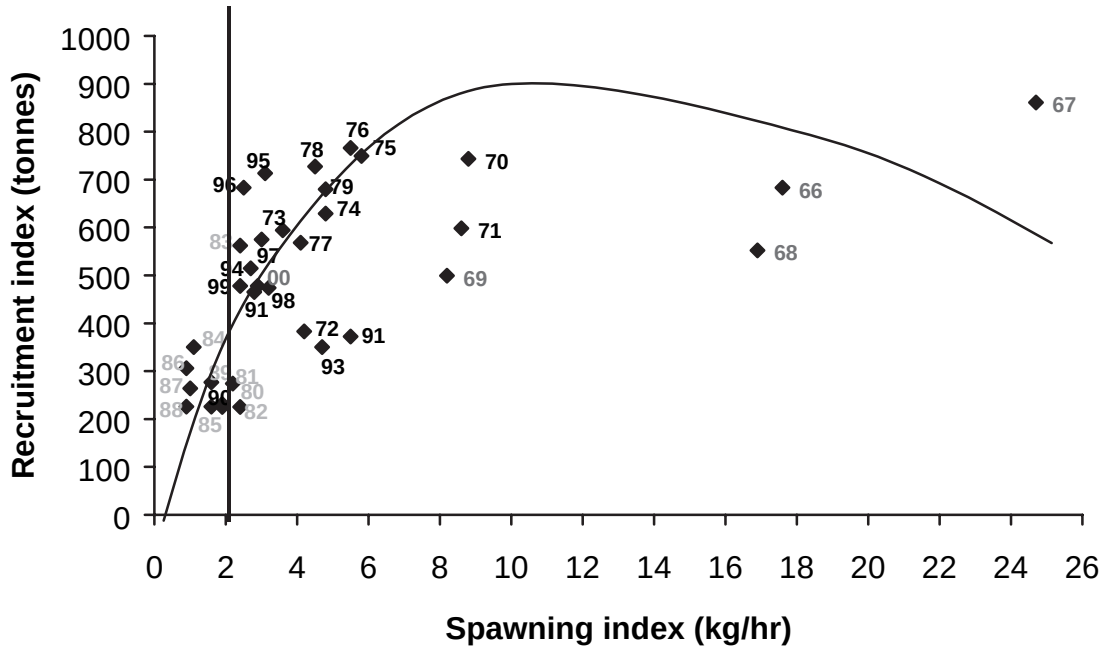

Figure 14. The SRR for the Shark Bay tiger prawn with the years of spawning and recruitment the following year indicated. The reference point of 2 kg/hr is indicated with a vertical line.

The level of the stock in relation to the accepted spawning SRR (Figure 14) indicates that the current spawning stock levels are appropriate to maintain recruitment levels. Continuation of fishery-independent surveys will allow derivation of spawning stock indices in the future and will act as a calibration for indices derived from the fishery-dependent catch rate data. During this 'interim' period, catch rates in adjacent months and areas are used to compare with the traditional spawning area catch rates. This is assumed to be the best available information in the absence of fishing in the spawning areas.

Robustness

High

The estimates are considered robust as they:

a) Provide a statistically demonstrated high degree of confidence.

b) Use multiple methods to verify estimates.

c) They are direct estimates of egg production.

d) Some estimates are calculated by a source independent of the fishers.

e) Research has been reviewed in scientific journals.

Since fishery-independent surveys only commenced in 2001, no detailed evaluation has been made. The intentions behind conducting these surveys were to develop a robust measure of spawning stock and avoid the impact of changes in the area closures. After log book data is entered and validated, new indices will be compared with log book catch rates to standardise the new indices with previous spawning stock indices.

Fisheries Management Response

Current: To ensure maintenance of the required level of breeding stock (see also background material for full descriptions):

a) The fishery is managed through input controls (including number of boats, power and size of vessels, controls on net design and materials plus other gear restrictions).

b) Key nursery areas are permanently closed to trawling.

c) Real time monitoring of catch and effort completed by Department staff. The annual fishing season is for a fixed period but has real-time closures in key spawning areas and also includes seasonal, area and moon closures directly controlling the effort that can be exerted on the stock.

d) Compliance policing includes use of VMS and gear checks.

e) Monitoring of improvements in technology that may increase fishing efficiency.

f) Ensure that any significant declines in the breeding population either from environmental effects or due to fishing is observed in time to implement appropriate management interventions.

Closures of tiger prawn spawning areas at the start of the season and also during the spawning period were implemented in 1996 and provided added protection. In 2001, the tiger prawn spawning closure areas and the timing of closure were implemented on a real time basis using a more conservative catch rate threshold (10 kg/hr) allowing for increased efficiency of the fleet since the 1970s. The effectiveness of this closure will be monitored, and changes implemented if required during the next three years using fishery-independent surveys.

Future: The success of the management arrangements over the past six years have seen the amount of catch taken from the fishery increase.

Some of the input controls currently in place will be reviewed such as the “375 boat unit formulation”. This rule notionally sets limits to the size and engine power of a vessel and has been an integral part of the input controls in this fishery. In simple terms the rule (which is a provision of the management plan) requires that the vessel does not exceed 375 boat units, calculated by the formula:

Boat units = Hull units + engine units where;

$$\text{Hull units} = \frac{\text{Measure Length x Breadth x Depth x 0.6 (dimensions in metres)}}{2.83}$$

Engine units = Installed engine power measure in kilowatts.

In recent years engine technology improvements have reduced the ability of the Department of Fisheries to measure and enforce the 375 boat unit formulation. Use of other methods for limiting overall vessel capacity and capitalisation will be evaluated during the review.

Fishery-independent recruitment trawl surveys have been conducted since 1993. Over the last three years, a systematic approach has been developed and two surveys (in March and April) are now conducted on an annual basis to determine recruitment strength in key areas. These indices will provide complementary information in the assessment of SRR in the future leading to fishery-independent measures of both spawning stock and recruitment levels.

Actions if Performance Limit Exceeded: Annually the fishery is closed in key areas once the catch rate declines to the lower limit, which provides protection to the breeding stock. Strategies available to offer further protection to the breeding stock if required include:

a) Further reductions in the total effort expended in the fishery through a reduction in the length of the fishing season or within season closures and/or extension of moon closures.

b) Additional area closures, particularly within spawning area.

These actions can be initiated within a season or prior to the beginning of the next season. The ability to implement these strategies is provided for within the FRMA.

With fishers continually improving their fishing efficiency it is likely there will be a need to periodically reduce effective fishing effort through reductions in the total number of nights fished on the tiger prawn stock.

Comments and Action

The key management strategy is a constant escapement policy designed to leave a minimum amount of spawning biomass irrespective of the initial recruitment levels. There is a process of continual improvement in the on-going development and refinement of the methods used to determine breeding stock estimates and manage the fisheries to ensure that it meets the objective of sustainability. This relates to both the collection of information and method of analysis. The use of Geographic Information System (GIS) for analysing data has commenced.

External Driver Check List

Environmental factors such as: climatic changes, cyclonic activity, ocean currents and sea-surface temperatures are known to affect the levels of recruitment of prawns and are therefore likely to impact on the level and productivity of breeding stock. In Shark Bay, the Leeuwin Current can have a major impact on larval settlement, survival and subsequent recruitment strength. Similarly, the level of predators and competing scavengers within the ecosystem may also impact the breeding stock levels. The most significant risk factors in the context of external drivers are probably cyclonic activity and significant habitat degradation. Loss of seagrass habitats would be likely to have a negative impact on tiger prawn stocks. The saltworks and dredging of ship access routes may impact on water movement

patterns and salinity regimes, which may affect nursery habitats. Any management change in these functions would require assessment of the possible impact on this fishery.

5.1.1.2 King prawns

Rationale for Inclusion

This is the primary target species of the SBP fishery.

ERA Risk Rating: Impact on breeding population (C2 L5 MODERATE)

In terms of consequence, the fishery was determined to be currently having only a 'moderate' impact on the breeding population level of king prawns. Whilst the fishery catches significant quantities of this species, their biology and dynamics make them more robust to harvesting than tiger prawns – they mature at smaller sizes and are more widespread. Therefore, the king prawns are at lower risk of recruitment overfishing than tiger prawns. However, with current management designed to harvest relatively large amounts of king prawns it was determined that it was "likely" that the fishery would be having a 'moderate' impact.

The impact of taking king prawns on the breeding population is therefore considered 'moderate' because this species is explicitly managed to catch high numbers whilst not impacting on subsequent recruitment levels.

Operational Objective

To maintain the spawning stock of western king prawns at or above a level that minimises the risk of recruitment overfishing.

Justification

Meeting this objective will ensure that there is sufficient breeding stock to continue recruitment at levels that will replenish what is taken by fishing, predation and other environmental factors.

Although a relationship has not been shown to exist between the extent of the western king prawn breeding stock and subsequent levels of recruitment (Penn, 1988; Caputi, 1993; Penn et al., 1995; Caputi et al., 1998) there will be a reduction in stock (and therefore the level of egg production) when recruitment levels are adversely impacted. This phenomenon is defined as recruitment over-fishing. Therefore, as a minimum, the breeding stock (or levels of egg production) should be maintained at levels above where these adverse impacts are likely to occur.

Indicator

The total catch, taking into consideration the effective effort of vessels operating, is used to assess the level of exploitation of king prawn stocks.

Performance Measure

Given no change in effort, total catch should be within the historical acceptable range of 1100-1600 tonnes.

Justification

King prawns are the most robust of the prawn species taken in Western Australia and within this fishery. Hence, the rates of fishing that maintain the spawning biomass of the other species (i.e. tiger prawns

– see above) are well below the levels at which there would be any chance of recruitment overfishing affecting this species. The overall management needs to ensure that the level and distribution of effort both temporally and spatially, optimises the catch of the more abundant king prawns whilst not over harvesting the other species (i.e. through the spatial and seasonal closures imposed).

Prawns can generally be fished to reasonably low abundance levels due to their life history strategies of short life span, high fecundity and high natural mortality. For king prawns, their low catchability provides added protection (Penn, 1984).

There is a long time-series of catch and effort information for this fishery and current effort levels are below the level of effort previously applied to the stock. Analysis of catch and effort data in the 1970s to the 1990s provided no evidence of a stock-recruitment relationship for king prawns, suggesting that the stock was never reduced to levels where this would become evident.

Consequently, at the levels of effort exerted during that period (which covered most environmental variations -i.e. Leeuwin Current, La Niña, and El Niño - likely to be encountered) sufficient breeding stock will be available to ensure ongoing recruitment levels. Furthermore, the introduction of seasonal, moon- and area-closures since this period provide even more restrictions on the overall fishing effort, which increases protection for the breeding stocks of king prawns.

Data Requirements for Indicator

Data Requirement	Availability
Commercial catch and effort data	Yes; since the 1960s, commercial catch and effort information is provided through voluntary daily log books completed by 100% of the boats

Evaluation

Summary: Historical catch and effort trends over the past 40 years indicate that there has been no decline in the production levels for king prawn. Consequently, the current performance of the fishery for maintaining a sufficient level of spawning biomass is meeting the agreed objective.

For this species, catches are largely related to the level of effort exerted by the fishery. For the last several years, the catch of king prawns has been within the acceptable range for this fishery (Figure 15). The lower catches seen in the early 1990s were a result of a shift of effort from king prawn stocks to the scallop fishery due to a very high scallop abundance on the scallop grounds.

Stock and recruitment studies indicate that the king prawn stock remain at a point which recruitment is not affected by spawning stock levels. Additionally, at the current level of exploitation, fluctuations in the current king prawn harvest are likely to result from effort level and environmental variations, not from the abundance of the spawning stock. As such, environmental factors are being incorporated into the Stock recruitment model in an attempt to improve the SRR for this stock.

King prawn landings for 1999 were considered exceptional considering the level of fishing effort, exceeding the five year average by 30%. This may be due to the strength of the Leeuwin current, which was well above average resulting in warmer water temperatures, and/or continued high levels of effective fishing effort. The relationship between the strength of the Leeuwin Current and the recruitment levels of king prawns is currently under investigation with the hope that a more predictive relationship can be developed.

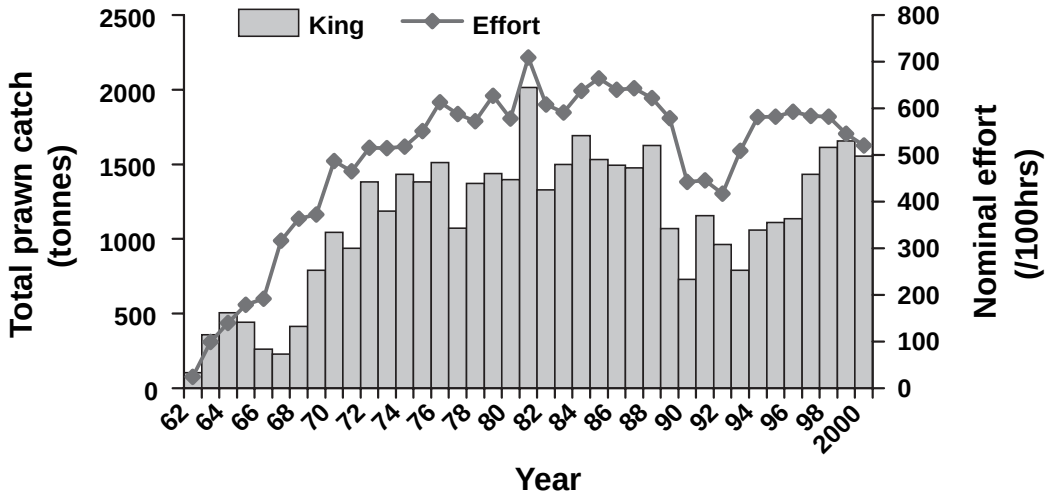

Figure 15. Historical catch (tonnes) of king prawns and nominal effort in the SBP fishery.

Robustness

High

The indicator is considered robust as:

- The Department of Fisheries has a long time-series of catch and effort information provided accurately by 100% of commercial fishers via daily voluntary log books. The log books are filled in on a shot by shot basis with estimated catch values. These estimates are then validated using processor unload records (actual quantity unloaded). Regular feedback and consultation with industry occurs to ensure they have an understanding of the need and value of accurate catch and effort information.
- Catch is considered to be a good indicator of relative abundance of king prawns in this fishery.
- Research upon which these assumptions are based has been reviewed in scientific journals.

Fisheries Management Response

Current: To ensure maintenance of the required level of breeding stock the following measures are employed (see background section for more details):

a) The fishery is managed through input controls (including number of boats, power of vessel, controls on net design and other gear restrictions).

b) Key nursery areas are permanently closed to trawling.

c) Real time monitoring of catch rates in areas completed by Department staff.

d) The annual fishing season is for a fixed period and includes seasonal, area and moon closures, which limit the opportunity for fishers to take prawns.

e) Compliance policing includes use of VMS and gear checks.

f) Improvements in technology that may increase fishing efficiency are monitored.

g) Any significant declines in the breeding population either from environmental effects or due to fishing are observed in time to implement appropriate risk management interventions.

Future: The success of the management arrangements over the past six years has seen the amount of catch taken from the fishery increase due to some of the overall effort in the fishery shifting towards king prawns through the various seasonal and spatial closures.

Some of the input controls currently in place will be reviewed such as the 375 boat unit formulation. See tiger prawn report (Section 5.1.1.1) for details.

Recruitment surveys, in key areas for king prawn recruitment have been conducted since 1993. In the last three years, a systematic approach has been developed and two surveys (March and April) are now conducted on an annual basis to determine recruitment strength in key areas. These indices may provide some catch prediction in the future.

Actions if Performance Limit is Exceeded: The following approach is used prior to the beginning of the next season when the performance limit is exceeded:

1. Find out why the acceptable catch range has not been met. Evaluate if there has been a shift in the targeting of king prawns that can explain the variation. If the lowered catch levels are due to effort reduction then no action to be taken.
2. If there is a drop in the relative abundance of king prawns, strategies available to offer further protection to the breeding stock if required include:
   - Further reductions in the total effort expended in the fishery through a reduction in the length of the fishing season or within season closures and/or extension of moon closures.
   - Additional area closures.
   - These actions can be initiated within a season or prior to the beginning of the next season.

The ability to implement these strategies is provided for within the FRMA.

Comments and Action

There is a process of continual improvement in the on-going development and refinement of the methods used to determine breeding stock estimates. This relates to both the collection of information and method of analysis. The use of GIS systems (in conjunction with the VMS data) for analysing data has commenced.

External Driver Check List

Environmental factors such as: climatic changes, cyclonic activity impacting habitat, ocean currents and sea-surface temperatures are known to affect the levels for recruitment of prawns and are therefore likely to impact on the level and productivity of breeding stock. In Shark Bay, the Leeuwin Current can have an impact on larval settlement, survival and subsequent recruitment strength. Developing a relationship between king prawns recruitment and the Leeuwin current will be investigated over coming years to determine if a predictable relationship is possible.

While there are a number of predators and competing scavengers within the ecosystem, which impact on the breeding stock levels and lead to the high natural mortality of this species, there is little evidence of significant variations in these rates amongst years. The most significant risk factors in the context of external drivers are probably cyclonic activity (although these occur only once in 20 years) and significant habitat degradation. The saltworks (which occupy a small portion of Shark Bay) and dredging of ship access routes may impact on water movement patterns and salinity regimes, which may affect the nursery habitats of king prawns.

5.1.2 By-product species

5.1.2.1 Coral and endeavour prawns

Rationale for Inclusion

Coral and endeavour prawns are caught as by-product in the SBP fishery. These species are not targeted but are caught in reasonable numbers during some years.

ERA Risk Rating: Impact to breeding populations (C2 L5 MODERATE)

In terms of potential impact on the breeding stock of coral and endeavour prawns, the consequence of fishing on coral and endeavour prawns was considered 'moderate'. It was considered likely that this level of consequence would result since the combined catch of both species is substantial. However, coral prawns are small and therefore many fall through the codend mesh and are not retained. As for endeavour prawns, their distribution (due to their habitat preference for inshore areas) is mainly in areas that are closed to trawling because these are the nurseries for the king and tiger prawns.

Operational Objective

To maintain the spawning stock of coral and endeavour prawns at or above a level that minimises the risk of recruitment overfishing.

Justification

This objective will ensure that there is sufficient breeding stock to continue recruitment at levels, which will replenish what is taken by fishing, predation and other environmental factors. This will continually ensure that the highest possible level of recruitment is only affected by environmental fluctuations and not by the level of spawning stock. Having the maximum level of recruitment also optimises the level of catch that can be taken by the fishery.

Indicator

The total catch, taking into consideration the effective effort of vessels operating, is used to assess the level of exploitation of coral and endeavour prawn stocks.

Performance Measure

Given no change in effort, total catch should be within the historical acceptable range of 80-280 tonnes for coral prawns; and 1-30 tonnes for endeavour prawns.

Justification

The acceptable catch range of 80-280 tonnes for coral prawns and 1-30 tonnes for endeavour prawns, is taken from the 10-year range of catch for these species. This level of management is considered appropriate, as there are several factors that contribute to the protection of these species, including:

- *The fishery does not specifically target either coral or endeavour prawns.*
- *Coral prawns are a small species; consequently many pass through the codend mesh and are not retained.*
- *It is common for coral prawns to be discarded in preference to higher value prawn species.*

- *Although no specific study has been conducted on the fate of discarded prawns, it is assumed that most but not all are discarded alive.*
- *Only a small proportion of both stocks can be harvested due to the mesh size, selectivity and distribution.*
- *Generally, only low catches of endeavour prawns are made. The extension of the nursery closure system in the late 1980s has further reduced fishing access to these stocks in most years.*

Due to the protection now given to these stocks as well as the small intermittent catches of both, it is not proposed to report on these species annually.

Data Requirements for Indicator

Data Required	Availability
Commercial catch and effort data	Yes; since the 1970s, commercial catch and effort information provided through voluntary daily log books completed by 100% of the boats

Evaluation

Coral prawns

Summary: Historical catch and effort trends indicate that there has been no significant decline in the production levels of coral prawns (Figure 16). Consequently, the current performance of the fishery for maintaining a sufficient level of spawning biomass is meeting the agreed objective.

The catch of coral prawns in 2000 was 150 tonnes. This catch remains within the acceptable catch range of 80 – 280 tonnes.

Endeavour prawns

Summary: Historical catch and effort information indicate that there has been no recent declining trend in the production levels of endeavour prawns (Figure 17). Consequently, the fishery is meeting its performance target. Given the lack of availability of this species to the fishery in most years, the catch of endeavour prawns in 2000 was 5 tonnes. The catch is likely to continue to vary greatly among years.

The endeavour prawn distribution is predominantly in the southern end of the Extended Nursery Area (eastern part of fishing grounds, Figure 3). There was an observed decline in catches in the early 1990s, which was partly due to high scallop abundance (which diverted effort away from the prawn fishery), but also due to redirection of effort away from areas close to the nursery areas, where they mainly live. Consequently, the current performance of the fishery (with a catch of only 5t for 2000) is maintaining a sufficient level of spawning biomass, which meets the agreed objective.

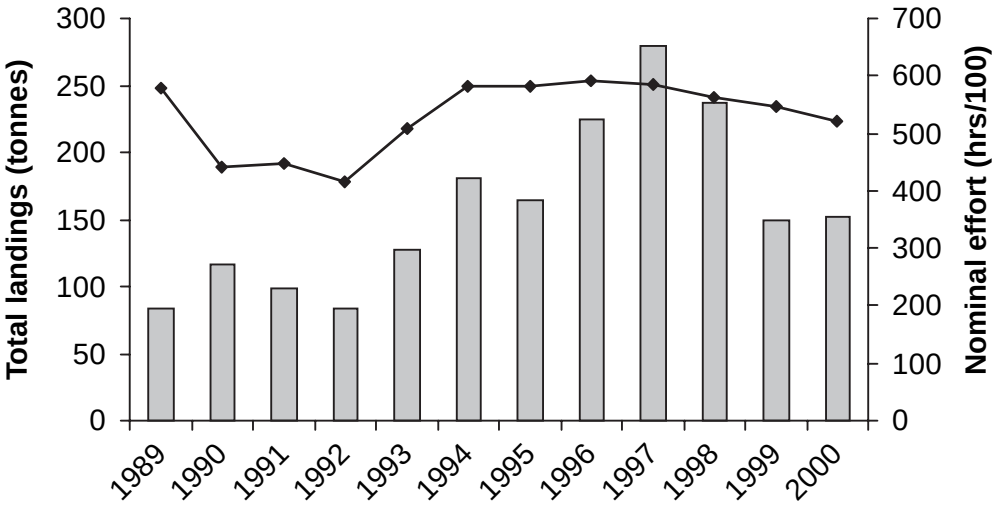

Figure 16. Historical catch (tonne) of coral prawns (bars) and overall nominal total effort (line) in the SBP fishery.

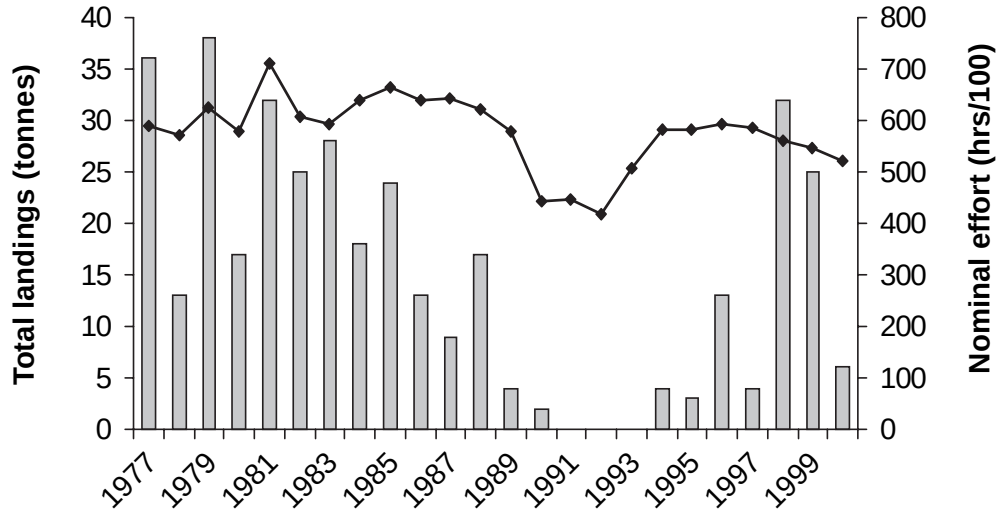

Figure 17. Historical catch (tonne) of endeavour prawns (bars) and overall nominal total effort (line) in the SBP fishery.

Robustness

Medium

This indicator has a medium robustness due to the following:

a) Long time-series of catch and effort information provided by 100% of commercial fishers via daily voluntary log books.

b) Data are aggregated for several species termed coral prawns.

c) Catch may not be an index of abundance for coral prawns due to the practice of discarding when more valuable species are caught in higher quantities and selectivity of trawl nets precludes catch of a large proportion of individuals.

d) Catch is not a good index of abundance for endeavour prawns due to non-targeting of the species and effort redistribution away from the areas where this stock occurs in recent years.

Fisheries Management Response

Current: Management strategies are in place to protect tiger prawn and king prawn breeding stocks, which also ensure the maintenance of the required level of breeding stock of coral and endeavour prawns. These strategies include:

a) The fishery is managed through input controls (see above for details).

b) The annual fishing season is for a fixed period and includes seasonal, area and moon closures limiting the opportunity for fishers to take prawns.

c) Compliance policing includes use of VMS and gear checks.

d) Monitoring of improvements in technology that may increase fishing efficiency.

Future: It is not anticipated that coral and endeavour prawns will be targeted by fishers due to the low economic value of these species compared to tiger and king prawns and the forced redirection of effort away from nursery areas where endeavour prawns mainly occur.

Actions if Performance Limit is Exceeded: The following strategy will be adopted prior to the beginning of the next season if the performance limits, for either of the species, is exceeded:

1. Find out why the acceptable catch range has not been met or is significantly over the acceptable range. Evaluate if there has been a shift in targeting of coral or endeavour prawns that can explain the variation. If lowered catch levels are due to effort reduction then no action to be taken.

2. If there is a significant drop, or a declining trend over three years in the relative abundance of coral or endeavour prawns, strategies to further protect the breeding stock by further reducing the total effort expended in the fishery (including a reduction in the length of fishing season or within season closures; or an extension of moon closures) will be investigated. These actions can be initiated within a season or prior to the beginning of the next season.

The ability to implement these strategies is provided for within the FRMA.

Comments and Action

The use of GIS systems for analysing data has commenced.

External Driver Check List

Environmental factors such as: climatic changes, cyclonic activity, ocean currents and sea-surface temperatures are known to affect the levels of recruitment of prawns and are therefore likely to impact on the level and productivity of breeding stock. In Shark Bay, the Leeuwin Current can have an impact on larval settlement, survival and subsequent recruitment strength.

5.1.2.2 Taking of scallops

The impact of taking scallops (*Amusium balloti*) on the breeding populations by this fishery is small. The Shark Bay Scallop Managed fishery takes the vast majority of scallops in Shark Bay. The full assessment of this species is located in the Environmental Assessment of the Shark Bay Scallop Managed fishery, which incorporates the catch of scallops by the SBP fishery.

5.1.2.3 Taking squid and cuttlefish

Rational for Inclusion

The SBP fishery catches and retains squid and cuttlefish as a by-product.

ERA Risk Rating: Impact on breeding population (C0 L5 NEGLIGIBLE)

Catches of squid have ranged between 3 tonnes in 1989 and 78 tonnes in 1995. The average over this period is approximately 31 tonnes. Catches of cuttlefish have ranged between 2 tonnes in 1991 and 39 tonnes in 1996. The average over this period is approximately 11 tonnes.

In terms of impact on breeding stock levels of squid and cuttlefish, the consequence of the Shark Bay Prawn Managed Fishery is considered negligible. This is due to the small and isolated catch in comparison to the extensive population size and distribution of these cephalopods along the WA coastline (*Dr. Fred Wells*[*]*, pers. comm.*).

While the species composition of cuttlefish in Shark Bay is not known, Adam (1979) reviewed the cuttlefish present in Western Australia. Four species which occur in Shark Bay have a maximum shell length of >100 mm and are thus possible fishery species. All are geographically widespread species at or near the end of their ranges in Shark Bay. Two species (*Sepia apama* and *S. novaehollandiae*) are temperate species near the northern limit of their ranges. The other two (*S. cultrata* and *S. pharonis*) are widespread tropical species near the southern limit of their ranges. Therefore the populations of the cuttlefish species in Shark Bay are only a small proportion of the total ranges of these species. Cuttlefish have short life spans, on the order of 1-2 years. For example, *Sepia apama* requires a single year to reach adult size. Mass mortalities after spawning have been reported (Lu, 1998).

In addition, cuttlefish are most common where there are rock outcrops, seagrass beds, and other areas, which provide habitat diversity and protection. And as a result, a significant proportion of the populations in Shark Bay would be unavailable to be caught by trawling operations because they don't occur in trawling areas (*Dr Fred Wells*[*]*, pers. comm.*). Also, fishery closures (and time closures) results in much of the potential trawl area not being fished, further protecting the species.

Worldwide, loliginid squids constitute major molluscan fisheries worth millions of dollars. The standing stock on the North West Shelf has been estimated at 4500 tonnes (Liu and Yeh, 1984). The species composition of the catch in Shark Bay is not known, but one of the species present is *Sepioteuthis*

[*] *Dr Fred Wells, Senior Curator of Molluscs, WA Museum*

lessoniana. Loliginids typically mature in one year or less. Their lifespan is short, 1-2 years, ranging up to 4 years in some species. *Sepioteuthis lessoniana* reaches sexual maturity in less than 100 days in Queensland (Dunning and Lu, 1998).

In terms of the risk assessment it was determined that it is 'likely' that the small amount caught by the SBP fishery was having only a 'negligible' impact in this group, resulting in an overall 'negligible' risk ranking for this issue.

5.1.2.4 Taking blue swimmer crabs

Rationale for Inclusion

The SBP fishery catches and retains blue swimmer crabs (*Portunus pelagicus)* as a by-product.

ERA Risk Rating: Impact on breeding population (C0 L5 NEGLIGIBLE)

The catch of blue swimmer crabs by the SBP fishery has ranged between 31 tonne in 1989 and 84 tonne in 1998, with an average catch of 34 tonne over this period. The risk assessment determined that it was 'likely' that the fishery would only be having a 'negligible' impact on the breeding stock levels of blue swimmer crabs, resulting in an overall 'negligible' risk ranking, due to the following:

- In Western Australia blue swimmer crab distribution extends from Albany to the Northern Territory border, and they inhabit a wide range of inshore and continental shelf areas, from the intertidal zone to at least 50m in depth (Fisheries WA, 2002).
- There is a comparatively limited area about where blue swimmer crabs are caught by prawn trawlers. There are extensive refuge areas both north and south along the coast and in deeper waters of the continental shelf that are generally not fished where blue swimmer crabs can be found.
- The SBP fishery takes only a very small proportion of the total catch of blue swimmer crabs. In the 2000/2001 season, the commercial fisheries around the State took 673 tonnes of blue swimmer crabs. Of this 182 tonnes were taken in Shark Bay by both scallop and prawn trawlers. This trawled crab catch constituted about 8% of the total commercial catch of blue swimmer crab in Shark Bay (Fisheries WA, 2002).
- Blue swimmer crabs, which are scavengers, may in fact benefit from trawling by increased food availability on the sea floor through discards being thrown overboard.
- As the legal size at first capture is well above the size at maturity, in all sectors of the fishery, the breeding stock levels are expected to be adequate to maintain stocks (Fisheries WA, 2002).
- Some crabs are thrown back, particularly undersized individuals. Many of the crabs hauled up in the trawl nets are still alive, and the survival of discarded individuals is generally estimated to be around 85%, based on experimental trials on trawl discard mortality in Cockburn Sound in 1999 and 2000 (Melville-Smith et al., 2001).
- A developmental commercial trap fishery for crabs exists in Shark Bay that lands much larger quantities of crabs annually. The developing blue swimmer crab fishery for crabs will be the primary system for management of this species in Shark Bay and where the full assessment of this species will be covered (including that caught by the SBP fishery).

5.1.2.5 Sharks

Rationale for Inclusion

The SBP fishery catches and retains sharks as a by-product.

ERA Risk Rating: Impact on breeding population (C0 L5 NEGLIGIBLE)

The risk assessment determined that it was 'likely' that the fishery would be having a 'negligible' impact on the breeding stock levels of sharks in Shark Bay, resulting in an overall 'negligible' risk ranking, due to the following:

- The catch of sharks is very minimal and has never exceeded 2 tonnes in any one year, with an average take of 1.5 tonnes per year. This is made up of more than one species, so that the take of any one species would be even lower. Trawlers take only a small amount of sharks in relation to the overall population size (*R. McAuley*[*], *pers. comm.*).
- The introduction of grids into the fishery in 2001/02 will further reduce the ability of trawlers to catch sharks, as most will be too large to fit through the grid bar-spacings.
- Sharks are managed under the WA Demersal Gill Net and Demersal Longline Fishery however this fishery has been excluded from the Shark Bay waters south of Steep Point since 1993 to protect adult breeding populations of Dusky Whaler Sharks (otherwise known as Bronze Whalers). Trawlers do not catch adult Dusky Sharks, which are approximately 3 metres in length and present in Shark Bay (*R. McAuley*[*], *pers. comm.*).

5.1.2.6 Mulloway

Rationale for Inclusion

The SBP fishery catches and retains mulloway (*Argyrosomus hololepidotus*) as a by-product.

ERA Risk Rating: Impact on breeding population (C0 L5 NEGLIGIBLE)

The risk assessment determined that it was 'likely' that the fishery would be having a 'negligible' impact on the breeding stock levels of sharks in Shark Bay, resulting in an overall 'negligible' risk ranking, due to the following:

- Mulloway is a schooling, temperate species, which is widely distributed throughout Australia from Exmouth south to southern Australia and around to the coast off southern Queensland. As such the area of impact by the SBP fishery is minor compared to the total mulloway stock distribution.
- There are few Western Australian fisheries, which target mulloway (except the Wetline Fishery) but they are caught as by-product in a variety of fisheries including the trawl, long line, gillnet and line fisheries (Department of Fisheries CAESS Data). As this species is not a key targeted species for any fishery, even the cumulative impacts as a result of all fisheries are not likely to be an issue.
- The SBP fishery has a recorded catch of mulloway of between 10 tonnes in 1997 and 2 tonnes in 2000. The variation in catch is probably due to the schooling nature of this species. The recorded take of this species from trawlers is a combination of line and trawl caught fish. Although the total stock size of mulloway is unknown, this harvest is highly likely to be minor in comparison to the likely stock size of a species that is distributed across the southern half of the Australian coast.

[*] *Rory McAuley, Shark Research Section, Department of Fisheries*

Murdoch University has submitted a funding application to the Fisheries Research and Development Corporation to undertake a project to investigate the biology of mulloway. The findings of this study will be reviewed in the light of this assessment report.

5.1.2.7 Taking of tuna

This species (Family Scombridae) is only caught with a line by crew on the trawl vessels and is managed under the Commonwealth managed West Coast Tuna and Billfish fishery. The relatively small take of tuna by trawlers will, nonetheless, be considered through the assessment process for the West Coast Tuna and Billfish fishery.

5.1.2.8 Other species

Rationale for Inclusion

The SBP fishery catches and retains other species, such as curio specimens (shells, fish etc), in very small numbers.

ERA Risk Rating: Impact on breeding population (C0 L5 NEGLIGIBLE)

Due to the very small numbers of such curio individuals that are likely to be taken by the SBP fishery, the impact of this on the breeding populations of these species was considered 'likely' to be 'negligible'.

A specific managed Specimen Shell fishery exists and covers the Shark Bay region.

5.1.2.9 Snapper

Rationale for Inclusion

Operators in the SBP fishery are permitted to catch adult snapper (*Pagrus auratus)* by line under the Shark Bay Snapper Management Plan. Each operator has been allocated 10 units within this fishery, which equates to an entitlement of approximately 1 tonne per boat (note that the value of a unit may vary from season to season depending on Research Division advice in relation to the Total Allowable Snapper Catch). It should also be noted that trawlers in the SBP fishery can only take snapper from within the bounds of the snapper fishery and therefore this mainly targets the oceanic stock (i.e. Operators cannot take snapper south of the line running from Cape Inscription due east).

The take of snapper under this entitlement is part of the management of another fishery and will be addressed under the assessment of the Shark Bay Snapper Managed Fishery.

The Shark Bay Prawn Managed Fishery also captures juvenile snapper, generally 50 to 150 mm, in length, as a minor bycatch species in their trawl nets. The catch of juvenile snapper is addressed in Section 5.2.1.5.

ERA Risk Rating: Impact on breeding population (C0 L5 NEGLIGIBLE) – Adult Snapper

The risk assessment determined that it was 'likely' that the impact of the SBP fishery on oceanic snapper breeding stock was 'negligible'. Assessment of the ocean stock falls within the Shark Bay Snapper Managed Fishery assessment.

The significance of the juvenile snapper bycatch in Denham Sound, and the effect on the inner western gulf stocks cannot currently be determined.

The Department of Fisheries is undertaking research in the western gulf of Shark Bay to better define the level of juvenile snapper biology/trawl interaction and includes:

- Otolith microchemistry to identify juvenile nursery areas;
- Juvenile habitat preferences;
- Experimental trawling using fine mesh covered codends; and
- Observer program onboard commercial prawn trawlers documenting snapper catches.

These studies will be completed by June 2002, with a full report of the results to be published in 2003. Any recommendations from this study will be used to determine if modifications of the management of the SBP fishery are required.

5.2 NON-RETAINED SPECIES

COMPONENT TREE FOR NON-RETAINED SPECIES

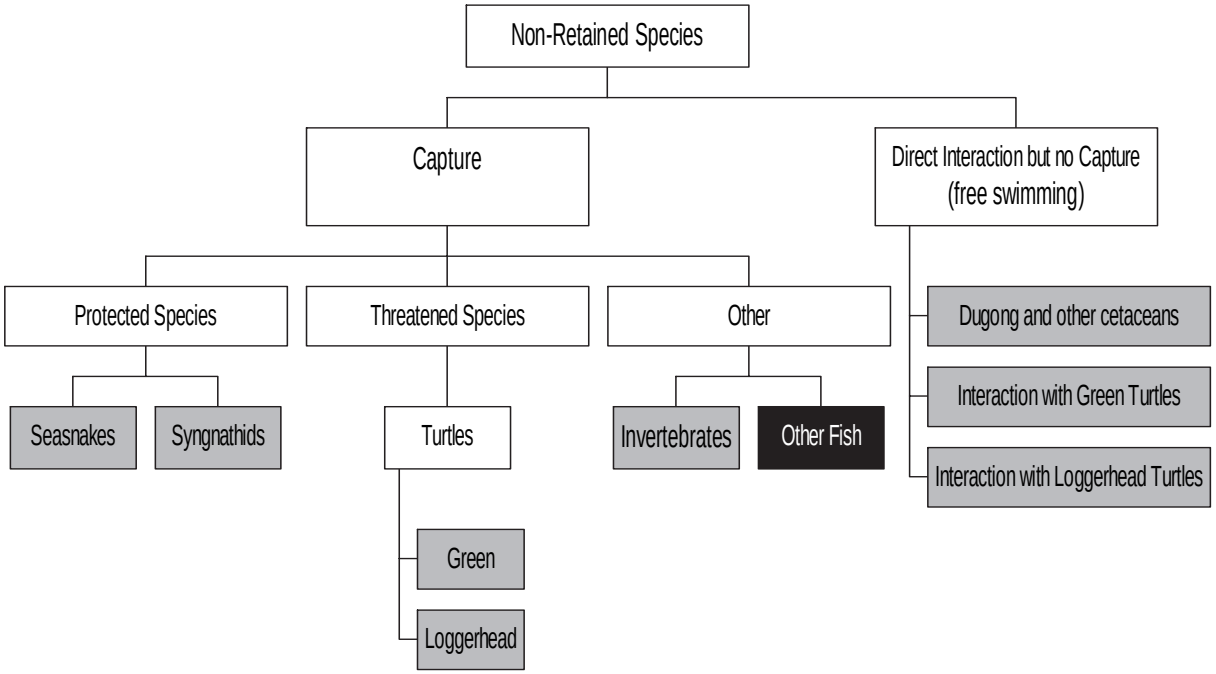

Figure 18. Component tree for the non-retained species.

Black boxes indicate that the issue was considered high enough risk at the June 2001 Risk Assessment workshop to warrant having a full report on performance. Grey boxes indicate the issue was rated as a low risk and no specific management is required – only the justification is presented.

5.2.1 Captured in nets

5.2.1.1 Threatened/listed species loggerhead turtles

Rationale for Inclusion

Loggerhead turtles (*Caretta caretta)* have been caught incidentally in the SBP fishery over the period of its operation. Since loggerhead turtles feed on sandbottom dwelling crustaceans that inhabit trawling grounds turtles may be vulnerable to being caught by the fishery. Loggerhead turtles are considered an endangered species under the Commonwealth and the equivalent under State wildlife conservation legislation as a result of the current status of their populations.

ERA Risk Rating: Impact on breeding population (C1 L3 LOW)

During the risk assessment workshop, this component was considered a 'low' risk, indicating that only a brief justification report is required. The determination of a minor risk was based on the fact that:

- BRDs incorporating grids and turtle exclusion hatches are being introduced into the fishery. The fleet has been fishing with one standard and one BRD net for the 2000 and 2001 season. The fleet will fish with 100% BRDs (BRDs in both of the twin rigged nets) from the commencement of the 2002 season.
- The short shot durations (approx. 60 mins) in the SBP fishery minimises the chance that if a turtle is captured it will drown before it is brought to the surface in the trawl net and released, at the completion of the shot. Research in Queensland suggests that these turtles can survive underwater for over 90 minutes.
- An on-board observer program run by the Department over the past 3.5 years has recorded the capture of 15 turtles (not extrapolated for the full fleet at present), which is considered a very low rate of capture over this period. All turtles were caught in the standard (non-BRD) net and released alive.

The SBP fishery encounters dense floating seagrass aggregations (*Posidonia australis* and *Amphibolis antartica*) from time to time – usually associated with cyclone events. This detached floating seagrass gets caught in the nets and usually makes trawling more difficult but still feasible. Experience from the 2000 and 2001 season, where vessels were fishing with one BRD net, has revealed that fishing in the heavy weed affected waters with a grid attached is almost impossible. The weed masses completely clog the grids, preventing prawns from moving through to the codend. As such, there will be three areas within the fishery where BRDs will not be required for specified periods of time. Even so, there is a minor opportunity for trawlers to catch turtles while fishing without BRDs. Information regarding number and location of turtle captures will be made available at the end of the Fisheries Research Development Corporation (FRDC) project (2002) as all data will be collected and analysed by then.

A full management report has been prepared for this issue that canvasses an approach and management response to this issue.

Operational Objective

a. During normal operations - To ensure that the SBP fishery adopts best practice measures to ensure that turtle captures are prevented.

b. During periods and areas of high weed - To ensure that during periods when BRDs are not operating, prawn-trawling operations do not adversely impact on the breeding populations of loggerhead turtles.

Justification

As is indicated, Objective a. is relevant in normal fishery operations, when the operation of BRDs is possible. Objective b. is relevant for fishing over the periods and within areas where BRDs will not be mandatory.

Indicator

a. Proportion of fleet fishing with two BRD grids.

Turtle exclusion devices are recognized as the best practice management technique for eliminating turtle capture in trawl fisheries. The proportion of the fleet fishing with BRDs will give a direct measure of the proportion of the fleet with the ability to catch turtles.

b. Proportion of turtles returned alive from standard net.

This indicator will be applicable during the short-term exemption periods, which allows vessels to trawl without BRDs, in specific areas.

Therefore, 'proportion of turtles returned alive' should also be measured as a better indicator of the true impact of the interaction with the fishing gear when BRDs are not being used.

Performance Measure

100% fleet fishing with two turtle exclusion devices. 90% turtles returned alive from non-BRD nets.

Justification

At the commencement of the 2002 season, all vessels were with two BRD nets. Since the full introduction of BRDs (i.e. Commencement of 2002 season) and in the later periods when exemptions to the use of BRDs in specified areas are granted, 90% of turtles should be returned alive. This level is set high as a precautionary measure due to the protected and threatened status of this species, but also in recognition that accidental losses still might occur.

Data Requirements for Indicator

Proportion of fleet fishing with two turtle exclusion devices.

Data required to measure this is:

- number of vessels with two BRDs,
- number of vessels without two BRDs.

Proportion of turtles returned alive.

Data required in order to measure this indicator is:

- number of turtles caught (recorded on a shot by shot basis),
- number of turtles returned alive (recorded on a shot by shot basis).

Data Availability

Proportion of fleet with two BRDs.

Department of Fisheries regulates the fishery gear used in this fishery and as such has information on the gear being used on each vessel. A compliance program is implemented across the fishery to monitor the use of gear throughout the season.

Proportion of turtles returned alive.

During periods when vessels are given exemptions from fishing with BRDs, observations of turtle capture and release would be needed. This may involve a combination of log book data plus independent observer data. In addition, some means of confirming subsequent survival rate should be considered so that post-release deaths don't go undetected.

Evaluation

Proportion of fleet with two BRDs.

All the vessels in the fishery are currently fishing with one standard and one BRD net. From the commencement of the 2002 season, it is expected that 100% of the vessels will be fishing with two BRD nets.

Proportion of turtles returned alive.

An observer program has been conducted over the last four years (in conjunction with BRD trials) and this program has recorded turtle captures across the fleet. During this period a total of 15 turtles have been caught in total, all in the non-BRD net. No turtles have been recorded caught in the BRD net. Of the loggerhead turtles caught over this period 100% were returned alive.

Robustness

a. Proportion of the fleeting fishing with two BRDs.

This indicator is robust as the compliance of this fishery is high ensuring that vessels will be fishing with BRD nets.

b. Proportion of turtles returned alive from standard nets.

This would vary depending upon the level of data collected through an independent observer program.

Fisheries Management Response

Current: The vessels in the fishery currently fish with one standard and one BRD net, under a licence condition. In 2002, the licence condition will be amended to state that all nets used in the fishery must have BRDs fitted. The bar spacing, angle of the grid, and escape hatch size have been designed and trialed to ensure that they are appropriate to exclude (with minimal injury) loggerhead turtles of the sizes found in Shark Bay.

Action if Performance Limit is Exceeded:

Proportion of fleet with BRDs: At the commencement of the 2002 fishing season, all vessels will legally be required to fish with two BRD nets. There will be two periods and areas where BRDs will be specifically not required under exemption issues by the Executive Director. Other than these circumstances, if a fishing vessel is found to be fishing without both BRDs, the operator of that vessel will be prosecuted.

Proportion of turtles returned alive: During the periods when the Executive Director of the Department of Fisheries (ED) grants exemptions to the use of BRDs, if less than 90% of the turtles are returned alive, a report will be prepared to assess the circumstances. If it is determined that there were no extraordinary factors responsible for triggering the performance measure, the exemption may be withdrawn. The ED will also consider this information when next requested to consider an exemption to BRDs.

Comments and Action

Summary of Actions:

- Introduce 100% BRD coverage to the fleet in 2002.
- Determine the protocols for vessels when fishing without BRDs.

External Driver Check List

None.

5.2.1.2 Threatened/listed species green turtles

Rationale for Inclusion

Green turtles (*Chelonia mydas)* are considered a vulnerable species under the Commonwealth and the equivalent under State wildlife conservation legislation as a result of the current status of their populations and are a common inhabitant of Shark Bay waters.

ERA Risk Rating: Impact on breeding population (C0 L5 NEGLIGIBLE)

In terms of the impact of the SBP fishery on the green turtle breeding population, the risk assessment determined that it was 'likely' that the fishery would be having a 'negligible' impact. This is because, although investigations have shown that green turtles occur commonly in Shark Bay, there have been minimal reporting of green turtles being caught in a trawl net through the fishery's duration. This is probably due to the fact that green turtles prefer to reside in seagrass habitats that trawls are excluded from and/or avoid. It is possible that green turtles may occasionally be affected by trawling when vessels fish close to seagrass banks however with the introduction of bycatch reduction devices, even in these circumstances, green turtles would not be caught.

5.2.1.3 Protected species seasnakes

Rationale for Inclusion

Seasnakes are common in Shark Bay and caught in the SBP fishery. Under the EPBC Act, all species in the family Hydrophiidae and family Laticaudidae are considered protected.

Six of the 22 species known to occur in Western Australia have been recorded in Shark Bay, including *Aipysurus pooleorum*, which is endemic to the region. Commercial utilisation of dead sea snakes taken as bycatch in licensed commercial fishing operations is permitted, subject to specific licensing by the Department of Conservation and Land Management (CALM) under the *Wildlife Conservation Act 1956*. Currently only one operator has a licence to take and/or receive dead seasnakes but is not currently operating.

ERA Risk Rating: Impact on breeding population (C1 L2 LOW)

During the risk assessment workshop, this component was considered a 'minor' risk (indicating that only a brief justification report is required), due to the following:

- Anecdotal evidence suggests that caught seasnakes are alive and aggressive (thought to be an indication of health and lack of damage from the trawl).
- A study of seasnake survival following capture by trawlers in the Gulf of Carpentaria indicated that 60% of seasnakes survived (Wassenberg et al., 1994).

- The shot durations in Shark Bay are less than in the Northern Prawn Fishery and as such the mortality of seasnakes in the SBP fishery is probably even lower.
- Most species are considered abundant or common in Shark Bay and are not known to be vulnerable.
- Data from the observer program conducted in the prawn fishery, found that 194 seasnakes have been caught from 916 trawls (924 hours of trawling). Of the seasnakes caught, 99% of individuals were returned alive.

5.2.1.4 Protected species syngnathids

Rationale for Inclusion

Syngnathids are the collective group that contain organisms such as seahorses, sea dragons and pipefish. Syngnathids are incidentally caught in the SBP fishery and are generally removed from the codend dead. Syngnathids are a protected species under the EPBC Act.

ERA Risk Rating: Impact on breeding population (C1 L2 LOW)

The potential consequence of the prawn trawling operations on breeding levels of syngnathids was considered 'minor'. Anecdotal evidence from observer program results has suggested that very low numbers of syngnathids are caught by this fishery, in the order of 1 per night across the whole fleet. Furthermore, it is suggested that the occurrence of syngnathids appears to be area specific and often syngnathids may not be caught for many nights in a row. As a result, this number (1 syngnathids per night across the fleet) is more indicative of an average for the season. It was considered 'unlikely' that this level of consequence would result because trawling occurs over areas that are mostly unfavourable to syngnathids. Syngnathids are known to favour seagrass and detached algae communities, which are not normally trawled over.

Opportunistic data will be collected on the catch of syngnathids, by observers and other technical staff on the vessels from time-to-time. This data will continually be compiled to determine a better profile of syngnathid catches in this fishery.

5.2.1.5 Discarded fish

Rationale for Inclusion

Trawling contributes to the mortality of several non-commercial fish species that are incidentally caught and die due to the disturbance they have experienced in the trawl net or from being out of water during the sorting process. These fish are discarded overboard, usually dead. In terms of volume, the sum of bycatch is between 4 and 8 times the annual prawn catch for this fishery, and small species of fish (which generally die and are returned overboard) make up the majority (at least approximately 70-80%) of the bycatch (*Dr. S. Newman*[*]*, pers. comm.*). The impact of this level of mortality on the sustainability of those species is explored here.

ERA Risk Rating: Impact on breeding population (C2 L3 MODERATE)

During the risk assessment workshop, the risk to the collective group of discarded fish species was considered. Using this method, the consequence of an impact to breeding populations of bycatch

[*] *Dr. Steve Newman, Department of Fisheries*

species, by the activity of trawling was considered 'moderate'. This was due to the fact that the amount of discards is large, possibly indicating that significant mortality of bycatch species occurs, however given the relatively small area of fishing compared to the overall area where these species probably occur, the mortality is probably sustainable.

In summary, of the small fish that are caught and discarded, very few are subject to other fishing mortality; therefore the trawl fishery is the only known direct activity impacting the species. Young fish, which are generally caught by trawlers, commonly have high mortality rates and as such the fishing mortality may have little additive impact on this rate. Secondly, as the species are generally only taken by trawling, maintaining a trawl impact of less than 40% on the stock distribution can be expected to keep all of the individual stocks above the maximum reference point of 0.4 of virgin biomass for most finfish species.

As trawling has occurred for at least 8 months of the year, every year, for a period of over 40 years, it is considered 'possible' that this level of consequence could result.

Following the risk assessment workshop, the Department of Fisheries undertook an assessment of the risk to individual discarded fish species taken in the SBP fishery. This was undertaken according to the same criteria developed and applied by Stobutzki et al. (2000), in the Northern Prawn Fishery.

Only two species of the 21 most commonly caught species (the spiny headed flounder *Engyprosopon grandisquamum*, and the heart headed flathead *Sorsogona tuberculata*), rated highly susceptible to trawling using the criteria. However, these species have high turnover rates and therefore the risk associated with fish bycatch was still rated as minor. They are also presumed to occur in areas outside of the trawled area.

The introduction of bycatch reduction devices such as square mesh panels in the net over the coming three years will reduce the overall amount of small fish caught and will substantially reduce the catch of some species.

Operational Objective

To ensure that adequate refuge areas are provided within Shark Bay, for discarded bycatch species of the SBP fishery.

Justification

Regardless of the level of impact on discarded fish species within the trawl grounds, if an adequate proportion of the populations of these species is located outside the trawl area, than this should ensure their sustainability.

Indicator

Information on the distribution of bycatch species (in particular the two more vulnerable species) both within and outside the area of trawling from a research survey of the region will indicate the proportion of the region that provides a refuge to these species from trawling.

Performance Measure

The majority of bycatch species are found in relatively significant numbers outside the trawled areas.

Justification

The Department of Fisheries will undertake a survey of species within and outside the trawl grounds to determine the proportion of refuge for bycatch species within the next five years.

Data Requirements for Indicator

Data Required	Availability
Detailed daily commercial log books provide information on fishing locations by latitude and longitude for each trawl shot, which can be used in GIS analysis	Yes; available since 1998
VMS data. Each boat can be polled for location at regular intervals according to compliance protocols and this information can be utilised in spatial analysis	Yes; available since 2000
Distribution of bycatch species within the Shark Bay Region	To be determined through bycatch distribution survey, which will be undertaken within the next five years

Evaluation

An evaluation of this issue will be provided following the completion of the survey.

Robustness

High

a) Compliance policing including the use of VMS, which can validate the voluntary log book records on location and speed of vessels in the fishery and gear checks.

b) Scientifically assessed methodology for undertaking the survey in collaboration with the Western Australian Museum.

It should be noted that the interpretation of the survey data is critical due to the large degree of background variation in the natural systems, which will be investigated.

Fisheries Management Response

Current: To ensure maintenance of the required level of breeding stocks of non-target species:

a) The fishery is managed through input controls that limit boats, gear, seasons and locations of trawling.

b) The annual fishing season is for a fixed period and includes seasonal, area and moon closures limiting total effort on all species.

c) Compliance policing includes use of VMS and gear checks.

d) Development of a Bycatch Action Plan.

e) Introduction of bycatch reduction devices.

Future: Implementation of grids during 2001/02, and the subsequent introduction of secondary fish

exclusion devices over the next two years, will reduce the overall bycatch taken, particularly small fish species. Preliminary trials indicate the potential to reduce some species by around 50%. From the specific experiments undertaken in Shark Bay in August 2000, there were insufficient numbers of spiny headed flounder caught for statistical analysis. For the small-toothed flounder (*Pseudorhombus jenynsii*), another species of flounder there was a significant reduction in the numbers (50% reduction) in the net with a grid and square mesh panel compared to the net without any bycatch reduction devices. There was a 35% reduction in the number of heart-headed flathead in the net with grid and square mesh panel but this was not of significance due to the high variability in the numbers caught between trawl shots.

Trawl studies focussing on the biodiversity of trawled and untrawled areas in the Shark Bay Region will provide additional information on the distribution of fish species, particularly for those species that appear to be more susceptible to trawling.

Total swept area calculations are currently made each season using the overall number of hours trawled, average headrope length and spread of the gear. The use of GIS systems for analysing data has commenced and annual monitoring of the spatial extent and swept area can be made.

Actions if Performance Limit is Exceeded: The strategies that are available to offer further protection to bycatch, if required, include expanding the system of area closures or further modifications to trawl gear to reduce bycatch levels.

Comments and Action

Even though a relatively low risk was associated with this issue since no species in the assessment were ever concluded to be of more than a minor risk, the Department has developed a proposal for FRDC funding to complete the survey during the next five years.

External Driver Check List

Environmental factors such as: climatic changes, ocean currents and sea-surface temperatures are known to affect the levels of recruitment of all fish species, including bycatch species.

5.2.1.6 Invertebrates

Rationale for Inclusion

The shallows of Shark Bay support an invertebrate community of abundance, diversity and zoogeographical significance (Fisheries WA, 1996). This has been attributed to the spatial isolation, high organic productivity and extensive seagrass beds and carbonate sand flats. Studies to date have revealed that 218 species of bivalve molluscs in the region with 75% of these coming from a tropical range, 10% from a southern Australian range and 15% being west coast endemics (Slack-Smith, 1990). Trawl gear interacts with the sea bottom where many of these species reside, and therefore there is a necessity to investigate this issue.

ERA Risk Rating: Impact on breeding population (C0 L5 NEGLIGIBLE)

It was therefore only considered ‘possible’ that the SBP fishery could even have a ‘negligible’ impact on invertebrate breeding populations in Shark Bay. This low ranking is due to the following:

- Anecdotal evidence suggests that the trawl areas of Shark Bay are typically sand bottom and contain few large invertebrates.

- The trawl gear is configured in a manner that largely precludes the capture of invertebrate species living on or in the substrate. There is a gap of approximately 20 centimetres between the ground chain and the footrope of the net. This is designed to reduce damage to the net through contact with the ground and specifically serves to minimise the capture of immobile and slow moving benthic organisms (and inanimate objects).
- Immobile and slow moving benthic species generally pass through the gap between the ground chain and the footrope. By contrast, mobile species (such as prawns) are disturbed by the ground chain and move up into the water column above the footrope and are subsequently caught in the net.
- Some large immobile organisms may also be 'flicked' up into the water column by the ground chain and subsequently captured in the net. The grids currently being trialed in Shark Bay have an escape opening to facilitate the removal of such organisms (and inanimate objects).
- Gilkinson *et al*. (1988) found that bivalves in the scour paths of the otter boards were displaced into sediment berms, however, of the 42 specimens in the scouring zones, only two showed major damage.

As detailed in the report 'Impact of taking discarded fish on their breeding populations' Section 5.2.1.5, the Department of Fisheries will be undertaking a survey of bycatch species throughout Shark Bay in order to ensure that bycatch species are adequately represented outside the trawl grounds and therefore have sufficient refuge. This survey is likely to provide similar information on the distribution both within and outside trawl areas, of other invertebrate species. This report will be reviewed following the completion of that study.

5.2.2 Interaction but no capture

5.2.2.1 Threatened/listed species green turtles

Rationale for Inclusion:

Green turtles (*Chelonis mydas)* occur in Shark Bay and are a vulnerable species under Commonwealth and State legislation. In a previous report (Section 5.2.1.2) it was demonstrated that trawlers rarely catch green turtles and as such the impact of this potential activity on green turtle populations is 'negligible'. This component addresses the issue of interaction between the fishery and green turtles, which does not result in capture – in particular but explores the issue of green turtles being hit by the hull of the vessels in the fishery, and the disturbance of breeding aggregations.

ERA Risk Rating: Impact on breeding population (C0 L5 NEGLIGIBLE)

For the issue of possible interactions (without capture) of green turtles, it was considered 'likely' that the SBP fishery would have a 'negligible' impact on the breeding populations, due to the following:

- Although investigations have shown that green turtles occur commonly as residents in Shark Bay, there are no major breeding sites for this species located within Shark Bay.
- There have been no reports of green turtles interacting with trawl vessels (eg. being knocked by boats or nets without being captured), but formal recording of such events that might occur has not been attempted.
- It is also unlikely that personnel on a working boat would be liable to detect any such occurrence.
- The fact that green turtles prefer to reside in seagrass habitats that trawls are excluded from and/or generally avoid suggests that such incidents are likely to be very few in any case.

- The relatively low speed at which trawlers travel is also likely a mitigating factor. Most of the reports of marine wildlife being hit by boats etc. involve high-speed boats that leave limited time for an animal to move out of its path. Trawlers travel at relatively slow speeds of 3-4 knots while trawling and up to 12 knots while steaming, and as such are unlikely to hit wildlife where avoidance behaviour is not impeded.

5.2.2.2 Threatened/listed species loggerhead turtles

Rationale for Inclusion

Loggerhead turtles (*Caretta caretta*) occur in Shark Bay and are an endangered species under Commonwealth and State legislation. This component addresses the issue of interaction between the fishery and loggerhead turtles, which does not result in capture –in particular but the issue of loggerhead turtles being hit by the hull of the vessels in the fishery, and disturbance of breeding aggregations of turtles.

ERA Risk Rating: Impact on breeding population (C1 L4 LOW)

For the issue of possible interactions (without capture) of loggerhead turtles, it was considered 'likely' that the SBP fishery would have a 'negligible' impact on the breeding populations, due to the following:

- Under the Draft Turtle Recovery Plan by the Commonwealth Government, only the capture by trawls is identified as a key threatening process. There has been no evidence of any additional impact between trawl fleets and turtle populations. However, there have been no attempts to find out whether such possible interactions might be relevant.
- Other impacts such as interactions between turtles and vessel hulls are unlikely due to the slow speed at which trawlers travel, allowing animals to move from its path.
- CALM has determined that the most substantial breeding aggregation of loggerhead turtles in WA waters focuses their nesting activity within Shark Bay on beaches at the northern end of Dirk Hartog Island, and that the most beachings occur there in October. Current information regarding loggerhead turtle mating aggregations in Shark Bay is unavailable. The location and distribution of any of these is yet to be defined, so the possible further significance of the trawler and loggerhead turtle interactions presently recorded within the Denham Sound area into October is also uncertain. Male/female associations for mating purposes can be expected to be occurring 6-8 weeks prior to females beaching to lay the first eggs of the season. Internesting habitats are of importance to the wellbeing of the nesting female loggerhead turtles and are also presently unknown. However, the SBP fishery season has ended by the time internesting habitat usage becomes important (R. Prince*, pers. comm.). Research on turtles in Shark Bay is the responsibility of CALM.

This issue will be revisited should further information on breeding aggregations become available from the CALM.

5.2.2.3 Interaction with dugongs and cetaceans

Rationale for Inclusion

Shark Bay is an internationally significant dugong habitat supporting a population of approximately 10,000 individuals (Marsh et al., 1994). Dugongs are a protected species under both State and Commonwealth legislation. This component addresses the issue of interaction between the fishery and

dugongs and cetaceans, which does not result in capture in particular but the issue of dugongs being hit by the hull of the vessels in the fishery.

ERA Risk Rating: Impact on breeding population (C1 L3 LOW)

For the issue of possible interactions (without capture) of dugongs, it was considered 'possible' that the SBP fishery may have a 'minor' impact on the breeding populations, due to the following:

- Large numbers of dugongs and their young can be found on the Faure Sill and Wooramel Seagrass Bank and between Faure Island and Gladstone Bay during the summer. All these areas are contained within the permanent nursery closure implemented in the 1960s (Marsh et al., 1994). Research indicates that dugongs migrate seasonally within the bay to find optimal water temperatures and as a result their habitat usage varies extensively from summer to winter (Anderson, 1986). Consequently, although trawling is physically separated from the areas used by dugongs for most of the season during the winter season there is some overlap of trawlers and dugongs.
- Over the period of the fishery, there has been one record of a dugong being captured, this individual was putrid and presumed to be dead well before the trawl net captured it. Also, a dead dugong found in Bremer Bay was thought to have drifted south (Leeuwin Current) and had marks consistent with trawl damage (*R. Prince*[*]*, pers. comm.*). Apart from these two reports there has been no evidence or record of a dugong capture or interaction over the period of the fishery, which is in excess of 40 years, however if numbers of dugongs increase this could lead to more captures or interactions in the future.
- Surveys carried out in 1989 and 1994 have estimated the population of dugongs in Shark Bay to be stable at 10,000 individuals (Marsh et al., 1994; Preen et al., 1997; *R. Prince*[*]*, pers. comm.*).
- The interactions with dugongs will be reassessed at the next major review (in approximately five years) of the fishery.

[*] *Robert Prince, Department of Conservation and Land Management*

5.3 GENERAL ENVIRONMENT

COMPONENT TREE FOR THE GENERAL ENVIRONMENT

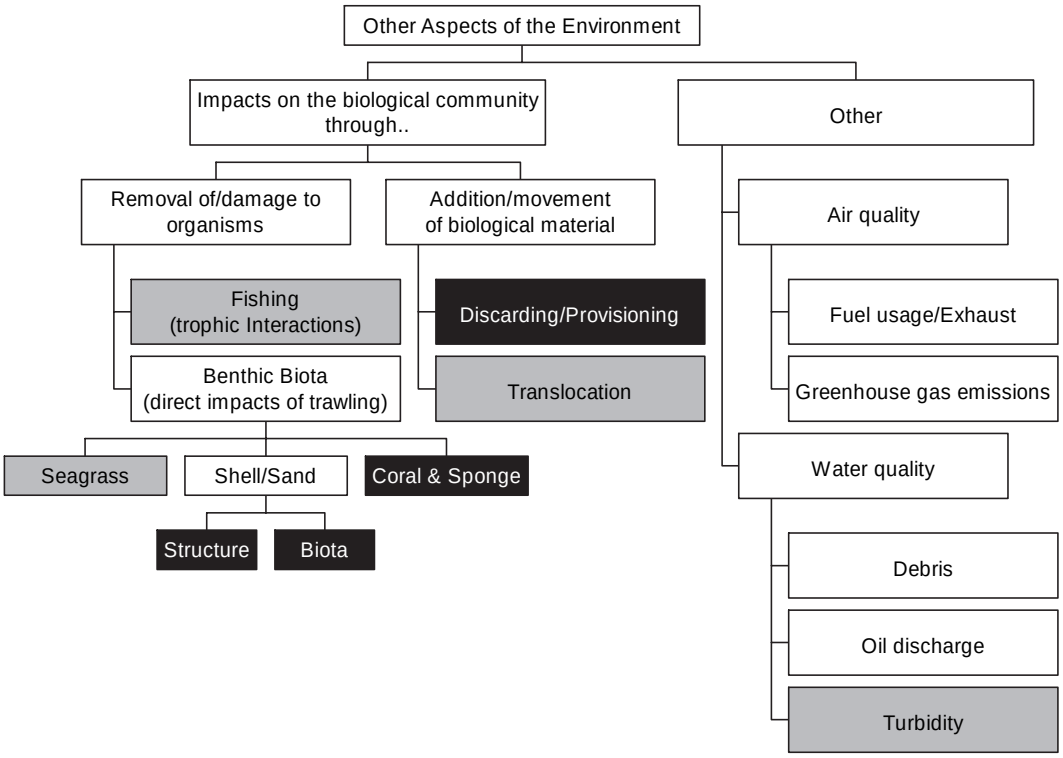

Figure 19. Component Tree for the Other Aspects of the Environment.

Black boxes indicate that the issue was considered high enough risk at the June 2001 Risk Assessment workshop to warrant having a full report on performance. Grey boxes indicate the issue was rated as a low risk and no specific management is required – only the justification is presented.

5.3.1. Impacts from removal or damage to the environment

5.3.1.1 Taking of prawns and by-product species

Rationale for Inclusion

In recent years, there has been growing concern about the potential impact that reducing the abundance of target and byproduct species may have on the trophic associations. The risks associated with the potential impacts of the reduction on numbers of tiger and king prawns, and other by-product species, on the populations of their predators and prey, therefore requires assessment.

ERA Risk Rating: Impact on trophic structure (C2 L2 LOW)

The impact on the environment by removing the sum of all retained species was considered 'unlikely' to even cause a 'moderate' change to the ecosystem, hence it was only a minor risk to the Shark Bay environment.

The information used to come to this conclusion for prawns includes:

- Prawns have a very high natural mortality rate resulting in a large percentage of the yearly recruits being removed naturally from the system (either from death or predation) by the end of the season regardless of fishing. The natural variation of prawns being very high is such that this would mask the effect of removing prawns due to fishing.
- The management arrangements of area and seasonal closures ensure that an adequate spawning stock of all species of prawns survive to reproduce recruits for the subsequent season.
- There are no known obligate prawn predators, which are likely to be directly impacted upon by the removal of adult-sized prawns. Most prawn predators are opportunistic and/or scavengers and therefore are not dependent on any one species. A variety of other small crustacean, invertebrate and fish species live in these areas. Consequently, it is not likely that the commercial take of prawns impacts significantly on the upper trophic levels within the Shark Bay ecosystem (i.e. prawns are not a keystone species).

In conclusion, the prawn population naturally goes up and down to such a large degree on both a monthly and annual frequency that predators can't rely on the full time presence of the prawns for their diet.

The information used to come to this conclusion for by-product species includes:

- The cumulative take of the by-product species (above the level of prawn catch) (primary and by-product) is relatively low, ranging between around 100 and 450 tonnes per season and representing approximately 12% of the total catch (see Table 4) per season. The impact of the take of by-product species on the environment was considered to be 'negligible' as the amount of each by-product species, and total by-product amount is insignificant in terms of g/m^2 and likely to be less than the background variation in abundance.
- Shark Bay is considered to be highly productive and as such the removal of this level of biological material is not likely to be detectable.
- Trawling only occurs in a relatively small area of Shark Bay (< 40% potentially and < 20% currently) and only for a period of eight months per year.
- Trawling had occurred for around 40 years at the time Shark Bay was highlighted as an area with outstanding values and declared a World Heritage Property. If the removal of biological material was having a significant detrimental impact on the environment of Shark Bay it is unlikely that the area would have achieved this status.
- Although no specific research on this subject has been undertaken in Shark Bay, several studies around the world have investigated this subject and found the following:
  - Following the review of ecosystems impacts of fishing, Jennings and Kaiser (1998) concluded from the current empirical evidence that it is wrong to assume that most predator-prey relationships are tightly coupled and the removal or proliferation of one species, which eats another, will result in detectable changes in ecological processes. Thus, merely because a prey species is being harvested does not automatically mean that a predator(s) must be affected.
  - Greenstreet and Hall (1996) studied periods in the North Sea trawl fishery 50 years apart and found little change in community structure of non-target species and the changes in target species were directly caused by fishing.

– Harris and Poiner (1991) examined changes in the tropical demersal fish community after 30 years of prawn trawling in the Gulf of Carpentaria. They found that the abundance of benthic-associated species had decreased and semi-pelagic increased. Most of these changes, however, occurred in the target and bycatch taxa directly as a result of fishing and there was little evidence of any indirect trophic related effects.

Table 4. Landings (tonne) of by-product by Shark Bay prawn boats between 1989 and 2000.

Year	Coral Prawns	Crabs	Squid	Cuttlefish	Tuna	Shark	Kingfish	Snapper
1989	84	3	3	6	<1			
1990	117	3	3	4	11			
1991	98	9	22	2	2	1		
1992	83	9	12	3	6	1		
1993	127	25	35	3	1	2		
1994	181	45	38	5	6	2		
1995	165	40	78	13	9	2		
1996	225	42	30	39	11	4		
1997	280	66	27	16	2	2	10	4
1998	237	84	67	13	34	2	6	2
1999	150	37	41	11	27	2	8	1
2000	152	43	19	13	19	0	2	0

5.3.1.2 Impact to sand/shell habitat

Rationale for Inclusion

Prawn trawling occurs mostly over the sand and shell habitats of Shark Bay. When trawling, ground chains and otter boards make contact with the sea bottom, disrupting organisms within the habitat. Evidence from video footage of trawled areas of Shark Bay suggests that trawling over sand has the effect of flattening this otherwise rippled and three-dimensional substrate. This may also indirectly affect the species that inhabit this area by changing the nature of their habitat.

ERA Risk Rating: Impact on habitat ecology and structure (C2 L5 MODERATE)

The potential impact on the sand and shell habitat, as a result of the prawn trawling operations was considered to have only a 'moderate' consequence due to the following:

- The total area open to trawling is approximately 40% of the area of Shark Bay Region.
- Of the area that is legally permitted to be trawled, less than 20% of this is trawled (due to targeting of known favourable grounds) (Figure 7).
- Studies of actual impacts from prawn trawling suggest only minimal impacts to infaunal communities.

It was considered 'likely' that this level of impact would result since fishing on sand habitats in Shark Bay has occurred consistently for 8 months of the year for over 40 years. Consequently, the level of risk was moderate, and needs to be managed within these acceptable levels.

Operational Objective

To maintain an acceptable level of impact on the shell/sand habitat in Shark Bay.

Justification

It is understood that prawns are predominantly targeted over sandy substrate. It should be noted that the area occupied by adult prawns is strongly related to the location of where nursery areas are.

Sandy habitats harbour many infaunal and epibenthic assemblages. In particular, the diverse invertebrate fauna that likely resides within the sandy areas of Shark Bay is considered an important value of Shark Bay (Fisheries WA, 1996) and should be protected. Although, trawl gear makes physical contact with the seabed, the regulations governing ground chains (max. 10mm) minimises impacts but may result in interactions with species using the sand habitat and any impact needs to be kept to an acceptable level.

Indicator

The percentage of the sand/shell habitat of the Shark Bay region that is trawled.

Performance Measure

Area of sand/shell habitat available for trawling needs to be kept to no greater than 40% of the total sand/shell habitat in Shark Bay.

Justification

The extensively trawled areas of Shark Bay are estimated to be less than 20% of the total waters in Shark Bay (13,000 km^2) and at least 25% of the total sand habitat (at least 9000 km^2) in Shark Bay (Fisheries WA, 1996). Based on the average number of trawl shots and number of vessels the estimate of the amount of ground covered would be around 7300km^2, if no overlap occurred. However, due to the concentration of fishing effort and resultant overlap, the actual swept area is estimated to be around 2150km^2 of the seabed within the bay (Department of Fisheries, in prep.). This is a relatively small percentage of the total area of bay and would provide around 75% refuge even if that area trawled were extensively impacted.

It should be noted, however, that there are a number of studies, which have shown that even in habitats that prawn trawling occurs it does not cause significant effects to the infaunal community. A meta-analysis of fishing impacts by Collie et al., (2000) found that otter trawling had the least impact of all forms of trawling. Specifically, Kaiser and Spencer (1996) found no detectable difference between trawled and untrawled areas (beam trawl) within mobile sediment (sand) regions. Van Dolah et al., (1991) studied changes in infaunal communities over 5 months for areas closed to shrimp trawling. They concluded that the seasonal reductions in abundance and number of species sampled had a much greater effect than fishing. Finally, Jennings and Kaiser (1998) suggest that light shrimp trawls do not cause significant disturbance to communities in poorly sorted sediments in shallow water.

In Australia, Gibbs et al., (1980) found minimal impacts on the benthic communities in sandy areas resulting from prawn trawling in Botany Bay, NSW. In southwest WA, Laurenson et al., (1993) compared trawled and untrawled areas using trawl samples and underwater videos. Their study concluded that

the dominant fauna of each area (sand bottom) showed marked similarities, although each group had a different group of less abundant species. The difference was attributed to the fact that the untrawled area was small and encroached in all directions by seagrass. Underwater video observation of both areas before and after the completion of the depletion experiment failed to detect any visual impact on the substrate or habitat. Extrapolating this study to Shark Bay, which is a similar habitat would indicate that trawling causes only minor and short-lived impact to sandy habitats.

Consequently, a performance measure of 40% is considered precautionary, while allowing for flexibility of the fleet for economic efficiency.

Data Requirements for Indicator

Data required would be:

- Knowledge of spatial distribution of trawled and untrawled areas.
- Knowledge of spatial distribution of sand habitats within Shark Bay region.

Data Availability (past - current – future)

Knowledge of spatial distribution of trawled and untrawled areas.

Based on log book data a good record exists of the location of trawled and untrawled areas. The recent introduction of a VMS to this fishery will provide more detailed information of the trawled areas of Shark Bay.

Knowledge of spatial distribution of sand habitats within Shark Bay region.

The distribution of habitats within Shark Bay is well understood from the extensive sedimentation studies done by University of Western Australia (Logan and Cebulski, 1970). In addition, data exists in GIS format, which was largely generated by the CALM.

Evaluation

Currently, trawling is estimated to be occurring in approximately 25% of the sand habitat within Shark Bay and is therefore meeting the objective.

Robustness

High

The indicator is considered robust as:

- Current trawling is only allowed within specific areas to provide protection to nursery areas and different habitats.
- Regulations do not allow fishing to occur in more than 40% of this habitat.
- Compliance policing includes the use of VMS, which logs the positions of vessels throughout the fishing season.

Fisheries Management Response

Current: Trawling is only allowed within specified areas to provide protection for sensitive nursery areas and seagrass habitats, which also affords protection to other habitats including the sand habitats. Vessels are now required to have a VMS operating during the season that logs the positions of vessels to ensure that trawling does not occur outside permitted areas.

Future: Fishing effort and distribution will be monitored to ensure that no more than 40% of the available sand habitat is trawled.

Actions if Performance Limit is Exceeded: Not applicable.

Comments and Action

The regulations do not allow for fishing to occur in more than 40% of the area. Therefore, the management of this issue is really assurance and compliance.

External Driver Check List

None

5.3.1.3 Impact to coral/sponge habitat

Rationale for Inclusion

Internationally, there has been concern about the impact of trawling on benthic habitats, and this has extended to Shark Bay. Coral (both soft and hard types) and sponge habitats are important sites for marine species. They provide habitat for fish and invertebrates and are the feeding and recruitment sites for many species. By virtue of their shape and physical structure, coral habitats are vulnerable to physical damage. In addition, given their generally slow growth rates, are slow to recover. Although sponges are faster growing and therefore more able to withstand fishing pressure, they are still vulnerable to physical damage.

There are coral (hard and soft) and sponge habitats in Shark Bay. The known areas of hard coral are particularly on the eastern shores of Bernier, Dorre and Dirk Hartog Island and in the Sandy Point, Bar Flats and Egg Island areas. The most popular recreational coral sites in the World Heritage Property occur in the more sheltered waters of Dirk Hartog Island and isolated coral outcrops such as those at Broadhurst Bight and Bar Flats much of which is subject to permanent closures under the trawl management plan. In Shark Bay, soft coral and sponge habitats occur in the relatively oceanic areas inside of the 20m depth from Carnarvon to Quobba in the northern embayment, and did occur in the area west of Elbow Shoals prior to 1969. Sponges also occur intermittently on sandy bottoms within the bay.

ERA Risk Rating: Impact on habitat ecology and structure (C1 L6 LOW)

The impact of the prawn trawling activities on the coral and sponge habitats in Shark Bay is considered ***low***. This is a result of the following factors:

- Firstly, trawling is not possible over these hard coral reef areas due to the loss of trawl gear and/or dangerous hook ups of the ground chains on the coral. Since the nets are expensive to purchase and time consuming to repair, fishing over this habitat is highly undesirable to fishers. Therefore, fishing over hard coral habitat has not occurred in this fishery (*Dr. J. Penn*[*]*, pers. comm.*). However, soft coral and sponge habitat can be trawled (although not targeted by the fishers). Numerous researchers have shown a relationship between penaeid prawns and sediment type (Hall & Penn, 1979; Ruello, 1973; Grady, 1971; Williams, 1958). The highest densities of prawns generally occur in sandy and muddy habitat, which generally do not contain structured growth such as coral or sponge that support predatory fish populations.
- At the commencement of trawling in Shark Bay, exploratory trawls were undertaken. Reports from these exploration exercises documenting the sand and mud bottom nature of the Shark Bay

indicate that trawling has not significantly altered the habitat pre-fishing. Extensive studies on the embayment habitats during the early 1960s (Logan and Cebulski, 1970) reported that the trawl ground areas consisted predominantly of sand sediments with molluscan, echinoderm and other macro-fauna, but did not mention sponges or soft corals.

- Under current conditions, a large proportion of the known areas of hard coral growth are protected as a result of permanently closed areas. Corals are prolific in the Sandy Point, Bar Flats and Egg Island area. Sandy Point is protected from trawling by a sanctuary zone of the marine park. The area around Egg Island is open to trawling at the end of the season (from around August to October) and trawling is permitted in parts of Bar Flats but is excluded from around mid April to around 1 August. Both of these areas however, are not part of the actively trawled area (refer to Figure 7).

The issue of impact on coral and sponge habitat was not considered **negligible** due to the following:

- Currently, there is anecdotal evidence (*Dr. J. Penn*[*]*, pers. comm.*) of an area of sponge and soft coral within the trawled region west of Elbow Shoals that was cleared by trawling in early periods of the fishery (1969). Also, recollections of staff with a long association with the fishery suggest that a small area of sponge and soft coral also existed about 10nm south-west of Elbow Shoals. Trawling has evidently gradually removed the sponge and soft coral that used to exist in this area. Similar soft coral and sponge habitats were located in research surveys along the eastern border of Shark Bay north of Carnarvon (*Dr. J. Penn*[*]*, pers. comm.*).

There have been several studies looking at the effects of demersal trawls on benthic habitats. 'A Review of Bycatch Issues relevant to the Shark Bay Demersal Trawl Fisheries' (Department of Fisheries, in prep.) discusses these studies in depth. There have been varying results, as summarised by the following:

- Gibbs *et al.,* (1980) - compared epibenthic assemblages in areas before and after trawling in Botany Bay and concluded that otter trawling caused no detectable alterations to the macrobenthic fauna but the large variabilities inherent in their data may account for the non-significant results.

- Laurenson *et al.,* (1993) - compared trawled and untrawled areas of south-western Australia using underwater video and concluded that physical impacts of trawling on the substratum were short-lived.

The study of the effects from trawling (Poiner et al., 1999) completed in the Great Barrier Reef found that:

- There were no significant differences in epifauna between fished and unfished regions but – the unfished regions were likely to have had some level of fishing and many areas within the fished areas may not have been fished;

- One trawl across unfished areas found no detectable impact; and

- Multiple trawls across the same track indicated that each trawl removed about 10% of the material;

- 13 trawls removed 70-90% of epifauna;

[*] *Dr. Jim Penn, Department of Fisheries – Research Division*

- Large areas of the Great Barrier Reef (160,000 km^2) are subject to trawling (at the time of the study) and this may have impacted upon vulnerable species in places where trawling in the same area is substantial (subsequently they have now put in closures such that 35% of the Great Barrier Reef is closed to trawling).

Operational Objective

To ensure that the SBP fishery does not significantly impact upon the coral and sponge habitat in Shark Bay.

Indicator

The amount of the coral and sponge habitat within the permitted trawl area, as a percentage of the total coral and sponge habitat in Shark Bay.

This provides the most meaningful measure of the potential of the fishery to impact on the coral and sponge habitat. Indicators relating to measuring the damage to coral and sponge habitats were rejected, as this would be difficult to measure and also difficult to determine the source of damage.

Performance Measure

No more than 20% of the remaining coral and sponge habitat in Shark Bay to be contained within the legally trawlable area.

Justification

Although it is understood that trawlers cannot fish over hard coral and do not target soft coral and sponge habitat, there is significant soft coral and sponge habitat still within the boundary of the trawl licence area and therefore susceptible to trawling. Assuming the worst-case scenario that all coral (soft and hard) habitats in the trawl licence area is impacted significantly, a refuge of 80% of this habitat outside this area of impact is considered to be precautionary given that some of this habitat would have been removed at the beginning of the fishery.

Data Requirements for Indicator

Information on the distribution of various coral and sponge habitats within the Shark Bay Region is needed.

Data Availability

The information on spatial distributions of coral and sponge on the trawl ground is limited. CALM undertakes a Shark Bay Marine Reserves Monitoring Program, which has incorporated some coral surveys in the bay. It is understood that the surveys have had a strong focus on popular tourist localities within this region, which generally do not include the trawl grounds. Therefore complimentary surveys of areas within the trawl ground may be needed to provide more precise estimates.

The Department of Fisheries will utilise historical trawl survey data and may seek funding and/or alliances with other departments, to better understand the distribution of corals, in particular soft corals, within Shark Bay.

Evaluation

Current estimates of the amount of coral and sponge within the permitted areas suggest that there are significant areas along the borders to the regular trawl grounds and only relatively small amounts remaining in the frequently trawled areas.

Robustness

Low

The robustness of the current estimates is low. More detailed and extensive surveys, or use of aerial photographs should improve this assessment.

Fisheries Management Response

Current: Current prevention of impacts to coral and sponge habitats by the prawn fishery in Shark Bay includes the direct limitation of trawling to the permitted areas, which appear to be mostly sand. The indirect management comes from the avoidance of the coral and sponge areas, in particular hard coral areas, by vessels due to the fact that nets become ripped and dangerous hook ups of the trawl gear occur if pulled over rough ground.

Future: A Draft Bycatch Action Plan has been prepared for this fishery, which recommends that an investigation into the proportion of coral and sponge subject to trawling be undertaken after which recommendations on the trawl grounds would be provided.

Actions if Performance Limit is Exceeded: If it is determined from future surveys that more than 20% of the coral and sponge habitat is contained within the legislated trawlable area, the trawl boundaries may be revised.

Comments and Action

Summary of Actions

- Review historical trawl surveys and seek funding or alliances to better understand the distribution of corals and other habitats within Shark Bay.

External Driver Check List

None.

5.3.1.4 Impact to seagrass habitat

Rationale for Inclusion

There are two forms of seagrass that exist in Shark Bay. One is the attached benthic seagrass forming habitat areas. The other is the detached free-floating seagrass. Benthic seagrass provides an important habitat for some protected species (turtles, syngnathids etc.) in addition to being a significant nursery site for many other marine species. Damage to these habitats needs to be addressed. Benthic seagrass are also particularly vulnerable to damage. It is the benthic, and not the detached, seagrass, which is considered here.

ERA Risk Rating: Impact on habitat ecology and structure (C0 L5 NEGLIGIBLE)

In terms of consequence, the potential impact of the SBP fishery to the seagrass habitat in Shark Bay was considered 'negligible' due to the following:

- As a result of the combination of permanently closed areas under the fishery's management plan and closed areas under the Shark Bay Marine Park management plan, only a very minor area of seagrass is contained within the trawlable area in Shark Bay (Figure 20). Minor damage may occur from fishing around the edges of seagrass banks but this is known to be a rare activity.
- In addition to this, most trawlers actively avoid trawling near seagrass areas as rolls of broken off seagrass get caught in the mouth of the codend causing the net to stop fishing and for the prawns already caught in the net to become entangled and difficult to release.
- The introduction of BRDs will further encourage trawlers to avoid seagrass areas since the grid component of the BRD is highly susceptible to clogging by seagrass balls.

It was considered highly 'likely' that only a 'negligible' impact would result.

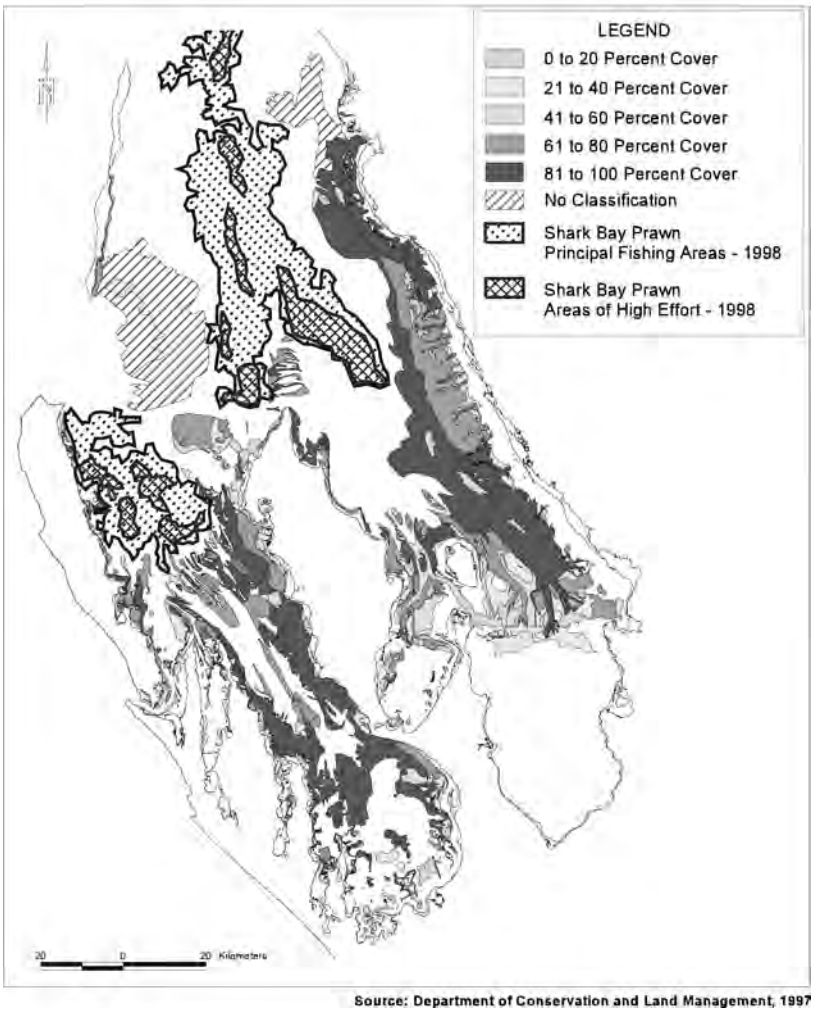

Figure 20. Shark Bay seagrass coverage, principal fishing areas and areas of highest fishing effort.

5.3.2 Addition of materials to the environment

5.3.2.1 Discarding fish

Rationale for Inclusion

Bycatch returned to the sea results in fish, and to a lesser extent crustaceans, being made available to others that would normally not have access to this food source. This may affect the feeding behaviour of some species, particularly predators, and increase abundances of other species throughout the water column and at the surface. For example, dead fish, which sinks to the seafloor becomes available to benthic scavengers – these fish would normally only be available, in that level of abundance, to pelagic predators.

Studies on the fate of discards through the trophic structure have not been undertaken in the SBP fishery, but it is has been looked at in other fisheries:

- Britton and Morton (1994) reviewed this issue and found that discarding has had a "positive" impact on bird population numbers as they can follow the North Sea fleet and consume 50% of the discards. Other benthic fauna can only get what actually falls down on to the seabed and only in the area where they live (Ramsey et al., 1997). Hence, this study concluded that discarding would not have a major impact on immobile benthic species.
- In the Great Barrier Reef trawl fishery, a study showed that the majority of the discards were fish. About 40% of the fish floated and are mostly taken in the daytime by birds, dolphins and sharks (Poiner et al., 1999). Poiner et al. (1999) concluded that because discards are dispersed over the seabed and most scavengers forage over a restricted area discards probably did not cause a measurable seabed impact.
- In Moreton Bay, Queensland, Wassenburg and Hill (1987) found that crabs were a dominant scavenger of bycatch from the prawn trawl fishery, with 30% of their diet coming from this source (note- over 65% of the bycatch material from this fishery sinks). This study also found that trawl discards have become the principal food source for three species of seabirds (Wassenberg and Hill, 1990). It is also thought that larger populations of the blue swimmer crab (*Portunus pelagicus*) occur in Moreton Bay than would normally exist because of the food provided by trawler discards (Wassenberg and Hill, 1987).

In the SBP fishery the ratio of discards to retained species is about 4-8:1. Of this, about 50% of the fish sink, and are mostly dead, becoming available to bottom feeders. Most of the crustaceans sink and many of these are alive when returned.

ERA Risk Rating: Impact to the environment (C2 L4 MODERATE)

The impact of the provisioning as a result of discarding bycatch from the SBP fishery is considered to have a 'moderate' risk. This was a result of the following factors:

- Although many studies have shown that various trophic groups prey upon bycatch species, few studies have found direct conclusive evidence of a resultant change in trophic structure.
- In Shark Bay, there is neither direct scientific evidence nor any anecdotal suggestion of changes to the food web from the removal of particular groups or species, or from food being cycled from the bottom of the sea floor to the surface.
- The area over which organisms are discarded is large and therefore any impacts would be diffused. The amount of discards is estimated to be approximately four to eight times the target catch. Thus

for 1998/99, the estimated discard amounts is 10,925 tonnes (based on five times target catch of 2185t). Over the area of the functional trawl fishery, 2150km^2, this would result in an average of five tonnes of discards per square kilometre, or a total of five grams per square metre. Given the duration of the fishery (8 months), this would equate to less than 1 gram/month of discards and is therefore very minor in terms of the overall productivity in Shark Bay. To account for the fact that discards may not be spread evenly, even if some areas experience ten times this amount of provisioning, i.e. 50g per square metre/year, the impact is still considered to be quite minor. Also, this is likely to be a worst-case scenario as a considerable proportion of the bycatch is crustaceans and elasmobranchs, which have a high survival rate and therefore do not contribute to the provisioning.

- While dolphins have been known to follow the vessels for discards, the amount of discards that result in this fishery (five tonnes of discards per square kilometre) is not significant. Furthermore, the discards from this fishery are seasonal since the fishery only operates for 8 months of the year. Therefore dolphins are still reliant on their normal feeding habits to sustain them through the year.
- The introduction of BRDs and the fish exclusion mesh panels in the SBP fishery will further reduce provisioning as BRDs reduce the amount of bycatch generated by the fishery and therefore a reduction in the amount of discards.

The impact of provisioning by the SBP fishery was not considered 'minor' due to the following factors:

- Trawling is considered to provide some specific 'benefit' to some seabird populations by aggregating food items normally at very low densities in the water column.
- It has been suggested that pied cormorants in Shark Bay (and crested tern populations in Exmouth Gulf) have increased in abundance as a result of discards from the inshore trawl fisheries (*Dr. N. Dunlop*[*]*, pers. comm.*).
- Increasing numbers of breeding cormorants can induce significant changes to the vegetation structure on small islands, often to the detriment of other wildlife (*Dr. N. Dunlop*[*]*, pers. comm*).
- Dolphins and sharks are known to follow trawlers in anticipation of a feed from discards.

It should be noted that reducing the bycatch with the use of BRDs could have a negative effect on the abundance of species, which have developed an association with discarded bycatch.

Operational Objective

To reduce the level of discards, which in turn will minimise the possible changes in trophic structure from provisioning.

Justification

The objective to manage the amount of discards was chosen over an objective relating to reducing the impact on trophic level due to discarding because the identified consequences were not major at current levels of discarding. Given this, it is considered that the most appropriate management objective would be to minimise the opportunity for this to occur, by reducing the amount of discards.

[*] *Dr Nic Dunlop, Conservation Council of WA*

Indicator

Ratio of discards to target catch

Changes in the current range of bycatch to catch ratios (or ratios once full implementation of BRDs complete) may indicate changes in fishers' behaviour in targeting prawns, abundance of bycatch species and/or prawns or lack of quality control with respect to the functioning of BRDs.

Amount of discards per season

The amount of discards will be monitored at intervals as the long-term measure of the performance against the objective.

Performance Measure

Reduction in the ratio of discards to target catch from pre-bycatch reduction device levels. Reduction in the amount of discards from pre-bycatch reduction device levels.

Justification

It is necessary that a precautionary approach be adopted since there is an absence of empirical data on the impact that discard provisioning has on the ecosystem. The precautionary approach is that the level of discards will not be increased beyond existing levels and preferably is reduced.

Data Requirements for Indicator

Data required to measure the indicator:

- Amount of discards. This would need to be gathered by observers, undertaking a bycatch observer program, on a five-year interval.
- Ratio of target catches to discards. To establish this data on the amount of target catch would be required in addition to the amount of discards (above).

Data Availability

Amount of discards: As a result of the observer program that has been conducted over the past four years in the SBP fishery, there was data collected on the amount and proportion of discards generated by the fishery. This observer program will likely cease following the full introduction of BRDs and as a result will not provide an on-going source of this data.

In order to measure the performance of the fishery in future years it will be necessary to undertake additional observer programs. It is intended to undertake a bycatch survey observer program every five years, in order to monitor the effectiveness of the bycatch reduction devices at reducing discards.

The amount of prawns caught is already recorded as part of the standard monthly catch returns.

Evaluation

A significant reduction in the amount of discards has resulted from the partial introduction of BRDs and this will continue to reduce with the full introduction of BRDs.

Evaluation of this indicator will be undertaken every five years.

Robustness

Low

The amount of discards will be determined based on industry log book data. As this is fishery-dependent the accuracy is expected to be low.

Fisheries Management Response

Current: BRDs are currently being introduced to the SBP fishery. Vessels have been fishing with one BRD and one standard net for the last two seasons and will fish with 100% BRDs from the commencement of the 2002 season. This is expected to reduce discards to a level that can be considered best practice, which will set the maximum allowable discard level.

Future: It is expected that new and improved designs of BRDs will be developed over the coming years. The Department of Fisheries encourages the development of gear that is capable of further reducing bycatch.

Actions if Performance Limit is Exceeded: In the event that the amount of discards increases, a report will be commissioned to investigate and document the reason for the increases. If the reason for the increase in discards requires management intervention, the following options should be investigated:

- Reducing bycatch through spatial or temporal closures.
- Further improvements to BRDs to reduce bycatch.
- Introduce effort restrictions to reduce catch of bycatch.

Comments and Action

Summary of Actions

- Introduce 100% BRDs in 2002; and
- Department of Fisheries research to monitor amount of discards on a five-year basis.

External Driver Check List

None.

5.3.3 General impacts on the environment

5.3.3.1 Creation of turbidity from trawling

Rationale for Inclusion

The interaction between the trawl gear and sea bottom has the possibility of raising sediments into the water column, resulting in increased turbidity. If the turbidity as a result of trawling, was above the natural level of turbidity, then that could have implications for the local communities by reducing light availability for seagrass, or by smothering benthic organisms such as sponges and corals.

ERA Risk Rating: Impact on the environment (C0 L5 NEGLIGIBLE)

The consequence of trawling in relation to the impact on turbidity was considered 'likely' to be 'negligible'. Due to the strong currents and tides in Shark Bay any turbidity caused by trawling would

not be measurable and therefore, insignificant compared to that caused by natural water movements (*Dr. J. Penn*[*]*, pers. comm.*).

Also, surveys of sediment composition over all trawl grounds (Hall and Penn, 1979) indicated that the majority of the ground was coarse-sand dominated. That is less than 10% of the sediment samples taken contained a noticeable mud component (>10%).

The softer sediment areas tended to be in more offshore locations away from seagrass areas. Secondly, the major source of turbidity in Shark Bay is from river outflow following cyclonic rains.

5.3.3.2 Translocation

Rationale for Inclusion

The movement of fishing vessels provides a mechanism for marine species to be transported beyond their natural range. In the extreme circumstance, fishing vessels could provide a vector for disease and exotic species. The hulls of the prawn trawl vessels alone mainly provide the opportunity for translocation to occur since these vessels do not contain ballast.

ERA Risk Rating: Impact on the environment (C0 L5 NEGLIGIBLE)

This risk of translocation of species occurring as a result of this fishery was considered 'likely' to be 'negligible' as vessels in Shark Bay have little interaction with fisheries in other regions and although some vessels have licences to operate in northern trawl fisheries, these are generally not utilised. Any change to this would result in a reassessment of the risk.

Vessels often move to Fremantle for seasonal maintenance. There is a connection of species along the western coast due to the Leeuwin Current. The only known feral species in the Fremantle area is the fan worm *Sabella* sp., which is a temperate species and unlikely to survive if transported to the Gascoyne tropical waters on trawl vessel hulls. It should also be noted that most vessel hulls undergo cleaning at the commencement of each season before movement back to the Gascoyne region.

[*] *Dr. Jim Penn, Department of Fisheries – Research Division*

5.4 GOVERNANCE

COMPONENT TREE FOR GOVERNANCE OF THE SBP FISHERY

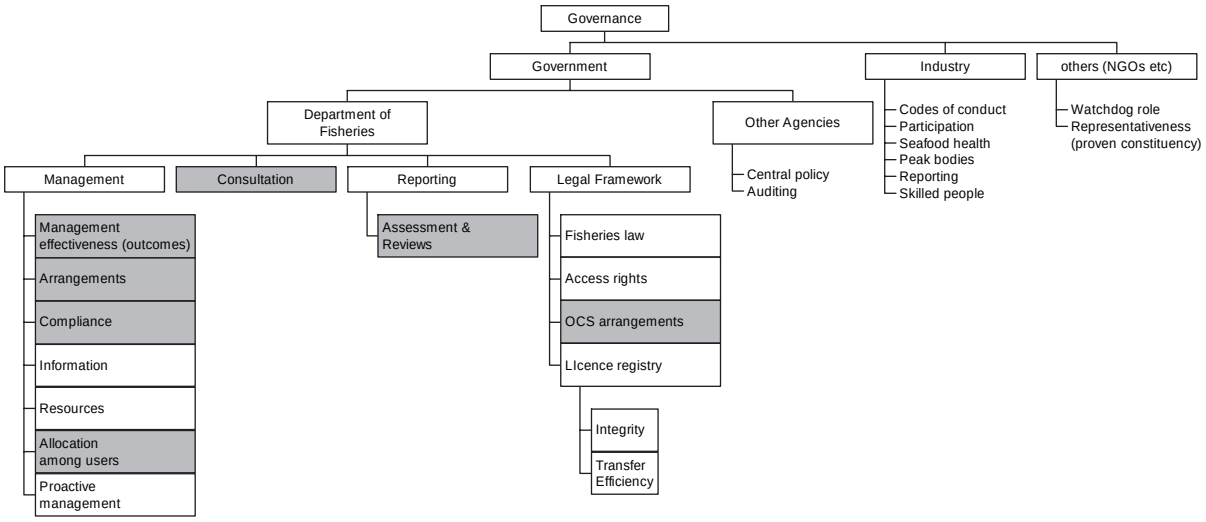

Figure 21. Component tree for governance of the SBP fishery.

Note: no generic components have been removed from the tree but only those boxes that are grey will be reported in this report.

5.4.1 Department of fisheries – management

5.4.1.1 Management effectiveness (outcomes)

Rationale for Inclusion

The effectiveness of management activities (eg. spatial and temporal closures, gear controls, limited entry) should ultimately be reflected by the extent to which the fishery continues to produce expected outcomes (maintaining prawn catches at acceptable levels for the individual species as well as the collective group). In Sections 5.1.1.1, 5.1.1.2 and 5.1.2.1, the catches for individual prawn species were discussed and analysed, therefore this section will look at the cumulative catch and assess whether current management arrangements are maintaining the total catch for all prawn species within an acceptable range. Thus, if the annual acceptable catch range of prawns is maintained then the community's expectation that variations in annual catch result only from annual changes in environmental conditions, or planned changes to the management of the level of commercial exploitation and not from depletion of stock will be continued. Any large unexplained variation in catch, particularly any significant and unexpected reduction in catch, is likely to be a reflection of a reduction in the management effectiveness and therefore reduce the community's confidence in the management of the resource and raise concerns about the on-going sustainability of the fishery.

Operational Objective

The commercial catch of all prawns is maintained within an acceptable range on an annual basis.

Justification

If all management arrangements developed for this fishery, including the restrictions on effective effort levels, compliance with the regulations is being maintained effectively, combined with our understanding of the size of the exploitable stock - then the total catch for the major prawn species caught (king, tiger and endeavour prawns) should be within the historical acceptable range. Any variation outside this range or below the level would elicit the need to explain the cause of this deviation from the expected.

Indicator

The total catch compared to historical acceptable range for the three major penaeid species in the SBP fishery.

Performance Measure

Under current fishing effort levels, the catch projections for this fishery are that the total catch of major penaeid species should be within the range of 1,611 – 2,183 tonnes but within this overall figure consideration needs to be given to catches at the species level, particularly for tiger prawns (see Section 5.1).

Justification

The justification for the individual levels for each penaeid species is located in Section 5.1.

Data Requirements for Indicator

The following data is required for this indicator:

Data Requirement	Data Availability
Commercial catch and effort.	Yes – obtained annually.
Historical catch levels.	Yes - records available and accessible.
Level of fishing effort and fishing power.	Yes – number of vessels, days fished, hours trawled, areas of operation and activity and fishing power comparisons readily available.
Environmental indicators.	Yes – key environmental indicators readily available.

Evaluation

Summary: Historical catch and effort information indicate that the acceptable catch range for the major prawn species is being maintained. Therefore, the performance measure has not been triggered and current management strategies appear to be effective in achieving the overall objectives for the fishery.

The total catch of the major penaeid species by the SBP fishery was 2,250 tonnes in 2000, which is just above the acceptable catch range (Table 5). This was caused by the higher than average king prawn catch linked to the sea temperature, which resulted in the high catchability of king prawns.

Robustness

Medium/High

The data required for the indicator in most cases are readily available. However the changes in fishing power and fleet efficiency through time need to be evaluated and considered in these analyses to ensure that the measures continue to be relevant.

Fisheries Management Response

Current: The management measures imposed to achieve the objective for the total catch (see above) also serve to achieve the objective of maintaining the spawning stock for the major prawn species caught at or above level, which minimises the risk of recruitment overfishing.

Historically, variations in catch outside of the acceptable range have been explained either in terms of increased fishing effort, increased fishing efficiency or seasonal environmental factors. The response to this has been to reduce fishing effort (e.g. spatial or temporal closures) with a focus on limiting the exploitation of tiger prawn breeding stock and to develop a predictive model to take account of environmental factors such as sea surface temperature and ENSO, El Ninó and La Nina events.

The decline in tiger prawn catches observed in this fishery in the 1980s, lead to the instigation of management actions to improve the spawning stock size of tiger prawns (see Section 5.1.1.1). Although tiger prawn stocks responded favourably to the management actions implemented, changes to the fleet efficiency is carefully monitored to ensure that tiger prawn spawning stocks are not over-exploited. Different to the two other prawn species caught in this fishery, tiger prawn stocks are managed by measuring the catch and effort rate of the fleet, not the total catch.

Future: The Department of Fisheries is doing further work to both improve the measurement of fishing efficiency and understanding the relationship between stock-recruitment and environmental factors and catch. The agency will continue to use input controls to adjust for variations in fishing efficiency. In addition, since 1993 fishery independent recruitment trawl surveys have been conducted. The indices developed from these surveys will lead to fishery independent measures of both spawning stock and recruitment levels and may lead to some catch prediction in the future.

When a long enough time series has been established, the Department of Fisheries will look at managing the prawn species in the fishery on a spatially based CPUE. Furthermore, the introduction of the VMS will lead to the ability of the Department of Fisheries to collect and analyse data on the area swept by this fishery and individual trawlers.

Actions if Performance Limit is Exceeded: If the catch is outside of the range of expected values then a review of the causes would be undertaken. This review would examine why the acceptable catch range was not met. If this variation is not explained by changes in effort or environmental variations or a peculiarity of fleet dynamics/behaviour then strategies that offer further protection to the breeding stock will need to be considered. These strategies could include:

- Further reductions in the total effort expended in the fishery through a reduction in the length of the fishing season or within season closures; and/or extension of moon closures.
- Additional area closures.

These actions can be initiated within a season or prior to the beginning of the next season.

Table 5. Total catch of the major prawn species for SBP fishery, 1962–2000.

YEAR	KING CATCH (t)	KING CATCH (kg/hr)	TIGER CATCH (t)	TIGER CATCH (kg/hr)	ENDEAVOUR CATCH (t)	ENDEAVOUR CATCH (kg/hr)	TOTAL PRAWN (t)	SCALLOP CATCH (t)	EFFORT (hrs trawled)	NUMBER BOATS
1962	105	43.3	47	19.3	-	-	152	-	2 420	4
1963	359	36.3	244	24.5	-	-	603	-	9 898	22
1964	506	36.2	407	29.1	-	-	913	-	13 960	28
1965	443	24.8	397	22.2	-	-	840	-	17 861	28
1966	261	13.6	406	21.2	-	-	667	-	19 211	29
1967	228	7.2	673	21.3	-	-	901	-	31 644	30
1968	414	11.4	499	13.7	-	-	913	-	36 379	29
1969	789	21.4	460	12.4	-	-	1 259	-	37 210	27
1970	1043	21.4	732	15.0	-	-	1 775	-	48 667	32
1971	937	20.2	609	13.1	-	-	1 546	-	46 483	32
1972	1383	26.8	369	7.2	-	-	1 752	-	51 522	31
1973	1186	23.0	636	12.4	-	-	1 822	-	51 474	32
1974	1433	27.6	668	12.9	-	-	2 101	-	51 814	32
1975	1383	25.1	770	14.0	-	-	2 153	-	55 134	35
1976	1511	24.6	771	12.6	-	-	2 282	-	61 340	35
1977	1071	18.2	550	9.4	36	< 1	1 657	-	58 757	34
1978	1371	23.9	729	12.7	13	< 1	2 112	-	57 244	35
1979	1439	23.0	660	10.5	38	< 1	2 137	-	62 655	35
1980	1398	24.2	253	4.4	17	< 1	1 668	-	57 786	35
1981	2014	28.4	324	4.6	32	< 1	2 370	-	70 904	35
1982	1328	21.8	236	3.9	25	< 1	1 589	139	60 788	35
1983	1499	25.3	477	8.1	28	< 1	2 004	65	59 137	35
1984	1693	26.6	351	5.5	18	< 1	2 062	52	63 750	35
1985	1532	23.1	236	3.6	24	< 1	1 792	58	66 410	35
1986	1494	23.3	325	5.1	13	< 1	1 832	48	64 009	35
1987	1477	23.0	274	4.3	9	< 1	1 760	114	64 300	35
1988	1627	26.2	259	4.2	17	< 1	1 903	186	62 168	35
1989	1069	18.4	300	5.2	4	< 1	1 373	49	57 923	35
1990	730	16.5	270	6.1	2	< 1	1 002	169	44 233	27
1991	1155	25.9	406	9.1	< 2	< 1	1 561	616	44 592	27
1992	964	23.1	362	8.7	< 1	< 1	1 326	1268	41 681	27
1993	790	15.5	365	7.2	< 1	< 1	1 155	465	50 888	27
1994	1059	18.2	548	9.4	4	< 1	1 611	272	58 092	27
1995	1110	19.1	784	13.5	3	< 1	1 897	173	58 242	27
1996	1136	19.2	731	12.3	13	< 1	1 880	125	59 232	27
1997	1433	24.5	626	10.7	4	< 1	2 063	101	58 393	27
1998	1614	28.7	538	9.6	32	0.6	2 185	75	56 175	27
1999	1656	30.4	579	10.6	25	0.5	2 261	90	54 523	27
2000	1555	29.9	689	13.2	6	0.1	2 250	25	52 049	27

Note: The 1981 effort and catch rate data in this table has been estimated from main engine hour records, as the log book system was not operational in 1981. Catches are measured to the nearest tonne, heads on. The number of boats refers to the maximum number of vessels that fished during any one month.

Comments and Action

While the Department has been able to maintain the catch of tiger, king, coral and endeavour prawns within acceptable levels, it continues to work on improving and refining the methods used to determine breeding stock estimates. The use of GIS systems for analysing data has commenced.

External Driver Check List

Environmental factors such as: climatic changes, cyclonic activity impacting habitat, ocean currents and sea-surface temperatures are known to impact upon recruitment and therefore are likely to impact the level and productivity of prawn breeding stocks. In Shark Bay, the Leeuwin Current can have an impact on larval settlement, survival and subsequent recruitment strength. Over the coming years, the relationship between recruitment of prawns and the Leeuwin current will be investigated to determine if a predictable relationship is possible.

5.4.1.2 Arrangements

Rationale for Inclusion

In Western Australia, a number of instruments are used to articulate the management arrangements for fisheries. The FRMA has elements that affect all fisheries in addition to this there are Management Plans, Orders, Regulations, Ministerial Guidelines and Policy Statements. In cases where current management arrangements were developed under the previous Act (as was the case for the SBP fishery), whilst the terminology is different (see Table 6 for details), the powers from the old Act have been transferred under various sections of the Transitional Provisions of the FRMA (**S 266** Savings and transitional provisions - Schedule 3 parts 8-12, 15-19).

The "Shark Bay Prawn Managed Fishery Management Plan" (the SBP Plan), which, in effect, is a set of rules as to how the fishery will operate, obtains its authority from the FRMA and, in conjunction with the Fish Resources Management Regulations 1995 (FRMR) and any relevant Ministerial Policy Guidelines, is the vehicle through which the fishery is managed. The SBP Plan and the associated documentation (which includes the ESD report) do include all information expected to be in a "Best Practice" set of management arrangements (as defined in the Department's ESD Policy - Fletcher 2002).

These arrangements should contain:

1. An explicit description of the management unit.
2. The issues addressed by the plan including the criteria to operate in the fishery, the manner of fishing, the fishing season, fishing zones, licence renewals, transfers and cancellations, fishers offences and major provisions and process for amending the plan.
3. Descriptions of the stocks, their habitat and the fishing activities.
4. Clear operational (measurable) objectives and their associated performance measures and indicators.
5. Clearly defined rules, including what actions are to be taken if performance measures are triggered.
6. Economic and social characteristics of the groups involved in the fishery
7. Management and regulatory details for the implementation of the actual management plan.
8. The reporting and assessment arrangements.
9. How and when reviews of the plan will occur (including consultation mechanisms).
10. A synopsis of how each of the ESD issues are being addressed.

In the future, Ministerial Policy Guidelines will be developed to incorporate the ESD report, including all performance measures, responses and information requirements within one year and will include a clear timeframe for implementation. These guidelines will also include timeframes for all management responses and set out procedures to enable the amendment of management arrangements to respond to new information. All changes to the management plan or arrangements will be reported to DEH. The implementation of a decision rule to close the fishery or prevent commencement of the fishing season, when recruitment of scallops is sufficiently low will be developed as a priority.

Guidelines will also be developed to address permitted byproducts with a robust system developed to add or remove species as appropriate. Suitable catch triggers will be developed to ensure any changes in targeting behaviour can be determined and be addressed within clear timeframes. These guidelines will include mechanisms for any cross-jurisdictional activities regarding relevant target and byproduct species, including squid.

Table 6. Comparison of terminology.

Old Act	New Act (FRMA)
Limited Entry Fishery	Managed Fishery
Notice	Order
Arrangement	Arrangement

Operational Objective

The Department of Fisheries, in consultation with the SBPMAC and other stakeholders, maintain a watch brief on the management plan, related legislation, regulations and arrangements to ensure it remains relevant and aligned with the fishery's management objectives and that collectively they cover the 10 main principles.

Justification

To have an effective and understandable plan for the management of this fishery with all of the 10 principles covered within the suite of arrangements developed for the fishery.

Indicator

The extent to which the management plan and supporting documentation addresses each of the issues and has appropriate objectives, indicators and performance measures, along with the planned management responses.

Performance measure

This should be 100%.

Evaluation

As an over-arching sub-component the performance of the management arrangements is evaluated on two levels – the micro level, i.e. the relevance of individual clauses and the role they play and on the macro level, i.e. the relevance of the plan as a whole and the role that it plays.

Current Performance against each of the areas required within the "plan"[2]:

[2] *"Plan" – includes all management arrangements*

1. **An explicit description of the management unit** – The management unit is explicitly described within the "Declaration of the Fishery" section of the SBP Plan.
2. **The issues addressed by the plan** –The issues that need to be addressed by the SBP plan and are documented within the eight ESD component trees and their reports.
3. **Descriptions of the stocks, their habitat and the fishing activities** – the SBP stock is well described in Section 2.1 and the fishing activities are described in Section 2.2.
4. **Clear operational (measurable) objectives and their associated performance measures and indicators** – These are now located in Section 5 for each of the major issues.
5. **Clearly defined rules, including what actions are to be taken if performance measures are triggered** – For each of these major issues, the management actions that are planned to be taken if performance limits were exceeded are articulated in Section 5.
6. **Economic and social characteristics of the groups involved in the fishery** – A brief articulation of the economic and social characteristics is located in Section 3.3 and there is to be a greater level of detail accumulated during the process of completing the remainder of the ESD components.
7. **Management and regulatory details for the implementation of the actual management plan** – The regulations relating to the SBP fishery are located in both the SBP Plan and the FRMR and orders (A set of which has been provided to EA).
8. **The reporting and assessment arrangements** – These arrangements are documented in Section 5.4.4.1 and include annual reporting against current agreed performance limits and targets and a five yearly review of these arrangements and assumptions.
9. **How and when reviews of the plan will occur (including consultation mechanisms).** – A watching brief is maintained by the Department of Fisheries and SBPMAC on the functionality of the management arrangements. The FRMA clearly sets out how the process for the review of any management plan must occur.
10. **A synopsis of how each of the ESD issues is being addressed** – A synopsis of ESD issues has been compiled within the Overview Table of this report.

Robustness

High

The management plan and related legislation represent a comprehensive set of fisheries management legislation that is performing well. The fact that the management arrangements are contained within legislation provides a high degree of stability with respect to how the fishery is managed. This said, the processes for achieving management plan changes are well understood by the majority of stakeholders and the system is flexible enough for the management process to respond to change stimuli.

Fisheries Management Response

Management has successfully administered the management plan and related legislation to achieve the broad objectives of the FRMA.

Comments and Action

The fishery is managed in a dynamic and consultative way (i.e. responds readily to changed circumstances), but fishers are often resistant to change; this means that before effort-reduction methods

are accepted by fishers, they require evidence of the need for such measures. While most fishers have a very high level of confidence in the Department's research activities, sometimes members of the industry demand certain knowledge before accepting the need for change and can be sceptical of research findings no matter how statistically valid. Individual fishers' views can understandably be greatly influenced by their own experiences and observations while fishing that sometimes may give them a contrary view of the state of the fishery. Nonetheless, there is generally a very good relationship between fishers and the Departmental research scientists and most will accept the advice of the researchers (albeit after questioning it in the context of their own experiences).

The commercial success of the fishery also appears to have encouraged many fishers to be somewhat risk averse and inclined to a very conservative approach to managing the fishery (particularly given their level of investment). While this encourages an attitude of avoiding risks to the sustainability of the fishery, it can also sometimes make some fishers resistant to changes in fishing rules that are designed to ensure sustainability. There is also sometimes a failure to recognise that the success of the fishery is in part due to a history of adaptive management. Proposed changes are often questioned on the basis that: "as the fishery is operating successfully why, should any changes be necessary or contemplated?"

External Driver Check List

- Resistance of fishers to change
- Reluctance of Minister or ED to exercise power

5.4.1.3 Compliance

Rationale for Inclusion

Effective compliance is vital to achieve the successful implementation of the management arrangements of any fishery. This involves a mix of sea and land patrols, radar watches, aerial surveillance and since 2000, a VMS.

Operational Objective

To have sufficiently high levels of compliance, which give confidence that, the management arrangements are effective.

Justification

The activities of the participants in the fishery need to be sufficiently consistent with the management framework and legislation to make it likely that the expected outcomes and objectives of the fishery will be achieved.

Indicators

The levels of compliance with the legislation, including the estimated level of illegal landings.

Degree of understanding of rules governing operation of the fishery by licensees and the broader fishing community.

Performance Measure

Currently, the performance measures are under development but given the structure of this fishery the measures will be developed sensibly and include all players.

Data Collection Requirements and Processes

Random Inspections of vessels at sea and port.

Ongoing collection of data on illegal activities.

Comparative data on the relative effectiveness of certain compliance techniques.

VMS and other vessel surveillance data.

Evaluation

For the SBP fishery, three offences were reported in 2000 and in 2001 only two infringements were given out. Thus current compliance techniques used in the SBP fishery are maintaining compliance by the fishers. Sea patrols and radar watches are conducted on a random basis during the season. Aerial compliance checks are also conducted throughout the season. Compliance operations are mainly focused on maintaining the integrity of the nursery areas within the Fishery. The compliance staff also conducts licence and gear inspections both at sea and port.

With the introduction of VMS to this Fishery in 2000, it was expected that random patrol activities would decrease overtime while targeted patrols investigating specific incidences would become the major focus of patrol activities.

Currently, a FRDC project is underway to examine compliance in the Western Rock Lobster fishery. This project aims to develop data collection, analysis and reporting protocols for all Western Australian recreational and commercial fisheries.

Robustness

Medium

The difficulties in identifying every illegal activity will remain.

Fisheries Management Response

The Regional Services division of the Department continues to gather intelligence on suspected and known illegal activity within the fishery and does so by using state of the art technology and sound procedures.

Comments and Action

The Department will continue to provide high standard compliance service to the SBP fishery. In 2000, the VMS was introduced into the SBP fishery, which enables the Department of Fisheries to monitor a vessels location, direction and speed. This allows for particular attention to be paid to the surveillance of nursery areas.

External Driver Check List

Changes to technology that may facilitate an increase the level of non-compliance.

5.4.1.4 Allocation among users

There is no recreational component to this fishery.

5.4.2 Department of Fisheries – legal arrangements

5.4.2.1 OCS arrangements

Although the licence area for the SBP fishery does extend into Commonwealth waters the functional fishing area of the fishery is within the State waters boundary.

5.4.3 Department of Fisheries – consultation

5.4.3.1 Consultation

Rationale for Inclusion

The FRMA has certain requirements with regard to consultation that must be undertaken in the course of managing fisheries. The management of the prawn fishery is based around a very extensive consultation and communication process.

There are sections in the FRMA that relate to the development of a management plan (Section 64) and to the amendment of a management plan (Section 65). Given that the SBP already has a management plan, Section 65 is the most relevant.

This states that:

S 65. Procedure before amending management plan

(1) A management plan must specify an advisory committee or advisory committees or a person or persons who are to be consulted before the plan is amended or revoked.

(2) Before amending or revoking a management plan the Minister must consult with the advisory committee or advisory committees or the person or persons specified for that purpose in the plan.

(3) Despite subsection (2), the Minister may amend a management plan without consulting in accordance with that subsection if, in the Ministers opinion, the amendment is –

(a) required urgently; or

(b) of a minor nature

(4) If –

(a) the Minister amends a management plan; and

(b) the amendment is made without consultation because it is, in the Minister's opinion, required urgently,

the Minister must consult with the advisory committee or advisory committees or the person or persons specified for that purpose in the plan as soon as practicable after the plan has been amended.

In addition, under clause 10 of the Management Plan, the ED can only make decisions after consultation with the licence holders.

The particular committee, which must be consulted for the SBP fishery is designated in the management plan as the SBPMAC. Section 41 gives the Minister the power to formulate a committee and create an instrument, which is gazetted to establish a committee.

In the future, opportunity will be provided to conservation, community and recreational fishing interests to participate in the processes of the main advisory body to the WA Fisheries minister for this fishery. Any relevant indigenous interests will also be considered through appropriate consultative mechanisms.

Operational Objective

To administer a consultation process that is in accordance with the requirements of the FRMA and the Management Plan, allowing for the best possible advice from all relevant stakeholders to be provided to the decision maker (Minister/ED) in a timely manner.

Indicators

- The Minister or the ED (or the Department on their behalf) conforms to the consultation requirements of the FRMA and the Management Plan.
- The level to which licencees consider that they are adequately and appropriately consulted.

Performance Measures

Advice provided to the Minister following each SBPMAC meeting.

Proper consultation procedures have been followed in any amendment of the management plan or any declarations under clause 10 of the Management Plan.

License holders and skippers meetings held annually.

Data Requirements

Views on the SBPMAC and related consultation processes collected from stakeholders at each annual meeting.

Documentation of the formal consultation procedures followed when an amendment is made.

Evaluation

Consultation on management of the prawn fishery is conducted in an open, accountable and inclusive environment where all sectors of the industry and the Departments managers and researchers collectively identify and discuss appropriate courses of action.

Decision makers take due notice of advice provided on the basis of this consultation and give reasons for any decisions, which vary from consultation-based advice.

Robustness

High

The consultation process is extremely well understood with relatively high levels of participation from the various stakeholder groups.

Fisheries Management Response

The Department has strong links to the trawl industry through a formal statutory process. Under Section 41(2) of the FRMA the SBPMAC has the function to "*provide information and advice to the minister on matters related to the protection and management of the fishery*".

Membership of the SBPMAC comprises; an independent Chairperson; ED; an officer from the Department; and commercial prawn fishers. Terms of appointment are usually for two years however members can seek to be reappointed for additional terms.

SBPMAC has a number of sub-committees, which are chaired by SBPMAC members, which receive input from MAC and industry members.

The Department does, however, also provide independent advice to the Minister on the implications of any proposal from SBPMAC, or any other body.

Comments and Action

The Department will continue to maintain a consultation body (such as the SBPMAC) for the SBP fishery.

External Driver Check List

Despite the robustness of the SBPMAC and other consultation processes used, disaffected parties may still seek to use political avenues to further their cause.

5.4.4 Department of Fisheries – reporting

5.4.4.1 Assessments and reviews

Rationale for Inclusion

It is important that the outcomes of the fisheries management processes administered by the Department for the SBP fishery are available for review by external parties. It is also important that the community is sufficiently informed on the status of this fishery, given that it is utilising a community resource. The reports that are currently provided annually are: the State of the Fisheries Report, the Annual report to the OAG; more irregular reports include the Parliamentary Inquiry, the ESD report, and an application to EA. There is a longer-term plan to have the entire system of management audited by the WA Environmental Protection Agency.

Operational Objective

Current: To report annually to the Parliament and community on the status of the fishery.

Future: To develop an independent audit process for the fishery at appropriate intervals. To develop a process where all protected species interactions by commercial operations should be reported and coupled with an education program to ensure industry has the ability to make accurate reports.

Indicators

- The extent to which external bodies with knowledge on the management of fisheries resources have access to relevant material.
- Level of acceptance within the community.

Performance Measure

General acceptance of the management system by the community.

Data Requirements

The majority of data required to generate reports is already collected in the course of pursuing resource management objectives. The Department conducts an annual survey of the community with respect to its opinion on the status of the State's fisheries and their attitudes to the performance of the Department.

Evaluation

The Department has implemented more than one process to report on the performance of this fishery and in doing so has ensured that the community has access to this information.

In addition to this base level reporting the development of a new process that will see the fishery undergo regular independent audits ensures this sub-component is well in hand.

The Department has been the recipient of a number of awards for excellence for its standard of reporting - Premiers Awards in 1998, 1999 for Public Service excellence, Category Awards in Annual Reporting in 1998, 1999, 2000; Lonnie Awards in 2000, 2001.

Current Reporting Arrangements for this fishery include:

State of Fisheries

Annual reporting on the performance of the fishery against the agreed objectives within the STATE OF THE FISHERY REPORT. This document is available in hard copy format but is also available from the Department's web site in PDF format.

Annual Report

A summary of this report is presented within the Department's Annual Report and is used in some of the Performance Indicators that are reviewed annually by the OAG. The OAG also periodically audits the information (both the data and processes) used to generate these reports.

ESD

This ESD Report (of which the material in the application was a subset), not only covers the environmental aspects of the fishery but the full social and economic issues. It is now available from the website.

Reports to Industry

Each year, the status of the resource, effectiveness of current management and any proposals for alterations to arrangements are presented to license holders and skippers. This includes the production of a summary report, which is provided to the audience.

Robustness

High

Fisheries Management Response

Current: For many years the Department has produced substantial and high quality documents that report on the operation of the Department and the status of its fisheries (including the SBP fishery)– these reports are the Annual Report and the State of the Fisheries.

Future: In line with the new Commonwealth Government requirements the Department of Fisheries is in the process of developing a tri-partite memorandum with the Western Australian Environmental Protection Authority and the OAG to conduct a regular audit of the fishery.

Comments and Action

The processes already established and those new external review processes that are all but established ensure that there will be many opportunities for appropriateness of the management regime and importantly the results it produces to be reviewed.

External Driver Check List

The assessments provided by independent review bodies and the community.

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7.0 Appendices

APPENDIX 1. TERMINOLOGY

Terminology for trawl gear

Booms	Steel structures to support trawl gear, outboard of the boats centre line.
Bridles	Wire rope connecting otter boards to towing warp. The bridle length in this fishery is 25 to 30 fathoms.
Codend	Netting connected to the end of the trawl net to gather the accumulated catch during each tow. The end of the bag can be opened by releasing a drawstring and then the contents can be emptied onto the boats sorting table.
Drop chain	Length of chain (approximately 150mm) connecting footline to ground chain at about 1m intervals. This results in a gap between the footline and the ground chain that allows benthic objects to pass beneath the trawl net.
Footline	Lower frame line to which netting is attached in a trawl.
Ground chain	The chain is of similar length to the footline and travels across the seabed. Prawns and scallops react to the oncoming chain by rising from the substrate and into the net over the footline.
Headline	Upper frame line to which netting is attached in a trawl.
Lazy line	Rope connected to the codend to allow it to be hauled onboard the boat.
Lead-ahead	Where the headline is forward of the footline to form a verandah of netting to prevent prawns from escaping over the head line when they are disturbed by the ground chain.
Net	On a trawl, consists of netting hung between two frame lines. The lower frame line includes the ground chain that is connected by drop chains. Mesh size permitted in this fishery is no greater than 60mm.
Otter board	A solid device set at an angle of attack to the tow direction to generate a lateral hydrodynamic force to spread or open the net or trawl system.
Spread	Is the lateral distance that the headline is opened while the gear is working. Spread is expressed as a percentage of headline length and is called spread ratio.
Warp	Main towing wire from booms to bridle.

APPENDIX 2. ATTENDEES LISTS

A2.1 Workshop 1

Attendees:

Bill Aird, Denham RFAC

David Adams, Exmouth RFAC

Emma Hopkins, Department of Environmental Protection

Felix Correia, Correia Holdings Pty Ltd.

Fred Wells, Snr Curator WA Museum

Heidi Grief, Department of Fisheries

Graeme Stewart, Industry – Shark Bay Prawn

Guy Leyland, WAFIC

Hamish Ch'ng, Industry Shark Bay Scallop

Jim Penn, Department of Fisheries

Jo Bunting, Department of Fisheries

Keith Shadbolt, Denham RFAC

Kerry Truelove, EA

Lindsay Joll, Department of Fisheries

Malcolm McGowan, Industry – Shark Bay Scallop

Mark Flanigan, EA

Martin Holtz, Recfishwest

Mervi Kangas, Department of Fisheries

Nic Dunlop, Conservation Council of WA

Nick D'Adamo, CALM

Paul Bowers, Aboriginal Lands Trust

Phil Unsworth, Department of Fisheries

Prof Di Walker, University of Western Australia

Richard Patty, Norwest Seafood

Rick Fletcher, Department of Fisheries

Rod Berg, Office of the Auditor General

Stephen Hood, Industry – Exmouth Gulf Prawn

A2.2 Workshop 2

Attendees:

Bill Aird, Denham RFAC

Bob Hoult, Denham

David Adams, Exmouth RFAC

Errol Sporer, Department of Fisheries

Felix Correia, Correia Holdings Pty Ltd.

Heidi Grief, Department of Fisheries

Hamish Ch'ng, Industry Shark Bay Scallop

Jenny Shaw, Department of Fisheries

Jim Penn, Department of Fisheries

Jo Bunting, Department of Fisheries

Keith Shadbolt, Denham RFAC

Les Moss, Shire of Shark Bay

Lindsay Joll, Department of Fisheries

Mark Hook, Shire of Shark Bay

Martin Holtz, Recfishwest

Mervi Kangas, Department of Fisheries

Nic Dunlop, Conservation Council of WA

Paul Bowers, Aboriginal Lands Trust

Prof Di Walker, University of Western Australia

Richard Patty, Norwest Seafood

Rick Fletcher, Department of Fisheries

Rod Berg, Office of the Auditor General

Robert Prince, CALM

Shane O'Donoghue, Department of Fisheries

Stephen Hood, Industry – Exmouth Gulf Prawn

APPENDIX 3. NATIONAL ESD CONSEQUENCE LEVELS AND LIKELIHOOD DEFINITIONS FOR RISK ASSESSMENT

Scope

- Retained/Non Retained/Protected species – assessed at level of locally reproducing population –unit stock
- Ecosystem – indirect impacts due to flow on effects on food chain assessed at the Regional/ Bioregional level
- Habitat (attached species – eg seagrass) assessed at the regional habitat level defined as the entire habitat equivalent to that occupied by the exploited stock.

A3.1 Table– Risk Matrix

	Consequence					
Likelihood	**Negligible**	**Minor**	**Moderate**	**Severe**	**Major**	**Catastrophic**
	0	**1**	**2**	**3**	**4**	**5**
Remote 1	0	1	1	1	1	1
Rare 2	0	1	1	1	2	2
Unlikely 3	0	1	1	2	2	3
Possible 4	0	1	2	2	3	4
Occasional 5	0	1	2	3	4	4
Likely 6	0	1	2	3	4	4

A3.2 Table Summary Consequence Definitions

Level	Ecological
Negligible	General - Insignificant impacts to habitat or populations, Unlikely to be measurable against background variability **Target Stock/Non-retained**: undetectable for this population **By-product/Other Non-Retained**: Area where fishing occurs is negligible compared to where the relevant stock of these species reside (< 1%) **Protected Species**: Relatively few are impacted. **Ecosystem**: Interactions may be occurring but it is unlikely that there would be any change outside of natural variation **Habitat**: Affecting < 1% of area of **original** habitat area *No Recovery Time Needed*
Minor	**Target/Non-Retained:** Possibly detectable but little impact on population size but none on their dynamics. **By-product/Other non-retained**: Take in this fishery is small (< 10% of total) 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%). **PProtected Species**: Some are impacted but there is no impact on stock Ecosystem: Captured species do not play a keystone role – only minor changes in relative abundance of other constituents. **Habitat**: Possibly localised affects < 5% of total habitat area *Rapid recovery would occur if stopped - measured in days to months.*
Moderate	**Target/Non Retained**: Full exploitation rate where long term recruitment/ dynamics not adversely impacted **By-product:** Relative area of, or susceptibility to capture is suspected to be less than 50% and species do not have vulnerable life history traits **Protected Species**:Levels of impact are at the maximum acceptable level Ecosystem: measurable changes to the ecosystem components without there being a major change in function. (no loss of components) **Habitat:** 5-30 % of habitat area is affected. :or, if occurring over wider area, level of impact to habitat not major *Recovery probably measured in months – years if activity stopped*
Severe	**Target/Non Retained**: Affecting recruitment levels of stocks/ or their capacity to increase By-product:Other Non-Retained: 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 greater than 50% and species should be examined explicitly. Protected Species: Same as target species **Ecosystem**: Ecosystem function altered measurably and some function or components are missing/declining/increasing outside of historical range &/or allowed/facilitated new species to appear. **Habitat**: 30- 60 % of habitat is affected/removed. *Recovery measured in years if stopped*

Level	Ecological
Major	**Target/Non Retained**: Likely to cause local extinctions **By-product:Other non-retained**:N/A **Protected Species**: same as target species **Ecosystem**: A major change to ecosystem structure and function (different dynamics now occur with different species/groups now the major targets of capture) Habitat: 60 - 90% affected *Recovery period measured in years to decades if stopped.*
Catastrophic	**Target/NonRetained**:Local extinctions are imminent/immediate **By-product/Other Non-retained** N/A **Protected Species**: same as target **Ecosystem:** Total collapse of ecosystem processes. **Habitat**: > 90% affected in a major way/removed *Long-term recovery period will be greater than decades or never, even if stopped*

A3.3 Table – Likelihood Definitions

Level	Descriptor
Likely	It is expected to occur
Occasional	May occur
Possible	Some evidence to suggest this is possible here
Unlikely	Uncommon, but has been known to occur elsewhere
Rare	May occur in exceptional circumstances
Remote	Never heard of, but not impossible

APPENDIX 4. ACRONYMS

BRDs	Bycatch Reduction Devices
CAESS	Catch and Effort Statistics System
CALM	Department of Conservation and Land Management WA
CPUE	Catch Per Unit Effort
EA	Environment Australia
ED	Executive Director of the Department of Fisheries
ENSO	El Nino Southern Oscillation
EPBCA	Environment Protection and Biodiversity Conservation Act 1999
ESD	Ecologically Sustainable Development
FRDC	Fisheries Research and Development Corporation
FRMA	Fisheries Resources Management Act 1994
FRMR	Fisheries Resources Management Regulations 1995
GIS	Geographic Information System
GPS	Global Positioning System
OAG	Office of the Auditor General
OCS	Offshore Constitutional Settlement
SA	South Australia
SBP	Shark Bay Prawn Managed
SBP Plan	Shark Bay Prawn Fishery Management Plan
SBPMAC	Shark Bay Prawn Management Advisory Committee
SCFA	Standing Committee for Fisheries and Agriculture
SRR	Stock-Recruitment Relationship
VMS	Vessel Monitoring System
WA	Western Australia
WAFIC	WA Fishing Industry Council

APPENDIX 5. RESEARCH

Strategic Research and Development Planning

Project -SBay scallops	Res.Group	Link	Gap	1970s	1980s	1990s	1997/98	1998/99	1999/00	2000/01	2001/02	2002/03	2003/04
TARGET STOCK MANAGEMENT													
1. Annual Stock Assessment													
Stock-recruit-enviro effects	**FWA**				✓	✓				**x CR**	**x CR**	**x CR**	**x CR**
Juvenile habitat monitoring	**FWA**			✓									
Modelling	**FWA**						✓	✓		**R**			
Yield/recruit, $/recruit	**FWA**									**R**			
Breeding stock	**FWA**												
2. Fishery Databases													
Commercial monitoring	**FWA**			✓	✓						**x CR**	**(x)**	**(x)**
Fishery independent surveys	**FWA**					✓			✓		**x CR**	**x CR**	**x CR**
Research log books	**FWA**			✓	✓	✓	✓	✓	✓	**x CR**	**x CR**	**x CR**	**x CR**
CAES returns	**FWA**			✓	✓	✓	✓	✓	✓	**R**	**x CR**	**R**	
Effort impact assessment (GIS)	**FWA**						✓	✓			**x CR**	**(x)**	
Fishing power monitoring	**FWA/I**			✓	✓	✓	✓	✓	✓	**R**	**x CR**	**x CR**	**x CR**
Processors returns	**I/FWA**			✓	✓	✓	✓	✓	✓	**x CR**	**x CR**	**x CR**	**x CR**
Database maintenance	**FWA**										**x CR**	**x CR**	**x CR**
3. Biology													
Tigers													
Reproduction	**FWA**			✓	✓								
Growth	**FWA**			✓	✓						**x**		
Habitat requirements	**FWA**			✓	✓					**x**			
Migration	**FWA**			✓	✓						**x**		
Natural mortality	**FWA**			✓							**x**		
Cathability/selectivity/gear efficiency	**FWA**				✓						**x**		
Kings													
Reproduction	**FWA**			✓	✓						**x**		
Growth	**FWA**			✓	✓						**x**		
Habitat requirements	**FWA**			✓	✓								
Recruit prediction	**FWA**										**x**		
Migration	**FWA**			✓	✓						**x**		
Natural mortality	**FWA**										**x**		
Cathability/selectivity/gear efficiency	**FWA**										**x**		

Project -SBay scallops	Res.Group	Link	Gap	1970s	1980s	1990s	1997/98	1998/99	1999/00	2000/01	2001/02	2002/03	2003/04
Corals													
Reproduction	**FWA**										**x**		
Growth	**FWA**										**x**		
Habitat requirements	**FWA**												
ENVIRONMENTAL MANAGEMENT													
Bycatch monitoring	**FWA**							✓	✓	**FRDC**	**FRDC**		
Habitat/effort impacts	**FWA**		✓								**(x) CR/ FRDC**	**(x) CR/ FRDC**	
Bio-diversity monitoring	**FWA**		✓									**(x) FRDC**	**(x) FRDC**
Formal risk assessment	**FWA**											**x FRDC**	
Marine Park Monitoring	**FWA**		✓										
SOCIOECONOMICS													
1. Resource allocation/native title													
Aquaculture	**FWA**												
Native Title													
World Heritage Areas	**CALM**												
2. Economics													
Economics	**I**												
Average price data	**I**					✓							
Fuel conusmption/expenses	**FWA**										**x CR**	**x CR**	**x CR**
Market research	**I**							✓	✓				
Value of ass. Infrastructure (?)	**I**												
3. Gear, vessels and vessel design													
Bycatch reduction devices	**I/FWA**							✓	✓	**FRDC/ CR**	**FRDC/ CR**		
Bison boards	**I/FWA**				✓						**x**	**x**	
4. Public health/quality													
On board handling	**I**					✓							
Occ. Health and Safety	**FWA/I**												
Product quality certification	**I**												

Project -SBay scallops	Res.Group	Link	Gap	1970s	1980s	1990s	1997/98	1998/99	1999/00	2000/01	2001/02	2002/03	2003/04
FISHERY MANAGEMENT													
1. Fishing rules													
Gear development/change proc.	**I/FWA**						✓	✓	✓	**R**			
375 rule modification/unitisation	**FWA**				✓					**R**			
Compliance	**FWA**				✓						**(x) FRDC**	**(x) FRDC**	**(x) FRDC**
VMS - electronic log books	**FWA**								**x CR**	**x CR**	**x CR**	**x CR**	**x CR**
Byproduct rules	**FWA**									**x**	**x**		
Non trawl closures	**FWA**									**x**	**x**		

- **Research Group Key: FWA-** Fisheries WA, **I-** Industry, **CSIRO WA**, **CSIRO QLD**
- **Project Status Key: -** complete **X** committed, **(X)** proposed but not approved/committed, **R** review
- **Funding Source- CR** cost recovery**, FRDC-** Fisheries Research and Development Corporation

APPENDIX 6. MATERIALS SUPPLIED TO ENVIRONMENT AUSTRALIA AGAINST THEIR SPECIFIC GUIDELINES

SECTION 4. ASSESSMENT OF THE SBP MANAGEMENT REGIME AGAINST THE COMMONWEALTH (EA) GUIDELINES FOR ASSESSING THE ECOLOGICALLY SUSTAINABLE MANAGEMENT OF FISHERIES

GENERAL REQUIREMENTS OF THE EA GUIDELINES

The management arrangements must be:

Documented, publicly available and transparent

As per the FRMA *"the Executive Director is to cause a copy of every order, regulation and management plan in force under this Act –*

- *To be kept at the head office of the Department; and*
- *To be available for inspection free of charge by members of the public at that office during normal office hours."*

In addition to the legislative requirements, the current management regime, as documented in the formal set of management regulations, can be purchased by interested parties from the State Law Publisher.

Of more relevance, is that any discussion papers and proposals for modifications to these management arrangements are distributed widely to stakeholder groups automatically and other interested individuals by request in hard copy format. Where appropriate, these are now also available from the Departmental web site www.fish.wa.gov.au.

Finally, once completed, the full ESD Report on the SBP fishery will be publicly available via publication and electronically from the Departmental website. This will provide increased transparency through explicitly stating objectives, indicators, performance measures, management arrangements for each issue and how the fishery is currently performing against these criteria.

Developed through a consultative process providing opportunity to all interested and affected parties, including the general public

S64 and S65 of the FRMA define the requirement for procedures that must be undertaken before determining or amending all management plans. More specifically, the management arrangements for the SBP fishery have been developed through formal consultation with industry and the general public, which includes the SBPMAC, and also from requested submissions from industry groups (eg WA Fishing Industry Council - WAFIC), other stakeholder groups (eg Recfishwest, Conservation Council of WA) and the general public.

The ESD Report for the SBP fishery was developed through a consultative process that included a wide variety of stakeholders including members of the Shark Bay prawn trawl industry, government (Departments of Fisheries, Conservation and Environment), recreational/regional groups (Recfishwest, Denham Shire Council), non-government environmental groups (Conservation Council of WA), Environment Australia and invited specialists (WA Museum, University of WA). Details of the methods used to generate this report including how the issues were identified, how these identified issues were subjected to a risk assessment, and how the objectives etc were developed are described in Section 3.5. Attendees at each of the workshops are listed in Appendix 2.

Ensure that a range of expertise and community interests are involved in individual fishery management committees and during the stock assessment process

The range of expertise and community interests that have been involved in the process of determining management and reviewing stock assessments is extensive. The groups that have been involved in the generation and review of the information contained in this report include:

- Department of Fisheries, WA;
- Department of Environment, WA;
- Department of Conservation and Land Management (CALM);
- The trawling industry;
- Western Australian Fishing Industry Council (WAFIC);
- Recfishwest;
- Conservation Council of WA;
- Museum of WA; and
- The University of WA.

The general consultation methods used for this fishery are summarised in the Governance Section 5.4.3.1. The attendee lists for the 2 meetings are listed in Appendix 2.

Be strategic, containing objectives and performance criteria by which the effectiveness of the management arrangements is measured

The ESD Component Reports (see Section 5) contain the available objectives, indicators and performance measures for measuring the effectiveness of the management arrangements for the SBP fishery. For some components, the objectives, indicators and performance measures are well established and the data are available to demonstrate levels of performance over time. For other components, the objectives, indicators and performance measures have only just been developed and/or the necessary data collection is only just being initiated. The status of this information is documented within each of the individual component reports within the ESD Report in Section 5.1-5.4.

Be capable of controlling the level of harvest in the fishery using input and/or output controls

The FRMA, and specifically the management plan for the SBP fishery provides the legislative ability to control the level of harvest within this fishery. This is achieved through the use of a sophisticated and effective combination of input control measures based upon limiting the number of vessels allowed to operate in the fishery, the amount (and type) of gear each of these boats may use, along with a set of the seasonal and spatial closures.

These arrangements have been varied during the past 40 years to ensure that management remains appropriate to achieve the sustainability objectives for the fishery. Thus, there have been both permanent and temporary reductions in the numbers of vessels allowed to operate; changes to compliance policing (eg VMS fitted vessels); changes to gear requirements (eg use of BRDs); and changes to permanent and temporary closures.

Contain the means of enforcing critical aspects of the management arrangements

The Department of Fisheries employs a large number of operational staff to ensure compliance with the critical aspects of the management arrangements for the SBP fishery. This includes at-sea patrols to ensure the closed seasons and closed areas, restrictions on gear and other operational rules are being adhered to.

Given the value of the licences, fishers themselves are also a source of information on illegal activities. A full summary of the compliance activities and their effectiveness is provided in Section 5.4.1.3.

Provide for the periodic review of the performance of the fishery management arrangements and the management strategies, objectives and criteria

There is an annual review of the performance of the major aspects of the SBP fishery through the completion of the "State of the Fisheries" report. This is updated and published each year following review by the Office of the Auditor General (OAG). It forms an essential supplement to the Department's Annual Report to the WA Parliament with the latest version located on the Departmental website www.fish.wa.gov.au.

The ESD Component Report contains a comprehensive performance evaluation of the SBP fishery based upon the framework described in the ESD policy (Fletcher, 2001). This includes the development of objectives, indicators and performance measures for most aspects of this fishery and includes status reports for those components that are not subject to annual assessment. This full assessment, including an examination of the validity of the objectives and performance measures, is planned to be completed and externally reviewed every five years.

Be capable of assessing, monitoring and avoiding, remedying or mitigating any adverse impacts on the wider marine ecosystem in which the target species lives and the fishery operates

Capabilities for the assessment, monitoring and avoidance, remedying or mitigating any adverse impacts on the wider marine ecosystem are documented in "Other effects on the environment" Section 5.3. This has been completed through a formal risk assessment analysis of the issues and, where necessary, the development of suitable monitoring programs.

Require compliance with relevant threat abatement plans, recovery plans, the National Policy on Fisheries Bycatch, and bycatch action strategies developed under that policy

The management regime complies with all relevant threat abatement plans for species where there are significant interactions. Details are provided in the 'non-retained species' Section of the ESD Report of which the draft Bycatch Action Plan for this fishery, which will be released in 2002 has been a major contributor (Section 5.2.).

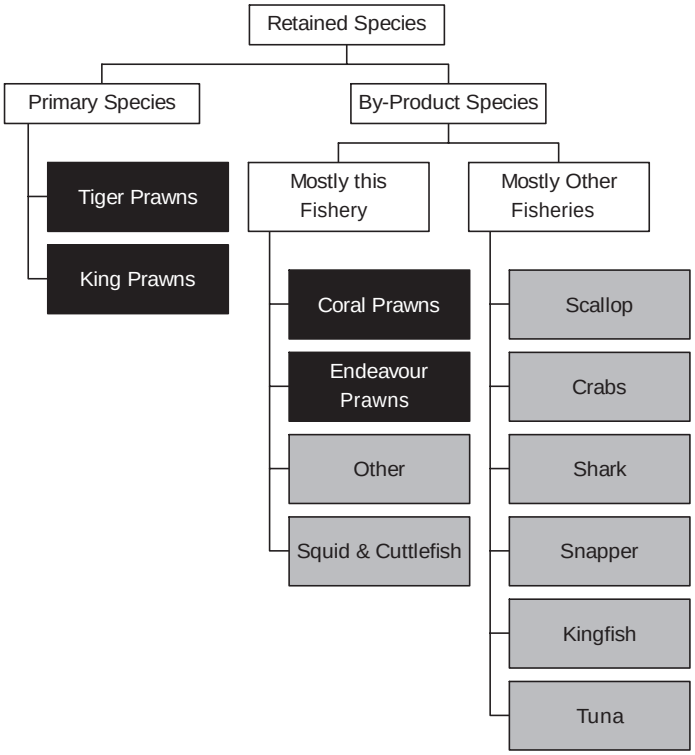
PRINCIPLE 1 OF THE COMMONWEALTH GUIDELINES

OBJECTIVE 1. MAINTAIN VIABLE STOCK LEVELS OF TARGET SPECIES

The fishery shall be conducted at catch levels that maintain ecologically viable stock levels at an agreed point or range, with acceptable levels of probability

The component tree detailing the retained species within the SBP fishery is shown below. Each of the target species and by-product groups retained by this fishery has been assessed with appropriately

detailed reports having been compiled on each of them. These reports are located in Section 5.1. Only the King (**Moderate Risk**), Tiger (**High Risk**), Coral and Endeavour Prawns (**Moderate Risk**) were of sufficient risk by the fishery to warrant detailed attention (5.1.1.1). Full justifications for not specifically assessing the other by-product components (Crabs, Shark, Snapper, Mulloway, Other, and Squid & Cuttlefish) are located in Section 5.1.2. These decisions were largely related to the relatively small quantities taken by the SBP fishery in comparison to other fisheries. These species will, therefore, be addressed in detail in other fishery assessments (which will incorporate what is caught by the SBP fishery).



Assessments of current fishery performance demonstrate that each of the prawn species (King, Tiger and Coral/Endeavour) are being maintained above levels necessary to maintain ecologically viable stock levels. Thus, in summary:

- The breeding stock level for the tiger prawn stock in Shark Bay is currently above the agreed reference point.
- The historical catch and effort trends over the past 40 years indicate that there has been no decline in the production levels for king prawn, which is consistent with there being sufficient on-going levels of spawning biomass for this species.
- Historical catch trends indicate that the production levels for coral and endeavour prawns remain within natural environmental levels, which is consistent with the recruitment potential of these species not having been affected by the fishery.
- The level of capture of other by-product species by this fishery is too small to have a significant impact on their dynamics.

Consequently, this fishery is meeting the requirements of Principle 1. The information relevant to this principle for these species is detailed below.

Information Requirements

1.1.1 There is a reliable data collection system in place appropriate to the scale of the fishery. The level of data collection should be based upon an appropriate degree of fishery independent as well as fishery dependent research and monitoring.

A substantial level of information is collected on the SBP fishery. Data is collected through a combination of fishery dependent and independent systems, many of which have been in place for decades. These ongoing monitoring programs are supported by a long history of research programs on the biology and ecology of prawns along the west coast of WA.

The specific data requirements needed to assess performance for each of the relevant objectives are detailed in the relevant sections of the National ESD reports in Section 5.1 Retained Species. The requirements are summarised as follows:

Monitoring Program	Information Collected	Robustness[1]
Fishery-independent spawning and recruitment surveys	Annual biological survey that measures the catch rates in different areas of Shark Bay and used to determine the index of spawning stock abundance of tiger prawns and the recruitment index for king prawns	High
Voluntary daily log books	Daily and shot-by-shot catch, Hours trawled and areas of operation	Medium/High
Fishery-dependent Catch Per Unit Effort (CPUE)	Determined through the voluntary daily log books	High
Vessel monitoring system	Location and speed of vessels – used by Dept. of Fisheries for managing compliance of closures	High
On-board observer program	Bycatch species and numbers	High (2000-2001 only)
Climatic data	Monthly Fremantle Sea Level data- used to estimate strength of Leeuwin Current; Rainfall data; Wind data and Swell Height Conditions; and Temperature logger	High

[1] *The level of robustness of these measures is discussed in full within each of the relevant component reports in Section 5.*

Assessments

1.1.2 There is a robust assessment of the dynamics and status of the stock dynamics and status for the target species. Review should ideally take place every year, and no greater than three years should elapse between reviews.

The status of the breeding stocks and intra-annual variation for king and tiger prawns are assessed and evaluated every year using a synthesis of information obtained from both fishery independent and dependent surveys. Full details of the current evaluation and a discussion of the robustness of the analyses used are located in 5.1.1.1 **and** 5.1.1.2**. These assessments are reported annually within the State of the Fisheries Report.**

Tiger Prawns

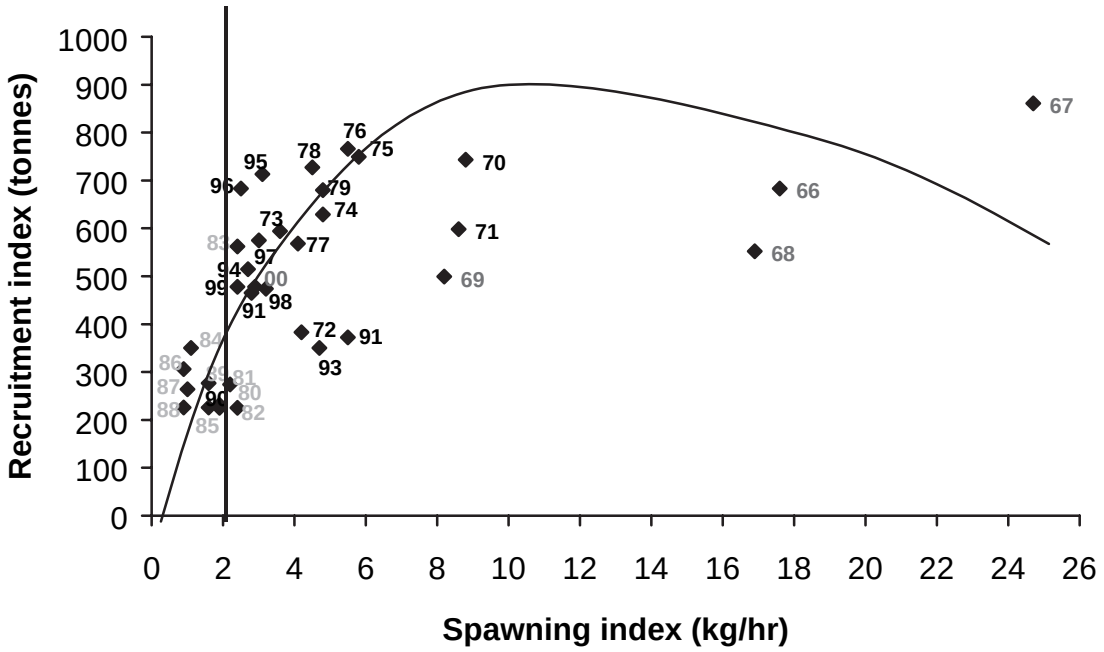


Figure 10. The SRR for the Shark Bay tiger prawn with the years of spawning and recruitment the following year indicated. (The reference point of 2 kg/hr is indicated with a vertical line).

The on-going assessment of the tiger prawn spawning stock, in relation to the accepted spawning stock-recruitment relationship (SRR), indicates that the current levels are above the performance limit (see Fig. 10). The value for 2000 was close to the preferred level of 4kg/hr, which is well above the limit reference point of 2kg/hr. This result should maintain appropriate levels of recruitment in the future.

Continuation of the fishery independent surveys over the next few years will allow the derivation of new spawning stock indices and act as a calibration for indices derived from the fishery-dependent catch rate data. During this 'interim' period, fishery-dependent catch rates obtained in adjacent months and areas to the traditional spawning area catch rates are being used. This is the best available information in the absence of specific fishing in the spawning areas. The new fishery independent based assessments should be available before the next major review.

King Prawns

For king prawns, the catches are largely related to the level of effort and have been within the acceptable range (1100-1600t) for this fishery for the last seven years (Figure 11). The lower catches seen in the

early 1990s were a result of a shift of effort from king prawn stocks to the scallop fishery due to a very high scallop abundance on the scallop grounds.

The analysis of catch and effort data in the 1970s to the 1990s provided no evidence of a stock-recruitment relationship for king prawns, which indicates that at the current level of effort exerted, which has covered most environmental variations, the king prawn breeding stock is more than sufficient to ensure long term recruitment.

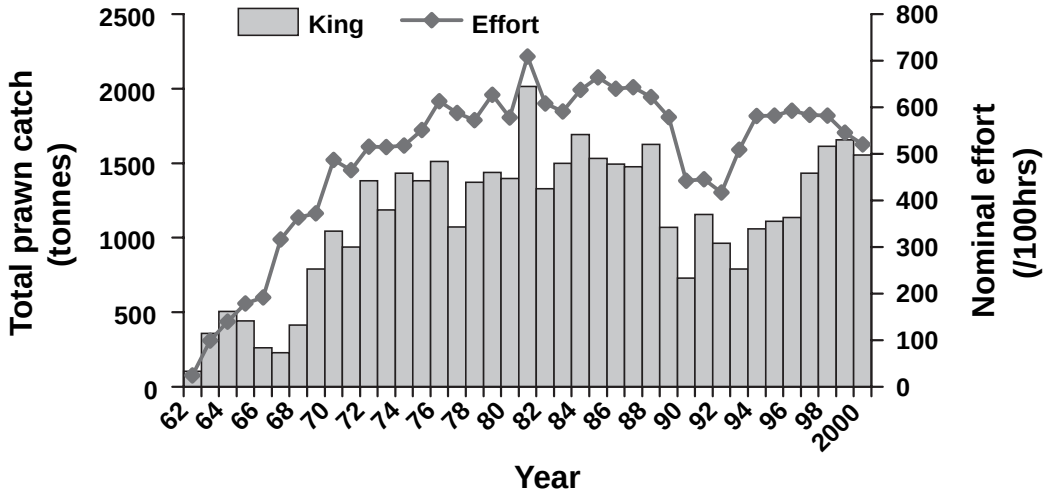


Figure 11. Historical catch (tonne) of king prawns and nominal effort in the SBP fishery.

1.1.3 The distribution and spatial structure of the stock(s) has been established.

The distribution of both the king and tiger prawn is well documented. In Australia, king prawns occur from South Australia, Western Australia, Northern Territory, Queensland and down the east coast to northern New South Wales. While the brown tiger prawn is generally regarded as an endemic Australian species, it occurs in Western Australia, the Gulf of Carpentaria and Queensland.

Whilst both species have a broad overall distribution across at least the northern half of Australia, largely due to the habitat requirements of their juveniles, they each have a number of separated locations where their abundance is sufficient to allow commercial fishing to occur. Thus, the prawns caught by the SBP fishery can be considered to originate from functionally separate stocks than other regions where fishing for these species occurs. More information on the distribution for both species and for coral and endeavour prawns is contained within Section 2 Background Information.

1.1.4 There are reliable estimates of all removals, including commercial (including discards), recreational and indigenous, from the fished stock. These estimates have been factored into stock assessments and target species catch levels.

Within the list of monitoring programs outlined above for the SBP fishery, data covering each of the sources of removal are outlined. Given the nature of this fishery, only the estimates of removals by the commercial sector are required and these are collected on a daily to monthly basis during the fishing season. There are no significant recreational or indigenous fisheries for prawns in Shark Bay. Furthermore, there is a minimal likelihood of a significant level of illegal capture of prawns by the commercial fleet.

Sector	Catch Data Collected	Frequency
Commercial	Fishers monthly returns, Processor unload records, Voluntary daily log books, On-board observer data	Daily or monthly during the season
Recreational	Not applicable	
Indigenous	Not applicable	
Illegal	Not applicable	

1.1.5 There is a sound estimate of the potential productivity (maximum safe long term yield) of the fished stock(s).

Tiger Prawns

The long history of this fishery (over 40 years) combined with the significant level of monitoring and research that has been done on the dynamics of this stocks has enabled one of the most reliable estimates of yield to be calculated for any prawn fishery. Thus, the stock recruitment relationship and associated management arrangements and trigger points developed for tiger prawns in Shark Bay are often used as the case study for prawn fisheries around the world.

The use of a constant escapement policy for the management of tiger prawn stocks to ensure the spawning biomass does not fall below the accepted minimum level provides a very robust way of determining annual yield. Such a flexible methodology for determining what yield can be taken each year is vital in fisheries capturing species that naturally have large variations in recruitment strength. Thus, in years where recruitment is relatively good, a relatively large yield can be taken, but in years where the recruitment levels are relatively low, less can be taken before the threshold catch rate is reached. With this type of management it is possible that in seasons where recruitment levels are particularly poor there could be close to no fishing permitted.

Given the history of this fishery and normal environmental fluctuations, the catch of tiger prawns by the SBP fishery should be within the range of 538-784 tonnes. This is described as the acceptable catch range and is assessed annually. Any deviation outside of this range must now trigger a review of the situation.

King Prawns

Because the major constraints on the fishery are designed to protect the tiger prawn stocks, and the king prawns are a more robust species in this environment, no definitive relationship for stock and recruitment has been identified for king prawn stocks (i.e. the stock has never been reduced to levels where this has been an issue). Thus, while there is no limit reference point for this species, an acceptable catch range has been generated. This was calculated from the data collected over the past 20 years, which includes a large range of environmental conditions.

The acceptable catch range for king prawns is 1059-1614 tonnes. There is now a developing understanding of the influence of the Leeuwin current on this value. When the Leeuwin current index is high, this indicates that the catch of king prawns in the next season is likely to be at the upper end of this range. This relationship is being explored more closely and could lead to a more precise estimate of catch being made a season in advance.

Endeavour and Coral Prawns

The acceptable catch ranges for endeavour and coral prawns are 1-30 tonnes and 80-280 tonnes, respectively.

Management Responses

1.1.6 There is a limit reference point, which is the biological and/or effort bottomline beyond which the stock should not be taken.

Tiger Prawns

The limit reference point for the tiger prawn spawning stock is 2 kg/hr in areas B and D of the fishery in August and July, respectively with the preferred spawning index level between 3 – 4 kg/hr. This catch rate relates to the efficiency values for the fleet in the 1970s.

The actual catch rate threshold when fishing is halted and main spawning grounds are closed is at 10kg/hr (which is determined to result in there being a 2 – 4 kg/hr level of tiger prawns left in these areas during the spawning season period). This constant escapement policy provides additional protection for the stock and the 10 kg/hr threshold incorporates the increases in fishing power of the fleet since the 1970s. The full justification for selecting this reference point and current performance against this measure is described in Section 5.1.1.1.

King Prawns

The limit reference point in this fishery for king prawn catch, given the current levels of effective effort, should not be more than 1600 tonnes. The total catch for king prawns should be within the historical acceptable range of 1100 – 1600 tonnes. If the fishery exceeds this range (either above or below), this would trigger a review of the fishery.

The full justification for selecting these reference points and current performance against this measure is described in Section 5.

1.1.7 There are management strategies in place capable of controlling the level of take.

A full description of the management arrangements is located in the attached management plan. A full discussion of the main regulations and their justifications are located in Section 2.1. The following is a summary of the management arrangements for both tiger and king prawns:

- The fishery is managed through input controls (including number of boats, power of vessel, controls on net design and other gear restrictions).
- Key nursery areas are permanently closed to trawling.
- Real time monitoring is completed by departmental staff.
- The annual fishing season is for a fixed period and includes seasonal, area and moon closures limiting the opportunity for fishers to take prawns.
- Compliance policing includes the use of VMS and gear checks.
- Monitoring of improvements in technology that may increase fishing efficiency.
- Any significant declines in the breeding population either from environmental effects due to fishing are observed in time to implement appropriate risk management interventions.

Significant effort is put into ensuring adequate compliance with these regulations. This includes at sea and aerial patrols to ensure closed seasons and closed areas, as well as operational rules are being adhered to. The use of VMS on the vessels will help the Department of Fisheries monitor vessel location and speed thus increasing compliance with closures while decreasing random patrol activities (full details on Compliance activities and their effectiveness are located in Section 5.4.1.3).

1.1.8 Fishing is conducted in a manner that does not threaten stocks of by-product species.

Full descriptions of the information available and the levels of risk of impact on these by-product species by the SBP fishery are located in sections 5.1.2. Only coral and endeavour prawns were rated as being of sufficient risk to require specific ongoing monitoring. The SBP fishery catches only minor amounts of scallops, snapper and tuna (by line – not trawl) and their management will be covered fully (including the take by SBP licenced fishers) within other fisheries environmental assessments.

In summary, (relating to objectives 1.1 –1.6), a number of the monitoring programs that are in place for the SBP fishery also provide relevant information on coral/endeavour prawns and other retained species. Even though this fishery does not target these species, a reasonable amount of each are caught during some years. As a result, an assessment of the status of both coral and endeavour prawns is completed annually using an analysis of catch rates calculated from data collected by the voluntary daily log books.

Total catch is used to assess the level of exploitation for both coral and endeavour prawn stocks. The historical acceptable catch range of 80-280 tonnes for coral prawns and 1-30 tonnes for endeavour prawns was generated from the 10-year range of catch for each of these species.

The distribution and relative sizes of these species results in neither of them being very susceptible to capture by this fishery - either they are mostly too small and pass through nets or the majority are inshore away from the main trawl grounds. Full justification for this approach is located in Section 5.1.2.1.

1.1.9 The management response, considering uncertainties in the assessment and precautionary management actions, has a high chance of achieving the objective.

Management actions taken within this fishery over the past 30 years have been extremely effective and there is, therefore, an extremely high probability that they will continue to achieve the main objective of maintaining the spawning stocks for the tiger and king prawns.

The management responses that are currently in place for the SBP fishery are very detailed, both for current actions, future actions and if the performance limits are reached/approached (see Section 5.1.1.1 and 5.1.1.2). This fishery is managed on a real time basis, including the use of average sizes and daily catch rates of the fleet determining how and where the fishery can operate.

The use of limit reference catch rates for the tiger prawn spawning stocks provides a mechanism for protecting on-going recruitment levels of all species. Furthermore, the additional use of catch based performance measures (acceptable ranges) for both tiger and king prawns, enables the Department to respond where changes outside the normal variations occur to ensure the maintenance of the spawning stock for both species. If the probability of these performance limits being reached increased, management arrangements could be implemented.

Strategies available to offer further protection to the spawning stock for both tiger and king prawns, if required, would include:

a) Further reductions in the total effort expended in the fishery through a reduction in the length of the fishing season or within season closures, and/or extension of moon closures.

b) Additional area closures, particularly within spawning areas.

OBJECTIVE 2. RECOVERY OF STOCKS

Where the fished stock(s) are below a defined reference point, the fishery will be managed to promote recovery to ecologically viable stock levels within nominated timeframes

There are no stocks within the SBP fishery that are currently below defined reference points/limits.

PRINCIPLE 2 OF THE COMMONWEALTH GUIDELINES

OBJECTIVE 1. BYCATCH

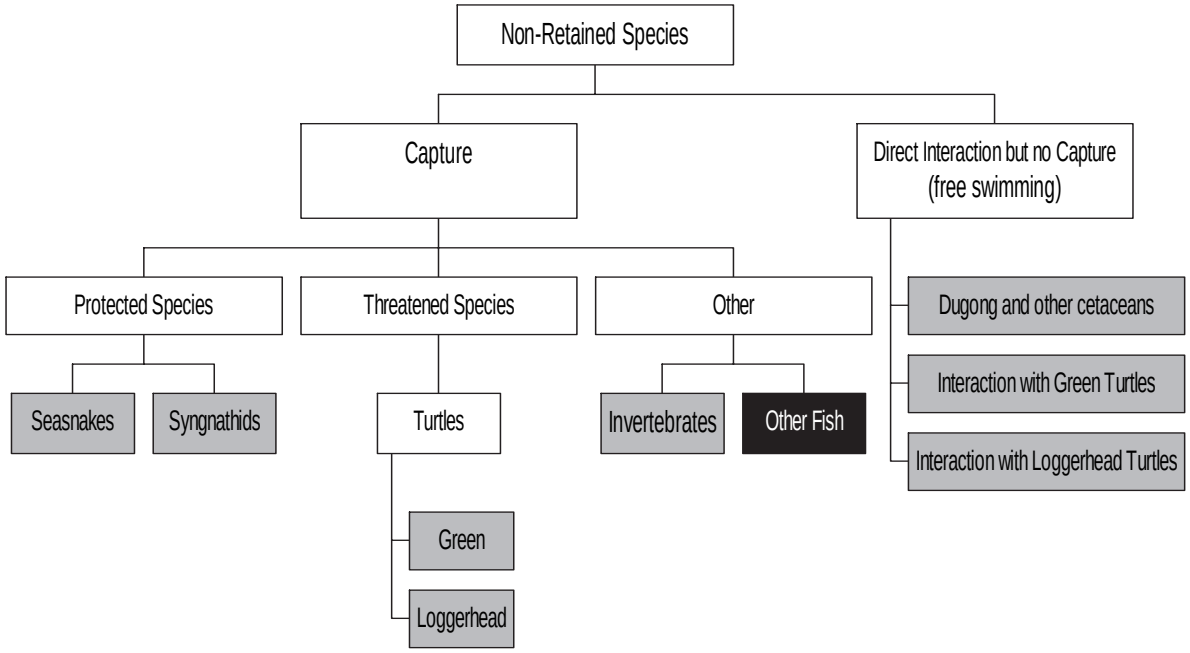
The fishery is conducted in a manner that does not threaten bycatch species

Nine non-retained species/groups were identified in this fishery and are shown below in the component tree. Of the nine, three are not actually captured in the nets but are thought to be possibly affected by general fishing operations.

There are relatively few non-retained species caught by this fishery that are thought to have a high susceptibility of being captured by trawling (only 2 of 21). Currently, the Shark Bay Prawn fishers are required to have one BRD in one of the two nets they use. In 2002, all Shark Bay Prawn fishers are required to use BRDs in both nets, short term exemptions will be allowed during times of high weed concentrations in trawling areas.

Full justifications on each of the non-retained species are presented in Section 5.2. The capture of fish that are subsequently discarded was the only category in non-retained species to warrant further attention.

These results from the risk assessments on these categories and in some cases the individual species, combined with the likely reduction in interactions following the introduction of BRDs, indicates that the performance of the SBP fishery is currently adequate in not threatening any of the bycatch species, including protected and threatened species. It is therefore meeting both objectives 1 and 2 of Principle 2.



Information Requirements

2.1.1 Reliable information, appropriate to the scale of the fishery, is collected on the composition and abundance of bycatch.

A Scientific Observer Program, based upon the information collected by the on-board observers, was designed and implemented for two years in 1998 for this fishery. In addition, all fishers in the SBP fishery are required to record information on some bycatch components of the catch. This information is collected and recorded into a Bycatch Journal and then compared to the more rigorous data collected in the Observer Program to detect any inconsistencies in the findings.

Assessments

2.1.2 There is a risk analysis of the bycatch with respect to its vulnerability to fishing.

A formal risk assessment for each of the identified non-retained/bycatch species (including those with direct interaction but no capture) was completed (see Section 3.4 for details on how this was completed). This assessment concluded that the SBP fishery was of negligible risk to invertebrates and only of moderate risk in the taking of discarded fish.

Discarded Fish – Summary

ERA Risk Rating (C2 L3 MODERATE)

Since trawling is a non-selective form of fishing, other species are caught. Small species of fish, which generally are dead when returned to the water, make up the majority of the bycatch. Although the amount of discards is large, due to the relatively small area where fishing occurs compared to the overall area where these species probably occur, the level of mortality resulting from this fishery is almost certainly sustainable. The full justification for the moderate risk rating and what future work is planned is documented in Section 5.2.1.5.

Invertebrates – Summary

ERA Risk Rating (C0 L5 NEGLIGIBLE)

The configuration of the trawl gear largely precludes the capture of large amounts of invertebrate species that live on top of or within the substrate. For full details see 5.2.1.6.

Management Responses

2.1.3 Measures are in place to avoid capture and mortality of bycatch species unless it is determined that the level of catch is sustainable (except in relation to endangered, threatened or protected species). Steps must be taken to develop suitable technology if none is available.

Data from the Shark Bay Bycatch Reduction Trials have shown that the level of bycatch is reduced with the use of BRDs in the nets (see Section 5.2.1.5 for further detail). All vessels are now legally be required to fish with two BRD nets.

The fishery only operates in a very small proportion of the Shark Bay region and the fishing season only lasts for 8 months of the year. This greatly reduces the impacts on any of these affected species.

Over the next two years, a subsequent introduction of secondary fish exclusion devices (square mesh panels in the cod ends) will further help to reduce the overall bycatch taken, particularly small fish species. Furthermore, fishers are now required to record bycatch data plus future on-board observer programs are planned.

Within the next 5 years the Department will undertake a survey of species within and outside the trawl grounds to determine the relative proportion of refuge areas for these bycatch species.

2.1.4 An indicator group of bycatch species is monitored.

Bycatch species will be monitored through a combination of independent on-board observer data and fisher recorded log book data.

2.1.5 There are decision rules that trigger additional management measures when there are significant perturbations in the indicator species numbers.

For each of the major bycatch species, performance limits based upon not having any increase from the current levels of interactions with the fishery have been developed. For each species, these limits will be reviewed once more precise data on distributions (from the survey work) and long-term data (on-going monitoring) has been collected and assessed.

Therefore, the risks associated with this group of species will be reassessed at the next major review of this fishery. This will occur within five years as a requirement of the WA ESD policy.

2.1.6 The management response, considering uncertainties in the assessment and precautionary management actions, has a high chance of achieving the objective.

As a result of the requirement changes for this fishery from the use of BRDs in one net to both nets as well as the additional fish, it is likely that there will be a decrease in the level of impact on the non-retained species by the SBP fishery. Nonetheless, as more data becomes available, the suitability of the current performance limits may need to be reviewed. If they are inappropriate and/or the current assumptions are found to be incorrect, appropriate alterations to practices will be taken.

A draft bycatch action plan that incorporates and deals with the issues identified in the ESD report will be released for comment shortly. This plan outlines in detail the proposals to deal with these issues, as summarised in this report.

OBJECTIVE 2.

The fishery is conducted in a manner that avoids mortality of, or injuries to, endangered, threatened or protected species and avoids or minimises impacts on threatened ecological communities

Information Requirements

2.2.1 Reliable information is collected on the interaction with endangered, threatened or protected species and threatened ecological communities.

Monitoring programs, based upon the information collected by the on-board observers, are now in place for cetaceans, dugongs, turtles, syngnathids and seasnakes. The log books also contain the ability to record interactions with each of these species. Previously the only information available was from the sparse data collected by the Dept. of Conservation and Land Management, who has the legislative responsibility for these species within WA waters.

Assessments

2.2.2 There is an assessment of the impact of the fishery on endangered, threatened or protected species.

A formal risk assessment for each of the identified species in these categories (including those with direct interaction but no capture) was completed (see Section 3.4 for details). In the capture category for non-retained species, this assessment concluded that the SBP fishery was a negligible risk to green turtles; and only a low risk to seasnakes, syngnathids and loggerhead turtles. For the direct interaction but no capture category for non-retained species, this assessment concluded that the fishery was of low risk to cetaceans & dugongs and loggerhead and a negligible risk to green turtles.

Capture

Loggerhead Turtles - Summary

ERA Risk Rating (C1 L3 LOW)

Loggerhead turtles have previously been caught incidentally in the SBP fishery. Since trawl times in this fishery are generally less than an hour, this species can withstand such lengths of time underwater and turtles are generally returned alive. In the trials on the BRDs that have recently been introduced, none of the nets with a BRD caught a turtle. The full introduction of BRDs since 2002 for this fishery should eliminate this as an issue except for periods when there is high levels of weed. (Section 5.2.1.1).

Green Turtles – Summary

ERA Risk Rating (C0 L5 NEGLIGIBLE)

There has been minimal reporting of green turtles being caught in a trawl net through the fishery's duration. Since trawls are excluded and/or avoid the seagrass habitat preferred by green turtles, their level of interaction is minimal. For full details see 5.2.1.2.

Seasnakes – Summary

ERA Risk Rating (C1 L2 LOW)

Seasnakes are caught in this fishery, but are generally returned to the water alive. Additionally, studies have shown that the survival rate of seasnakes following capture is 60%. Data from the observer program in the SBP fishery indicated 99% of the seasnakes captured were returned alive. The full rationale for the minor risk rating for seasnakes is documented in Section 5.2.1.3.

Syngnathids – Summary

ERA Risk Rating (C1 L2 LOW)

Syngnathids are incidentally caught in the fishery and are generally found dead in the codend. Results from an observer program for the prawn trawling fisheries suggests that very low numbers of syngnathids are caught in the order of 1 per night across the entire fleet and this is more indicative of an average for the season. The full rationale for the minor risk rating for Syngnathids is documented in Section 5.2.1.4.

Interaction but No Capture

Interaction with Green Turtles

ERA Risk Rating (C0 L5 NEGLIGIBLE)

There have been no reports of green turtles interacting with trawl vessels in transit. This is probably due to the fact that trawls are excluded from and/or avoid the preferred habitat of the green turtles, seagrass habitats. Additionally, due to the slow trawling speeds, the likelihood of hitting or injuring wildlife is unlikely. For full details see 5.2.2.1.

Interaction with Loggerhead Turtles- Summary

ERA Risk Rating (C1 L4 LOW)

The Draft Turtle Recovery Plan developed by the Commonwealth government states that there has been no evidence of any additional impact (besides capture) between trawl fleets and turtle populations. Additionally, due to the slow speeds at which the vessels trawl at it is unlikely that any interaction between the turtle and the vessel hull would occur since the animal can move from its path. The full rationale for the minor risk rating for loggerhead turtles is documented in Section 5.2.2.2.

Cetaceans & Dugongs – Summary

ERA Risk Rating (C1 L3 LOW)

There has been no evidence or record of a live dugong being captured or interaction over the period of the fishery, which is in excess of 40 years. For full details see 5.2.2.3.

2.2.3 There is an assessment of the impact of the fishery on threatened ecological communities.

There are no threatened ecological communities associated with the SBP fishery.

Management Responses

2.2.4 There are measures in place to avoid capture and/or mortality of endangered, threatened or protected species.

As previously mentioned above in 2.1.3, with the current status of at least one BRDs and two required in 2002 for this fishery (except for small periods of time in 2 zones when floating weed levels make using grids impossible), it is expected that the quantity and likelihood of captures of all these species/ groups will be minimised and likely reduced.

2.2.5 There are measures in place to avoid impact on threatened ecological communities.

Not applicable.

2.2.6 The management response, considering uncertainties in the assessment and precautionary management actions, has a high chance of achieving the objective.

Given the relatively low levels of interactions of the SBP fishery with non-retained species and the introduction of BRDs within the next season makes it highly likely that there will be a decrease in level of impact on these threatened species by the SBP fishery, particularly turtles. Nonetheless, as monitoring data becomes more available, the suitability of the current performance limits may need to be reviewed. If they are inappropriate and/or the level of interactions increases, appropriate alterations to the practices will be taken.

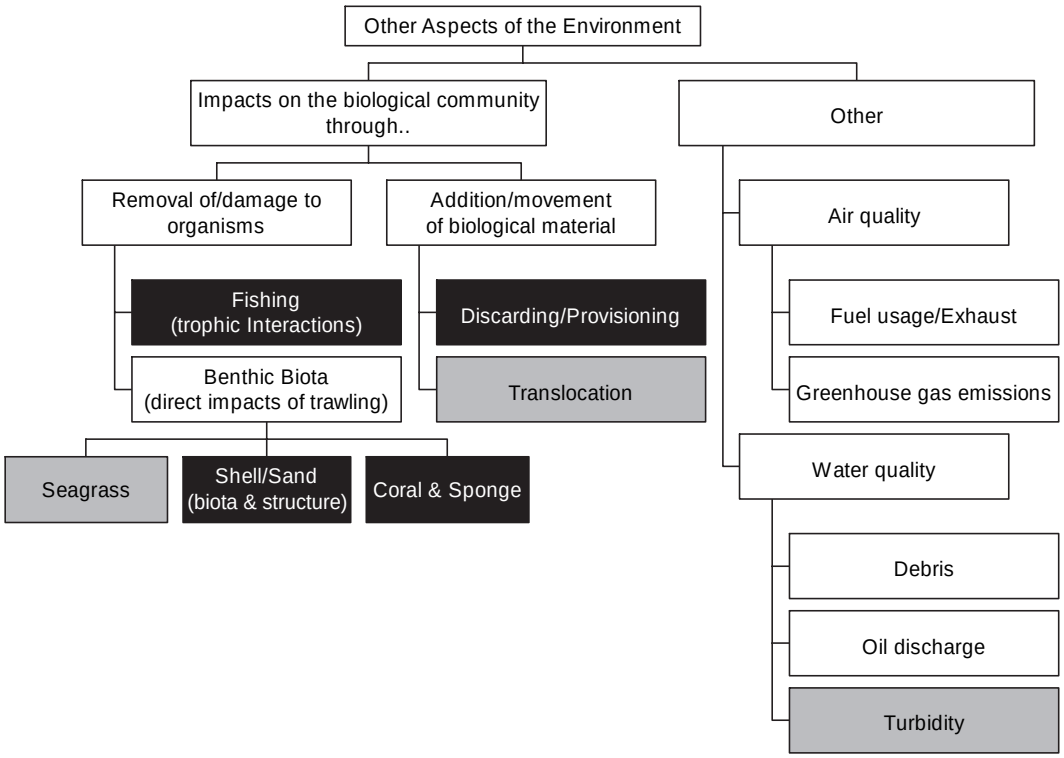
As previously mentioned, a draft bycatch action plan that incorporates and deals with the issues identified in the ESD report will be released for comment shortly. This plan outlines in detail the proposals to deal with these issues, as summarised in this report.

OBJECTIVE 3. GENERAL ECOSYSTEM

The fishery is conducted, in a manner that minimises the impact of fishing operations on the ecosystem generally

The issues that relate to the broader ecosystem, which were identified for the SBP fishery are shown in the following component tree. A formal risk assessment process subsequently assessed each of these issues with the information relating to each issue detailed in Section 5.3.

Of the seven issues identified, three were rated as a moderate risk; the remaining issues were rated as a negligible or low risk. Consequently, given that the moderate risks are being monitored and managed, the SBP fishery's current performance is meeting objective 3 and this acceptable performance is likely to at least continue but probably improve in the future.



Information Requirements

2.3.1 Information appropriate for the analysis in 2.3.2 is collected and/or collected covering the fisheries impact on the ecosystem and environment generally.

Appropriate levels of information have been obtained for most of the issues identified, which has allowed for a sensible assessment of the level of risk to be determined. This information includes data collected, which is directly related to the SBP fishery in terms of the stock assessment and status of prawn stocks, levels of catch and effort, gear designs, and understanding of spatial and temporal closures. There are a number of research publications that provide valuable evidence on the effects of prawn trawling on sand, seagrass and coral communities, and trophic structures in similar fisheries/environments in other parts of Australia and elsewhere.

In cases where the level of information was insufficient, processes are already in place to remedy this situation thus resulting in a more informed decision to be made (eg distribution of different environments in Shark Bay, composition and distribution of fish species within and outside trawled grounds).

Assessment

2.3.2 Information is collected and a risk analysis, appropriate to the scale of the fishery and its potential impacts, is conducted into the susceptibility of each of the following ecosystem components to the fishery.

A formal risk assessment was completed (see Section 5.3 for details) on each of the identified issues relevant to the SBP fishery (see component tree for issues). The identified issues that were assessed and a summary of the outcomes are located in Table 7 – complete justifications are located in the performance reports in Section 5.3.

Table 7. Summary of Risk Assessment Outcomes for Environmental Issues Related to the SBP fishery.

ISSUE	RISK	SUMMARY JUSTIFICATION	FULL DETAILS
Impact of taking target and byproduct species of the ecosystem (Trophic Level Effects)	Low	Most prawn predators are opportunistic due to the natural variability of the prawn populations. There are no obligate prawn predators in Shark Bay. Spatial and temporal closures ensure that adequate stocks of all these species are present each year. The cumulative take of bycatch is relatively low. The total level of removal of biological material by the SBP fishery is not likely to be detectable because Shark Bay is a highly productive region.	5.3.1.1
Impacts on Benthic Biota:			
Seagrass	Negligible	Most seagrass areas are permanently closed to trawling. Trawlers actively avoid this habitat due to the entanglement caused by seagrass caught in the net. The introduction of BRDs will further encourage trawlers to avoid seagrass areas because the grids are highly susceptible to clogging.	5.3.1.4
Sand/shell	Moderate	The extensively trawled areas of Shark Bay are only about 25% of the total sand habitat, which provides a refuge of around 75%. Experimental studies have shown only minor and short-lived impacts in this habitat from prawn trawling on the biota in sandy habitats. More detailed information will be collected on the spatial distribution of trawled vs. untrawled areas and sand habitats within Shark Bay from VMS data.	5.3.1.2

ISSUE	RISK	SUMMARY JUSTIFICATION	FULL DETAILS
Coral/sponge	Moderate	Most trawlers do not target coral/sponge habitat due to the damage and danger that results from trawling in such areas. Prawns tend to occur in the highest densities in sandy and muddy habitats. A large proportion of hard coral areas are protected by permanent closures. More information on spatial distributions of coral/sponge habitat within Shark Bay is needed.	5.3.1.3
Translocation	Negligible	Vessels in Shark Bay have little interaction with fisheries in other regions. Although vessels do move to Fremantle for seasonal maintenance, the Leeuwin Current provides a natural connection between Fremantle and the trawl grounds. Most vessel hulls undergo refit (which includes cleaning of the hull) at the commencement of each season before movement to the trawling grounds. So there is no chance of moving material into the Shark Bay region.	5.3.3.2
Discarding bycatch (Provisioning)	Moderate	The area over which the bycatch is discarded is large and therefore any impacts would be diffused. Introduction of BRDs will reduce the amount of bycatch generated by this fishery, which in turn reduces the amount of discards. Data on the ratio of discards to target catch will continue to be monitored.	5.3.2.1
Turbidity	Negligible	Turbidity caused by trawling is insignificant compared to that caused by the natural water movements due to the strong currents and tides in Shark Bay (Hall and Penn, 1979).	5.3.3.1

Management Responses

2.3.3 Management actions are in place to ensure significant damage to ecosystems does not arise from the impacts described in 2.3.1.

The most important management methods required to ensure that there is minimal impact on the broader ecosystem are associated with ensuring that the significant biomass levels of prawns are maintained. In most cases this serves to achieve both objectives (eg. a sustainable fishery and minimal impacts on any trophic interactions). Other management measures such as gear restrictions, area closures (including permanent and temporary closures), use of BRDs in the nets, limiting number of vessels allowed, and future research further minimise the potential for these impacts to occur.

As previously mentioned above, the two of the three moderate risk ratings for the potential impacts of the fishery on sand/shell and coral/sponge habitat were largely associated with the lack of knowledge of the spatial distribution of different habitats and trawled vs. untrawled areas within Shark Bay. With the proposal of future studies to be conducted on the different habitats within Shark Bay and the introduction of the VMS this information will enable a more accurate assessment of these issues.

The moderate risk rating for the impact of discarding fish on the environment was also due to lack of knowledge concerning the amount of discards and ratio of target catches to discards. With the proposal of an observer program to monitor the amount of discards on a five-year basis, more information will be generated to accurately assess this issue too.

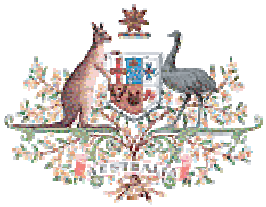
2.3.4 There are decision rules that trigger further management responses when monitoring detects impacts on selected ecosystem indicators beyond a predetermined level, or where action is indicated by application of the precautionary approach.

All issues except for shell/sand, coral/sponge and discarding were not of sufficient risk to require specific target levels as they are effectively covered by the other management arrangements. For the impacts on the shell/sand, coral/sponge the current spatial distribution of trawling is acting to ensure that these habitats are not impacted at unacceptable levels. The current level of discarding was determined to be, at worst, only a moderate risk to the ecosystem and this is likely to be reduced following the introductions of the various BRDs over the coming years. Consequently, the risk associated with this issue should be reduced by the next assessment.

2.3.5 The management response, considering uncertainties in the assessment and precautionary management actions, has a high chance of achieving the objective.

Given that the risk assessment identified that under current management arrangements there have been minimal or negligible impacts of the SBP fishery on the broader ecosystem even after around 30 years of fishing, it is highly likely that the fishery will continue to meet the objectives of having only acceptable levels of impact. If future studies indicate that further management is required of the various habitat types and composition and abundance of fish and invertebrate species, then appropriate actions will be developed.

APPENDIX 7. APPROVAL AND RECOMMENDATIONS FROM EA



THE HON. DR. DAVID KEMP MP
MINISTER FOR THE ENVIRONMENT AND HERITAGE

The Hon Kim Chance MLC
Minister for Agriculture, Forestry and Fisheries
11th Floor, Dumas House
2 Havelock Street
WEST PERTH WA 6005

Dear Minister

In November 2001 the Western Australian Department of Fisheries (WADF) submitted the document *Application to Environment Australia for the Shark Bay Prawn Fishery Against the Guidelines for the Ecologically Sustainable Management of Fisheries for Continued Listing on Section 303DB of the Environmental Protection and Biodiversity Conservation Act 1999* for assessment under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The submission has been assessed in accordance with the protected species provisions of Part 13 and the wildlife trade provisions of Part 13A of the EPBC Act.

I am pleased to advise that assessment of the fishery is now complete. The assessment report will be available on the EA website at: http://www.ea.gov.au/coasts/fisheries/index.html.

I am satisfied that it is unlikely that fishing operations conducted in accordance with the management arrangements will adversely affect the conservation status of protected species, or affect the survival and recovery of threatened species. The *Shark Bay Prawn Management Plan 1993* requires that all reasonable steps are taken to ensure that protected species are not injured or killed and the level of interactions with such species in the fishery is not likely to adversely affect the conservation status of protected species or the survival and recovery of listed threatened species. Hence, the management arrangements for the Shark Bay Prawn (SBP) fishery meet the requirements of Part 13 of the Act and I propose to accredit the plan accordingly. Accreditation will ensure that individual fishers operating in accordance with the plan are not required to seek permits in relation to interactions with protected species in Commonwealth Waters.

I am satisfied that for the purposes of the wildlife trade provisions in part 13A of the EPBC Act, the management arrangements provide the basis for the fishery to be managed in an ecologically sustainable way. I therefore propose to amend the list of exempt native specimens to include all specimens taken in the SBP fishery for a period of five years. Such listing will serve to exempt the fishery from other export controls of the Act and exempt exporters from requiring export permits under the Act.

The SBP management arrangements meet the Commonwealth *Guidelines for the Ecologically Sustainable Management of Fisheries*. The fishery is managed under a comprehensive, adaptable,

precautionary and ecologically based regime capable of controlling, monitoring and enforcing the level of take from the fishery. The combination of management arrangements, data gathering and proposed research provides confidence in the fishery's ability to manage impacts on the wider ecosystem.

While there are some environmental risks associated with this fishery, I believe that DFWA is taking a proactive approach to mitigating these risks and addressing them adequately. Officers from our two departments have discussed some key areas requiring ongoing attention. I understand that they have agreed to a number of recommended actions, focussed on ensuring the continuation of good management practices. The recommendations for the SBP fishery are attached to this letter. I look forward to receiving your agreement in relation to the implementation of these recommendations.

I would like to thank you for the constructive way in which your officials have approached this assessment and I look forward to reviewing the remainder of the Western Australian managed fisheries.

Yours sincerely

Signed on 11 February 2003

DAVID KEMP

Recommendations to the Western Australian Department of Fisheries on the ecologically sustainable management of the Shark Bay Prawn Fishery

1. Opportunity should be provided to conservation, community, recreational fishing and world heritage area management interests to participate in the processes of the main advisory body to the WA Fisheries Minister for this fishery. DFWA should also ensure that any relevant indigenous interests are considered through appropriate consultative mechanisms.
2. The ESD report, including all performance measures, responses and information requirements, should be formally incorporated into the management regime and decision making process within one year, with a clear timeframe for implementation.
3. EA should be informed of any changes to the management plan or managerial commitments in the ESD report.
4. The ESD report should be amended to incorporate time frames for all management responses to breaches of performance measures.
5. Permitted byproduct should be limited to species currently harvested, with a robust system developed to add or remove species as appropriate. Suitable catch triggers should be developed to ensure any change in targeting behaviour can be detected and addressed as it occurs. Management responses should be clarified, with timeframes for implementation, to address such changes, so that the management arrangements are able to minimise threats to byproduct species.
6. DFWA should participate in any cross-jurisdictional activities regarding relevant target and byproduct species, including squid.
7. Ongoing monitoring should be implemented sufficient to identify long-term trends in bycatch between fished and unfished areas to ensure that information used in the risk assessment for the fishery remains based on accurate and current data.
8. The importance of specific areas and habitats to applicable bycatch species during all stages of their life cycle should be considered when applying the results of biodiversity research to management arrangements.
9. A mechanism should be developed to enable the amendment of management arrangements to respond to new information or future Government plans and policies.
10. All protected species interactions by commercial operations should be reported and coupled with an education program to ensure industry has the capacity to make accurate reports.