

Towards self-management for the Western King Prawn Fishery in Spencer Gulf, South Australia

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1. INTRODUCTION

Western king prawns (*Melicertus latisulcatus*) were first trawled from Spencer Gulf by the Fishery Investigations Ship *Endeavour* in 1909. A Danish seine boat made the first unsuccessful attempt at commercial prawn trawling in Spencer Gulf in 1948. The South Australian Department of Fisheries and Fauna Conservation carried out exploratory trawling on a number of occasions between 1957 and 1964, again with no commercial success. Some Port Lincoln fishermen had limited success in 1961.

The industry showed its true potential in 1967. A trawl fisherman began an extensive resource survey of Spencer Gulf in July 1967. After two and a half months of surveying the southern area during daylight and dark, he finally caught the first commercial quantity of prawns from the bend of the “Gutter” in October 1967. Other fishermen joined the new fishery and it rapidly developed. In March 1968, the then Director of Fisheries closed all South Australian waters to trawling and 25 permits for prawn fishing were granted. These early management measures were critical in preventing over-exploitation of the resource and over-capitalisation within the fishery.

In 1981, the first prawn trawl surveys were conducted. These structured surveys were carried out on several occasions throughout the year and aimed at improving the understanding of the distribution and abundance of prawns in the gulf. From these surveys, the first harvest strategies were developed. Over time, industry and government collaboratively improved harvest strategies such that mean harvested prawn size has increased dramatically, trawl effort has halved and catches are optimised for growth and recruitment success.

The Spencer Gulf and West Coast Prawn Fishermen’s Association (the Association) was formed near the inception of the fishery in 1968 and has played an increasingly important role in the management of the fishery over time. While fishers were key drivers in harvest strategy development from its onset, the introduction of the *Fisheries (Management Committees) Regulations 1995* provided the industry with a formal role in co-management. Fisheries Management Committees (FMCs) were developed for each South Australian commercial fishery and are responsible for providing advice to the Minister (and Director of Fisheries) on matters regarding management of the fishery.

Today, the Association has a strong membership base, a sound governance structure and is economically self-sufficient. It applies and promotes ecologically sustainable fishing practices and actively endorses the product and management of the fishery. While the imminent introduction of the new *Fisheries Management Act 2007* in South Australia signals the end of the FMCs, its legislation provides even greater opportunity

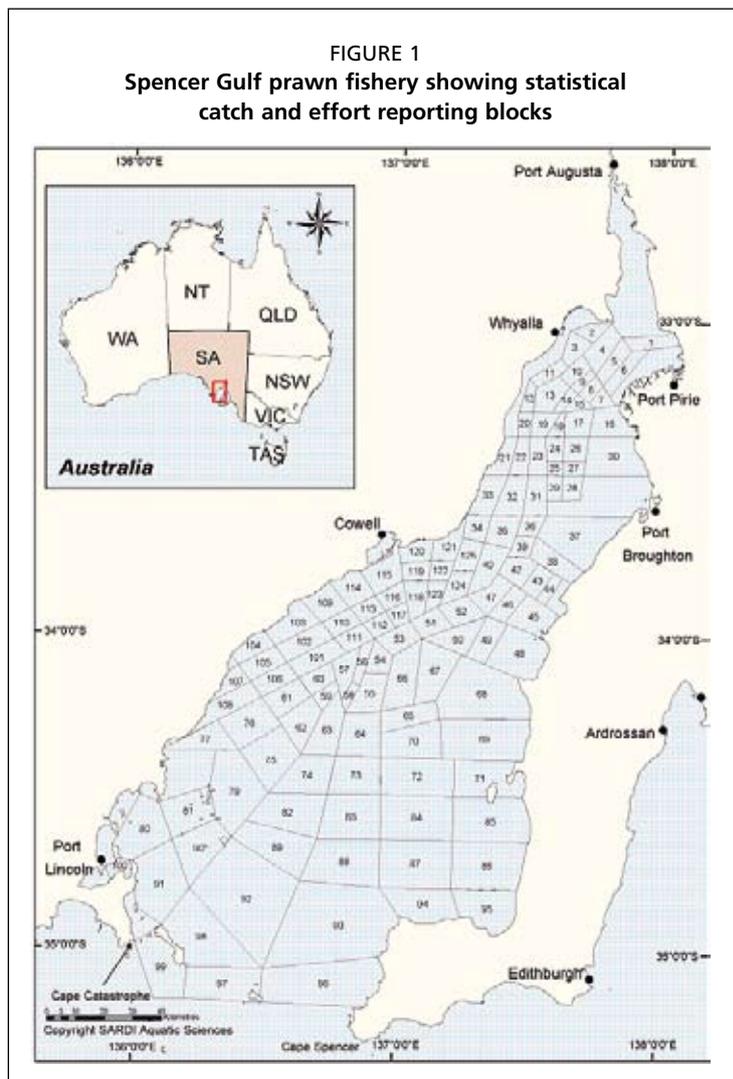
for industries such as the Spencer Gulf prawn fishery to move toward greater self-management.

2. FISHERY DESCRIPTION AND HISTORY

2.1 The Spencer Gulf prawn fishery

The Spencer Gulf prawn fishery includes all South Australian waters of Spencer Gulf that are north of the geodesic line joining Cape Catastrophe, Eyre Peninsula and Cape Spencer, Yorke Peninsula (Figure 1). Commercial fishery licence holders in the Spencer Gulf fishery may engage in the taking of western king prawn (*Melicertus latisulcatus*)¹ by trawling. In addition, commercial licence holders are permitted to retain two by-product species taken incidentally in fishing operations [slipper lobster, (*Ibacus* spp.) and southern calamary (*Sepioteuthis australis*)].

There are 39 commercial fishery licences issued for the Spencer Gulf prawn fishery and registered vessels operate almost exclusively in this fishery. No new licences can be issued under the regulations. There is effectively no recreational fishery for western king prawns in South Australia, due to regulations that prohibit the taking of western king prawns in waters less than 10 metres depth.



Commercial fishing is undertaken using the demersal otter trawl technique, which consists of towing a funnel-shaped net leading into a bag (commonly referred to as a cod end) over the sea bottom behind a boat. Otter boards (or doors) are used to keep the trawl nets open horizontally while being towed. A separate large-mesh bag (crab bag) acts to retain blue crabs and large fish, sharks and rays, while prawns flow through to the cod end. The crab bag reduces blue crab mortality and incidental damage to prawns.

Trawling is undertaken during the night anytime between sunset and sunrise, depending on the season. Trawl shots are of short duration relative to other prawn fisheries, averaging approximately one hour. After each shot, the cod end is emptied straight into a hopper system, which immerses the catch in seawater prior to sorting. The contents of the crab bags are spilt onto sorting tables with separation racks fitted. These racks reduce the time to sort prawns retained in the crab bag from all other bycatch, increasing

¹ The taxonomical classification of the subgenus *Penaeus* has recently been revised to the generic level of *Melicertus* (Perez Farfante & Kensley 1997). The new species name for western king prawn is accordingly *Melicertus latisulcatus*. [Pérez Farfante, I. & B. Kensley (1997)]

bycatch survival by minimising handling and ensuring a rapid return to the sea.

After separation, prawns are graded either mechanically or by hand. The prawns are then either cooked before being packed or packed unprocessed to suit market demand and snap frozen. Some catch is still stored in large built-in refrigerated brine tanks before delivery to on-shore processing facilities. At the end of each fishing trip, the catch is off-loaded and either consigned as frozen product direct to markets or transported to fish processing factories for packaging or value-added processing. Major ports for the Spencer Gulf fleet are Port Lincoln, Wallaroo (south of Port Broughton), Port Adelaide (about 150 km east, in Gulf St. Vincent) and Port Pirie (Figure 1).

Catch and effort data have been collected for the fishery since its inception in 1968 (see Figure 2). Catches from the fishery increased rapidly from 1968, reaching 2 521 tonnes in 1974. Annual catches thereafter have generally ranged between 1 400 and 2 400 t, averaging almost 1 900 t during that period. Effort peaked during 1980 at 44 563 trawl hours. Thereafter, effort has declined regularly and significantly. The peak catch of the fishery (2 739 t) was obtained in 2001 and required less than 50 percent of the effort expended during 1980 (Figure 2).

Economic reporting on the fishery shows that the average vessel catch over the past ten seasons (years) ranges between 43 and 60 tonnes a vessel, with a current average beach price of A\$17 a kilogram. To counter price pressures from cultured prawns, the industry has invested in a marketing strategy and developed a brand name to position their product in both domestic and international markets.

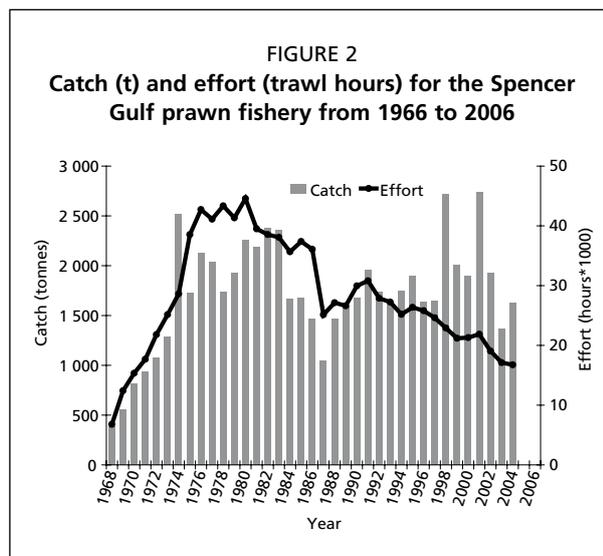
2.2 Biological characteristics

Prawns are crustaceans with five pairs of swimming legs (pleopods) as well as five pairs of walking legs (pereiopods), with the front three having claws. Although they are capable of swimming, prawns spend most of their life on or close to the seabed. They are nocturnal and some species burrow into the seabed during the day, emerging at night to feed.

From about 12 months of age, female western king prawns mature and spawn in the deeper waters of the Gulf (15–60 metres). Spawning occurs between November and March with peak activity occurring in two waves – late November/early December and late January/early February. Mating occurs between hard shell males and soft shell (recently moulted) females. Prawns can become mature as small as 25 millimetres CL (carapace length), but the proportion that mature at this size is small. Fertilisation success increases with increasing size. Each fertilised female can release between 60 000 to 800 000 eggs, with proportionately more eggs released per unit of body weight and increasing size.

After fertilisation, larvae undergo morphological changes and develop from nauplii, then mysids, and finally into post-larval stages during four to five weeks of planktonic larval life. The success of larval dispersal to favourable nursery habitats is an important factor affecting reproductive success. During this period of dispersal, high mortality occurs.

Post larvae grow rapidly and juvenile prawns remain in the nursery areas for between 5 to 10 months, depending on the timing of settlement and water temperature. They then move offshore into the deeper waters at a size of 20 to 28 millimetres CL as new



recruits. The major nursery areas for the fishery are found in northern Spencer Gulf, predominately on the western side, though recruitment can occur over most of the extent of the Spencer Gulf coastline. There is a strong relationship between the number of spawners and recruits (Dixon, Roberts and Hooper, 2006; Dixon and Sloan, 2007).

The growth of prawns is seasonal with maximum growth occurring in autumn, as spring and summer energy is mostly directed to reproduction. Little growth takes place between July and December. Temperature alone does not control growth, which is also subject to a number of other factors such as spawning date, tidal amplitude and day length. The growth rate of females is faster than males, with substantial differences in sizes for prawns from two to three years of age. Annual differences in growth rates also occur and these can significantly affect the quantities of annual harvest. There are large annual and regional differences in survival and density-dependent mortality that may be important in regulating population numbers.

2.3 Ecological characteristics

In Spencer Gulf, western king prawns prefer to live in depressed gutters comprised of soft, sandy substrate into which they are able to burrow. As with all trawling methods used in the fishing industry, the demersal otter trawl technique used in Spencer Gulf may cause damage to the benthos. There are, however, some mitigating factors that tend to minimise adverse effects on the ecology of the regions fished. These include:

- i. Prawn trawling only occurs on sandy or mud bottom where the water is relatively deep (> 10 metres). Accordingly, fishing does not take place over fragile sea-grass areas. In addition, a number of permanent closures in waters greater than 10 metres depth have been introduced to protect environmentally sensitive areas (i.e. areas with high catches of important or abundant bycatch species).
- ii. The prawn fishery is spatially focussed in a relatively small area of Spencer Gulf and fishing is limited to approximately 50 nights a year. While catch has remained relatively stable since 1974, commercial trawling hours have more than halved (Figure 2).
- iii. The legislation under which these fisheries operate specifically prohibits the taking of the majority of fish and blue crab bycatch species. While some of the bycatch taken in the trawling process does not survive, a high proportion does survive due to the short trawling times and the use of hopper systems and 'crab bags', which allow bycatch to be immediately returned to the sea.
- iv. Fishers are sensitive to the goal of reducing bycatch and support bycatch studies (Carrick, 1997, 1999; Dixon, Svane and Ward, 2005; Svane, 2002; Svane, Rodda and Thomas, 2007), which describe the type, variety and number of marine organisms that find their way into the trawl nets.
- v. The Prawn Fisheries Management Committee has strongly supported trawl research and technological development to further reduce bycatch.

Prawns are more commonly associated with warmer tropical or sub-tropical water regimes. The Gulfs of South Australia are considered unique in being at the lower limit of temperature tolerance for the western king prawn. The high seasonal variability in water temperatures in the Gulf has a considerable influence on the species biology and behaviour. Of particular importance is the impact of water temperature on growth, spawning and catchability.

Prawns are far less susceptible to capture during daylight hours. Catchability of prawns is also strongly related to the phase of the moon, with highest catch rates during the dark phase of the moon. The proportion of soft-shelled prawns increases over the full to last quarter moon phase in some months, which can result in reduced returns through lower prices.

These biological and behavioural responses to the environment are important

drivers in the determination of appropriate fishing strategies. Understanding each of these ecological factors is paramount for the effective management of the fishery.

3. MANAGEMENT

3.1 Regulatory management history

In March 1968, all South Australian waters were closed to trawling and 40 permits for prawn fishing were offered. Of those, only 25 were taken up. The fishery was split into two management zones and all waters less than 10 metres depth were permanently closed to trawling. The *Preservation of Prawn Resources Regulations 1969* provided fishers with a licence to fish for prawns. The number of licences was cautiously increased as knowledge of the resource improved. In 1971, the two management zones were merged and licences restricted to 39 boats.

The *Fisheries Act 1982* (the Act) provides a broad statutory framework to ensure the ecologically sustainable management of South Australia's fisheries resources. The two key objectives of the Act are:

- i. ensuring, through proper conservation, preservation and fisheries management measures, that the living resources of the waters to which this Act applies are not endangered or overexploited and
- ii. achieving the optimum utilisation and equitable distribution of those resources.

The Act establishes a set of regulation-making powers to formalise a co-management process for fisheries management in South Australia. The *Fisheries (Management Committees) Regulations 1995* outlined a set of co-management principles and established a number of Fisheries Management Committees (FMCs) for key fisheries or groups of fisheries, including the Prawn Fisheries Management Committee (the Prawn FMC). Each FMC is led by an independent chair and comprises commercial fishers, a Government policy manager, a fishery scientist and a recreational fishing representative. Corporate objectives and goals of each FMC are described in a five-year strategic and business plan. The FMCs have provided the principal forum for input into fisheries management and research issues for all stakeholders of South Australian fisheries since 1995.

Management arrangements developed by the Association, in consultation with Government, are raised and endorsed through the FMC process. For example, the Association recently developed an Environmental Management System (EMS) that was endorsed through the FMC and then applied in the fishery. In another example, prior to each fishing period, harvest strategies are developed by an Association sub-committee and ratified through the FMC. This co-management process has enabled the Association to demonstrate its capacity to develop and implement management arrangements that ensure the ecologically sustainable management of the fishery.

3.2 Current regulations and management arrangements

The regulations that currently govern the management of the Spencer Gulf Prawn Fishery are the *Fisheries (Scheme of Management – Prawn Fisheries) Regulations 2006* and the *Fisheries (General) Regulations 2000*. Table 1 provides an overview of the current management arrangements for the fishery.

There are 39 fishers licensed to harvest western king prawn in Spencer Gulf. They are also permitted to harvest slipper lobster and southern calamary, which are a common bycatch. Licences are transferable and corporate ownership is permitted. Any boat used in the fishery must be registered and be appropriately endorsed upon the licence under which it is being operated. Boats must not exceed an overall length of 22 metres and the main engine must not exceed 365 continuous brake horsepower. Both single and double rigged otter trawl nets are permitted to be used in the fishery with a minimum cod-end mesh size of 4.5 centimetres and a

TABLE 1
Management controls in the Spencer Gulf Prawn Fishery

Management tool	Current restriction
Permitted species	Western king prawn (<i>Melicertus latisulcatus</i>), Slipper lobster (<i>Ibacus</i> spp.), Southern calamary (<i>Sepioteuthis australis</i>)
Limited entry	39 licences
Licence transferability	Permitted
Corporate ownership	Permitted
Spatial and temporal closures	Adjusted based on survey results
Closed areas	No trawling in waters shallower than 10m
Method of capture	Demersal otter trawl
Trawl rig	Single or double rig
Trawling times	Not during daylight hours
Maximum headline length	29.26 m
Minimum mesh size	4.5 cm
Maximum vessel length	22 m
Maximum vessel power	365 brake horse power
Catch and effort data	Daily and monthly logbook submitted monthly (by trawl shot)
Landing locations	Landings permitted anywhere in the State
Landing times	Landings permitted at any time during the season
Season	November, December, March to June

maximum headline length of 29.26 metres. The headline length of any single prawn trawl net used in a double rig must not exceed 14.63 metres.

In addition to the permanent closure of shallow waters (<10 m depth) to trawling introduced in 1968, a series of areas closures (north of Point Lowly, north of Port Broughton, Arno Bay, Cowell, Port Pirie and Port Victoria) have since been voluntarily introduced by the Association. These closures have been implemented to protect important habitats, juvenile prawn grounds and the benthic communities they support. The remaining trawl grounds are primarily sand and mud sediments, with relatively low species diversity and biomass. As harvest strategies developed and fishing became more efficient, seasonal closures have been introduced, so that today, fishing only occurs during November, December and March to June. These seasonal closures aim to protect the spawning biomass, to maximise value by allowing for sufficient growth and to maximize capture efficiency, which is lowest during winter months.

3.3 Prawn surveys

Prawn stock surveys using industry vessels have been regularly conducted in the Spencer Gulf since 1981. Initially, the location and timing of survey shots were highly variable as fishers and researchers tried to obtain an understanding of the distribution and abundance of prawns throughout the gulf that underpinned a biological understanding of the resource. Today, surveys have developed to meet the real time management needs of the fishery.

There are two types of prawn stock surveys conducted: stock assessment surveys and spot surveys. Stock assessment surveys are carried out three times a fishing season. The primary aim of stock assessment surveys is to obtain a snapshot of the status of the resource, to provide assurance that harvest strategies are sustainable. Stock assessment survey data are one of the critical elements for assessment of the fishery (Carrick, 2003; Dixon, Roberts and Ward, 2005, Dixon; Roberts and Hooper, 2006). They provide data on relative biomass, prawn size, distribution and abundance, recruitment to the fishery and data on spawning and reproduction.

There are 209 trawl shots conducted throughout the Gulf during each stock assessment survey. These survey shots are repeated at the same locations and times each year, to be directly comparable. The first stock assessment survey is in November, prior to the commencement of the fishing season. The second survey in February is to assess

the resource after the November/December harvest period, prior to fishing in March. The third survey is conducted in April, toward the end of the season and during the period with the highest commercial catches per night.

Stock assessment surveys also provide essential information for the development of harvest strategies. The overall status of the resource, determined from average catch rates observed on surveys, as well as the distribution, abundance and size data obtained from these surveys are used to determine closure lines for fishing.

Spot surveys are smaller, targeted surveys that are conducted between stock assessment surveys. They are generally conducted in areas that were previously closed in the hope of being able to include new areas in a revised harvest strategy. Therefore, the location and timing of spot surveys are determined by industry, based on their expectations of changes in the distribution of prawn stocks. New areas are not opened to fishing unless data from a stock assessment or spot survey suggest that it is appropriate.

Survey shots are generally 30 minutes in duration and are located using GPS to ensure consistency. Stock assessment surveys are always conducted during the dark phase of the moon in the same month each year, as catch rates are significantly affected by the moon phase (catch rates are highest during the dark phase of the moon). Spot surveys may be conducted during any moon phase. The data collected on stock assessment and spot surveys include total catch, data on prawn size and trawl time and distance. Additional information is collected on stock assessment surveys to further inform fishery assessment.

Stock assessment surveys are jointly co-ordinated by the Association and the South Australian Research and Development Institute (SARDI) to ensure independence in the information collected. Spot surveys are entirely co-ordinated by the Association. The Government annually issues an authority for the Association to conduct surveys when necessary. Within this authority, the Association must inform the Fisheries Agency of the details of the survey, including details of participating vessels and survey locations. The Association has contractual arrangements with licensed vessels, such that the licensed vessel can conduct surveys on their behalf. Vessels are paid a fixed amount for their services. Survey vessels must process the catch in the manner specified by the Association and all the catch proceeds of the catch are administered by the Association to offset the cost of the surveys.

3.4 Management Plan

The powers contained in the *Fisheries (Management Committees) Regulations 1995* provide the legal basis for the preparation of the Management Plan (Dixon and Sloan, 2007). The Management Plan is an expression of the policy that applies in relation to the Spencer Gulf Prawn Fishery to inform the exercise of any discretionary decision-making powers in the legislation as they apply to the fishery.

There are four key management goals identified in the Management Plan that have been developed by the Prawn FMC:

- i. Maintain ecologically sustainable stock levels
- ii. Ensure optimum utilisation and equitable distribution
- iii. Minimize impacts on the ecosystem and
- iv. Enable effective management with greater industry involvement.

Each of these goals is linked to a set of objectives and strategies that operationalise the management goals (Table 2). This comprehensive list demonstrates the competing and compatible management outcomes that the prawn industry and fisheries agency are pursuing to implement an ecosystem-based management approach to fishing. The Management Plan covers both ecological and economic objectives. The Plan recognizes that maximising the value of the resource requires decisions that optimise value (by targeting larger prawns and areas with high catch rates) and reduce fishing costs. High

TABLE 2
Management goals, objectives and strategies for management of the Spencer Gulf Prawn Fishery during 2007–11

Goal	Objective	Strategies
1. Maintain ecologically sustainable prawn biomass	a. Spencer Gulf prawn stocks harvested at ecologically sustainable levels	<ul style="list-style-type: none"> • Maintain a restriction on the number of licences and the total amount of gear in the fishery. • Develop spatially and temporally explicit harvest strategies for each fishing period in line with established target and limit reference levels and decision rules. • If the stock is determined to be operating below the established limits, the fishery will be managed to promote recovery to ecologically viable stock levels, within agreed timeframes.
	b. Sufficient biological and environmental information exists to inform management decisions.	<ul style="list-style-type: none"> • Collect fishery-dependent information through commercial logbooks. • Maintain the fishery-independent prawn survey program. • Assess the status of the stock through quantitative stock assessment. • Collect appropriate environmental data to aid assessment. • Review and update the strategic research and monitoring plan.
2. Ensure optimal utilization and equitable distribution	a. A fishery exploited for maximum economic value	<ul style="list-style-type: none"> • Within a framework of sustainable exploitation, develop harvest strategies that match target size with market requirements • When targets are reached, allow for higher exploitation levels to capture economic benefits from the fishery (subject to the constraints outlined under goal 1).
	b. An economically efficient fleet.	<ul style="list-style-type: none"> • Develop management arrangements that allow commercial operators to maximise operational flexibility and economic efficiency. • Undertake economic surveys of the commercial fishery to assess economic performance against a set of economic indicators.
	c. Equitable public access	<ul style="list-style-type: none"> • Review appropriateness of access arrangements between sectors once within the life of the Management Plan • Develop a mechanism for altering access arrangements should a change be required
3. Minimize impacts on the ecosystem	a. Minimize fishery impacts on by-catch and by-product species	<ul style="list-style-type: none"> • Maintain a limit on the amount of gear used in the fishery. • Maintain permanent closed areas. • Undertake a risk assessment to determine the vulnerability of by-catch and by-product species to overfishing from prawn trawling. • Develop mitigation strategies for bycatch and by-product species deemed at high risk of overfishing from prawn trawling. • Promote the development of environmentally friendly fishing practices.
	b. Avoid the incidental mortality of endangered, threatened and protected species	<ul style="list-style-type: none"> • Undertake a risk assessment to determine the vulnerability of endangered, threatened and protected species to fishing operations. • Improve data recording systems to capture fishing interactions with endangered, threatened and protected species. • Develop management measures to avoid interactions with endangered, threatened and protected species.
	c. Minimize fishery impacts on benthic habitat and associated species communities	<ul style="list-style-type: none"> • Maintain a limit on the amount of gear used in the fishery. • Maintain permanent closed areas. • Promote development of environmentally friendly fishing gear and fishing practices. • Develop strategies for assessment of impacts on habitat and associated species communities
4. Enable effective and participative management of the fishery	a. Industry delegated greater responsibility in management	<ul style="list-style-type: none"> • Industry manage the spot survey process and develop harvest strategies (with reference to PIRSA Fisheries and SARDI). • Industry manage all at-sea operations of the fleet. • Develop an improved industry decision-making structure to satisfy governance requirements. • Develop explicit allocation of prawn resources between sectors. • Develop a process for the industry association to review the necessary ecological assessment report to the CDEH for export accreditation.
	b. Management arrangements reflect concerns and interests of the wider community.	<ul style="list-style-type: none"> • Promote stakeholder input to the management of the fishery, through established co-management processes. • Ensure that social and cultural issues are given appropriate consideration when new management strategies are being developed. • Communicate management arrangements to the wider community.
	c. Management arrangements are complied with.	<ul style="list-style-type: none"> • Undertake annual compliance risk assessment. • Implement a cost-effective compliance and monitoring program to address identified risks. • Promote high levels of stakeholder stewardship through established management processes and Fishwatch activities.
	d. Costs of management of the fishery funded by relevant stakeholders	<ul style="list-style-type: none"> • Ensure stakeholders are involved in development of management arrangements for achieving management objectives • Determine the annual real costs of management, research and compliance for the fishery. • Recover an economic return from commercial licence holders, sufficient to cover the attributed costs of fisheries management, research and compliance in line with established cost recovery principles.

TABLE 3
Performance indicators for assessment of the Spencer Gulf Prawn Fishery

Objective	Performance Indicator	Limit Reference Point
1a	Recruitment index	>35
1a & 2a	Total commercial catch (t)	>1800
1a & 2a	Mean commercial CPUE (kg/hr)	>80
1b	Fishery independent surveys	3 surveys completed
1b	Stock assessment report	Completed
2b	Economic report	Completed
1a	Indices of future and current biomass	Neither index is below lower threshold levels in 2 consecutive surveys
2a	% vessel nights with mean size >280prawns/7 kg	<2%
2b	Gross Value of Production (GVP)	<0% change
2b	Management Costs	>10% increase
2b	Return on investment	<0% change
4a	Committee comply with harvest strategy decision rules	Committee develops all harvest strategies based on results of surveys and in accord with decision rules
4c	Fleet complies with harvest strategies	Fleet operates within prescribed open areas and times described in every harvest strategy

The limit reference point of <0% for return on investment is considered realistic as farmed prawns are driving prices down worldwide: the target is to try and maintain current value – which is a significant challenge in itself!

catch rates also reduce the area trawled and nights fished, reducing total bycatch and impacts on benthic communities.

The extent to which the Management Plan is achieving the range of stated goals and objectives is assessed using a combination of indicators designed to measure performance of the fishery. These performance indicators are assessed against reference points, which are agreed quantitative measures based on clearly defined management objectives. Reference points begin as conceptual criteria, which capture in broad terms the management objectives for the fishery. To implement fishery management, it must be possible to convert the conceptual reference point into a technical reference point, which can be calculated or quantified on the basis of biological or economic characteristics of the fishery (Caddy and McMahon, 1995).

Limit reference points are used for rational exploitation of the prawn resource and are defined as an agreed level above which stock stress may occur and immediate action is required to remedy the situation before long-term damage to resource productivity may result. The Prawn FMC has developed a range of performance indicators and limit reference points from which the fishery can be assessed, each relating to a specific objective of the Management Plan (Table 3).

If a limit reference point is exceeded, a number of explicit actions result:

- i. The Minister for Agriculture, Food and Fisheries is notified and participants in the fishery, as appropriate.
- ii. A detailed review is undertaken including an assessment of the additional performance measures where appropriate. (Additional performance measures are secondary performance indicators used to help inform assessment in case any of the primary performance indicators are breached.) A synopsis of the causes is to be provided and implications of failure to achieve the minimum desired performance.
- iii. Where appropriate, key stakeholder groups are to be consulted regarding the need for alternative management strategies and the collection of additional data.
- iv. A report is provided to the Minister within three months of the initial notification on the effects of breaching the performance indicator, including any recommendations on management strategies.
- v. Minister or Director of Fisheries must consider recommendations, endorse supported strategies and implement them as appropriate.

TABLE 4
Management costs for the Spencer Gulf prawn fishery for 2005/06

Management activity	2005/06 \$	Comments
Research	331 728	Delivery of stock assessment that reports on fishery performance indicators
Non Discretionary		
Economic Research	18 613	Report on fishing input costs and market prices
Non Discretionary		
Policy and Management	67 012	Provision of management services from Fisheries Agency
Non Discretionary		
Legislation	9 802	Amendments to scheme of management or legal notices that regulate fishing
Non Discretionary		
Licensing	21 392	Cost to issue licences, collect annual fees and provide advice to licence holders
Non Discretionary		
Compliance	96 390	Fisheries Agency compliance operations to address fishery risk assessment high priorities
Non Discretionary		
Directorate	19 904	Service delivery contract management
Non Discretionary		
Fishery Management Committee	30 000	Operational expenditure for Fishery Management Committee (e.g., meetings, correspondence, papers)
Discretionary		
Extension Services	132 609	Prawn industry extension services
Discretionary		
Additional	80 000	Committee At-Sea and Extension services
Services		
Discretionary		
Fish Research & Development Corporation Levy	100 725	National funding contribution based on 0.25% of rolling 3-year average GVP
Discretionary		
Total	1 104 129	\$28 311/licence

3.5 Cost Recovery for management programmes

There is a minimal administrative charge to register a boat with a prawn licence -A\$68. However, the Spencer Gulf fishery licence fee for 2007/08 is A\$25,959. Programmes required for management of the fishery are determined each year through consultation with the Prawn FMC. Programmes relate to policy management, research, licensing and legislation, compliance and discretionary industry services. Costs associated with these programmes for 2005/06 are documented in Table 4.

The costs of all programmes are determined through negotiation between the Fisheries Agency and the Fishery Management Committee. Non-discretionary programmes are essential for industry to fund; however, the level of service and associated costs can be negotiated. Where no agreement can be reached, the Minister makes a decision, which may support either the Fisheries Agency or the industry position. However, all parties have come to a realisation over time that it is in the best interests of all parties to determine the services and avoid reference to the political process, as this passes decision-making outside the control of the participants (particularly industry) and can lead to sub-optimal outcomes. Many services are requested by industry.

There have been no referrals to the Minister to determine services in recent years, due to the strong relationship between industry and agency managers and adherence by all parties to the fishery management goals.

3.6 Harvest strategy development and management

The regulations for harvest strategy development and management are documented in the Management Plan. Harvest strategies are the mechanism for managing fishing

effort using spatial and temporal closures. Specifically, this involves the development of appropriate fishery closure lines (a series of GPS co-ordinates) and the dates of trawling. The primary aim of the harvest strategy is for the fleet to target areas of high catch rates of larger sized prawns to ensure biological sustainability and promote economic efficiency.

The harvest strategy functions at two scales: (a) harvest strategy development and (b), harvest strategy management. Harvest strategies are developed prior to the commencement of fishing during each harvest period. The development phase involves the determination of suitable areas of the fishery to open based on data obtained from surveys. Strategies are developed by industry, ratified through the FMC process and authorized by statutory notice.

Once established, the harvest strategy is managed on a daily, or even hourly, basis during the fishing as is run by the “Committee at Sea” (a group of vessel skippers that includes Association representatives and the appointed “co-ordinator at sea”). Management of the harvest strategy is refined from data obtained during commercial fishing and involves changing the area open to fishing to avoid areas with small prawns or low catch rates. This real-time management of the harvest strategy, which may be on an hourly basis, is unique to our knowledge within a trawl fishery.

The Committee at Sea became an organised body with the introduction of a Fishery Management Committee in 1985. The Committee at Sea is made up of nine members, the majority of whom are licence holders and the remainder boat skippers. The raw data on daily catches is not currently available to all fishers, but the industry is looking to establish an electronic logbook system that would support industry-wide communication. High catch-rate areas are identified for all fishers. The harvest strategy is determined by the Committee at Sea and relayed to the fleet through an industry-operated radio station.

4. INDUSTRY ROLE

The Committee at Sea makes decisions on the harvest strategy on a majority basis, following the objectives and performance indicators in the Management Plan. The Association Executive Committee also makes management decisions on a majority basis, operating formally with agendas and minutes. Under the current Fishery Management Committee structure, the Association would bring management issues to the table that are to be brought to the attention of the fisheries agency, particularly if some government intervention was required.

The 39 licences are owned by different companies, although there are close family and financial associations between some companies. There are six main prawn buyers, but many licence holders now consign their catch to domestic markets or export directly from the boat to reduce transaction costs on prawns sold to the retail sector. This maintains or increases the returns to the boats. Passing on price increases to the consumer is not realistic, so there is an incentive to ensure that costs in delivering to the market are reduced.

When prawn catch rates fall during a harvest period, it is up to the Committee at Sea to cease fishing. If prawns are considered to be too small, the Committee at Sea will cease fishing. The industry now has the capacity and maturity to manage the resource with a long term view, so fishing will cease if the opportunity cost of continuing does not meet the expected future return from leaving the prawns to spawn and grow. This mindset and understanding underpins the management success of this fishery.

5. DISCUSSION

There are several key elements to the management history of the Spencer Gulf prawn fishery that have enabled the industry to move toward a higher level of self-management. While much of the success of the fishery is attributed to the decision

in 1968 to limit entry, collaborative relationships developed between industry and government have enabled greater delegation of management responsibility to industry over time. This delegation is based on the industry's demonstrated maturity and willingness to be responsible for management decisions and the actions of their Association members.

This collaborative relationship began in the 1980s and was strengthened when the *Fisheries (Management Committees) Regulations 1995* were established to provide a legal framework for co-management. Of South Australia's major fisheries resources, the Spencer Gulf prawn fishery has evolved further than other fisheries in the co-management process. This is amply demonstrated through the Association's involvement in harvest strategy development and real-time management, capacity development within the organisation, sound governance, decision-making arrangements and financial self-sufficiency.

The performance indicators and guidelines for harvest strategy development, which are key components of the Management Plan, provide confidence for the Minister and community that the resource is being managed sustainably and in an economically efficient manner. The ongoing, real-time research programme that underpins the data used for harvest strategy development and performance assessment is also regarded as an essential safeguard to the well-being of the fishery.

Harvest strategy guidelines are easily audited and as such the decisions of the industry in harvest strategy development can be assessed. Other non-biological performance indicators include the extent of compliance breaches and feedback control from the Committee at Sea. The effectiveness of the harvest strategy in terms of catch output (prawn size and magnitude of the catch) is also assessed. Other key biological performance indicators include relative biomass (catch rate) and recruitment to the fishery.

Reference points and performance indicators are reviewed periodically. Changes may occur to biological reference points as more scientific information on the stock status of the prawn fishery is provided from the strategic research programme. Other performance indicators may also change to ensure that the management of the fishery is subject to a continuous improvement programme.

Regardless of the level of responsibility provided to the industry for management, the ultimate responsibility for ecologically sustainable development of the prawn resource of Spencer Gulf rests with the Minister. As such, the Minister at all times retains the power to regain control of the fishery, should he deem that it is not being sustainably managed.

Under the current Act, the Minister delegates those day-to-day management responsibilities of the resource to the Prawn FMC. Improved fisheries legislation, soon to be proclaimed in South Australia, will allow for further delegation of management responsibility to certain fishing industry groups. This will include structuring their own programmes for the identification of fishery services and implementation of cost recovery for those services, without the Fisheries Agency funding those services through licence fees. The Fisheries Agency's role will shift more to an audit function, which ensures that the right governance arrangements are in place to provide for scientific reporting to validate that the fishery is being exploited under an agreed, ecologically-sustainable development framework. Notably, however, self-management does not imply that total responsibility for management rests with industry. A number of core functions, such as regulation and compliance prosecutions and auditing, will not be delegated, as they remain a core function of government.

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