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SOUTH AUSTRALIAN FISHERIES MANAGEMENT SERIES

Ecological Assessment of the South Australian Rock Lobster (*Jasus edwardsii*) Fishery

Assessment Report Prepared for Environment Australia, against the *guidelines for the ecologically sustainable management of fisheries*

For the purposes of Part 13 and 13(A) of the *Environment Protection and Biodiversity Conservation Act 1999*

17 April 2003

Prepared by the Agriculture, Food and Fisheries Division of Primary Industries & Resources, South Australia

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FOREWORD

The marine, estuarine and freshwater fisheries resources of South Australia are community owned resources. The role of the Government, as custodian of these resources on behalf of the broader community and future generations, is to ensure that they are used in an ecologically sustainable and economically efficient manner, while at the same time maximising returns to the community.

Experience world-wide has demonstrated that where unrestricted use of fisheries resources is allowed, there is little incentive for individuals involved in harvesting to conserve fish stocks. The resulting competition among and between user groups often leads to reduced biological and economic productivity. Left unmanaged, the increase in fishing effort that results from competition is reflected in lower individual catches in the recreational fishing sector, and over-capitalisation and reduced financial returns in the commercial fishing sector. Loss of these resources to the community can result in significant regional economic problems.

In managing fisheries resources, Governments have the primary responsibility of ensuring long term sustainability. Governments must also ensure that the basis for sharing fisheries resources among all users is clearly understood and accepted as equitable, and that the allocation of fisheries resources and their level of utilisation are consistent with the needs of present and future generations.

To facilitate better decision-making by the Government in managing South Australia's fisheries resources, a number of fishery-specific stakeholder-based fishery management committees have been established to provide expertise-based advice to the Minister for Agriculture, Food and Fisheries. These committees are comprised of Government managers, research scientists, commercial and recreational fishers, fish processors and members of the general community. Each of these committees are convened by an independent chairperson. Appointment of members and the terms of reference of the committees are embodied in the *Fisheries (Management Committees) Regulations 1995*.

Where there is considered to be threats of serious or irreversible damage to fisheries resources, or the environment upon which they depend, a lack of full scientific certainty or insufficient information will not prevent the Government from making a resource management decision. Where resource management decisions must be made in an environment of uncertainty the Government, in partnership with the fisheries management committee, will take a precautionary approach to the management of South Australia's fisheries resources.

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1 INTRODUCTION

1.1 Purpose

This report has been prepared by the Agriculture, Food and Fisheries Division of the Department of Primary Industries and Resources, South Australia (PIRSA), in association with the Northern and Southern Zone Rock Lobster Fisheries Management Committees.

The purpose of this report is to provide Environment Australia with a detailed assessment of the management arrangements in place for the South Australian Southern and Northern Zone Rock Lobster Fisheries, against the ‘*guidelines for the ecologically sustainable management of fisheries*’, set out in the *Environment Protection and Biodiversity Conservation Act 1999* (the EPBC Act). It is intended that this report serve to have southern rock lobster (*Jasus edwardsii*), taken from South Australian waters, placed on the list of exempt native specimens for export under Part 13 and 13(A) of the EPBC Act.

1.2 Scope of the Management Plans

The *Fisheries Act 1982* (the Fisheries Act) provides the broad statutory framework to ensure the ecologically sustainable management and development of South Australia’s marine, estuarine and freshwater fisheries resources. In the administration of the Fisheries Act, the Minister for Agriculture, Food and Fisheries, the Director of Fisheries and all established Fisheries Management Committees must pursue the following objectives, outlined in Section 20 of the Act:

(a) *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*

(b) *achieving the optimum utilisation and equitable distribution of those resources.*

South Australia has management jurisdiction for *J. edwardsii* from the low water mark out to 200 nautical miles in the waters adjacent to South Australia, under an Offshore Constitutional Agreement between the South Australian and Commonwealth Governments. Separate Management Plans were developed for the Southern and Northern Zone Rock Lobster Fisheries in 1997. Both Management Plans cover commercial, recreational, traditional and illegal fishing activity for southern rock lobster undertaken within South Australian waters. Both Management Plans are available on the PIRSA website at www.pir.sa.gov.au

The management of the South Australian Rock Lobster Fishery is not subject to any specific international or regional management regimes or legal instruments, except for the United Nations Convention on the Law of the Sea, to which the existing management regimes comply. Regular dialogue exists between PIRSA Fisheries and each State jurisdiction with a responsibility for managing *J. edwardsii*, through a range of national and tri-state management and research fora. However, the management arrangements and fishery assessment processes in place for other jurisdictions are not explicitly taken into account during the annual catch and effort level setting processes undertaken in South Australia.

The Management Plans provide a statement of the broad policy framework and harvest strategy employed to ensure the ecologically sustainable management and development of the South Australian Rock Lobster Fisheries. The regulations that govern the management of the South Australian Northern and Southern Zone Rock Lobster Fisheries are established in the *Scheme of Management (Rock Lobster Fisheries) Regulations 1991* and the *Fisheries*

(General) Regulations 2000.

The Management Plans provide direction to the development of regulations but do not form part of the *Scheme of Management (Rock Lobster Fisheries) Regulations 1991* and do not have any statutory basis. The powers contained in Section 14 of the *Fisheries (Management Committees) Regulations 1995* provide the legal basis for the preparation of the Management Plans. The Fisheries Management Committee regulations assign responsibility for the preparation of Management Plans to individual Fisheries Management Committees.

The Management Plans operate for a five year period (1997 to 2002), subject to annual review and amendments that are considered necessary by the Northern and Southern Zone Rock Lobster Fisheries Management Committees, the Director of Fisheries or the Minister for Agriculture, Food and Fisheries. Each Management Plan includes a copy of the existing Five Year Strategic Research and Monitoring Plan for the fishery, which provides details of the strategic research priorities established for each fishing zone.

Both Management Plans (and Strategic Research and Monitoring Plans) are currently undergoing a comprehensive review and will be updated during 2003/04. A recent review of the management arrangements in place for the Northern Zone has led to PIRSA Fisheries confirming a move towards introducing a quota system in the Northern Zone¹. These arrangements are intended to be implemented by 1 November 2003.

It is important to note that PIRSA, in consultation with key stakeholder groups and the broader community are currently undertaking a comprehensive review of the Fisheries Act. This review, which is expected to be completed by the end of 2003, is likely to result in changes to the principal objectives of the Fisheries Act and, in turn, the broad sustainability framework for the management of South Australia's fisheries resources.

1.3 Description of the Fishery

Southern Rock Lobster is distributed from southwestern Western Australia to the south coast of New South Wales and around the North and South Islands of New Zealand. Fishing for rock lobster has been carried out in South Australia since early European settlement. In the early 1940's lobster processing for the United States 'lobster tail' market commenced, which proved to be a catalyst for the development of the fishery throughout South Australia.

The fishery constitutes South Australia's most valuable commercial fishery, with the annual gross landed value of production (GVP) currently estimated to be \$83 million (Morrison 2002). Production in the Northern and Southern Zones was 674 and 1,713 tonnes respectively in the 2001/02 fishing season. The Rock Lobster Fishery, like other State fisheries, generates export revenue for South Australia (approximately \$110 million), creates employment in catching and handling operations (approximately 2,000 jobs, mostly in regional areas) and generates business in supporting fishing service and supply industries. The annual business turnover for both fisheries is estimated to be \$230 million (Morrison 2002).

The South Australian Rock Lobster Fishery has been separated into two discrete fishing zones for the purposes of management since 1968 (Fig. 1). This geographic separation recognises key differences in the physical and ecological character that exist between the eastern and western borders of South Australia. The climatic and oceanographic influences on each fishery are quite distinct because of the wide geographic separation between each zone.

¹ Refer to documents: Northern Zone Rock Lobster Fishery – A management Review Discussion Paper (2002) and Long Term Management Options for the Northern Zone Rock Lobster Fishery (2002) for a more detailed account of the recent management review process (www.pir.sa.gov.au).

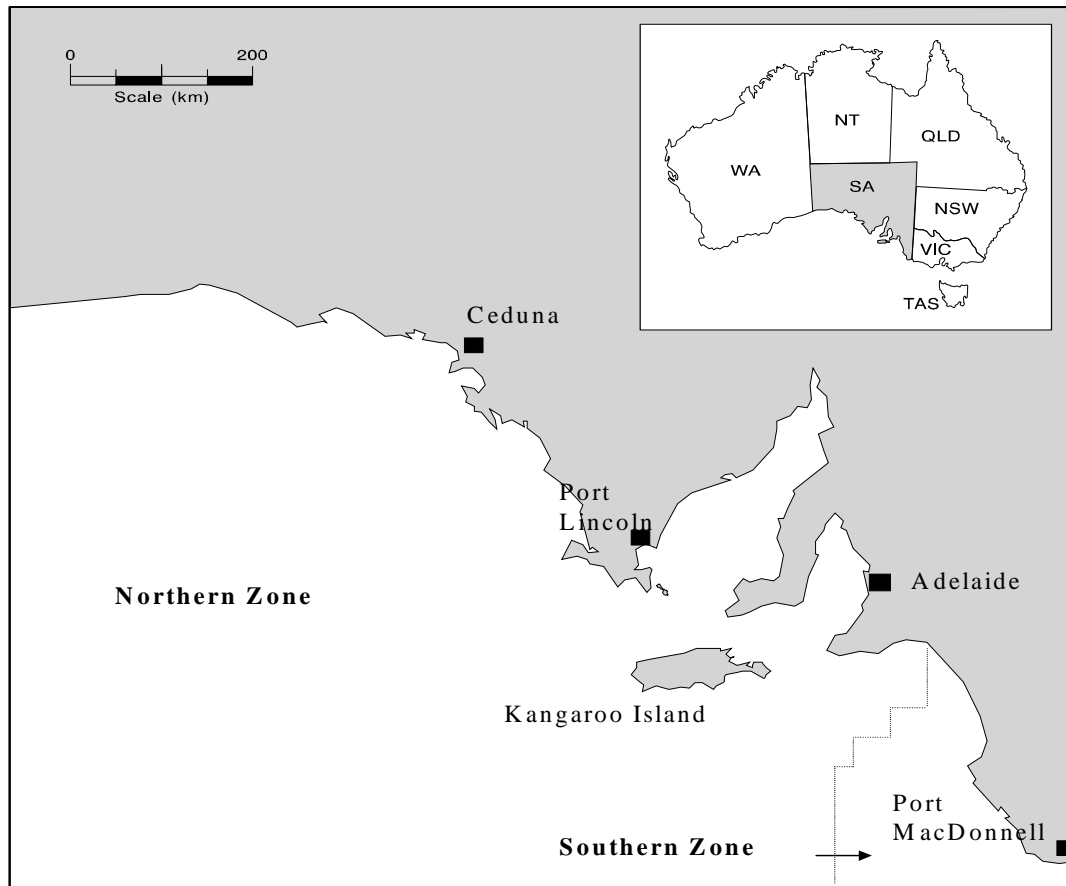


Figure 1. The northern and Southern Zones of the South Australian Rock Lobster Fishery.

The Northern Zone is generally characterised by patchy and discrete reef formations (mainly granite) that are separated by large expanses of sandy bottom. These characteristics are known to limit the amount of suitable habitat afforded to lobster and result in a generally more patchy distribution of lobster and higher inter-annual variability in recruitment strength. In contrast, the Southern Zone is characterised by more continuous and inter-connected limestone reef formations, strong upwelling and more reliable puerulus settlement and recruitment patterns (Lewis 1981).

Different management arrangements have been adopted for the commercial fishery in each zone in response to these unique characteristics. In the Northern Zone, the perceived difficulties associated with TAC setting and catch monitoring, that arise as a result of higher recruitment variability and the large geographic expanse, have underpinned the historical industry and Government support for a management system based primarily on input controls. Despite this, the fishery has arguably progressed to a different position in 2002, where the environmental carrying capacity and long term sustainable yield is much better understood. In the Southern Zone, the fishery is managed primarily on the basis of an Individually Transferable Quota (ITQ) system, which is complemented by a mix of input controls including limited entry, a closed season and gear restrictions.

Both commercial fisheries, while based principally on the capture of *J. edwardsii*, allow access to a range of other species. Key by-product species include octopus (*Octopus maroum*) and giant crab (*Pseudocarcinus gigas*). The majority of Southern and Northern

Zone Rock Lobster Fishery licence holders have some level of access to the South Australian Marine Scalefish Fishery (MSF) and the Commonwealth Southern Shark Fishery. Those rock lobster fishers with access to the MSF are only permitted to fish in one fishery on a single fishing trip, to avoid uncontrolled effort expansion in the MSF.

The South Australian Rock Lobster Fishery is one of several State managed fisheries for *J. edwardsii*. Beyond the western border of South Australia a small Western Australian fishery for *J. edwardsii* operates under an input control system. To the south east, *J. edwardsii* also supports the Tasmanian and Victorian Rock Lobster Fisheries, which both now operate under quota management systems similar to the management system in place for the South Australian Southern Zone Rock Lobster Fishery (and that proposed for the Northern Zone).

Due to the different management arrangements in place for each zone and the different geographic characteristics, a separate compliance and monitoring program is in place to ensure limited compliance and monitoring resources are used cost-effectively. The input control managed Northern Zone has a compliance program which has focussed principally on monitoring the numbers of pots used per vessel, days spent fishing per vessel, gear and vessel specifications, the prohibition on double-pulling during a single day and the area in which fishing is permitted.

The output controlled Southern Zone has a compliance program focussed more on monitoring the landing of lobster and adherence to individual vessel catch limits. A Dockside Monitoring Program has recently been introduced to improve the cost-effectiveness of monitoring landings in the Southern Zone. Compliance with size limits and prohibition on the retention of egg-bearing females is a common feature of both compliance programs. A Risk Assessment process has recently been adopted by the PIRSA Fisheries Compliance unit to assist in developing a more strategic approach to resource deployment and improve cost-effectiveness.

1.3.1 Southern Zone

Management arrangements for the Southern Zone Rock Lobster Fishery are outlined in the Management Plan (Zacharin 1997a) and formalised in the *Scheme of Management (Rock Lobster Fisheries) Regulations 1991* and the *Fisheries (General) Regulations 2000*. The current management controls for the Southern Zone Rock Lobster Fishery are outlined in Table 1.

Table 1. Current management controls for the Southern Zone Rock Lobster Fishery.

Control	Southern Zone
Licences	181
Season	October 1 to April 30
Minimum legal length (both sexes)	98.5 mm CL
Egg bearing females	No retention
Dead lobsters	Landed whole with tail split and dyed
Holding of live lobsters	Holding on vessels or on land
Current TAC	1770 tonnes
Total pots	11,923
Pot lifts per day	No restriction
Minimum pot allocation per licence	40
Maximum pot allocation per licence	100
Maximum pots to be fished per licence	100

Pot specifications	Maximum diameter 1 m; maximum height 1 m, maximum weight 40 kg; single top entrance; mesh size 50 mm diameter or escape gaps 55x150 mm.
Closed Areas	Margaret Brock Reef, Cape Jaffa and Rivoli Bay
Maximum vessel length	No Limit
Maximum main engine BHP	No Limit
Catch and effort data	Daily logbook submitted monthly
Catch and disposal records	Daily CDR records
Landing points	Eight designated landing points

1.3.2 Northern Zone

Management arrangements for the Northern Zone Rock Lobster Fishery are outlined in the Management Plan (Zacharin 1997b) and formalised in the *Scheme of Management (Rock Lobster Fisheries) Regulations 1991* and the *Fisheries (General) Regulations 2000*. The current management controls for the Northern Zone Rock Lobster Fishery are outlined in Table 2. As previously stated, a major management review process has been undertaken in the Northern Zone over the past twelve months, in response to progressive reductions in biological and economic productivity. As a result of this review process, a quota management system will be implemented in the Northern Zone by 1 November 2003.

Table 2. Current management controls for the Northern Zone Rock Lobster Fishery.

Control	Northern Zone
Licences	69
Season	November 1 to May 31
In-season closures	60 closure days selected by fishers over three fishing periods in blocks of five days per closure period.
Minimum legal length (both sexes)	105 mm CL
Egg bearing females	No retention
Dead lobsters	Landed whole
Holding of live lobsters	Holding on vessel, in corfs, or on land
Total pots	3,950
Hauling of pots per day	Hauled once per day
Minimum pot allocation per licence	25
Maximum pot allocation per licence	70
Maximum pots to be fished per licence	70
Pot specifications	Maximum diameter 1 m; maximum height 1 m; maximum weight 40 kg; single top entrance; 50 mm mesh size or escape gaps 55x150 mm.
Closed Area	Gleason Landing
Maximum vessel length	18 metres
Maximum main engine BHP	1,200
Catch and effort data	Daily logbook submitted monthly
Catch and disposal records	None

1.3.3 Recreational Fishery

There is an important recreational fishery for southern rock lobster in South Australia. Recreational fishers are permitted to take rock lobster during the same season as the commercial fishery in each zone. Recreational fishers have access to all harvesting methods, which include diving, drop nets, hoop nets, pots (same dimensions as commercial sector) and

bait sticks. A maximum of 4 lobster per person or 8 lobster per boat may be taken each day. A recreational possession limit of 15 lobster per person is in place.

All rock lobster pots must be registered with PIRSA Fisheries, at which time a coloured tag is provided which must be attached to the float at all times. A maximum of two rock lobster pots may be registered by any person over the age of 15 years.

All rock lobster caught by recreational fishers must have the centre tail fan clipped to a recognisable straight line, before landing to allow compliance officers to identify recreational catches. The same differential size limits that apply for the each zone of the commercial fishery also apply to the recreational fishery. Retention of egg-bearing females is prohibited at all times.

The total catch of rock lobster taken by the recreational sector is nominally capped at 4.5% of the total State-wide catch (commercial and recreational). If the total recreational catch is estimated to have exceeded 4.5% of the total catch, PIRSA Fisheries will enter the open market in the following season to lease quota or pots from the commercial sector to offset the increased recreational catch. In 2001, PIRSA Fisheries estimated that at current harvest levels the recreational catch would reach 4.5% at a trigger level of 21,000 recreational pot registrations. In estimating this trigger limit, the catch from other methods such as dive, drop net and hoop net are taken into account.

Using this mechanism, if more than 21,000 pots were registered in any given fishing season, PIRSA Fisheries would enter the market in the following season to lease back the required amount of pots or quota from the commercial sector. A total of 7,494 individual recreational pot registrations were issued for a total of 13,276 recreational pots during the 2001/02 fishing season. As of March 2003, a total of 6,512 pot registrations were issued in the recreational fishery, for a total of 11,482 individual recreational pots for the 2002/03 fishing season.

A detailed recreational catch and effort survey was undertaken by SARDI Aquatic Sciences during the 2001/02 fishing season to assist in estimating the recreational pot registration trigger limit, and moreover, the management of the recreational fishery. Once finalised, this report will be used to review the current recreational pot trigger limit.

1.4 Consultation and co-management

Section 32 of the Fisheries Act establishes a set of powers to formalise a co-management process for fisheries management in South Australia. The *Fisheries (Management Committees) Regulations 1995* outline a set of co-management principles and establish a number of Fisheries Management Committees (FMCs) for key fisheries, including a separate FMC for each Rock Lobster Fishery.

The FMCs provide the principle forum for stakeholder consideration of fisheries management and research issues relevant to each fishery. The regulations set out the advisory role and function of the FMCs, which are designed to assist the Minister for Agriculture, Food and Fisheries and the Director of Fisheries in the administration of the Fisheries Act, consistent with the section 20 objectives of the Fisheries Act and the designated Management Plans for each fishery. The role and function of FMCs has evolved over time, since their establishment.

FMC membership consists of a PIRSA Fisheries Manager, a SARDI scientist, commercial fishers, recreational fishers, a committee support officer and in some instances community members. An independent Chairperson, appointed by the Minister, chairs each FMC. The current membership of each Lobster FMC does not include a general community member.

However, recreational and commercial fishing members are generally people selected from the regional coastal communities relevant to each fishery, who also facilitate broader community input to the FMC process.

Each FMC is also required to hold an annual public meeting each year to allow for members of the broader community to discuss relevant issues with FMC members and provide an opportunity for the FMC to report on its activities. Observers are also welcome to attend meetings, upon agreement from the independent FMC Chair. Note that the review of the *Fisheries Act 1982* currently being undertaken is expected to result in some changes to FMC membership structure and operation. The operating costs of each FMC are fully recovered from licence holders in each commercial fishery. Each FMC meets approximately six to eight times per year.

The FMC regulations assign responsibility for the preparation of Management Plans to individual Fisheries Management Committees. Key stakeholder and community input to the development of management arrangements and strategic research and monitoring priorities is facilitated through the FMC process, during the development and periodic update of the Management Plans. In addition, PIRSA Fisheries is currently in the process of establishing a joint Research Sub-committee for both fishing zones to facilitate better coordination of input from key stakeholder groups to the development and review of strategic research priorities and to allow for periodic independent review of stock assessment reports.

Section 37 of the Fisheries Act requires the Minister, or his/her delegate, to consult with licence holders who may be adversely affected by a change to licence conditions, in particular, the removal of a species or gear entitlement. No formal requirements currently exist in the Fisheries Act to consult with the broader community concerning fisheries management decision-making, including that which relates to the setting of research priorities.

However, PIRSA Fisheries does consult with the broader South Australian community through public comment processes, as a matter of course, when significant policy changes or developments are being considered. For example, all formal Fisheries Management Plans (which include a strategic research plan) undergo an extensive public consultation process. Formal community consultation and accountability provisions are being considered as part of the Fisheries Act review process.

All new fishing regulations or Fisheries Act amendments are subject to the disallowance provisions set out under the *Subordinate Legislation Act 1978*, and as such can be disallowed by either house of Parliament, if deemed appropriate.

2 ECOLOGICAL ASSESSMENT

2.1 Principle 1

A fishery must be conducted in a manner that does not lead to over-fishing, or for those stocks that are over-fished, the fishery must be conducted such that there is a high degree of probability the stock(s) will recover.

2.1.1 Objective 1.

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.

2.1.1.1 Information requirements

- *There is a reliable information collection system in place appropriate to the scale of the fishery. The level of data collection should be based upon an appropriate mix of fishery independent and dependent research and monitoring.*

The following guide to the species retained as part of commercial rock lobster fishing in South Australian waters (Fig. 2) was developed using the National ESD Reporting Framework established by the Standing Committee on Fisheries and Aquaculture (SCFA) Ecologically Sustainable Development (ESD) working group (Fletcher *et al* 2002). The by-product component is expanded on in section 2.2.1.

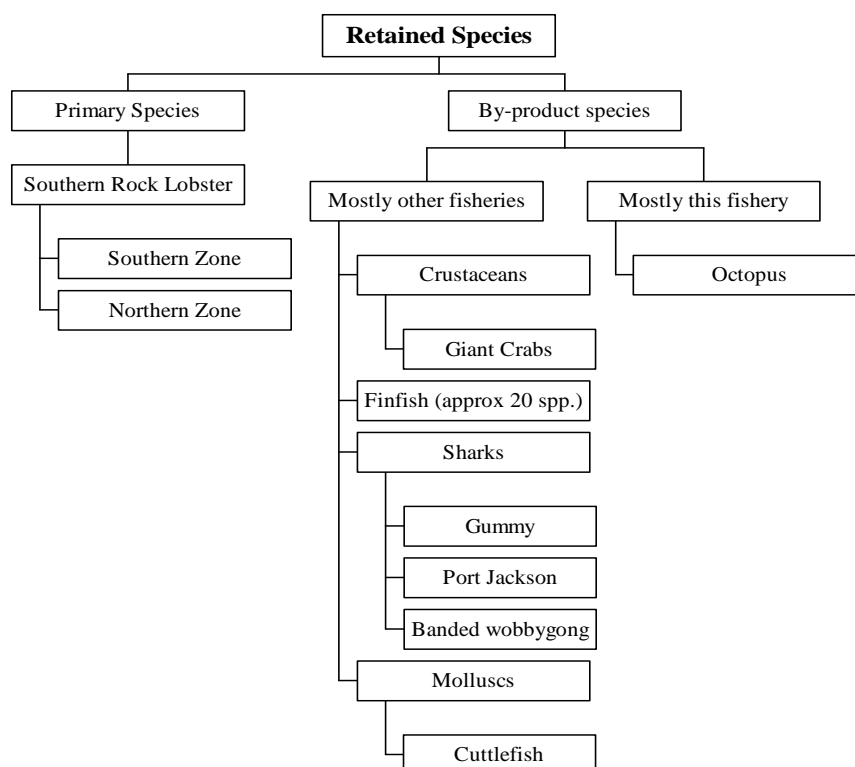


Figure 2. Retained species component tree for the South Australian northern and Southern Zone rock lobster fisheries.

There are several discrete fishery dependent and independent rock lobster data collection programs administered by the Aquatic Sciences division of the South Australian Research and Development Institute (SARDI) across both lobster fishing zones.

Fisheries Dependent Data

Commercial catch sampling of southern rock lobster has taken place since the 1960s when the Commonwealth Scientific and Industrial Research Organisation (CSIRO) undertook a southern rock lobster research program in Tasmania, Victoria and South Australia. These studies were undertaken at the point of landing and therefore collected catch length frequency data by sex. During the 1975 and 1976 fishing seasons, a similar exercise was repeated by South Australian researchers, and again in 1985. These data constitute a historical record of the population structure during earlier periods of fishing.

Commercial Fishing Logbook

The existing South Australian data collection system is underpinned by a compulsory catch and effort logbook system. Daily fishing records are reported in the logbook and submitted at monthly intervals. Catch and effort logbooks were first introduced to the fishery in the 1960s, following the CSIRO survey work. Since their introduction, there have been periodic changes to the logbook in line with changes in the fishery and in line with progress in information technology, which has provided new opportunities to manage and analyse progressively more detailed data. Logbooks included information on both catch by number and catch by weight from the early 1970s which provides a history of the mean weights in the fishery and, via weights at age, the stock structure and recruitment etc.

Data have been collected on a spatial grid of fishing areas since the logbook program was introduced. Initially, these were at a scale of 20 nm², but in 1983 were generally changed to 1 degree blocks of longitude and latitude (approximately 60 nm² areas), except for those areas which were naturally constrained by the coastline and hence cover smaller areas. Validation of areas fished has been periodically undertaken by comparing declared logbook data with exact positions recorded for recaptured tagged lobsters and or catch sampling data. Additional data categories were introduced in 1983 to collect data on the average depth fished and numbers of sub-legal, dead and spawning lobster.

The numbers and weight of octopus have also been collected since 1983. In 1994, the logbook format was changed to include the capture details of giant crab and have been progressively adapted to collect more comprehensive giant crab catch data. In the 2000/01 fishing season, a list of marine scalefish by-catch and by-product species was added to the logbook to simplify and improve data collected on non-target species taken in the course of lobster fishing. These data sections of the logbook are compulsory.

Catch and effort data are entered into the South Australian Rock Lobster (SARL) database upon receipt and late returns are promptly pursued to ensure high levels of data availability and quality. The SARL is a secure, modern, relational database, which is professionally managed and maintained. Details currently recorded in the daily logbook include:

- licence number, licence holder, date and main port of landing;
- Marine Fishing Area (MFA) where fishing took place;
- depth in which pots were set;
- number of pots set;
- weight of retained legal-sized lobsters - reported at the end of each trip or as a daily estimated weight;

- landed number of legal-sized lobsters;
- number of undersized lobsters caught;
- number of dead lobsters caught;
- number of spawning lobsters caught;
- weight of octopus caught;
- number of octopus caught;
- number of giant crab pots;
- depth of giant crab pots;
- landed weight of giant crabs;
- landed number of giant crabs; and
- the species, weight, number and form of any marine scalefish species taken as part of the rock lobster fishing operation.

Gear and Vessel Data

Gear and vessel data have been collected in both fisheries at various times since 1991, with varying degrees of success and accuracy. In the late 1990s a prescribed form was introduced to the fishery to facilitate data collection on vessels and gear. These data are collected to record the history of advancements in fishing technology and thereby form an important information source on which to base catch and effort analyses. Data has been collected both through the daily logbook and through specific surveys (Prescott, unpub.) on vessel hull size and type (eg. planing or displacement), engine design and power output, pot design and bait used, use of electronic aids such as sonar and global positioning systems and other fishing equipment and navigational aids used to assist fishing efficiency. This data has proven to be of particular importance in tracking the expansion in effective effort levels in the Northern Zone, which is currently managed primarily under an input control system.

Catch and Disposal Records

In the Southern Zone, where a quota system is in place, a catch and disposal form is completed and submitted in a locked box before fishers leave the weighing scales where their catch weight is certified. These data include the weight and number of lobsters landed, the number of tails landed from lobsters dead in pots, and catch weight and numbers of giant crabs. These data are compared with the research catch and effort data collected via commercial logbooks and form an independent check on their accuracy. There is typically a difference of less than 0.3% difference between the two data sources (Prescott, JH 2001, pers. comm.).

Voluntary Catch Sampling Program

In 1991, a voluntary catch sampling program was introduced in both fishing zones to collect additional biological information on sub-legal and legal size lobsters in the catch. The primary function of the program was aimed at the collection of more detailed information on the retained and non-retained catch (primarily size frequency and sex) than is otherwise collected through compulsory logbooks. In addition, information on environmental conditions such as water temperature is also collected. The program started with commercial fishers sampling from several pots (usually 3) each day, for the duration of the fishing season. In 1994, the program was improved by collecting data from individual catch positions of hundredths of a minute (ie. an accuracy of 10s of metres), rather than from a standard statistical block.

During the 1995 season, voluntary sampling was reduced to one week each month over the period of the third quarter of the moon. During the following season, sampling was

undertaken as part of a Fisheries Research and Development Corporation (FRDC) project that aimed to determine the optimal sampling strategy required to produce minimum and quantifiable variances of mean lengths and catch rates (McGarvey *et al.* 1999b). This study demonstrated that the optimal design should incorporate a high percentage of boats, with sampling done on as many days as possible from a small fraction of the pots on each boat. During the 1997 and 1998 seasons, fishers were encouraged to follow this sampling strategy. Commercial fishers were supported by research staff who went to sea on commercial vessels to encourage more fishers to participate in the program and to demonstrate the methods to new participants.

The voluntary catch sampling program has been continuously maintained for ten fishing seasons, though rates of participation have been variable. During the past three seasons industry participation in the voluntary catch sampling program has been on average approximately 40%. Obtaining comprehensive data at a fine spatial scale has greatly improved stock assessment. Throughout the life of the voluntary catch sampling program, trips have been made by research personnel on commercial vessels to train commercial fishers, and to perform extension and quality control roles with respect of the data collected.

In 2000, the logbook section requiring data to be recorded on sub-legal, dead and spawning lobster was made voluntary. This decision was made in recognition of the likely improvements in data quality attainable by only collecting data from those fishers who choose voluntarily to provide it. Approximately 85% of fishers currently provide this information voluntarily.

Also in 2000, an additional class of catch (legal catch returned to the sea) was added to accommodate legal size lobsters that may be returned because of size, colour, hardness or damage where fishers seek more actively to maximise economic returns, per kilogram landed. This practice occurs more widely in the Southern Zone under the quota management system.

Accuracy of the Data

While recognising the natural limitations of fishery-dependent data, PIRSA Fisheries and SARDI Aquatic Sciences have high levels of confidence in the existing rock lobster data set and consider the information collected to be very reliable and accurate. This sentiment was confirmed in 2002 by an independent review of stock assessment and research processes in the Northern Zone Rock Lobster Fishery, undertaken by Dr Paul Breen and Dr John McKoy of the New Zealand National Institute of Water and Atmospheric Research (NIWA).

In the report entitled 'Review of Current and Past Stock Assessments for the South Australian Northern Zone Rock Lobster Fishery', Breen and McKoy (2002) stated that "*Our first major point in the report is that South Australia has very good biological and fishery data as a result of programs conducted in the 1990's by Jim Prescott and his colleagues*". This review process was not part of a systematic review process, but rather, was initiated in response to concerns over the status of the Northern Zone stock. These review documents are available on the PIRSA Fisheries website (www.pir.sa.gov.au).

At present, the incentives for misreporting catch in the Northern Zone, which is managed principally on the basis of input controls, are not considered significant. The Northern Zone has a long track record of demonstrated high levels of compliance and industry support for the current management arrangements. The combination of these elements and the compliance and monitoring programs in place underpin the confidence that PIRSA Fisheries has in the data collection system for the Northern Zone.

Whilst it could be argued that a greater incentive exists to misreport catch landings in the Southern Zone, due to the nature of the management arrangements in place (quota system), existing penalties create a deterrent for catch misreporting. There is evidence to suggest that catch misreporting existed in the Southern Zone during the early period prior to and immediately following the implementation of a quota system. However, high levels of industry support for the management arrangements has evolved over time, resulting in low levels of catch misreporting based on compliance intelligence. These elements, together with the large scale compliance and monitoring program in place, underpin the confidence that PIRSA Fisheries has in the data collection system currently in place for the Southern Zone.

Joint Industry and Government initiatives have commenced to explore cost-effective methods of recording catch and effort information at finer spatial scales in both fishing zones through a move to electronic logbooks.

Fishery Independent Data

Southern rock lobster larval settlement dynamics have been studied and monitored in South Australia since 1989. Rates of puerulus and post-puerulus settlement are monitored using larval collectors, at seven locations throughout the state. These include five collectors in the Southern Zone at Blackfellows Caves, Livingston, Beachport, Cape Jaffa and Kingston and two in the Northern Zone at McLaren Point and Taylor Island.

Additional puerulus collectors are considered necessary in higher recruitment areas of the Northern Zone, such as southern Kangaroo Island and southwestern Yorke Peninsula to improve the usefulness of the data collected. The combined puerulus settlement indices are compared with fishery-dependent pre-recruit indices and catch per unit effort data for each zone, lagged by three and four years for the northern and Southern Zones respectively, to validate predictions on future recruitment strength.

It would be possible to develop an independent catch sampling program for the South Australian Rock Lobster Fisheries using the voluntary catch sampling data, to overcome the inherent limitations of the fishery dependent catch and effort logbook program. However, a fishery independent catch sampling program would necessarily be large because of the large variances (which are only partially estimated in the fishery dependent data collection program) experienced in the fishery, and presumably, the desire for such a program to have the power to detect changes in lobster abundance.

Dockside Monitoring Program – Southern Zone

In the 2000/01 fishing season, an industry initiative to monitor catches at the point of landing through a Dockside Monitoring Program (DSM) was introduced in the Southern Zone, in association with PIRSA Fisheries. The aim of this program is to improve the integrity of the Southern Zone Rock Lobster Fishery quota monitoring system. The DSM requires an independent dockside monitor to be on duty during core business hours at all weigh stations in the Southern Zone (8 prescribed landing points) to observe and record certified weights at the point of landing. Dockside monitors do not have any cohesive powers and only undertake observations of fisher landings and records with the cooperation of commercial fishers. Over 95% of the Southern Zone fleet have actively participated and cooperated with the program since its inception. The DSM is intended to provide an additional form of landed weight validation.

Processor Data

Processor purchase records are recorded on monthly logbooks submitted to SARDI. These records provide some opportunity for an additional check on lobster landings, but may be confounded by purchases from other *J. edwardsii* fisheries external to South Australia, eg. Western Australia, Victoria or Tasmania.

Non-target Species Catch Monitoring

An independent monitoring program for non-target species catches was introduced in both zones in the 2001/02 fishing season to monitor and record information on by-product, by-catch and non-target species (including protected species) interactions associated with rock lobster fishing. This program involves SARDI researchers undertaking low level at-sea monitoring (approx. 0.07% of total days fished in the southern zone and 0.08% in the northern zone) to record non-target species interactions and catch composition. Catch sampling of by-catch and by-product is also undertaken in-port (approx 1% of total trips in the southern zone and 0.3% in the northern zone) as part of this program to improve cost-effectiveness and ensure an adequate sample size is achieved. This data is used to validate logbook data collected by commercial fishers and will be quantitatively analysed and reported following the completion of the 2002/03 fishing season. At this stage, the by-catch monitoring program is intended to be continued for at least one more season to ensure adequate data are collected and analysed. Following this, the costs and benefits of the program will be evaluated to determine the future need and/or frequency for periodic ongoing by-catch monitoring.

Recreational Fishery Data

Surveys are periodically undertaken to quantify the recreational lobster catch across both fishing zones and all recreational methods. The first substantive survey was undertaken in 1998 on pot fishers and collected the following baseline information from each recreational fisher participating in the survey:

- the number of lobster caught each fishing trip each month;
- the amount of effort spent catching lobster;
- the amount of gear employed;
- the type of gear employed
- the location from which the lobster were taken;
- the number of lobster returned to the water and the reason; and
- the frequency of targeted lobster fishing.

This survey was repeated during the 2001/02 fishing season and was expanded to collect more detailed information and include all recreational fishing methods. In addition, a voluntary catch and effort logbook was issued to all recreational pot fishers in the 2001/02 season. The results of this survey are currently being finalised and will be made available on the PIRSA Fisheries website, when available. More detailed information on how recreational catch and effort data is periodically collected and analysed is provided later in this section.

2.1.1.2 Assessment

- *There is a robust assessment of the dynamics and status of the species/fishery and periodic review of the process and the data collected. Assessment should include a process to identify any reduction in biological diversity and /or reproductive capacity. Review should take place at regular intervals but at least every three years.*

There is an independent annual stock assessment process in place for both zones of the South Australian Rock Lobster Fishery. The stock assessment process is primarily based on the performance of each zone against the management objectives established in each Management Plan, as measured by a set of performance indicators with a defined reference range (Table 3).

SARDI Aquatic Sciences is part of PIRSA and is a key research provider for the South Australian Government. SARDI Aquatic Sciences are independent of the fisheries policy group and are contracted by PIRSA Fisheries to undertake a separate annual stock assessments for each lobster fishing zone. The most recent stock assessment reports for each zone are available on the PIRSA Fisheries and Aquaculture website at www.pir.sa.gov.au Indicators used to assess the annual performance of each fishing zone separately are outlined in Table 3.

Table 3. Performance indicators and estimation methods used in the Southern and Northern Zone Rock Lobster Fisheries.

Performance Indicator	Description	Measurement
Exploitation Rate	Reflects the fraction of the population (legal size) harvested by the fishery each year.	Estimated by qR model To be estimated using integrated assessment model
Catch Rate	Reflects the catch (kg) per pot lift taken in the fishery, and is closely correlated with lobster abundance.	Nominal catch rate (as recorded in logbooks) Standardised catch rate estimated using qR model Standardised catch rate to be estimated using integrated assessment model
Egg Production	Reflects the reproductive capacity of the fishery by providing an estimation of the number of eggs produced by all mature females in the population, as a percentage of the virgin egg production.	Estimated by the qR model To be estimated using integrated assessment model.
Pre-Recruit Abundance	Provides an index of the pre-recruit (undersize) abundance, using the number of undersized lobster recorded in the commercial catch each year.	Estimated from logbook records. Estimated using the qR model To be estimated using the integrated stock assessment model

Mean Weight	Indicates changes in the stock structure (size and age), which can be used to determine the average age and size of lobster in the population. Higher mean weight values usually reflect a lack of newly recruited lobster in the population and are likely to be associated with higher exploitation rates. Higher recruitment in any given year will generally be reflected in a lower mean weight or size because of a greater frequency of smaller lobster in the fishery	Nominal mean weight. Estimated using the qR model.
Biomass	Reflects the sum total weight of the legal size population. Model estimates of biomass are a key indicator used to determine what the maximum sustainable yield for a given fishing season should be. Biomass estimates are also used to determine the reproductive capacity of the population, based on estimates of the spawning biomass.	Estimated by the qR model To be estimated using integrated assessment model
Puerulus settlement Index	Reflects larval (puerulus) settlement abundance and provides a measure of future recruitment strength, and hence future catch.	Observed larval settlement.
Annual Commercial Catch	Provides an indicator of the relative abundance of lobster in the Northern Zone and the capacity for the fleet to catch the established TAC in the Southern Zone.	Recorded catch by weight and numbers in logbooks.
Annual Recreational Catch	Reflects the abundance of lobster, the availability of recreational opportunities and the relative participation of the recreational community in the fishery.	Estimated using surveys and recreational logbook records every 2 years.
Total recreational pot registrations	Used as a proxy to estimate the total recreational catch including that taken by divers, drop nets, hoop nets etc.	Total pot registrations recorded on PIRSA Fisheries Licensing database.

The current Management Plans in place for each fishing zone establish a historical reference range for five (Southern Zone) and six (Northern Zone) key performance indicators, which include exploitation rate, catch rate, egg production, pre-recruit index, mean weight and total catch. All of the existing performance indicators set out above will be reviewed and updated as part of the 5 year review of the Management Plans.

In isolation, individual performance indicators are not considered to provide robust measurements of the degree to which key management objectives are being achieved. Rather, aggregate information provided by considering estimations of a suite of performance indicators, using a range of mathematical and empirically based methods to estimate indicator values, is used to provide a rigorous assessment of the degree to which management objectives are being achieved.

The stock assessment model that has been used since 1997 to assess the status of each fishing zone, by generating estimates of the fishery performance indicators (in particular exploitation rate, egg production, recruit numbers and biomass), is the dynamic qR model (McGarvey *et al.* 1997, 1998; McGarvey and Matthews 2001). Outputs from the qR model have been presented in all stock assessment reports for both zones since 1997 (e.g. Prescott *et al.* 1997, 1998; Prescott and Xiao 2001). The qR model has undergone periodic peer review through publication in international scientific journals (eg. McGarvey and Matthews 2001).

The reference range for all performance indicators corresponds to the period between 1992

and 1996². This period was chosen as the reference period based on the historical performance of the fishery across each zone and because both zones were considered to be operating with relative stability from the selected base year of 1992 onward, in terms of production levels, harvest levels/rates, fishing methods employed and other technologies used. During the late 1980s and early 1990s there was rapid uptake of new technologies such as GPS and a trend towards a use of planing hulls, which improved the effectiveness of the fleet considerably.

Each Management Plan refers to a list of management actions that must be carried out, should the estimated value of a performance indicator fall outside of the reference range. The performance indicator estimates presented in table 4a and 4b describe the current status of each fishing zone relative to the reference period, as measured by the qR model and other empirical methods.

Table 4a. Performance of the Northern Zone in 2001/02 fishing season, as measured against the reference period set out in the Management Plan.

Fishery performance indicators	Reference Range	2001/02 Status
Exploitation rate	0.261 – 0.276	0.231 – 12% below the lower reference value
Egg production (billions of eggs)	799 - 956	721 - 10% below the lower reference value
Pre-recruit abundance (no's per potlift)	0.18 – 0.30	0.20 undersize per pot lift - within the reference range
Catch rate (kg per potlift)	1.25 – 1.43	1.08 kg/potlift - 14% below the lower reference value
Annual Catch (tonnes)	891 – 1,064	674 tonnes – 24% below the lower reference value
Mean weight (kg)	1.06 – 1.13	1.16kg - 3% above the upper reference value

The Northern Zone is currently performing below the reference range established in the Management Plan. A series of significant effort reductions have been implemented and a full management review has been undertaken in response to the current status of the fishery. As previously stated, a quota management system will be implemented in the Northern Zone prior to the commencement of the 2003/04 fishing season.

Table 4b. Performance of the Southern Zone in 2001/02 fishing season, as measured against the reference period set out in the Management Plan.

Fishery performance indicators	Reference Range	2001/02 Status
Exploitation rate	0.49 – 0.58	0.30 – 49% below the lower reference value
Egg production (billions of eggs)	963 - 1046	1,617 – 35% above the upper reference value
Pre-recruit abundance (no's per potlift)	1.17 – 1.51	1.42 undersize per pot lift - within the reference range
Catch rate (kg per potlift)	0.935 – 1.138	1.88 kg/potlift – 65% above the upper reference value
Mean weight (kg)	0.783 – 0.816	0.815 - within the reference range

The Southern Zone is currently performing well above the reference range established in the Management Plan. The TAC was increased by 50 tonnes in the 2002/03 fishing season in recognition of significant biomass growth. A more detailed analysis and interpretation of the current status of each fishing zone is provided later in this section of the document when the productivity of the stock is examined. Also, refer to Ward *et al* (2002a,b).

² Note that reference values are re-calculated annually using the updated qR model.

The qR Model

The qR model incorporates information about annual mean lobster weight, in addition to the more widely reported total catch and CPUE. The qR model is used to provide estimates of annual changes in exploitation rate, egg production and recruit numbers, through changes in mean size of lobster in the catch. Generally, higher exploitation levels will reduce the mean size of lobster by shortening the mean life span and consequently the opportunity to grow to a large size (McGarvey *et al* 1998). Higher recruitment in any given year is reflected in a lower mean weight or size because of a greater frequency of smaller lobster in the population, and therefore the commercial catch. A detailed description of the qR model is provided in McGarvey and Matthews (2001) and Ward *et al* (2002a,b).

Other stock assessment models (delay-difference, biomass dynamic) that fit to catch and effort data use only catch by weight (C_w) and rely on C_wPUE as a measure of relative fishable biomass. The qR model adds catch by numbers to the fitted data set. Because catch-by-weight divided by catch-by-number gives the mean weight of an average lobster, the addition of the catch-by-number time series gives information about yearly mean size in the legal catch, otherwise available only from length-frequency samples. Because catches by weight and number constitute a 100% sample, the quality of information obtained about changes in mean size from catch data is far more precise than that obtained from length frequencies, which typically constitute a 0.1% to 1.0% sample fraction. Thus the qR model uses C_wPUE as a measure of change in abundance and mean weight as a measure of change in size structure.

The qR model is age-based. This permits the estimation of yearly egg production, again as a total absolute number of eggs hatched yearly. Only legal-size lobsters are estimated in the qR population description. However, to improve the quality of yearly egg production estimates in the Southern Zone, where some females spawn prior to reaching legal size, the qR estimates of yearly egg production were modified to include one year class of undersize lobsters (those present one year prior to entering the legal stock).

The recent independent review of stock assessment research undertaken by NIWA (Breen and McKoy 2002) concluded that the qR model is an appropriate tool for assessing the status of the South Australian Rock Lobster Fishery³. The model has been refined over time, most notably during the peer review process for publication of McGarvey and Mathews (2001). As a result of peer review, outputs from the current (2002) version of the qR model differ slightly from those presented in previous stock assessment reports (e.g. Prescott *et al.* 1997, 1998; Prescott and Xiao 2001) and in the Southern and Northern Zone Rock Lobster Fishery Management Plans (Zacharin 1997a,b). The two major changes from previous versions are: (i) the replacement of the least squares by normal likelihoods for the fits to catches in both number and weight; and (ii) the adoption of a Baranov rather than a straight bi-linear Schaefer catch relationship.

Estimates of catch in numbers and weight from the 2002 version of the qR model fit closely with measurements of C_n and C_w obtained from both fishing zones (Ward *et al* 2002a,b). There is a strong relationship between the estimates of recruitment provided by the qR model and the estimates of pre-recruits (pre-recruits/pot-lift) recorded in logbooks by commercial fishers in the catch sampling program. The strong correlation between recruit estimates from the qR model and the independent pre-recruit index confirm the suitability of the qR model as a stock assessment tool for both zones of the South Australian Rock Lobster Fisheries (Fig.3).

³ Refer to Breen and McKoy (2002) on the PIRSA Fisheries website at www.pir.sa.gov.au

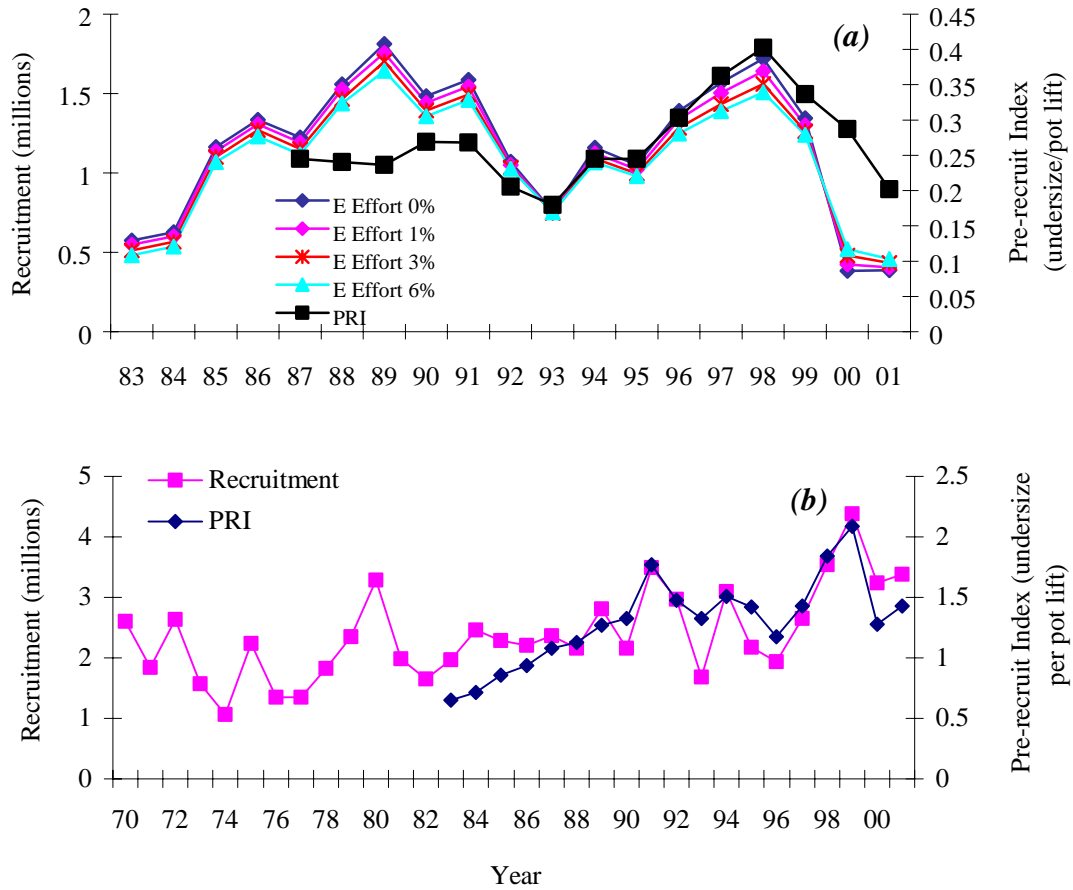


Figure 3. Relationship between qR model estimates of recruitment and pre-recruit index estimated from logbook records for the Northern Zone (a) and the Southern Zone (b). Note that the Northern Zone qR model estimates include a consideration of increases in effective effort over time by 0, 1, 2 and 3 percent (Source: Ward *et al* 2002a,b).

The mean monthly puerulus settlement data collected through the puerulus monitoring program (explained in section 2.1.1.1) is used to calculate an index of annual puerulus settlement for each fishing zone. The settlement index for each zone is assessed against annual commercial CPUE and the pre-recruit index for each zone (lagged by five and four years respectively in the Southern Zone and lagged by three and four years in the Northern Zone). There is a positive correlation between the annual settlement index and the time-lagged annual CPUE and pre-recruit index, for both fishing zones (Figs. 4a and 4b). However, these relationships are considered to require further examination.

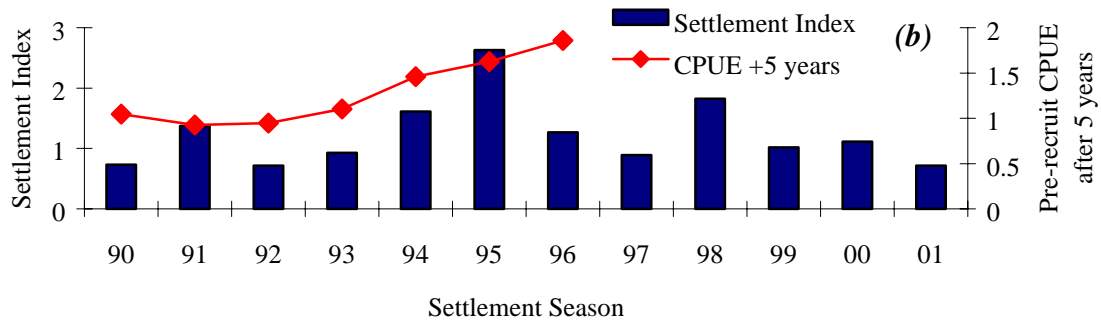
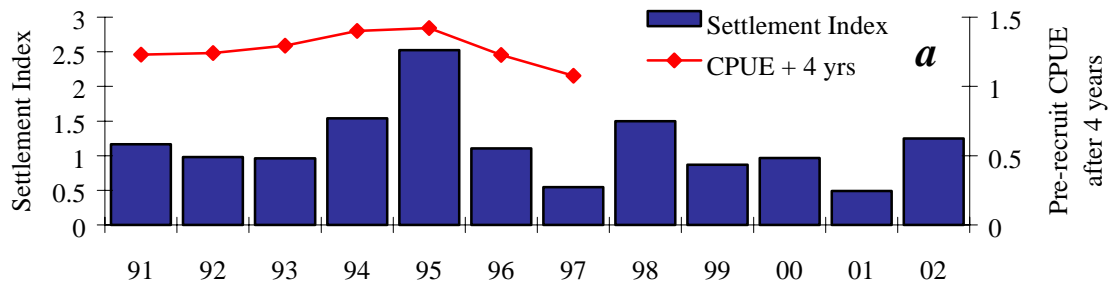


Figure 4a. Relationship between settlement index and CPUE lagged by 4 and 5 years, respectively for the northern (a) and southern (b) zones (Source: Ward *et al* 2002 a,b)

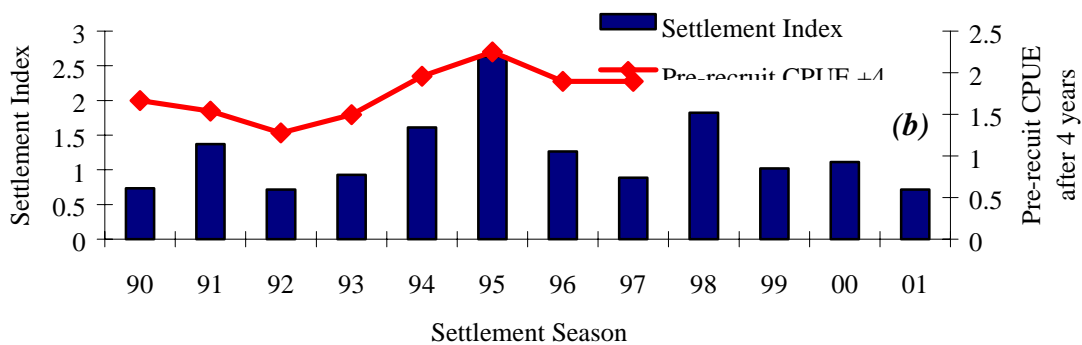
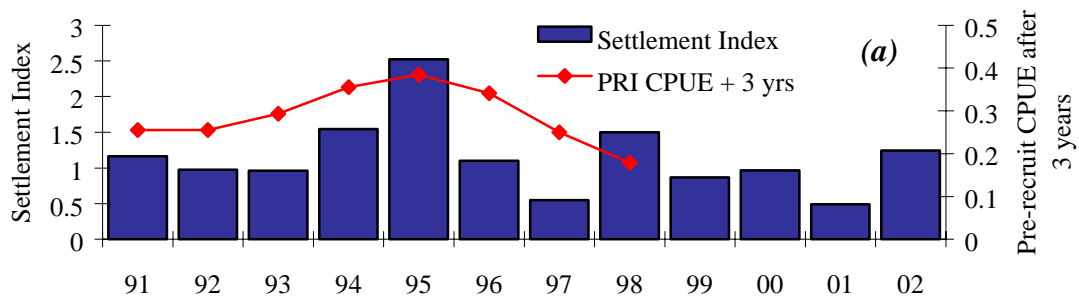


Figure 4b. Relationship between settlement index and Pre-recruit CPUE lagged by 3 and 4 years, respectively for the northern (a) and southern (b) zones (Source: Ward *et al* 2002a,b).

Integrated Assessment Model

SARDI Aquatic Sciences is currently developing an integrated risk assessment model for the South Australian Rock Lobster Fisheries, as part of an FRDC funded project (project 2001/123). The project, entitled 'Risk analysis and sustainability of the southern rock lobster, *J. edwardsii*, resources in South Australia' is scheduled for completion in December 2003. The following objectives have been established for the project:

- To undertake a careful review of appropriate models developed and used in other invertebrate fisheries, including those used in Tasmania and Western Australia
- To develop a spatial, sex, time and age dependent model (or equivalently a spatial, sex, time and size dependent model), taking advantage, where possible, of model components developed elsewhere.
- To develop a simulation model based on the outputs from the above model.
- To use the simulation model to evaluate various harvesting strategies to empower the fishing industry and managers to make better informed decisions and respond skilfully to critics.
- To use the model to forecast catch and abundance for individual areas.
- To use the model to answer the following questions: how much risk is associated with any particular TAC or level of effort, how much more can fishers gain in revenue terms under alternative harvesting strategies while demonstrating long term sustainability with a quantified risk, which fishing regime produces a sustainable fishery while at the same time maximises catch and revenue, how does the current harvesting strategy compare with the optimal harvesting strategy, how much more biological information is gained or lost by adopting various harvesting strategies, what are the implications of lobster aggregating behaviour for the assessment of the stock?
- To develop a modelling option that allows management to produce reports consistent with the ESD reporting framework developed by SCFA.

In short, the model is a sex-specific, age and time dependent model designed to use and integrate all available data, including the catch by weight and number recorded in commercial log-books, length-frequency data, and tagging data, to provide population projections under a range of harvest strategies and to conduct risk analysis. In its present form, the model ignores the spatial component of lobster movements in the Northern Zone because analysis of tagging data indicates that most lobsters in the Northern Zone undertake relatively few large-scale movements, due largely to the patchiness in the distribution of reef habitat. A detailed mathematical description of the integrated assessment model is available in Ward *et al* (2002b).

The integrated model is intended to provide a tool to improve the capacity for managers to predict the likely stock responses to various alternative harvest strategies and quantitatively assess the risk associated with adopting different harvest strategies. This approach is intended to allow appropriate levels of precaution to be quantitatively factored into formal decision-making. An integrated assessment approach was recommended by the recent independent review of current and past stock assessments for the Northern Zone Rock Lobster Fishery (Breen and McKoy 2002).

Following the completion of the integrated model, a review will be undertaken to determine the ongoing use of the qR model. It is likely that future assessments will incorporate information from both modelling approaches (qR and integrated) as well as using empirical methods, where appropriate to ensure that a balance between model outputs and practical experience is used in management decision-making.

Reductions in Biological Diversity

There is no evidence to suggest that reductions in biological diversity of *J. edwardsii* have occurred as a result of fishing in South Australia. However, no targeted research has been directed at investigating this issue as it is generally accepted that genetic patterns in *J. edwardsii* are not spatially structured, due to the early life history characteristics of the species and long larval phase, which results in significant stock mixing throughout southern Australia.

There is a theoretical low risk that selection against fast growing lobster could occur as a result of the use of a minimum size limit for management purposes, which could plausibly reduce biological diversity in the sense that a greater proportion of slower growing animals could be represented in the population. However, current information on the spatial variation in lobster growth rates, confirmed through extensive tagging studies undertaken across both fishing zones in South Australia (Prescott 1996; McGarvey *et al* 1999) and similar studies undertaken in other States, suggests that this is not occurring. In addition, the size structure of the population has been monitored each year since 1991 at different spatial scales across each zone through the voluntary catch sampling program. The current size structure of the population (Ward *et al* 2002a,b) supports the assumption that selection of faster growing animals has not occurred.

Size limits have been used as a management and conservation tool in the South Australian Rock Lobster Fisheries for over thirty years and are used widely by other fisheries management agencies throughout Australia and internationally.

Periodic Review Process

The annual stock assessment process includes a regular internal review process of assessment methodologies and information requirements. The current FRDC project being undertaken by SARDI Aquatic Sciences, aimed at developing an integrated risk assessment model for the South Australian Rock Lobster Fisheries, is evidence that such internal periodic review takes place.

The data requirements and stock assessment model currently used to assess the status of the South Australian Rock Lobster Fisheries (the qR model) has been periodically reviewed and updated, when advances in knowledge have been made or shortcomings identified. As previously stated, the most recent peer review (and update) of the qR model was undertaken in 2001 through publication in the ICES Journal of Marine Science (McGarvey and Matthews 2001). Periodical review of the qR model and the developing integrated model will continue to occur as significant advances in knowledge are made or when shortcomings are identified, as part of the core research and stock assessment program administered by SARDI Aquatic Sciences.

The recent independent review of stock assessment research undertaken by NIWA (Breen and McKoy 2002) concluded that the qR model is an appropriate tool for assessing the status of the South Australian Rock Lobster Fishery. In addition, NIWA recommended that an integrated model be developed to increase the capacity to forecast future catches and stock responses to alternative harvest strategies. This recommendation is consistent with the modelling approach being developed by SARDI Aquatic Sciences.

The existing research priorities for each fishing zone are outlined in a 5 year strategic research and monitoring plan, set out in each of the Management Plans, which are currently under review. PIRSA Fisheries is currently exploring options to establish a stakeholder forum to

annually review the stock assessment process and methodologies in South Australia, and for updating strategic research priorities for the South Australian Rock Lobster Fisheries. Moves have also been made to establish a national (tri-state) research body for Southern rock lobster to improve coordination of research and stock assessment on the species across all management jurisdictions. Additional consideration will be given to the full range of recommendations provided by Breen and McKoy (2002) through the established management committee process and the process outlined above.

- *The distribution and spatial structure of the stock(s) has been established and factored into management responses.*

Southern rock lobster is distributed from southwestern Western Australia to the south coast of New South Wales, on several seamounts in the Tasman Sea and around the North and South Islands of New Zealand (Ward *et al* 2002a). Genetic and larval studies have demonstrated that a single genetic stock exists throughout southern Australia and New Zealand (Booth *et al.* 1990; Ovenden *et al.* 1992).

A working hypothesis on stock structure adopted for the South Australian Rock Lobster Fishery is that the stock is largely self-recruiting despite the long larval phase, but mixes with stocks to the east and west to a variable degree, dependent upon inter and intra annual variations in broad scale oceanographic conditions (Prescott *et al* 1997).

As previously stated, the South Australian Rock Lobster Fishery has been separated into two discrete fishing zones for the purposes of management. This geographic separation recognises key differences in stock structure, which relate to biological productivity and variations in the physical and ecological character between the eastern and western borders of South Australia. Productivity is higher in the Southern Zone than the Northern Zone, due mainly to the larger amount of limestone reef habitat afforded to lobster and strong upwelling (refer to section 1.3). The productivity of the Northern Zone is also known to be limited by its close proximity to the western extension of the geographic distribution of *J. edwardsii*.

The sex and age composition of the landed catch is known to be a function of seasonal patterns in the availability of lobster, due to physiological behaviour patterns relating to growth and reproduction. Growth of legal sized lobster is incremental and directly linked to moult frequency, which occurs annually during June/July for females and in October/November for males. During the moult period and the time it takes for the exoskeleton to harden, lobster seek shelter and protection from predators which results in a significant proportion of the population becoming unavailable to the fishery, and hence reduced catches and catch rates. In addition, mating also takes place when the female exoskeleton is softer, immediately following the moult, reducing the availability of lobster further during this period.

These characteristics result in the sex composition of the catch comprising approximately 60% females in November/December and approximately 60% males in January/February, and through the winter months. A prohibition on the retention of egg-bearing females exists all year round. It could be argued that the current closed winter seasons in place for both zones improves the probability of maintaining a stable sex ratio in the population.

A tagging study undertaken between 1996 and 1999, in which over 16,000 lobsters were tagged and recaptured, demonstrated that growth rates vary between locations in South Australia (McGarvey *et al.* 1999). Differential growth rates exist between male and female lobster. Mean annual growth rates range from 7-20 mm for males and 5-15 mm for females. The highest growth rates have been recorded in the northwestern areas of the State, around

the southern Yorke Peninsula, while the lowest growth rates occur around the River Murray Mouth. Lobster density and temperature are considered to be the main factors that determine growth rates. Growth rates are highest in areas of low lobster density and high water temperature (McGarvey *et al.* 1999). Lobster growth rates are generally higher in the Northern Zone because of these factors.

Lobster maturity is considered to have a stronger relationship with age than size. As such, faster growing lobster reach sexual maturity at a larger size and may require a higher minimum size limit to ensure adequate protection is afforded to the parental stock, maximise female egg-production and maximise yield per recruit. The mean size at sexual maturity for females varies at different spatial scales across the State and is estimated to range from 101mm to 105mm carapace length in the Northern Zone and 89.5mm to 110.5mm carapace length in the Southern Zone. The estimated size at which 50% of females are mature (average across each zone) is slightly higher than 100mm in the Northern Zone and slightly lower than 100mm in the Southern Zone.

Each zone has a different size limit (105mm and 98.5mm in the northern and Southern Zones respectively) in recognition of the broad scale spatial variation in growth rates, length at maturity and the generally faster growth rates in the Northern Zone. The same size limit applies for both males and females in each zone. Generally speaking, this may have the effect of limiting egg production in the northern parts of each zone and affecting yield in the southern parts of each zone. However, in many areas where females mature above the minimum size limit they are not caught in abundance (Prescott and Xiao 2001).

Prescott (unpub.) quantitatively evaluated the Southern Zone stock outcomes of alternative management approaches including adjustments to minimum and maximum size limits, improvements to gear selectivity and TAC manipulation. As a result of this study a strategy aimed at continuing to build the biomass through maintaining the constant TAC strategy was adopted for the Southern Zone in 2000.

While this issue may theoretically have marginally contributed to the recent reduced biological productivity in the Northern Zone, the stock decline currently being experienced is considered to be largely associated with the sustained levels of fishing pressure, expansions in effective effort levels and a prolonged cycle of low recruitment. A stock-rebuilding strategy is currently being developed to ensure increases in biomass, egg production and yield are achieved in the Northern Zone, within a reasonable timeframe (refer to section 2.1.2.1). The Northern Zone minimum legal size limit was increased in 1994 from 98.5mm to 102mm and again in 2000 from 102mm to 105mm, in recognition of the zone-wide benefits obtainable for egg production and yield.

In contrast, the Southern Zone is considered to be in a much stronger position, due to a significant increase in biomass resulting from a stock-building strategy involving maintenance of the TAC at a constant level during the period between 1995 and 2002. In the Southern Zone, this strategy was considered more appropriate and more direct than investigating adjustments to the minimum legal size limit.

Egg-production levels vary at different spatial scales throughout each fishing zone due to the spatial variation in growth rates and subsequent variation in size at sexual maturity. Annual mean egg-production in the Southern Zone is estimated to be on average approximately double that of the Northern Zone, which reflects the higher productivity and larger biomass in the Southern Zone.

As growth rates are generally higher around the southern tip of the Yorke Peninsula and in the

northwestern part of the Northern Zone, a larger proportion of immature females are taken in the commercial catch than in other parts of the zone. However, the density of lobster is generally lower in the northwestern part of the zone due to the patchiness in habitat availability throughout the Great Australian Bight region, which offsets the impact on zone-wide egg-production levels. This issue is also offset by the generally larger densities and slower growth rates of lobster in the southeastern parts of the Northern Zone, particularly around Kangaroo Island, which result in a smaller proportion of immature females being captured in this part of the zone.

Similar spatial variation in egg production exists in the Southern Zone. Growth rates are generally lower in the far southeast, near Port MacDonnell and Beachport. As such, egg-production is generally higher in the southern part of the zone due to a greater proportion of mature animals in the population being protected by the minimum size limit.

No clear stock-recruitment relationship has been identified for *J. edwardsii* in South Australia, Tasmania, Victoria or elsewhere (Prescott *et al* 1998). The poor understanding of this relationship for *J. edwardsii* makes it difficult to draw any firm quantitative conclusions about the management implications resulting from the regional differences in levels of egg-production across each zone. Essentially, precautionary management strategies have been put in place to ensure sufficient levels of biomass and egg-production are maintained to in turn ensure adequate recruitment over time.

While spatial variation in growth rates and size at sexual maturity exists throughout South Australian waters and within each fishing zone, the existing size limits (along with other key management controls) are considered to provide adequate protection for both males and females and ensure sufficient biomass levels, egg production and recruitment in each respective zone. The current status of the Southern Zone confirms the success of this strategy over time.

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

All estimates of removals from each sector within South Australia are factored into the annual stock assessment for both fishing zones and are taken into account when setting annual total allowable catch (TAC) and/or effort levels in each fishing zone.

Commercial

Information on the commercial catch has been collected since the early 1960s when logbooks were first introduced in South Australia. Information on lobster catch by weight and numbers is available from 1970 onward (Figs 5 and 6). All historical information is used in the annual assessment process. Since 1993/94 when a quota system was introduced in the Southern Zone, additional catch disposal information has been available to assist in validating logbook information for the Southern Zone. The resolution and accuracy of the data has understandably improved over the past 40 years.

Commercial logbook information is also collected from both fishing zones on the number legal size lobsters returned to the water because of life status, size, colour, hardness, or damage. A recent study by Brock, Prescott and Ward (2002) demonstrated that, over the last 5 years approximately 240,000 lobster have been killed each year as a result of pot-induced octopus predation, which represents an estimated 4% of the total annual lobster catch. This pot-induced lobster mortality is taken into account in the TAC and effort setting process for

each zone. Southern Zone fishers are permitted to retain dead lobsters for personal consumption, but must dye the tails to clearly identify each animal as one kept for personal use.

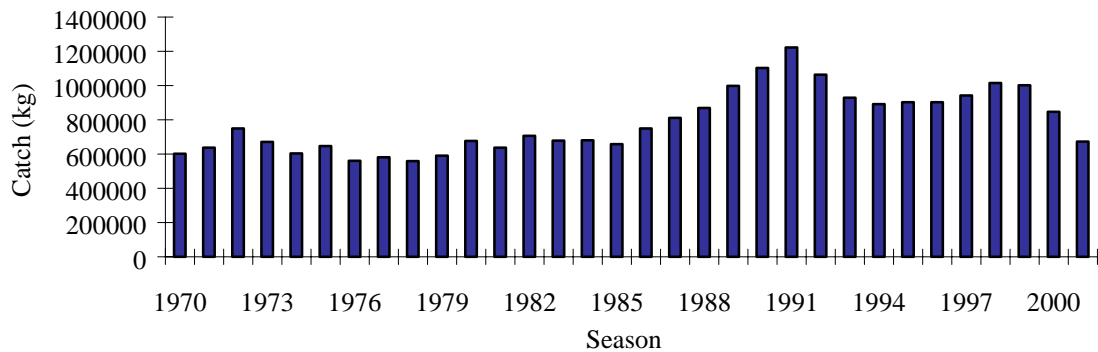


Figure 5. Inter-annual trends in the commercial catch in the Northern Zone Rock Lobster Fishery (Source: Ward *et al* 2002b).

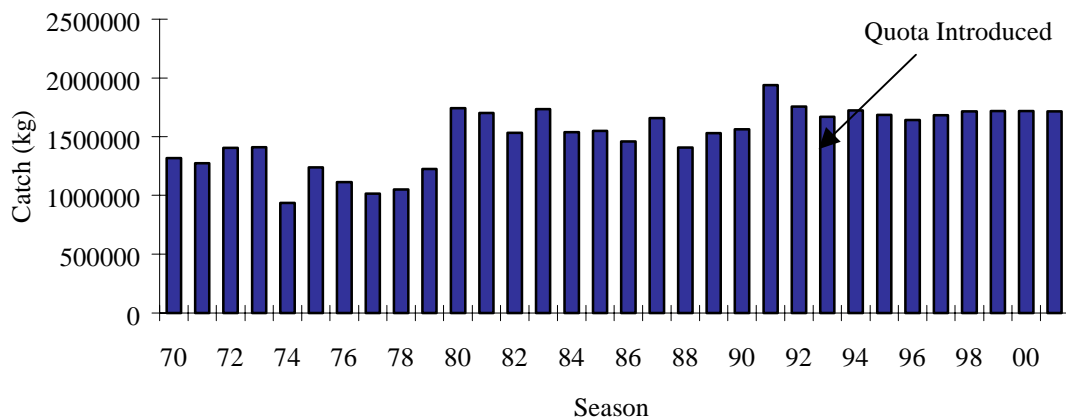


Figure 6. Inter-annual trends in the commercial catch in the Southern Zone Rock Lobster Fishery (Source: Ward *et al* 2002a).

Recreational

A survey of recreational pot fishers undertaken by McGlennon (1999) estimated the total lobster catch taken by the recreational pot fishery to be approximately 67 tonnes (less than 3% of the total commercial catch taken across both zones). The survey indicated that approximately 60% of the recreational pot catch was taken in the Southern Zone, with most fishers fishing exclusively in one zone during any season. The catch of lobster taken by recreational divers, drop nets and hoop nets was not investigated during the 1999 study.

SARDI Aquatic Sciences undertook a similar survey in the 2001/02 fishing season, incorporating the lobster catch taken by all recreational methods including pots and divers. A preliminary investigation of the recreational catch taken by drop nets, hoop nets and bait sticks was also undertaken as part of this survey. The results of this survey are still being finalised and will be available during the 2002/03 fishing season. The recreational catch is known to fluctuate in line with resource availability and as recreational opportunities increase or decrease.

While the results of the latest survey have not been finalised, the recreational catch is thought to have increased in recent times due to improved recreational opportunities associated with recently revised access arrangements and improved availability of lobster, particularly in the Southern Zone. PIRSA Fisheries will continue to periodically commission surveys of the recreational lobster catch to ensure a reliable estimate of the recreational take is factored into stock assessment and management of the fishery.

Indigenous

No information is available on the indigenous catch of rock lobster in South Australian waters. Currently no specific access arrangements are in place to provide for indigenous fishing practices. As such, all non-commercial activity is managed under the recreational arrangements. A review of the Fisheries Act is currently being undertaken by PIRSA Fisheries, in consultation with all stakeholder groups. As part of this process, arrangements for indigenous fishing practices across all South Australian fisheries are being reviewed.

Illegal

Although there is likely to be some level of illegal fishing activity in both fishing zones, as in most fisheries, the size of the illegal catch has not been formally quantified. During the 2001 season, PIRSA Fisheries compliance officers recorded 2 infringements by commercial fishers in the Northern Zone from 336 checks, while 21 infringements were recorded in the recreational sector across both fishing zones. With the move to quota management arrangements in the Northern Zone, the risk profile and compliance strategy for the commercial sector is being revised.

During the 2001 Southern Zone season, 16 minor infringements by commercial fishers were recorded from 621 checks, while 21 infringements were recorded in the recreational sector across both fishing zones. Recent improvements in the TAC monitoring system and the introduction of an industry initiative to monitor landings through a dockside monitoring program have reduced opportunities for illegal catches in the commercial sector. Under the quota management arrangements in place for the commercial sector, quota evasion remains the highest risk to the fishery and the integrity of the quota system.

Significant potential is considered to exist for illegal activity to occur at the South Australian/Victorian border. Such illegal activity could be in the form of dual licence holders misreporting catch taken in the waters of either State, or through Victorian based fishers entering South Australian waters opportunistically. PIRSA Fisheries in association with Victorian Fisheries and the Southern Zone Rock Lobster Industry have undertaken opportunistic at-sea border patrols to monitor compliance with the State border. A range of issues are being considered by South Australia and Victoria to address these concerns.

In 2001, the South Australian Government provided a \$3 million commitment over a three-year period to improve fisheries compliance resourcing throughout the State. This commitment has improved the effectiveness of compliance operations in both the commercial and recreational sectors of the fishery, through an improved capacity to act strategically and respond to issues arising. On the basis of the high level of industry support for the management arrangements in each zone, the strong compliance with regulations and the near absence of any recent allegations of significant illegal lobster fishing in both fishing zones, it is considered unlikely that illegal fishing is currently a significant source of fishing mortality. PIRSA Fisheries will continue to improve community awareness of management regulations and resource sustainability issues.

While the current stock assessment process does not explicitly take into account unreported catches, SARDI Aquatic Sciences have modelled the impacts of unreported catches on stock status using the qR model. The results of these modelling exercises demonstrated that recruitment levels can be influenced by significant unreported catches. The integrated model currently being developed could also be used to model the effects of unreported catch on the outputs of the model. As such, management strategies and compliance programs are designed to minimise the scope for unreported catches.

- *There is a sound estimate of the potential productivity of the fished stock/s and the proportion that could be harvested.*

The productivity of each fishing zone is estimated using a range of data sources, but primarily on the basis of fishery-dependent data collected through logbooks. It is important to note that the fishery-dependent data set reflects the effectiveness of fishing operations in terms of how, where and when the gear is used, the standards for the gear itself and the fishing technology used to set it. These data are standardised using various modelling techniques to improve the accuracy of relative abundance estimates and to ensure that inter-annual variances in abundance etc are accurately interpreted. This issue has proven to be of particular importance in the Northern Zone, which is at present still managed under an input control system.

Southern Zone

The latest Southern Zone stock assessment report (Ward *et al* 2002a) suggests that the current harvest strategy and compliance program aimed at maintaining a constant harvest of lobster through holding the TAC at 1,720⁴ tonnes has allowed the stock to build significantly. The legal size relative biomass is estimated by the qR model to have increased by 50% since 1998 and be the largest in the recent history of the fishery (Fig. 7a). Similarly, egg production is estimated to be 35% above the upper reference point established in the Management Plan, and be the highest recorded in the recent history of the fishery (Fig. 8b).

Exploitation rate for the Southern Zone is currently estimated to be 30%, which is 49% less than the lower reference point established in the Management Plan. The exploitation rate has decreased steadily in the Southern Zone since 1996, due to continued increases in the biomass and operators fishing fewer days to harvest the same quantity of lobster. A number of different measures of recruitment strength (refer to section 2.1.1) all indicate that the Southern Zone has experienced strong (above average) recruitment in recent years. While there is considerable variability in annual recruitment patterns, the overall trend in recent years demonstrates that recruitment to the Southern Zone has steadily increased. All of these indications represent positive outcomes for the stock.

Table 5. Estimated performance indicator values for the Southern Zone Rock Lobster Fishery (1992/93 – 2001/02). Source: Ward *et al* (2002a).

Fishing Season	Exploitation Rate	Egg Production	Pre-recruit Abundance	Catch Rate (kg/pot-lift)	Mean Size (kg)
1992/93	0.49	1045	1.47	1.00	0.78
1993/94	0.54	1046	1.32	1.01	0.82
1994/95	0.50	1033	1.51	1.14	0.81
1995/96	0.53	994	1.41	1.06	0.80
1996/97	0.58	963	1.17	0.94	0.80
1997/98	0.58	1005	1.50	0.95	0.82

⁴ The TACC was increased by 50 tonnes to 1,770 tonnes for the 2002/03 fishing season in recognition of stock building progress. This is the first increase in the TAC since 1995/96.

1998/99	0.51	1153	1.96	1.10	0.76
1999/00	0.38	1307	2.25	1.46	0.76
2000/01	0.34	1468	1.90	1.63	0.79
2001/02	0.30	1617	1.90	1.86	0.83

In the Southern Zone, female yield per recruit is considered to be close to the maximum likely to be achieved, while the male yield per recruit is considered to be marginally lower than the maximum that could be achieved by introducing a larger minimum size limit for males (Prescott unpub.). While the male yield per recruit is not currently maximised, the current harvest strategy takes into account the economic/market benefits of maintaining the current size limit. This strategy aims to balance the biological needs of the stock with a desire to optimise the landed value of production, consistent with the section 20 objectives of the Fisheries Act.

There has been some concern expressed that if the biomass continues to build, some level of density dependent population growth may result, particularly if the average age/size of lobster in the population continues to increase at the current rate. PIRSA Fisheries, in consultation with the established fisheries management committee is currently revising the Southern Zone harvest strategy, as part of the formal five year Management Plan review. As part of this review, a range of alternative harvest strategies will be evaluated. For a detailed assessment of the full suite of fishery performance indicators refer to Ward *et al* (2002a).

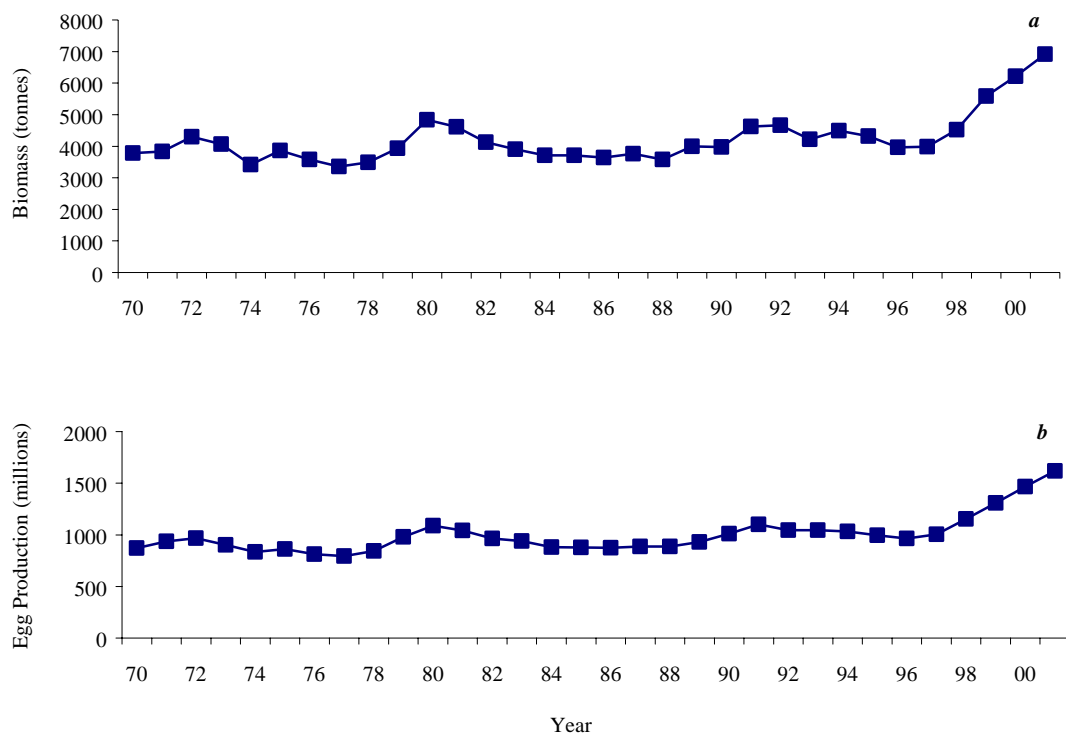


Figure 7. Model (qR) estimated biomass (a) and egg-production (b) in the Southern Zone (Source: Ward *et al* 2002a).

Northern Zone

The most recent Northern Zone stock assessment report (Ward *et al* 2002b) suggests that the current management strategy, aimed at maintaining a constant harvest rate of lobster, has resulted in a stock decline, below the reference range established in the Management Plan. The assessment suggests that this declining trend will continue unless effort levels are

reduced significantly in the short term. The range of management responses introduced to address the Northern Zone stock decline are described further in section 2.1.1.3.

The Northern Zone is known to be generally less productive than the Southern Zone due to a number of factors. The Northern Zone is generally characterised by patchy and discrete reef formations (mainly granite) that are separated by large expanses of sandy bottom (Lewis 1981). These characteristics are known to limit the amount of suitable habitat afforded to lobster and result in a generally more patchy distribution of lobster and higher inter-annual variability in recruitment strength. The productivity of the Northern Zone is also known to be limited by its close proximity to the western extension of the geographic distribution of *J. edwardsii*.

The Northern Zone legal size relative biomass is estimated (using the qR model) to have declined to a level that is considered to be the lowest in the recent history of the fishery (Fig. 8a)⁵. Similarly, egg production is currently estimated by the qR model to be 10% below the lower reference point established in the Management Plan (Fig. 8b). Exploitation rate in the Northern Zone is currently estimated to be 23% (Table 6), which is 12% below the lower reference value (26% in 1994) established in the Management Plan (Ward *et al* 2002b). The recent decline in exploitation rate reflects the effectiveness of introducing effort reductions, which have resulted in operators fishing fewer days and as such taking a smaller fraction of the available biomass. Table 6 outlines estimates for all performance indicators for the period 1996/97 to 2001/02.

Table 6. Estimated performance indicator values for the Northern Zone Rock Lobster Fishery (1992/93 – 2001/02). Source: Ward *et al* (2002b).

Fishing Season	Exploitation Rate	Egg Production	Pre-recruit Abundance	Catch Rate (kg/ pot-lift)	Mean Size (kg)	Total Commercial Catch (t)
1992/93	0.276	956	0.206	1.43	1.07	1,064
1993/94	0.266	863	0.18	1.29	1.12	929
1994/95	0.261	825	0.245	1.26	1.1	891
1995/96	0.268	799	0.245	1.25	1.13	903
1996/97	0.266	813	0.302	1.25	1.06	902
1997/98	0.267	861	0.35	1.29	1.04	943
1998/99	0.267	928	0.38	1.4	1.03	1,016
1999/00	0.259	946	0.34	1.42	1.05	1,001
2000/01	0.254	843	0.25	1.23	1.13	846
2001/02	0.231	721	0.18	1.08	1.21	674

Inter-annual recruitment strength is known to be primarily driven by environmental factors, which are generally not well understood. A number of different measures of recruitment strength (refer to section 2.1.1) all indicate that the Northern Zone has experienced declining recruitment over at least the past three years. There appears to be a long term cyclical pattern of recruitment evident in the Northern Zone that coincides with 10 yearly intervals⁶. If the current pattern is consistent with the trend evident in data from previous decades, the fishery is likely to be experiencing a period that coincides with a ‘trough’ in the recruitment cycle. The decadal recruitment pattern referred to is also evident in the historical commercial catch variation (Fig. 8a).

⁵ A range of biomass and egg-production estimates are provided, to take into account a range (0, 1, 3 and 6 percent) of potential increases in effective effort, over time.

⁶ Note that this data is only available over two ten year cycles and is not considered comprehensive enough to draw from it any firm quantitative conclusions.

Forecasts of future recruitment strength were undertaken during 2002 using the qR model (Ward *et al* 2002b) during the review process, previously discussed. These forecasts suggest that recruitment could be expected to increase in future years, subject to a range of hypothetical assumptions including the nature of future management arrangements. It is important to note that the information provided by these analyses is largely theoretically based and is not considered to be robust. As such the information has only been used as a guide and has not been relied upon for management purposes. SARDI Aquatic Sciences are currently developing a capacity for both the qR model and the integrated model to incorporate puerulus settlement data which would improve the robustness and reliability of model simulations to forecast future recruitment strength. Until a more robust recruitment forecasting capacity has been developed, such information will not be used decisively for management decision-making.

The total commercial catch in the Northern Zone has fluctuated between 600 and 1200 tonnes during the past 20 years (Fig 5). During this same period, regular effort reductions have been implemented to remove over 160,000 pot-lifts from the fishery, in recognition of increases in the effectiveness of fishing effort over time. The average catch over the past 20 years is estimated to be approximately 890 tonnes. The nature of the management arrangements in the Northern Zone (primarily input controls) and the spatial distribution of fishing effort throughout the zone, mean that this information can be used to provide inferences on the relative productivity of the species for the Northern Zone region. For a detailed assessment of the full suite of fishery performance indicators refer to Ward *et al* (2002b).

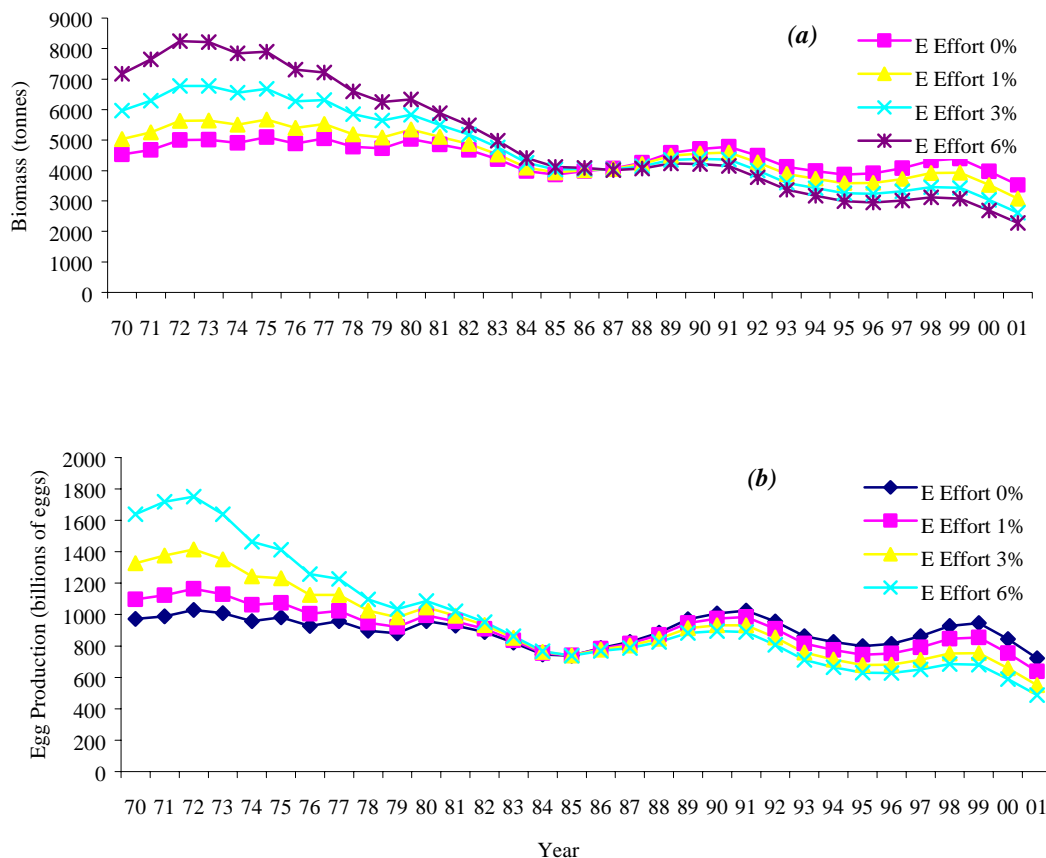


Figure 8. Model (qR) estimated biomass (a) and egg-production (b) in the Northern Zone.

2.1.1.3 Management responses

- *There are reference points (target and/or limit), that trigger management actions including a biological bottom line and/or a catch or effort upper limit beyond which the stock should not be taken.*

The following harvest strategies for each fishing zone explicitly link the annual fishery stock assessment process to management arrangements and the annual decision-making processes to adjust the harvest level (or harvest rate) in each zone respectively. The performance indicators (and established reference range) set out in each Management Plan are critical to this process and are estimated annually by SARDI Aquatic Sciences using a combination of modelling techniques and empirically based methods. The performance indicators and methods of estimation are described in more detail under section 2.1.1.2.

Southern Zone

The following Southern Zone Rock Lobster Fishery harvest strategy is outlined in the current Management Plan (Zacharin 1997a). A key goal of the current harvest strategy has been to build the stock by maintaining a constant harvest of lobster, through constraining the annual total catch to a pre-defined limit (currently 1,770 tonnes). It should be noted that this Management Plan is currently under review and will be updated during 2003. A more formal harvest strategy will be developed during this review process to reflect advancements in knowledge and improved management practices.

Table 7. Management objectives, strategies and performance indicators for the Southern Zone Rock Lobster Fishery.

Management Objectives	Management Strategies	Performance Indicators
<p><u>Biological</u></p> <p>To maintain rock lobster populations at sustainable levels across the fishery.</p> <p>To harvest rock lobster at a size likely to provide for adequate levels of recruitment.</p>	<p>Adopt a 'precautionary approach' in the management of the rock lobster resource;</p> <p>Set a sustainable total allowable commercial catch for the fishery each year;</p> <p>Restrict the number of licences in the fishery to a maximum of 185;</p> <p>Set legal minimum size limits which protect a proportion of the adult spawning stock.</p> <p>Control the total recreational catch by all methods to 4.5% of the total catch.</p>	<p><u>Fisheries Management</u></p> <p>Exploitation rate</p> <p>Catch rate</p> <p>Egg production</p> <p>Pre-recruit index</p> <p>Mean size of lobster</p> <p>Puerulus settlement index</p> <p>Biomass</p> <p>Catch vs TAC</p> <p>Estimated total recreational catch</p> <p><u>Fisheries Compliance</u></p> <p>Reduction in illegal activity determined by number of reports for offences.</p> <p>Cost effective use of compliance resources.</p> <p>Every fisher formally checked at the scales at least once per year.</p> <p>Greater support from stakeholders for Fishwatch.</p>

<p><u>Economic</u></p> <p>To maintain the economic return from the Southern Zone rock lobster fishery at a level which provides for fair and reasonable benefits to licence holders.</p> <p>Optimise yield from the fishery.</p> <p>To recover an economic return from licence holders sufficient to cover attributed costs of management, research and compliance for the fishery.</p> <p>To provide for economic efficiency and flexibility in management arrangements by developing harvesting strategies that minimise costs.</p> <p>To protect the resource through the provision of adequate compliance resources.</p>	<p>Allocate total allowable commercial catches to licence holders as individual transferable pot quotas;</p> <p>Set licence fees at a level sufficient to recover all attributed management, research and compliance costs;</p> <p>Set legal minimum size limits which assist in optimising yield;</p> <p>Develop harvest strategies which minimise commercial fishing costs;</p> <p>Develop flexible management arrangements; and</p> <p>Support cost effective compliance strategies to protect the resource from illegal harvesting</p>	<p>Gross Value of Product (GVP).</p> <p>Cost of management programs compared with GVP.</p> <p>Return on Investment (ROI).</p> <p>Determination of any major operating cost increases (eg possible future loss of fuel rebate).</p>
<p><u>Environmental</u></p> <p>To minimise the environmental impact of rock lobster fishing.</p> <p>To minimise potential conflict with other users of marine resources.</p>	<p>Promote environmentally sensitive fishing practices in the industry and promote actions that reduce fishery impacts; and</p> <p>Identify the potential for conflict with other marine resource users and determine strategies to reduce these conflicts.</p> <p>Monitor and collect information on by-catch and other environmental impacts of fishing.</p>	

<u>Social</u>		
To maintain and provide for reasonable levels of public access to the rock lobster resource.	Monitor participation and catch by the recreational sector in the fishery;	The number of commercial licences.
To ensure a high level of awareness of occupational health, safety and welfare issues in the fishery.	Promote occupational health and safety issues within the industry;	The number of recreational pot registrations.
To keep the community informed regarding the status of the rock lobster fishery.	Develop educational and awareness packages for the community about the fishery; and	The amount of regional employment attributed directly or indirectly to the fishery.
To maintain the regional development nature of the rock lobster fishery.	Develop management arrangements which ensure continued levels of access to the fishery by owner/operators in regional communities.	

A significant change to the current harvest strategy, under the review of the current Management Plan, will be the development of a more formal decision-making framework for future TAC adjustments.

Reference Range

The period between 1992 and 1996 is established in the current Southern Zone Rock Lobster Fishery Management Plan as a reference period. To this end, an implicit goal of the existing Management Plan is to maintain the estimated values of the performance indicators within the 1992 to 1996 range. Estimates of each performance indicator for the reference period are set out in the Management Plan⁷. Apart from exploitation rate and mean size, the lower limits for the reference period outlined in table 6 indicate an undesirable position for the fishery to be in, which should be avoided by management⁸.

Table 8. Target and limit reference range for the Southern Zone Rock Lobster Fishery. Source: Management Plan (Zacharin 1997a).

Reference Point	1992/93	1993/94	1994/95	1995/96	1996/97
Exploitation rate	0.489	0.542	0.498	0.525	0.579
Egg production	1,045	1,046	1,033	994	963
Pre-recruit abundance	1.47	1.32	1.51	1.41	1.17
Catch rate (kg/pot lift)	0.9961	1.0146	1.1383	1.0568	0.9351
Mean size (kg)	0.7831	0.8156	0.8077	0.8038	0.8049

Refer to the previous section (2.1.1.2) on stock productivity for estimated performance indicator values beyond 1996/97. PIRSA Fisheries and the Southern Zone Rock Lobster Fishery Management Committee will automatically take the following management action, if one or more of the performance indicators are estimated to fall outside of the historical range set out in the Management Plan:

1. Notify the Minister for Agriculture, Food and Fisheries and participants in the fishery as appropriate.

⁷ Reference values are estimated by an updated (2002) version of the qR model.

⁸ A reduction in exploitation rate would reflect a reduction in the fraction of the population being harvested, and as such represent a positive outcome for the stock. A reduction in mean size may reflect a higher number of new recruits entering the fishery.

2. Undertake an examination of the causes and implications of ‘triggering’ a reference point.
3. Consult with the Southern Zone rock lobster industry and Director of Fisheries on the need for alternative management strategies or actions, which may include changes to the:
 - TAC in subsequent years;
 - minimum legal size limit; or
 - fishing season; and
4. Provide a report to the Minister and industry, within three months of the initial notification, on the outcomes of a review of the effect of triggering a reference point.

Given the inherent uncertainty in assessment processes and the range of external factors that can influence assessment outcomes, PIRSA Fisheries considers this non-prescriptive approach to management review and response to be appropriate. A more structured approach may be considered if and when tools become available which can provide management with the capacity to quantify the level of risk and uncertainty associated with the adoption of various alternative management strategies.

A recreational pot registration trigger limit of 21,000 pots has been established as a proxy for the total state-wide recreational catch across both fishing zones (as outlined in section 1.3.3), which requires PIRSA Fisheries to enter the market to lease quota or pots from the commercial sector if more than 21,000 recreational pots are registered in any given fishing season. This arrangement is in place to ensure stock sustainability by ensuring that the total recreational catch is capped and does not exceed 4.5% of the total state-wide catch, without that catch being accounted for in the following fishing season.

Northern Zone

The following Northern Zone Rock Lobster Fishery harvest strategy (Table 7) is outlined in the current Management Plan (Zacharin 1997b). A key goal of the current harvest strategy has been to maintain a constant harvest rate of lobster by constraining the annual exploitation rate (harvest rate) to below a pre-defined upper limit (28%). Under this strategy, the total catch increases when the sock size increases due to increased recruitment, and if the stock size declines, so does the catch.

As previously stated, a new management system based on ITQs is being implemented in the Northern Zone during 2003. As such, the Management Plan is currently under review and will be updated during 2003. The current harvest strategy will be modified, and where necessary, improved to reflect the changes to management arrangements being implemented.

Table 9. Management objectives, strategies and performance indicators for the Northern Zone Rock Lobster Fishery.

Management Objectives	Management Strategies	Performance Indicators
<p><u>Biological</u></p> <p>To maintain rock lobster populations at sustainable levels across the fishery.</p> <p>To harvest rock lobster at a size likely to provide for adequate levels of recruitment.</p>	<p>Adopt a 'precautionary approach' in the management of the rock lobster resource.</p> <p>Restrict the number of licences in the fishery to a maximum of 75.</p> <p>Control fishing effort by manipulating days fished.</p> <p>Set legal minimum size limits which assist in protecting a proportion of the adult spawning stock.</p> <p>Control the total recreational catch by all methods to 4.5% of the total catch.</p>	<p><u>Fisheries Management</u></p> <p>Exploitation rate</p> <p>Catch rate</p> <p>Egg production</p> <p>Pre-recruit index</p> <p>Mean size of lobster</p> <p>Biomass</p> <p>Puerulus settlement index</p> <p>Total Commercial Catch</p> <p>Estimated total recreational catch</p> <p><u>Fisheries Compliance</u></p> <p>Reduction in illegal activity determined by number of reports for offences.</p> <p>Cost effective use of compliance resources.</p> <p>The number of offences detected against the number of checks performed.</p> <p>Greater support from stakeholders for Fishwatch.</p>

<p><u>Economic</u></p> <p>To maintain the Northern Zone rock lobster fishery at a level which provides for fair and reasonable economic benefits to licence holders and the community through employment and export revenue.</p> <p>To recover an economic return from licence holders sufficient to cover attributed costs of management, research and compliance for the fishery.</p> <p>To provide for economic efficiency and flexibility in management arrangements by developing harvesting strategies that minimise costs.</p> <p>Optimise the yield from the fishery.</p>	<p>Set licence fees at a level sufficient to recover all attributed management, research and compliance costs.</p> <p>Support cost effective compliance strategies to protect the resource from illegal harvesting.</p> <p>Develop harvest strategies which minimise costs.</p> <p>Develop flexible management arrangements.</p> <p>Set minimum size limits. Assess economic benefits of alternative management strategies.</p>	<p>Gross Value of Product (GVP).</p> <p>Cost of management programs compared with GVP.</p> <p>Return on Investment (ROI).</p> <p>Determination of any major operating cost increases (eg possible future loss of fuel rebate).</p>
<p><u>Environmental</u></p> <p>To minimise the environmental impact of rock lobster fishing.</p> <p>To minimise potential conflict with other users of marine resources.</p>	<p>Promote environmentally sensitive fishing practices in the industry.</p> <p>Identify areas of conservation significance to the Northern Zone rock lobster fishery that may be worthy of conservation.</p> <p>Be pro-active in dealing with conservation issues that may impact on the fishery.</p> <p>Take an ecosystem approach in considering management arrangements for the fishery.</p> <p>Monitor and collect information on by-catch and other environmental impacts of fishing.</p>	

<u>Social</u>		
To maintain and provide for reasonable levels of access to the rock lobster resource for recreational fishers.	Monitor and regulate participation and catch by the recreational sector in the fishery.	The number of commercial licences.
To ensure a high level of awareness of occupational health, safety and welfare issues for skippers and crew.	Promote occupational health and safety issues within the industry.	The number of recreational pot registrations.
To inform and educate the community about the management of the rock lobster resource in the Northern Zone.	Develop educational and awareness packages for distribution to the wider community.	The amount of regional employment attributed directly or indirectly to the fishery.
To maintain the current nature of the rock lobster fishery and provide for regional employment in the fishery.	Consider regional employment in the development of management arrangements for the fishery.	

A significant change to the current harvest strategy, under a revised Management Plan, will be the movement from a constant exploitation rate strategy to a constant catch strategy, which will include a formal decision-making framework for TAC setting and adjustment.

Reference Range

The period between 1992 and 1996 is established in the Northern Zone Rock Lobster Fishery Management Plan (Zacharin 1997b) as a reference period. To this end, an implicit goal of the existing Management Plan is to maintain the estimated values of the performance indicators within the 1992 to 1996 range. Estimates of each performance indicator for the reference period are set out in the Management Plan. Again, apart from exploitation rate and mean size, the lower limits for the reference period outlined in table 8 indicates an undesirable position for the fishery to be in, which should be avoided by management.

Table 10. Target and limit reference range for the Northern Zone Rock Lobster Fishery. Source: Management Plan (Zacharin 1997b).

Reference Point	1992/93	1993/94	1994/95	1995/96	1996/97
Exploitation rate	0.276	0.266	0.261	0.268	0.266
Egg production	956	863	825	799	813
Pre-recruit abundance	0.206	0.180	0.245	0.245	0.302
Catch rate (kg/pot lift)	1.43	1.29	1.26	1.25	1.25
Mean size (kg)	1.07	1.12	1.10	1.13	1.06
Total commercial catch	1,064	929	891	903	902

PIRSA Fisheries and the Northern Zone Rock Lobster Fishery Management Committee will automatically take the following management action, if one or more of the performance indicators are estimated to fall outside of the historical range set out in the Management Plan:

1. Notify the Minister for Agriculture, Food and Fisheries and participants in the fishery as appropriate;
2. Undertake an examination of the causes and implications of 'triggering' a reference point;

3. Consult with the Northern Zone rock lobster industry and Director of Fisheries on the need for alternative management strategies or actions, which may include changes to the;
 - fishing season,
 - minimum legal size limit, or
 - current pot restrictions.
4. Provide a report to the Minister and industry, within three months of the initial notification, on the outcomes of a review of the effect of triggering a reference point.

Refer to the previous section on the Southern Zone for an explanation of these response measures and the response measures that are in place to account for changes in the recreational catch level.

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

Southern Zone

The current Southern Zone management strategy is primarily based on controlling the total catch to within a pre-defined limit, through the establishment of an annual TAC, which is allocated to individual operators in the fishery as ITQs. The current TAC is set at 1,770 tonnes. In addition, a number of complementary input controls (eg. a seasonal closure and pot restrictions) and output controls (eg. minimum legal size limit and prohibition of retention of egg-bearing females) are used. The full suite of management controls and strategies in place for the fishery are set out in table 1 and table 5, respectively. Table 9 outlines major management milestones in the Southern Zone

Table 11. Major management milestones for the Southern Zone.

Year	Management Arrangement
1968	Limited entry declared
1978	June, July, October closed
1980	May and August closed, October opened
1984	15% pot reduction
1987	Buy-back of 40 licences (2400 pots)
1993	April closed; TAC implemented for 1993/94 season (1,718 tonnes)
1994	TAC set at 1,740 tonnes
1995	TAC set at 1,720 tonnes
1995 - 2002	Constant TAC strategy (1,720 tonnes)
2001	Dockside Monitoring Program introduced
2002	TAC increased by 50 tonnes (1,770 tonnes)

The principle measure controlling the commercial catch is the TAC, which is reviewed annually. The TAC has been maintained at a level (1,720 tonnes) designed to facilitate stock building since the 1995/96 fishing season. The recent increase in biomass provides strong evidence that the current management strategy has been successful in achieving this goal and is capable of controlling the level of take. The TAC was recently increased by 50 tonnes in recognition of significant progress towards stock building.

There is a compliance program in place that is considered to be effective at enforcing the controls established in table 1. In 2001, PIRSA Fisheries introduced a formal risk assessment approach to fisheries compliance and monitoring activity, which has improved the effectiveness of the Southern Zone enforcement program. In addition, while difficult to measure, the Dockside Monitoring Program is considered to have improved compliance with

catch limits and further limited the scope for illegal activity in the commercial sector.

Northern Zone

The current Northern Zone management strategy is primarily based on controlling the annual exploitation rate (harvest rate) to within the reference range set out in the Management Plan (26 - 28%). This strategy has aimed to control aggregate effort levels by adjusting the number of total pot-lifts (through limiting the available fishing days and pot numbers) to account for increases in the effectiveness of fishing effort and fluctuations in stock size, over time.

Under this constant exploitation rate strategy, the total catch increases when the stock size increases, due to increased recruitment. Under this approach, it is assumed that a stable relationship exists between exploitation rate and fishing effort⁹. This strategy has been employed in the Northern Zone because of the characteristically high variability in recruitment. PIRSA Fisheries, in partnership with the commercial industry, have a demonstrated track record (table 11) of making effort level adjustments aimed at controlling the level of take, when they have been considered necessary. Note that the recent effort reductions implemented in the fishery have resulted in an estimated exploitation rate of 23%, which reflects an exploitation rate 12% below the lower reference value (26% in 1994) set out in the Management Plan (Ward *et al* 2002b).

Table 12. Major management milestones in the Northern Zone.

Year	Management Arrangement
1968	Limited entry declared
1985	10% pot reduction; max 65 pots
1992	10% pot reduction; max 60 pots
1993	1 week additional fixed time closure
1994	LML increased from 98.5 to 102mm CL; additional 1 week fixed time closure
1995	Additional 1 week fixed time closure
1997	Flexible closure options introduced
1999	Additional 3 days of fixed time closure added
2000	LML increased from 102mm CL to 105 mm CL
2001	7% effort reduction (additional 15 day fixed closure at start of season)
2002	8% effort reduction (introduced as flexible closure options); greater flexibility in time closure system introduced; Management review process - agreement to introduce ITQ management system by 1 November 2003
2003	Implementation of ITQ arrangements; Implementation of escape gaps

Recreational Fishery

There are measures in place to control the level of take in the recreational sector, which include bag and boat limits, gear restrictions, seasonal closures and spatial closures. In addition, the total catch of rock lobster taken by the recreational sector is capped at 4.5% of the total state-wide catch (commercial and recreational). If the total recreational catch is estimated to have reached or exceeded 4.5% of the total catch, PIRSA Fisheries will enter the open market in the following season to lease quota or pots from the commercial sector to offset the estimated increase in the recreational catch. All rock lobster taken by the recreational sector must have the middle tail-fan clipped to allow easy identification of recreational catch. Table 12 provides a summary of the controls in place for the recreational sector.

⁹ A difficulty with this system, as with all input control systems, is the capacity to monitor and respond to increases in the effectiveness of fishing effort.

Table 13. Recreational management controls.

Management Measure	Control
Cap on total recreational catch	4.5% of the total state-wide catch
Daily bag limit	4
Daily boat limit	8
Possession limit	15
Minimum legal size limits	98.5mm (Southern Zone); 105mm (Northern Zone)
Closed season	1 Oct to April 30 (sz); 1 Nov to 31 May (nz)
Egg-bearing females	No retention
Closed areas	Same as commercial sector (table 1 and 2)
Use of pots	Maximum of 2 per person; each pot must be registered and marked with a current pot registration tag.
Use of spear, hook or other pointed instrument	Prohibited
Use of caufs	Prohibited
Use of hoop nets	Maximum of 3 per person
Use of drop nets	Maximum of 3 per person
Use of a snare	Permitted
Pot specifications	Same as commercial sector (table 1 and 2)
Centre tail fan	Must be clipped to a recognisable straight line

- Fishing is conducted in a manner that does not threaten stocks of by-product species. (Guidelines 1.1.1 to 1.1.7 should be applied to by-product species to an appropriate level).

There are a number of species taken as by-product in the fishery (Fig. 2). Table 13 sets out the species which are permitted to be retained by rock lobster fishers, as by-product for trade or business, under Schedule 1 of the *Scheme of Management (Rock Lobster Fisheries) Regulations 1991*.

Table 14. Non-target species permitted to be retained for trade or business in the South Australian Rock Lobster Fisheries.

Species Common Name	Species Scientific Name
<u>Marine Scalefish</u>	
Anchovy	<i>Engraulis australis</i>
Barracouta	<i>Thyrsites atun</i>
Bluethroated wrasse	<i>Notolabrus tetricus</i>
Bream	<i>Acanthopagrus butcheri</i>
Cod	Family Moridae
Dory	Family Zeidae
Flathead	Family Platycephalidae
Flounder	Family Pleuronectidae; Family Bothidae
Garfish	<i>Hyporhamphus melanochir</i>
Horse mackerel	<i>Trachurus declivis</i>
Leather jacket	Family Aluteridae
Ling	<i>Genypterus blacodes</i>
Mackerel	<i>Scomber australasicus</i>
Morwong	Family Cheilodactylidae
Mullet	Family Mugilidae
Mulloway	<i>Argyrosomus hololepidotus</i>
Nannygai, Red snapper, Swallowtail	Family Berycidae
Pilchard	<i>Sardinops neopilchardus</i>
Red mullet	<i>Upeneichthys porosus</i>
Salmon	<i>Arripis truttaceus</i>

Snapper	<i>Chrysophrys auratus</i>
Snook	<i>Sphyraena novaehollandiae</i>
Sole	<i>Aserragodes haackeanus</i>
Sweep	<i>Scorpius aequipinnis</i>
Tommy ruff	<i>Arripis georgianus</i>
Trevalla	<i>Hyperoglyphe antarctica</i>
Trevally	<i>Usacaranx georgianus</i>
Whiting	Family Sillaginidae
<u>Crustaceans</u>	
Crab, giant	<i>Pseudocarcinus gigas</i>
Crab, velvet	<i>Nectocarcinus tuberculatus</i>
<u>Molluscs</u>	
Cockle	Suborder Teledonta
Cuttlefish	<i>Sepia</i> spp.
Mussels	<i>Mytilus</i> spp.
Octopus	<i>Octopus</i> spp.
Oyster	Family Ostreidae
Scallop	Family Pectinidae
Squid, calamary	<i>Sepioteuthis australis</i>
Squid, arrow	<i>Nototodarus gouldi</i>
Beachworm; Bloodworm; Tubeworm	Class Polychaeta
<u>Sharks</u>	
All shark, skate and ray species (other than white pointer sharks)	Class Elasmobranchii (<i>Carcharodon carcharias</i>)

Rock lobster pots are considered to be highly selective because of design features, which are based on the known behavioural characteristics of rock lobster. Species and size selectivity is also known to be enhanced by incorporating the use of escape gaps in pots. The current mesh size used to cover the ‘bee-hive pot’ construction used across both South Australian fishing zones is 50mm. Escape gaps are currently not required in rock lobster pots used in South Australia, unless the pot is constructed with a mesh size less than 50mm. Following the results of SARDI research completed in 2001/02, there is agreement to introduce two escape gaps of 57mm high x 280mm wide in each pot used in the Northern Zone.

A proposal to introduce escape gaps of 55mm high x 280mm wide is still being considered by the Southern Zone industry. Industry concern in the Southern Zone exists over the economic and biological loss which may result from the introduction of escape gaps because they may: (1) reduce the capture of octopus, which in turn may increase octopus predation on rock lobster through the existence of a larger octopus population; and (2) increase the ingress rate of octopus in lobster pots, which in turn may increase pot-induced lobster mortality through octopus predation.

There are a number of scalefish, shark, crustacean and molluscan species that are taken as by-product and by-catch in the SA rock lobster fisheries. The degree to which these species are taken as by-product or by-catch varies across individual licence holders in each fishing zone. When retained, these species are either used as: (1) bait for rock lobster fishing operations; (2) by-product for commercial purposes; or (3) by-product for personal consumption.

An independent by-product/by-catch monitoring program commenced in both fishing zones at the start of the 2001/02 fishing season. This program involves SARDI researchers undertaking low level at-sea monitoring to record non-target species interactions and total catch composition. Catch sampling of by-catch and by-product is also undertaken in-port as part of this program to improve cost-effectiveness. This data is used to validate data collected by commercial fishers through logbooks and will be quantitatively analysed and reported on

following the completion of the 2002/03 fishing season. The by-catch/by-product monitoring program is described in more detail in section 2.1.1.1 (Information Requirements – Principle 1) and 2.2.1.1 (Information Requirements – Principle 2).

The main by-product species taken for commercial purposes in each fishing zone is octopus (*Octopus maorum*), which is a common attribute of other fisheries for rock lobster in Australia and New Zealand. A recent study of the species taken in the South Australian fisheries by Brock, Prescott and Ward (2002) demonstrated that, since 1983 between 38,000 and 119,000 octopus have been taken per year in lobster pots across both zones, the majority being taken in the more productive Southern Zone. The study suggested that over the last 5 years approximately 240,000 lobster were killed each year as a result of pot-induced octopus predation, which represents an estimated 4% of the total annual lobster catch.

The study found that the relative abundance of octopus, as measured by CPUE data, does not appear to have declined in any statistical fishing blocks since 1983 and demonstrated that, over the last 26 years there have been large inter-annual fluctuations in catch rates across both zones. Brock, Prescott and Ward (2002) suggested that current levels of octopus mortality, as a result of the by-product taken by rock lobster fishers, has had no measurable effect on the population of octopus within the geographic extent of the fishery. The study concluded that there is no evidence to suggest that existing octopus by-product levels are unsustainable.

The main marine scalefish by-product species taken in rock lobster pots for bait purposes are leatherjackets and wrasse. Preliminary results of the by-product/by-catch study being undertaken by SARDI Aquatic Sciences suggests that the take of scalefish species in the rock lobster fishery, relative to that of other targeted scalefish fishing (both commercial and recreational), is low in most cases and does not present any significant risks to by-product species populations¹⁰. The risk analysis intended to be completed as part of the by-catch monitoring program will provide a quantitative assessment of the impacts on non-target species populations associated with rock lobster fishing, relative to that of other target fisheries for marine scalefish. The interaction with scalefish species is addressed in further detail under the by-catch section (2.2) of this report.

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

Based on current assessments, while the Southern Zone is performing at a higher level than the Northern Zone (relative to the established management objectives and reference range established in each Management Plan), on balance the fishery in each zone is considered to be performing at an acceptable level against the objective aimed at conducting the fishery at catch levels that maintain ecologically viable stock levels.

Southern Zone

A quota management system was introduced in the Southern Zone following a series of significant effort reductions and a fleet structural adjustment process. The quota system was designed to remove the ongoing threat of increases in effective fishing effort and limit the risk to the fishery of overfishing and over-capitalisation. As previously discussed, the current Southern Zone management strategy has allowed the stock to build substantially.

The legal sized relative biomass is estimated by the qR model to have increased by 50% since 1998, and be the largest in the recent history of the fishery. Similarly, egg-production is estimated to be the highest recorded in the recent history of the fishery. Exploitation rate has

¹⁰ Summary catch and effort statistics for the South Australian Marine Scalefish Fishery can be obtained from SARDI Aquatic Sciences, upon request (Knight, Tsolos and Doonan 2002).

decreased steadily since 1996 due to continued stock building. The entire fleet now spends less time searching and fishing, which has reduced the costs of fishing and the overall impact on the marine environment. The fishery continues to generate high levels of regional employment and make significant contributions to regional and State economies. The current management arrangements have high levels of stakeholder support.

The fishery is considered to be performing well against all established biological, economic, social and environmental management objectives set out in the Management Plan. All current performance indicator estimates are either exceeding or within the established reference range set out in the Management Plan. Recent recruitment estimates indicate that the current stock status will continue to improve (Ward *et al* 2002a).

Northern Zone

The existing input control system in the Northern Zone has been in place for many years. The system is considered to have been effective at controlling the level of effort in the fishery over time, through ongoing adjustments to fishing days, pot numbers and licence numbers. However, the system has a number of shortcomings symptomatic of many effort-controlled fisheries, in particular the limited capacity to estimate and control any suspected expansion in effective fishing effort levels.

Improvements in effort have taken many forms in the Northern Zone and may include changes in the technology used to locate and catch lobster, bait effectiveness, vessel design and capacity and individual motivation and skill levels. Changes in effective effort levels can be large, incremental sudden increases (eg. GPS, sonar, planing hulls, etc) or steady, constant and more unpredictable increases (eg. skipper skill levels). Such increases are known to occur in all input control managed fisheries, as fishers have an incentive to replace restricted inputs with greater use of unrestricted inputs.

In response to these stock sustainability concerns and the known increases in effective effort levels, a comprehensive review of the current management arrangements was undertaken during 2002. This process has led to a revised management approach for the zone. PIRSA Fisheries is currently in the process of introducing an ITQ management system for the Northern Zone, by November 2003.

The most recent Northern Zone stock assessment report (Ward *et al* 2002b) suggests that the current management strategy, aimed at maintaining a constant exploitation (harvest) rate of lobster, has resulted in a stock decline, below the reference range established in the Management Plan. In this assessment, Ward *et al* (2002b) suggest that a declining trend will continue unless effort levels are reduced significantly in the short term. A range of management responses have been introduced to provide adequate protection for the remaining stock and ensure stock recovery within a reasonable timeframe (refer to section 2.1.2.1).

Relative biomass in the Northern Zone is estimated by the qR model to have declined to a level that is considered to be the lowest in the recent history of the fishery. Similarly, egg production is currently estimated to be 10% below the lower reference level established in the Management Plan. Exploitation rate in the Northern Zone is currently estimated to be 23%, which is 12% below the lower reference value (26% in 1994) established in the Management Plan (Ward *et al* 2002b). This reduction reflects the measurable impact of introducing effort reductions, which have resulted in operators fishing approximately 30 fewer days each year, since the 2000/01 fishing season.

A number of different measures of recruitment strength (refer to section 2.1.1) all indicate

that the Northern Zone has experienced declining recruitment levels in recent years, which has contributed to the current poor performance of the fishery. Refer to section 2.1.1.2 on stock productivity for further detail on recruitment patterns.

The total commercial catch in the Northern Zone has fluctuated between 600 and 1200 tonnes during the past 20 years. During this same period regular effort reductions have been implemented to remove over 160,000 pot-lifts from the fishery. The average catch over the past 20 years is estimated to be approximately 890 tonnes. The significant effort reductions (total of 15%) introduced over the 2001/02 and 2002/03 fishing seasons are considered to be an appropriate precautionary short term response to the current status of the fishery, while more detailed long term ITQ management arrangements are implemented.

The decision to introduce an ITQ management system by 1 November 2003 will improve the performance of the fishery over time and ensure stock recovery management objectives are achieved within a reasonable timeframe. Despite the current stock decline, the fishery continues to generate high levels of regional employment and make significant contributions to regional and State economies.

The fishery is considered to be performing well against all established biological, economic, social and environmental management objectives set out in the Management Plan. All current performance indicator estimates are either exceeding or within the established reference range set out in the Management Plan. Recent estimates of pre-recruitment and puerulus settlement indicate that recruitment to the zone may improve (Ward, T.M 2003, pers. comm).

Recreational

The current objectives for recreational fisheries management for all recreational fishing activity in the State are focussed on the goal of maximising the social and economic benefits of recreational fishing to the community of South Australia. These objectives are pursued by providing equitable and sustainable levels of community access to the marine, estuarine and freshwater resources of the State.

In line with this broad goal, the recreational arrangements in place for the rock lobster fisheries are designed to provide equitable and sustainable access to rock lobster. Together, the diversity of recreational fishing methods permitted, the current bag and boat limits in place and the nominal cap on the total recreational rock lobster catch are considered to ensure the right balance is achieved between providing equitable recreational opportunities and meeting broad sustainability objectives

A survey of recreational catch and effort in the rock lobster fishery is currently being finalised by SARDI Aquatic Sciences. This survey will provide further indications of the extent to which the current arrangements are meeting established management objectives for recreational fishing.

2.1.2 Objective 2.

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.

2.1.2.1 Management responses

- *A precautionary recovery strategy is in place specifying management actions, or staged management responses, which are linked to reference points. The recovery strategy*

should apply until the stock recovers, and should aim for recovery within a specific time period appropriate to the biology of the stock. If the stock is estimated as being at or below the biological and / or effort bottom line, management responses such as a zero targeted catch, temporary fishery closure or a 'whole of fishery' effort or quota reduction are implemented.

The Southern Zone is currently performing well above the biological reference range established in the Management Plan and as such, this section is not considered pertinent to this report.

In the Northern Zone, a stock recovery plan is being developed in response to the recent stock decline. A range of short and long term measures have been introduced to address the stock decline, which are in line with the suggested management responses set out above of 'a zero targeted catch, temporary fishing closures or a whole of fishery effort or quota reduction'. The management responses that have been implemented include:

- A 7% effort reduction (in available fishing days – approx. 14 days less fishing per licence) implemented in the 2001/02 fishing season to restrict the total catch;
- An 8% effort reduction (in available fishing days – approx. 15 days less fishing per licence) implemented in the 2002/03 fishing season to further restrict the total catch; and
- The introduction of an ITQ management system (by 1 November 2003) aimed at restricting the annual total catch to a precautionary pre-defined limit for an agreed timeframe to promote stock recovery.

The effort reductions implemented during the 2001 and 2002 fishing seasons reduced the overall exploitation rate in the fishery to an estimated 23%, which is 12% below the lower reference value (26% in 1994) set out in the Management Plan (Ward *et al* 2002b). A revised harvest strategy aimed at stock recovery will be finalised in consultation with key stakeholder groups during 2003, in line with the intention to introduce ITQ management arrangements by 1 November 2003. Specific details of the revised harvest strategy are still being developed.

The timeframe over which the stock may be expected to recover is primarily dependent on the amount of lobster that enter the fishery as new recruits each year, the amount extracted through fishing, the amount that die naturally and a range of environmental factors. Clearly, the less lobster extracted through fishing in the short term, the greater the opportunity for the stock to recover within a reasonable timeframe. In setting targets and timeframes for stock recovery, PIRSA Fisheries will prioritise the biological needs of the stock and broader ecosystem, while ensuring that an appropriate balance is achieved between the biological, economic and social objectives established for the fishery. Stock recovery targets will be defined by specifying a range of reference values (yet to be determined) for each performance indicator. These values will be set conservatively to indicate progress towards stock recovery objectives.

A conservative constant harvest level will be set for the fishery in the short term (3 – 5 years) to promote stock recovery. While a formal harvest strategy for the fishery is still being developed, the initial harvest level is likely to be set in a range between 600 and 700 tonnes, subject to the performance of the fishery during the 2002/03 fishing season. This range represents a harvest of between approx. 67% and 78% of the average total harvest from the fishery over the past 20 year period (890 tonnes). The performance of the harvest strategy will be evaluated each year and will be fully reviewed after five years. The long term sustainable harvest level for the fishery is considered to be in the range of between 750 and 850 tonnes.

The revised harvest strategy will focus explicitly on stock recovery and incorporate revised management objectives, strategies, performance indicators, reference values, decision rules and data requirements, which will continue to be explicitly linked to the annual stock assessment process.

PIRSA Fisheries considers that the range of management response measures introduced in the Northern Zone are consistent with a precautionary approach, and moreover, the legislative requirements of the Fisheries Act in relation to resource protection and stock sustainability. The revised harvest strategy will be developed to ensure that the fishery is managed to promote stock recovery within a reasonable timeframe.

2.2 Principle 2

Fishing operations should be managed to minimise their impact on the structure, productivity, function and biological diversity of the ecosystem.

2.2.1 Objective 1.

The fishery is conducted in a manner that does not threaten by-catch species.

2.2.1.1 Information requirements

- *Reliable information, appropriate to the scale of the fishery, is collected on the composition and abundance of by-catch.*

The Information presented in Figure 9 was created using the process developed by Fletcher *et al* (2002), to provide a guide to non-target species interactions across both fishing zones. Figure 9 sets out individual species, or groups of species, that are not retained as part of the commercial catch.

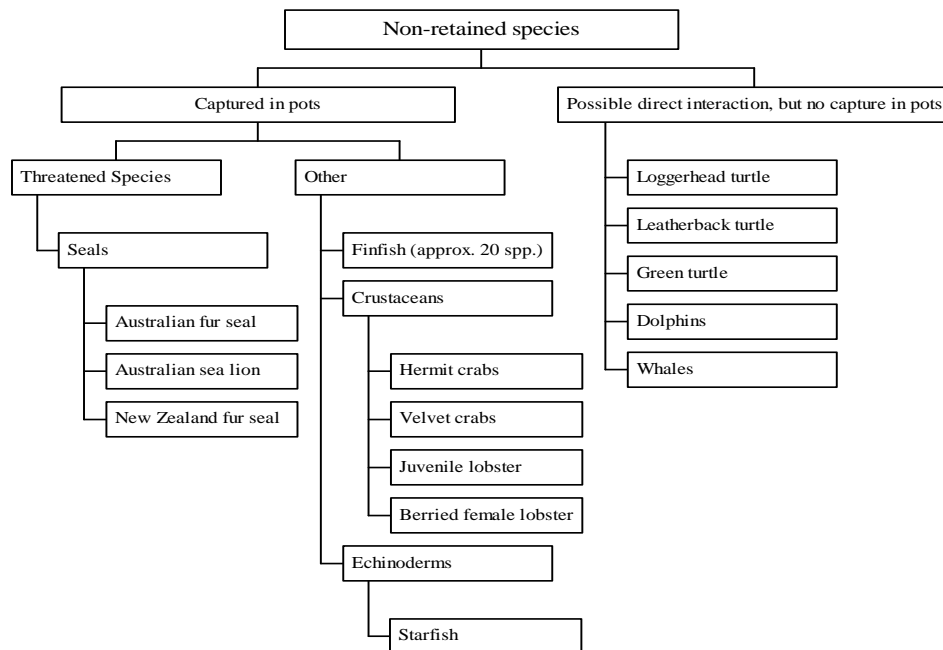


Figure 9. Component tree for non-retained species in the northern and Southern Zone rock lobster fisheries.

As outlined in the previous section on by-product (2.1.1.3), information on by-catch and by-product species composition and other non-target species interactions is currently collected by SARDI Aquatic Sciences as part of a by-catch monitoring program, which commenced in both fishing zones in the 2001/02 season. The by-catch monitoring program involves SARDI researchers undertaking low level at-sea monitoring to record non-target species interactions and catch composition. Catch sampling of by-catch and by-product is also undertaken in-port as part of this program to improve sampling cost-effectiveness. For details of the level of coverage at sea and in port, refer to section 2.1.1.1 (Information Requirements – Principle 1).

Wildlife and protected species interactions are also recorded as part of the program, and also on an *ad-hoc* basis (not compulsory) through commercial fishing logbooks. The data collected through this program will be quantitatively analysed and reported on following the completion of the 2002/03 fishing season. Table 14 was constructed using preliminary species catch composition data derived from the by-catch monitoring program.

Table 15. Non-target species catch composition in the Northern and Southern Zone Rock Lobster Fisheries, as recorded by the existing by-catch monitoring program.

Species Common Name	Species scientific name
<u>Marine Scalefish</u>	
Horseshoe Leatherjacket	<i>Meuschenia hippocrepis</i>
Chinaman Leatherjacket	<i>Nelusetta ayraudi</i>
Bluethroat Wrasse	<i>Notolabrus tetricus</i>
Sixspine Leatherjacket	<i>Meuschenia freycineti</i>
Velvet Leatherjacket	<i>Meuschenia scaber</i>
Barber Perch	<i>Caesioperca rasor</i>
Snapper	<i>Pagrus auratus</i>
Yellowstriped Leatherjacket	<i>Meuschenia flavolineata</i>
Brown Striped LeatherJacket	<i>Meuschenia australis</i>
Orangespotted Wrasse	<i>Notolabrus parilus</i>
Bluelined Leatherjacket	<i>Meuschenia galii</i>
Largetooth Beardie	<i>Lotella rhacina</i>
Moonlighter	<i>Tilodon sexfasciatum</i>
Ocean Perch	<i>Helicolenus percoides</i>
Red Snapper	<i>Centroberyx gerradi</i>
Bearded Rock Cod	<i>Pseudophycis barbata</i>
Conger Eel	<i>Conger verreauxi</i>
Jackass Fish	<i>Nemadactylus macropterus</i>
Maori Wrasse	<i>Ophthalmolepis lineolata</i>
Harlequin Fish	<i>Othos dentex</i>
Silver Spot	<i>Threpterus maculosus</i>
Knife Jaw	<i>Oplegnathus woodwardi</i>
Rosy Wrasse	<i>Pseudolabrus psittaculus</i>
Banded Seaperch	<i>Hypoplectrodes nigroruber</i>
Red Cod	<i>Pseudophycis bachus</i>
Spinytail Leatherjacket	<i>Acanthaluteres brownii</i>
Red Mullet	<i>Upeneichthys vlamingii</i>
<u>Sharks</u>	
Port Jackson Shark	<i>Heterodontus portusjacksoni</i>
Banded Wobblygong	<i>Orectolobus ornatus</i>
Gummy Shark	<i>Mustelus antarcticus</i>
<u>Crustaceans</u>	
Juvenile rock lobster	<i>Jasus edwardsii</i>
Crab, giant	<i>Pseudocarcinus gigas</i>
Crab, hermit	

Crab, velvet	<i>Nectocarcinus tuberculatus</i>
<u>Molluscs</u>	
Cuttlefish	<i>Sepia</i> spp.
Octopus	<i>Octopus maorum</i>
<u>Echinoderms</u>	
Starfish	
Sea urchins	

There are relatively few non-retained species in the South Australian Rock Lobster Fisheries. On balance, the majority of marine scalefish, crustacean and shark species taken in pots across both fishing zones are kept as by-product for bait purposes or for purposes of trade or business. However, this does vary across each fishing zone and at the individual business level depending on the requirements of each fishing operation. For example, some fishers purchase bait (mainly European carp and Australian salmon) prior to the start of each fishing season and as such do not retain all of the marine scalefish by-catch taken in pots during a season. Preliminary results of the by-catch monitoring program demonstrates that non-target species catch composition does vary at different spatial and temporal scales across the northern and Southern Zones.

Rock lobster fishers are currently not required to record non-retained species in the prescribed logbook¹¹. Preliminary information collected through the current by-catch monitoring program and anecdotal information from fishers indicates that by-catch is low (ie. most non-target catch is retained as by-product and therefore is required to be recorded in logbooks). Rock lobster discarded under regulations (ie. minimum size limit or egg-bearing females) or because of issues related to marketability (eg. carapace condition, limb-loss, colour or size) are required to be recorded in the logbook.

2.2.1.2 Assessments

- *There is a risk analysis of the by-catch with respect to its vulnerability to fishing.*

An initial screening process of all non-target species has been undertaken by PIRSA Fisheries using the qualitative risk assessment approach suggested by Fletcher *et al* (2002) to identify any high priority by-catch issues that may require a specific management response. The only issue that emerged as one which may require further monitoring and investigation was the potential interaction between rock lobster pots and seals. For the majority of non-target species, the quantity taken by the rock lobster fleet is considered to be low or negligible, relative to the quantities taken in other target fisheries.

No formal risk analysis has been undertaken with respect to non-target species in the South Australian Rock Lobster Fisheries, as in most cases the impacts are considered to be inherently low or negligible due to the known high selectivity of the gear and its low impact on temperate shallow rocky reefs (Casement and Svane 1999). In addition, the use of marine scalefish taken as by-product in rock lobster pots for bait purposes is considered to be a sustainable practice of attaining bait, provided the relative quantities taken do not increase substantially over time and no threats are posed to any of the species taken. Ongoing periodic monitoring of by-catch will ensure that any such increases are detected and able to be addressed. The use of locally caught bait also reduces the risk of disease introduction through bait importation.

A number of by-catch species are able to be returned to the water alive, depending on the depth from which they are taken. While no studies have been undertaken on the post-release survival rates of by-catch species in the rock lobster fisheries, SARDI researchers have been

¹¹ Retained non-target species are required to be recorded in the prescribed logbook.

investigating the post-release survival rates of line caught fish through a national project funded by FRDC. The results of this study may provide some inferences on the survival rate of by-catch released from rock lobster pots.

The primary objective of the current by-catch monitoring program is to undertake a formal risk assessment to quantify the vulnerability of non-target species, including endangered, threatened and protected species, to rock lobster fishing¹². As stated previously, this project will be finalised and reported on during 2003. Following this risk analysis, a more formal non-target species management strategy will be considered. While not stated in each of the Management Plans (Zacharin 1997a,b) the current objective for management of by-product and by-catch in both rock lobster fishing zones is to maintain appropriately low levels of impact of each fishery on by-product and by-catch species.

2.2.1.3 Management responses

- *Measures are in place to avoid capture and mortality of by-catch 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.*

Rock lobster pots are considered to be highly species and size selective. The current minimum mesh size used to cover the 'bee-hive pot' construction used across both South Australian fishing zones is 50mm. All commercial and recreational fishers must use this minimum mesh size or fit two escape gaps of 55mm high x 150mm wide. As a result of these arrangements, fishers use a mix of both options. However, there has been a shift towards the use of escape gaps in both zones over time. The increased use of escape gaps reflects a recognition from fishers that escape gaps: (1) enhance pot selectivity and reduce sorting time because of the reduced numbers of undersized lobster and other species captured in pots; (2) reduce pot-induced lobster mortality through octopus predation; and (3) reduce juvenile lobster handling mortality associated with exposure to sunlight, wind, ultraviolet light etc, limb loss and predation upon being returned to the water.

The results of a targeted research project completed by SARDI Aquatic Sciences in 2001/02 (Prescott, unpub.) indicated that the current minimum 50mm mesh size is not efficient at ensuring adequate escapement opportunities for undersized lobster in both fishing zones. The main benefits of using escape gaps are the potential gains in yield and egg-production that result from reduced pot-induced mortality, reduced discard mortality and reduced limb-loss and other damage through handling. As a result of the study, the following optimal escape gap dimensions were proposed: 57mm high x 280mm wide the Northern Zone and 55mm high x 280mm wide in the Southern Zone, in recognition of the different minimum size limits in place for each fishing zone. These escape gap dimensions are aimed at maximising the retention of legal sized lobster and minimising the retention of undersized lobster, as well as reducing the catch of unmarketable non-target species.

The Northern Zone industry has supported the introduction of escape gaps across the fishery, by November 2003, however, the proposal is still being considered by the Southern Zone industry. Primarily, the Southern Zone industry is concerned over the extent to which the introduction of escape gaps will increase the pot ingress and egress rate of octopus, having the following impact: (1) reducing the capture rate of octopus, which in turn may increase octopus predation on rock lobster populations through the existence of a larger octopus population; (2) increasing the rate of pot-induced lobster mortality through octopus predation because octopus are able to more readily enter and exit pots; and (3) reduced economic

¹² More detailed and specific analyses of the interaction between rock lobster pots and seals is intended to be undertaken as part of a targeted research program – refer to section 2.2.2.1.

returns through reduced catch rates of octopus. The recent study by Brock, Prescott and Ward (2002) did not support the first two of these hypotheses.

In addition, the Southern Zone industry is concerned that the capture rate of legal sized lobster will be reduced if escape gaps are introduced. Brock, Prescott and Ward (2002) confirmed this hypothesis to be true, depending on where in the zone fishing takes place and what escape gap dimensions are used. The reduction in the catch rate of legal size animals was only marginal for the proposed escape gap size of 55mm x 280mm, particularly when considered in the context of the quota management arrangements in place, which provide adequate opportunities for fishers to catch individual catch quotas.

On the basis that escape gaps have been proven to enhance the selectivity of pots used in both South Australian fishing zones (Prescott, unpub), by reducing the level of by-catch (primarily of undersized lobster but also for other non-target species such as marine scalefish) PIRSA Fisheries will continue to consult with the Southern Zone industry sector on the appropriateness of pot escape gaps for both the commercial and recreational sectors. PIRSA Fisheries and SARDI Aquatic Sciences, in association with the Southern Zone Rock Lobster Fisheries Management Committee, have planned a series of port visits for the first and second quarters of 2003 to progress the issue.

Additional research has been undertaken by Brock, Saunders and Ward (2002) to develop a two-chambered rock lobster trap, which aims to minimise the within-trap predation by octopus. The trap design trialed was successful in reducing relative within-trap octopus predation by 70%, however, rock lobster catches were also reduced. Further modification and development of the trap is considered necessary if it is to be used widely in the commercial industry. Opportunities for further investment in development of this approach will be explored during 2003.

A progressive reduction in the number of pot-lifts and overall days spent fishing in the Southern Zone over the past three fishing seasons, due to improved catch rates associated with the higher lobster abundance, has undoubtedly reduced the overall impact on non-target species populations. The introduction of a quota system in the Northern Zone is intended to yield similar results in the long term.

- *An indicator group of by-catch species is monitored.*

No indicator group of non-target species is monitored in these fisheries. The by-catch monitoring program currently being undertaken by SARDI Aquatic Sciences will continue to collect information on by-catch and other non-target species interactions during the 2003/04 fishing season. The risk to by-catch species taken in both rock lobster fishing zones is currently considered to be minimal because of the low level of take and interaction, relative to that of other targeted fishing operations, which are managed under separate arrangements. The current management of by-catch and by-product species will be re-evaluated following completion of the risk analysis, to be undertaken in 2003/04 as part of the by-catch monitoring program. Following this analysis, the need for ongoing monitoring and the periodicity of future by-catch studies will be determined.

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

As stated previously, following the formal evaluation of risk to non-target species populations posed by rock lobster fishing, a more formal non-target species management strategy which may include performance indicators and reference limits will be considered. If an

unacceptable level of risk is identified for any of the species taken as by-product or by-catch, PIRSA Fisheries will introduce appropriate management measures to reduce the level of risk. The Fisheries Act provides the capacity for managers to respond swiftly to such risks.

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

Although not documented in the Management Plans, the current objective for management of by-product and by-catch in both rock lobster fishing zones is to maintain appropriately low levels of impact of each fishery on by-product and by-catch species. The current by-catch study being undertaken by SARDI Aquatic Sciences will provide PIRSA Fisheries with a capacity to formally evaluate the extent to which this objective is being achieved. This will be undertaken during 2003. However, the initial screening process of risks to by-catch referred to previously, indicates a low level of risk to by-product and by-catch species populations is posed by rock lobster fishing. The introduction of pot escape gaps will aim to improve performance against this objective over time.

A number of other factors are also considered to act as indirectly to ensure that the overall risk to by-catch species populations remains low: (1) the long term trend of decreased pot-lifts and reduced overall days spent fishing in the Southern Zone, and the associated reduction in the spatial distribution of effort; (2) the move to introduce quota in the Northern Zone, which is intended to provide similar benefits to those demonstrated in the Southern Zone; and (3) the lack of gear (pot/trap) development over time and relative constancy in fishing practices, notwithstanding other improvements in technology aimed at improving lobster catching efficiency (eg. colour sounders, G.P.S, sonar, planing hulls etc).

Based on the low level of impact on non-target species and on the strength of the range of measures that have been introduced to address by-catch issues, PIRSA Fisheries considers that the performance of the fishery against established environmental objectives is acceptable and that the fishery is being conducted in a manner that does not threaten by-catch or by-product species. In addition, anecdotal reports from fishers suggest that there has been no discernible change to the non-target species catch composition over the 60 year period during which the fishery has operated.

The fishery assessment process established for the South Australian Marine Scalefish Fishery provides a more rigorous assessment for a large number of the non-target marine scalefish species taken in both rock lobster fishing zones, which reflects the relative take of these species in each fishery. Information on the assessment of the Marine Scalefish Fishery is available from SARDI Aquatic Sciences.

2.2.2 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.

2.2.2.1 Information requirements

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

Potential exists for a number of protected marine species to interact with rock lobster pot float lines on rare occasions. These species include whales, dolphins, seals and turtles. The degree

to which fishers may encounter each of these species varies temporally and spatially, although this has not been formally quantified. Information on these interactions has been collected on an *ad-hoc* basis through commercial logbooks and research cruises over many years and also through the current by-catch monitoring program. It is currently not compulsory for fishers to record interactions with endangered, threatened or protected species in the prescribed fishery logbook.

On rare occasions, seals in the family Otariidae are known to interact with float lines and become captured in rock lobster pots. Seals that may interact with rock lobster pots in South Australian waters include the Australian sea lion (*Neophoca cinerea*), the New Zealand fur seal (*Arctocephalus forsteri*) and the Australian fur seal (*A. pusillus doriferus*).

Information on these interactions is collected in an *ad-hoc* way through commercial logbooks (currently not compulsory), through research cruises, by National Parks and Wildlife and via the current independent by-catch catch monitoring program. Although the level of seal interaction in each fishing zone appears to be low (generally lower in the Southern Zone than it is in the Northern Zone) it has not been independently and formally quantified. On this basis, the rock lobster industry in both South Australian fishing zones has supported the establishment of an on-board monitoring program to formally assess and quantify the level of interaction between rock lobster fishing and seals, in order to develop appropriate mitigation measures. Options and partnerships to progress the development of this project will be investigated during the course of 2003.

At present, it is not compulsory to record interactions with endangered, protected or threatened species in the South Australian Rock Lobster Fisheries. Consideration is currently being given to amending the existing Rock Lobster Fishery logbook or generating a new dedicated logbook to provide scope for fishers to record interactions with endangered, threatened and protected species, across all South Australian fisheries.

2.2.2.2 Assessments

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

There has been no formal risk assessment of the vulnerability of endangered, threatened or protected species to rock lobster fishing. However, the impact of the fishery on populations of these species is considered to be low or negligible. The proposed on-board monitoring program will provide additional information to facilitate impact assessments being undertaken.

Seals

The South Australian Rock Lobster Fisheries operate in waters that are adjacent to a number of seal breeding sites and specified critical habitats (Shaughnessy 1999). There are a number of major breeding colonies of Australian sea-lions and New Zealand fur seals throughout South Australia. Three locations in South Australia were estimated to account for 42% of the total Australian sea-lion population and most (77%) of the New Zealand fur-seal population in Australia exists in central South Australian waters.

While seal interactions appear to be rare, the most frequently reported interactions relate to seals attempting to remove bait and lobster from pots, seal predation on juvenile rock lobster returned to the water and seal interactions with float lines. The impacts associated with these rare interactions include cuts and infections from float lines, death by drowning through

capture in pots and death by drowning through entanglement in float lines. Of concern, is the relative proportion of seal pups, which could potentially be captured in pots, because of the ease with which they are able to enter pots, particularly if seal exclusion devices are not used. The mortality rate of seals associated with pot interactions has not been formally quantified, but is likely to be low, based on information collected during collaborative work previously undertaken between SA rock lobster fishers and National Parks and Wildlife staff.

Some anecdotal reports of seal interactions with marine debris have been documented in South Australian waters. Some of this debris, namely plastic bait packaging straps, may have originated from commercial rock lobster fishing vessels. The impacts associated with these interactions include cuts and lesions and death by drowning due to entanglement (Shaughnessy 1999).

The current impact of rock lobster fishing on seal populations is considered to be low. However, the frequency of seal interactions and the level of impact are considered to require further monitoring and investigation, as outlined above. It is intended that the monitoring program proposed to be undertaken, form the basis of a formal risk analysis of the impacts on seal populations associated with rock lobster pot fishing and also be used to develop appropriate mitigation measures. Note that many rock lobster fishers already use seal exclusion devices in pots, as a result of previous collaborative work undertaken with National Parks and Wildlife.

Turtles

Turtle interactions with float lines in the South Australian Rock Lobster Fisheries are rare, due primarily to the low abundance of turtles distributed throughout South Australian waters. Carrick (1999) prepared a report entitled “The Spencer Gulf Penaeid Shrimp Fishery: A Case for an Exemption to the US Shrimp Embargo” in response to concerns over turtle interactions with the South Australian Spencer Gulf Prawn Fishery. This report documented that three turtle species have been recorded in South Australian waters. These include the loggerhead turtle (*Caretta caretta*), the leatherback turtle (*Dermochelys coriacea*) and the green turtle (*Chelonia mydas*).

No turtle rookeries occur in South Australia. The nearest rookery is approximately 1,800 nautical miles from the southern Spencer Gulf. Information indicates that no breeding populations or rookeries occur south of 25° 50' S and that both air temperature (for egg incubation) and sea water temperature impose natural limitations on rookery distribution in Australia (Carrick 1999). Turtles are known at times to be distributed further south in the east Australian current and the Leeuwin current during summer months.

Due to the factors outlined above, the impact of rock lobster fishing on turtles populations is considered to be negligible. No formal risk assessment has been undertaken for turtles in the rock lobster fisheries, nor is it considered necessary. However, ongoing monitoring of turtle interactions will continue to occur through the current by-catch monitoring program and potentially as part of the proposed seal monitoring program.

Dolphins and Whales

The Head of the Bight is a significant breeding and calving area for the endangered southern right whale. The Northern Zone Rock Lobster Fishery encompasses the waters of the Great Australian Bight, with fishing activity occurring during the period between November and May of each year. No fishing is permitted in the sanctuary zone of the Great Australian Bight Marine Park, established primarily for southern right whales and Australian sea-lions.

Anecdotal information exists to suggest that interactions between whales and dolphins and rock lobster pot float lines may occur on rare and infrequent occasions. On the basis that these events are extremely rare, no formal impact assessment has been undertaken, nor is it considered necessary. Due to the minimal interaction, the impact of rock lobster fishing on whale and dolphin populations in South Australian waters is considered to be negligible. However, ongoing monitoring of whale and dolphin interactions will continue to occur through the current by-catch monitoring program and potentially as part of the proposed seal monitoring program.

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

There are no threatened ecological communities currently listed in South Australian waters and there have been no specific assessments of the Rock Lobster Fishery impacts on ecological communities in South Australia. A study has been undertaken to assess the direct effects of rock lobster pots on rock lobster habitat, namely temperate shallow rocky reefs in South Australia (Casement and Svane 1999). Refer to section 2.2.3.2 of this document for a more detailed explanation of this study. The current plan of the State Government to implement a representative system of Marine Protected Areas may result in changes to the current classifications.

2.2.2.3 Management responses

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

A number of measures have been introduced to minimise rare interactions with endangered, threatened and protected species in the South Australian Rock Lobster Fisheries.

A number of methods have been trialed to minimise the number of seal interactions with rock lobster pots. These include: (1) seal exclusion devices which consist of a vertical spike situated at the base of the pot neck, designed to stop seals and large fish from entering pots; and (2) attaching the bait storage container to the side of the entrance neck of the pot to prevent seals from being able to manoeuvre their heads far enough around the inside of the pot to steal the bait. National Parks and Wildlife seal specialists endorsed the seal exclusion devices developed by South Australian rock lobster fishers during field trials. Although not regulated in South Australia, these measures are used widely by the industry. Importantly, there are significant economic incentives for rock lobster fishers to avoid seal interactions, due to the reduced lobster catch rates associated with bait loss and seal predation.

In response to community concerns associated with marine debris, the commercial industry, in partnership with the local and State Government's, has developed a plan to introduce a series of waste reception facilities along the South Australian coast in key fishing ports¹³. The facilities are aimed at reducing, and eventually eliminating, marine debris associated with rock lobster fishing. These waste disposal facilities are a component of the 'clean green' project being developed by the South Australian Rock Lobster Advisory Council, to have the fisheries formally accredited against a comprehensive set of best practice guidelines. The aim of the project is to improve the environmental management of the fishery in each zone, covering the fishing practices carried out at sea to the delivery of the product to the market.

Rock lobster pot soak time is currently not regulated in South Australia. However, it is standard practice for commercial rock lobster fishers to set and haul pots once per day. The

¹³ The first of these facilities was opened in December 2002 in Port MacDonnell in the South East of South Australia.

need to maintain bait effectiveness and fisher concerns over the known impacts on the catch associated with pot-induced octopus predation mean that this principle is generally applied by most fishers across the fleet in both fishing zones. In the quota managed Southern Zone, recent changes to general fishing patterns in response to market price fluctuations (market fishing), are having an impact on soak time which may see the need for measures to be introduced to control pot soak time. PIRSA Fisheries will continue to monitor fishing patterns in the fishery to determine whether this issue requires management measures to be introduced.

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

There are no threatened ecological communities in South Australian waters. However, commercial rock lobster fishers are not permitted to fish in a number of areas specified as marine parks (eg Great Australian Bight Marine Park Sanctuary Zone), prescribed rock lobster fishing sanctuaries (Margaret Brock Reef, Cape Jaffa, Rivoli Bay and Gleason Landing) or other established aquatic reserves.

An issue of increasing concern to South Australia is the potential threat to the integrity of marine ecosystems and biodiversity presented by introduced exotic species (eg. *Caulerpa taxifolia*). Research is currently being undertaken to determine the impact of *C. taxifolia* on native marine plants and animals, to monitor the rate of spread of known populations and to investigate the impact of eradicating the seaweed through freshening affected waterways.

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

The fishery in each zone has an inherent low level of interaction with endangered, threatened or protected species and does not have an impact on any threatened ecological communities. On this basis and on the strength of the range of measures that have been introduced to address issues such as seal interactions, it is considered that the performance of the fishery against established management objectives is acceptable and that the fishery is being conducted in a manner that avoids mortality, or injuries to, endangered, threatened or protected species. The Fisheries Act provides scope to respond swiftly to any issues that may require the protection of a species or aquatic habitat.

2.2.3 Objective 3.

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

2.2.3.1 Information requirements

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

The following ‘general ecosystem effects’ component tree (Fig. 10) has been developed using the process outlined by Fletcher *et al* (2002) to identify the range of potential wider ecosystem impacts that may be associated with rock lobster fishing across both fishing zones.

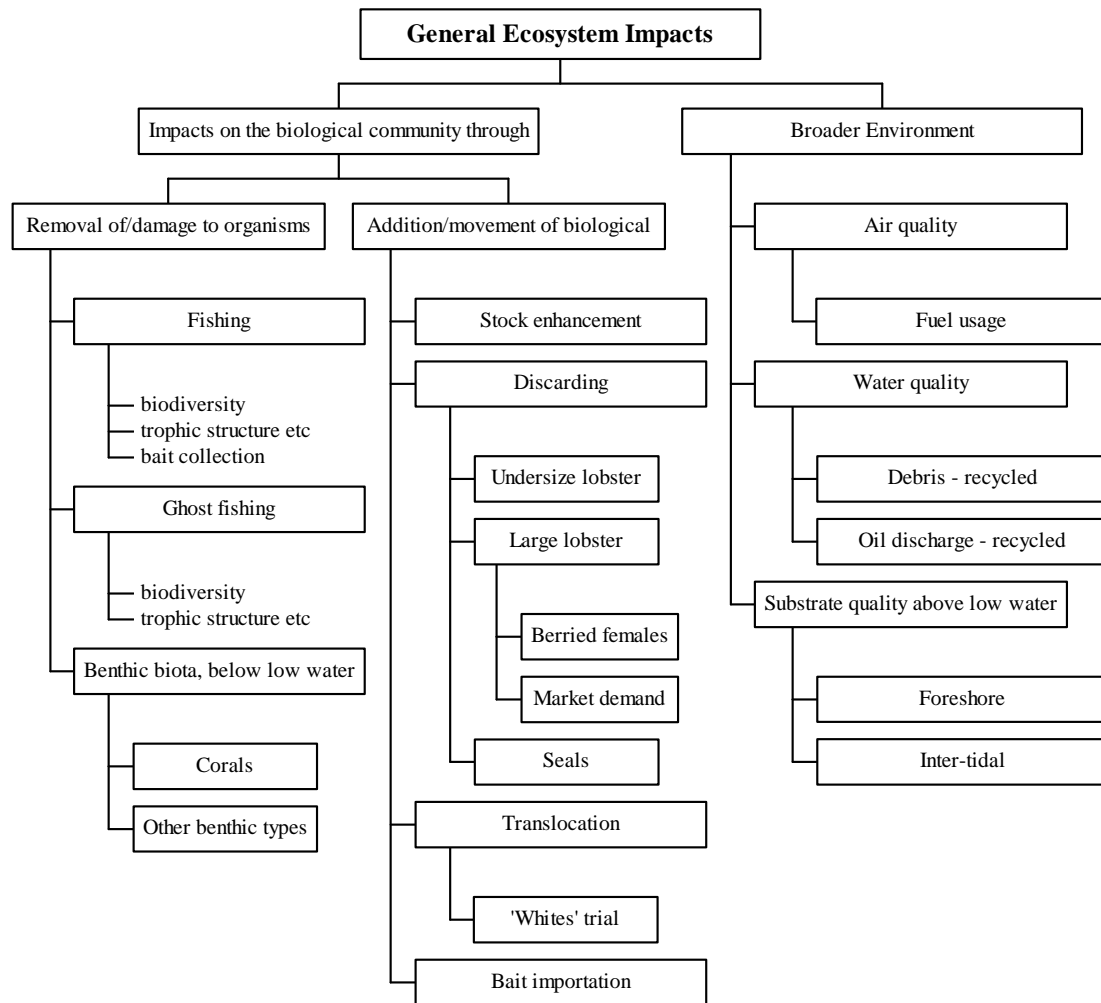


Figure 10. Component tree identifying the general ecosystem effects associated with the Northern and Southern Zone rock lobster fisheries.

No specific information on the broader ecosystem impacts of rock lobster fishing is currently regularly collected. However, as previously outlined there is a large body of information relating directly to rock lobster fishing and rock lobster population (and key by-product species such as octopus) responses to fishing in South Australia, which could be used as part of a quantitative assessment of the potential ecosystem impacts of rock lobster fishing. Such information includes annual estimates of productivity, biomass and recruitment, egg production, spatial and temporal distribution of fishing effort, etc.

There is a large body of scientific literature containing information on the biology, early life characteristics and ecological role of southern rock lobster (eg. Breen and Mann 1976; Lewis and Gleeson 1978; Copes 1978; MacDiamid 1981; Mann 1982; Lewis 1983; Miller 1985; Cole *et al* 1990; Booth 1994; Prescott *et al* 1996; Booth *et al* 1991; Ovenden *et al* 1991; Prescott and Lewis 1992; Edgar and Barrett 1997; McGarvey *et al* 1997a; Booth *et al* 1999; Bruce *et al* 1999; McGarvey *et al* 1999a; Phillips *et al* 2000; Mayfield and Branch 2000; Musgrove 2000; McGarvey and Matthews 2001).

An FRDC project proposal has been developed to investigate the ecosystem effects of rock lobster and abalone fishing on temperate rocky reefs in South Australia, in response to the

emerging need for improved understanding of the broader ecosystem impacts of fishing. The proposed study is intended to assist the process of developing a representative system of Marine Protected Areas (MPAs) for South Australia and improve the scope for fisheries managers to integrate broader ecosystem requirements into fisheries management regimes. While there is considered to be an inherently low ecological impact associated with rock lobster fishing, the proposed study will provide scope for the fishery to formally assess the extent to which the objective of 'minimising the impact of fishing operations on the ecosystem generally' is being met.

Additional research and information collection in this area may also flow from the South Australian Government's plan to introduce a representative system of MPAs. As previously discussed, there are a number of lobster fishing sanctuaries distributed throughout South Australia and across both fishing zones that were introduced many years ago. These areas provide ideal opportunities for research into the broader ecosystem effects associated with rock lobster fishing as well as other forms of marine use.

2.2.3.2 Assessment

- *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:*

1. Impacts on ecological communities

- *Benthic communities*
- *Ecologically related, associated or dependent species*
- *Water column communities*

2. Impacts on food chains

- *Structure*
- *Productivity/flows*

3. Impacts on the physical environment

- *Physical habitat*
- *Water quality*

There has been no formal risk assessment of the ecosystem components listed above. Data that currently exists on these ecosystem components (eg. Casement and Svane 1999) and that which is intended to be collected through targeted research programs (proposed FRDC project on the ecosystem impacts of lobster and abalone fishing) will facilitate a formal ecological risk assessment for the fishery in the future. The information presented in Figure 10 uses the approach suggested by Fletcher *et al* (2002) to provide an outline of the potential ecosystem impacts associated with the rock lobster fishing in each zone.

Impacts on Ecological Communities

The research proposal (previously outlined) to investigate the ecological impacts of rock lobster and abalone fishing is intended to provide better information for managers to address issues regarding the potential wider ecosystem impacts of rock lobster fishing, through the development of a performance assessment system.

Impacts on Food Chains

There are no known predators that rely solely on southern rock lobster as their only prey species. Similarly, southern rock lobster prey on a large number of algae, finfish, molluscs and crustaceans. The maintenance of sustainable rock lobster biomass levels across both fishing zones in South Australia is considered to minimise the risk of disturbance to wider food chain interactions. The study referred to above may also provide information to assess the impact of rock lobster fishing on food chains. A study undertaken by Brock, Prescott and Ward (2002) found that rock lobster fishing has had no measurable impact on octopus populations (a key predator species for rock lobster) in South Australia, over nearly a twenty year period.

Impacts on the Physical Environment

Physical Habitat

As previously discussed, a study by Casement and Svane (1999) assessed the direct impacts on the physical environment, namely shallow sub tidal reef biota, caused by the deployment and retrieval of rock lobster pots (light beehive design, heavy beehive design and square pot). The results of this study showed that rock lobster pot fishing in South Australia had minimal physical impacts on shallow temperate rocky reefs.

Water Quality

The impacts of rock lobster fishing on water quality are considered to be low due to the small number of vessels operating across South Australian waters, relative to the geographic expanse of the fishing grounds and the range of industry measures being developed to improve waste disposal and address potential localised impacts. The development of the previously discussed 'clean green' industry initiative is aimed at reducing the environmental impacts associated with rock lobster fishing by improving the environmental performance of both fishing zones through improved industry practices.

The clean green initiative aims to establish a comprehensive set of standards to address target and non-target species sustainability, ecological interactions, environmental impacts, food safety and product quality, which will be regularly audited by an independent accreditation body established by the joint Australian/New Zealand standards organisation, JAS-ANZ. The establishment of a series of waste reception facilities for oil, plastics and cardboard commenced in December 2002.

2.2.3.3 Management responses

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

The management arrangements for each zone are aimed at controlling the total catch of lobster, either directly through quota restrictions or indirectly through effort restrictions, to ensure ecologically sustainable rock lobster population levels are maintained. These management arrangements, along with a range of other complementary management measures (refer to section 1.3), including gear specification restrictions, are considered to ensure the long term sustainability of rock lobster populations and minimise the overall impact on the ecosystem. A 40kg restriction on the maximum weight of pots was introduced to minimise the impact of pots on reef structures.

The range of initiatives being developed as part of the industry clean green program will aim to further reduce the overall environmental impact of rock lobster fishing in South Australia. PIRSA Fisheries continues to work in partnership with the rock lobster industry, other State Government natural resource management agencies and the wider community in the planning of marine protected areas and in researching and monitoring interactions between rock lobster fishing and other marine species.

- *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.*

The inherent low impact of rock lobster fishing on the broader ecosystem has meant that research projects aimed at the development of specific ecosystem indicators have been assigned lower priorities, relative to other rock lobster sustainability research needs. This said, the research proposal previously outlined, aimed at developing a performance assessment system to monitor the ecosystem impacts associated with rock lobster fishing, will aid the development of system-based indicators.

A recent independent review of strategic research priorities for the South Australian Northern Zone Rock Lobster Fishery (McKoy, Seebohm and Breen 2002) supported the approach outlined above. The existing strategic five year research and monitoring plan for both fishing zones will be updated during 2003 as part of the Management Plan review for each fishery. Ecosystem-based research will be assigned a higher priority during this review process.

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

While a formal ecological risk assessment has not been undertaken for the South Australian Rock Lobster Fisheries, the impacts on the ecosystem associated with rock lobster fishing are considered to be acceptable and inherently low, as previously discussed. This is evidenced by the maintenance of long term sustainable catches being produced by the ecosystem over the greater than 60 year period during which commercial fishing has occurred.

On this basis, the fishery is considered to be conducted in a manner that inherently minimises the impact of fishing operations on the ecosystem generally. The proposed research program aimed at quantifying the ecosystem impacts associated with rock lobster and abalone fishing in South Australia will provide scope to formally assess the extent to which this objective is being achieved.

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