
**Review and update of the Strategic
Research and Monitoring Plan for the
South Australian Northern Zone rock
lobster fishery**

**NIWA Client Report: AUS2002-002
August 2002**

NIWA Project: NAURLR02015

Review and update of the Strategic Research and Monitoring Plan for the South Australian Northern Zone rock lobster fishery

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Prepared for

Primary Industries South Australia

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Executive Summary

This is a report written for Primary Industries South Australia by John McKoy and Paul Breen of NIWA and Kym Seebohm of NIWA Australia.

In this report we examine progress made against the previous strategic research plan for the Northern Zone rock lobster fishery. Reasonably good progress was made, and most of the recommended items outstanding were either low priority or have become low priority. Technique development was not pursued as actively as necessary, leaving a gap in assessment capability at a critical time.

We evaluate the plan and current management against the Guidelines for Ecologically Sustainable Fisheries from Environment Australia. There are two main deficiencies: management actions and bottom lines are not spelled out for times of low biomass, and the fishery is weak, in documentation rather than in practice, with respect to bycatch and ecosystem issues. Specific recommendations are made to remedy this.

We discuss research and data priorities for the short and medium term, with specific program recommendations and estimated timings. Monitoring should continue as before, with enhanced capture of bycatch data. More routine analyses should be made of the monitoring data. The new length-based model must be completed urgently, and a catch forecasting model should be developed. Technique development should be considered a routine part of the assessment each year. Design and evaluation of decision rule management, or “management procedures”, should be done in 2003.

1. Introduction

This is a report written for Primary Industries South Australia by John McKoy and Paul Breen of NIWA and Kym Seebohm of NIWA Australia.

In this report we examine progress made against the previous strategic research plan for the Northern Zone rock lobster fishery, and we evaluate that plan and current management against the Guidelines for Ecologically Sustainable Fisheries from Environment Australia. We discuss research and data priorities for the short and medium term, with specific program recommendations and estimated timings.

2. Terms of Reference and Review Structure

The following terms of reference from the tender document are the basis for this report on this phase of the contract:

- 1) *Update Strategic Research and Monitoring Plan for 2002-2007.*
- 2) *Update the strategic research and monitoring program for 2002-2007 that includes recommendations on the scope, timings, priorities and resources required to undertake rock lobster sustainability research and monitoring.*
- 3) *As appropriate, provide advice on research and monitoring requirements for non-target species, including environmental issues.*

Provide advice on data requirements for target and non-target species.

Special considerations include:

- *Review progress against previous plan (Breen 1996);*
- *Undertake consultation via telephone and/or written questionnaire with managers, SARDI and industry;*
- *Update previous Strategic Research Plan in light of current working environment (EA sustainability guidelines), new information and circumstances;*
- *Present a written report to the review sub-committee.*

We have taken the “*previous plan (Breen 1996)*” to be the summary presented in Working Papers #3 and 4 of Breen (1996), which included recommendations and priorities for both “*monitoring*” and “*research*” activities. We have taken the “*previous*

Strategic Research Plan” to be Appendix II of Zacharin (1997) entitled “Five year strategic research plan for the South Australian Northern Zone rock lobster fishery”.

The Management Plan for the South Australian Northern Zone Rock Lobster Fishery (Zacharin 1997) was prepared by the Northern Zone Rock Lobster Fishery Management Committee in association with PIRSA as a requirement of the *Fisheries Act 1982* and the *Scheme of Management (Rock Lobster Fisheries) Regulations 1991*. The Plan covered the period 1997-2002 and provides a description of the fishery, compliance and enforcement requirements, fishery management objectives and strategies, reference points and performance indicators, and requirements for the review of the Plan. A five-year strategic research plan, developed by the Rock Lobster Research Sub-Committee, was attached to the Plan. It makes reference to core research requirements, as identified by Breen (1996), and focuses on annual stock assessments and the delivery of key performance indicators, namely catch rate, exploitation rate, total egg production, abundance of pre-recruits and mean size of rock lobster. Several other discrete research projects were outlined and a research activity plan for the 1997-2002 period was provided.

3. Progress against the Previous Plan

Breen (1996) listed the priorities he saw for research in his Working Paper 3. He listed only what he saw as high and medium-term priority projects. In Table 1, we list these and comment on progress made against them.

Table 1. Recommended activities in the Breen (1996) report, with their priorities and comments.

Monitoring data	Priority	Comments
catch and effort	auto	Done well, more analysis should be made
database development	auto	Done, database needs documentation and error-checking work
fishing power	high	Some data were collected but not analysed
pot catch data	high	Done well, more analysis should be made
length frequencies	high	Done well, more analysis should be made
temperature data	high	Some data were collected but not analysed
larval settlement data	high	Data were collected, some analysis but more could be done
Date for per-recruit analyses		
finish growth rate estimates	high	Well done
moult staging	medium	Completed and published
length-fecundity	medium	Not done
handling mortality	medium	Not done
size-selectivity	medium	Not done

Monitoring data	Priority	Comments
YPR database	medium	
write-up of Population Dynamics	high	Well done
Data for production analyses		
recreational catch	medium	Estimate produced
illegal catch	high	Compliance estimates negligible
Detailed spatial modelling		
writing up	high	Done
adaptive management feasibility	medium	FRDC proposals made but not prosecuted
adaptive management experiment	medium	
Assessment work		
upgrading per-recruit analyses	auto	Done
upgrading surplus-production analyses	auto	Southern Zone priority only
examine age-structured production model	high	Done
refining model, etc.	auto	Partly done
assessment process	auto	Partly done
technique development	high	qR model; some new work not seen
non-specific assessment work	high	Done

3.1 Monitoring the fishery

The Breen report saw catch as the most important monitoring index, and it has been monitored well. McGarvey *et al.* (1998) refer to “some miss reported catches” (sic); this is not discussed further, but in any case errors in catch data are hard to correct.

The Breen report saw CPUE as the next most important index, and suggested appropriate standardisation of the index to remove “variability caused by consistent trends among areas, months, lunar cycle, temperature and even fisher skills.” This was done in some of the assessments, but not in the assessment presented in 2002. Given that there are at least some problems in the logbook data, there should be some consideration and documentation of error handling procedures for the CPUE standardisation. In New Zealand this takes up a substantial part of the standardisation work.

The Breen report stated “Recent technological changes have caused big changes in fishing power. This needs to be documented, either continuously or at regular short intervals, so that annual increases in fishing power can be estimated and the CPUE indices corrected. This is planned as part of collecting compulsory catch and effort data.” It is not clear what was done under this heading. No regular collection of technological data appears to have been made. However, some data were collected (Prescott 2001b) but have not been described or used in the assessment.

The Breen report listed voluntary catch sampling as the next priority for monitoring - the detailed pot-catch data and length frequencies that could be used to give indices of

standardised CPUE, pre-recruit abundance, mature female abundance, etc. These data have been collected well through the present, but have not been analysed fully. Although standardised pre-recruit indices were made from these data by Prescott & Xiao (2001) and earlier assessments, the latest assessments did not present or use these indices. Standardised CPUE from the voluntary program was not worked up or used. The amount of data available is much smaller than in the compulsory logbook program, but is independent, and should be examined in the same way that pre-recruit indices are examined.

Length frequencies have not been regularly presented in recent assessments, and in the most recent publication (Prescott 2001a) were shown simply as the sum of numbers-at-size for all areas combined. Both the population length structure and the sampling intensity may vary among areas (and depths and months), so the overall length frequency for the Northern Zone in a year should be taken as weighted frequencies, where weighting is done by the catch taken in an area, in an area by month cell, or even in an area by month by area by depth cell.

We have seen no analysis of the length frequency data.

Temperature data have been collected in the voluntary catch sampling program but have not been worked up or used in the assessment. These are potentially valuable for understanding environmental influences on the fishery, because they are bottom temperatures unavailable from satellite monitoring.

About larval (puerulus) settlement, the Breen report said “The value of this index is unproven for this species. However, all states plus New Zealand are using the index, early results in New Zealand are promising, and a considerable (15 years or so) time series is necessary before making a decision.” Data are still collected in the SZ and a pilot study was begun in the NZ; some results were summarized by McGarvey *et al.* (1998). No recent analysis has been published, although preliminary work provided to us in the course of the review looked promising.

3.2 Yield, egg- and dollar-per-recruit analyses

The Breen report saw this work as the next highest priority. With better assessment tools available, the importance of this kind of work has diminished since 1996.

Yield-per-recruit analyses were upgraded and published by Prescott *et al.* (1997). Egg-per-recruit analyses were also upgraded (e.g. Prescott & Xiao 2001).

Moult staging work was completed and reported by Musgrove (1999). Lesser priority suggestions dealt with fecundity, handling mortality, trap size-selectivity, and economic information. These were apparently not done, but were always of lesser priority.

3.3 Production analysis

The Breen report suggested that “Production analysis should be made as part of the state-of-the-stocks assessment. This could be conducted with a simple model or an age- or size-structured simulation model.” The qR model (McGarvey & Matthews 2001) fulfilled this part of the plan. Suggested surplus-production modelling was a priority only for the SZ, and was overtaken by the qR model in any case.

A medium priority was to estimate recreational catches for use in the model. Early estimates are available in Zacharin (1997). An estimate of 67 t in 1998 was provided by McGlennon (1999) and discussed by Prescott & Xiao (2001), but has not been used in the assessment. Only about 40% of this (27 t) was from the NZ. Prescott & Xiao (2001) report only two commercial and 21 recreational infringements in the NZ, from 332 checks made by Compliance officers, and conclude that illegal catches are small.

The Breen report suggested that “Estimating exploitation rates should be a high priority.” The best way to do this was with a model, and the qR model has exploitation rate as a primary output. Another priority filled by the qR model was technique development, which the Breen report suggested should be ongoing. The recent work by Xiao is also an example of this. However, the assessment presented in 2002 presented only preliminary results from the new model, while the qR model assessment was not state-of-the-art (see Breen & McKoy 2002). Thus technique development did not keep up, and the 2002 assessment was less informative than it might have been.

3.4 Simulations from the Walters/McGarvey model

The Breen report thought that “if the model's potential is to be fully realised, some programming and other work will be required after June 1996.” This programming was done in association with the University of South Australia (McGarvey and Gaertner 1997; Walters *et al.* 1998), and for a time the model could be downloaded from the web.

3.5 Adaptive management experiments

The Breen report suggested that “If the model is accepted as a major assessment tool, and if the feasibility study is positive, these experiments will be an important part of the research in the medium term.” Proposals were made to FRDC, but there were apparently no adaptive management experiments.

3.6 Catch forecasting

The Breen report said: “This assessment idea refers to forecasting short-term changes in catch caused by changes in recruitment and the environment. It will require catch

and effort data, annual biomass estimates, annual pre-recruit estimates, time series of larval settlement, and some knowledge of environmental impacts on recruitment. ... In the medium term, a model for catch forecasting should be developed.” Most of the required inputs are available, but this idea was not pursued.

3.7 Stock-recruitment relations

In 1996, the situation was: “As the Strategic Plan suggests, this should be seen as an extremely long term objective only. The required long time series of breeding stock and larval settlement indices have been started.” This remains the case.

3.8 Finishing the Population Dynamics program

The Breen report thought some work was required for a while after the program ended, such as processing new tag returns. Growth rate data arising from the 1993-96 tagging program were analysed and reported by McGarvey *et al.* (1999). Data were limited in some areas, especially the west coast of the Northern Zone.

The report recommended publication of the results of the Population Dynamics program: major results were published as Prescott *et al.* (1997), and the model was described generally by Walters *et al.* (1998).

3.9 Non-specific assessment work

This topic was to make provision for stock assessment work that was required on specific topics by the Management Committees, such as evaluation of a maximum legal size regulation for one area. There appears to have been much of this work, as predicted.

3.10 Assessments

The Breen report suggested that “Stock assessment should be a formal and annual process, with adequate time to plan for and conduct the assessment. It should respond to a clearly identified mandate from managers. Results should be documented after being subjected to form some form of peer review.”

Much progress was made towards this in the 1996-2001 period. Assessments were annual and mostly documented through 2000; they responded to the mandate from the Northern Zone Management Plan until the 2000 and 2001 assessments. They do not seem to have been peer reviewed outside SARDI. For complete comments on the assessment see Report 1 from this project.

3.11 Summary

Much work was done after the 1996 report. Data collection for this fishery appears to be in very good shape: the fishery is very well monitored and a variety of non-fishery data is collected.

Priorities shifted during the last 6 years in any case. The Walters/McGarvey model is probably no longer a priority. Simple procedures such as YPR, EPR and surplus-production analysis have been overtaken by much more powerful tools in fisheries practice worldwide. The items not done were generally low or lower priority than the high-priority items, such as the fecundity-at-length work, handling mortality, etc. Catch forecasting is an exception, and there are abundant data from the NZ with which to begin this project.

More work is required in association with several of the items discussed above; this will be identified and discussed in the next section.

The notable deficiency was in technique development. The Breen report said “Work is required to develop the appropriate techniques from the data available. The requirement for technique development should be seen as ongoing: South Australia now has some of the best data of any lobster fishery, and existing techniques may be inadequate for full analyses.” The work done developing and sensitivity testing the qR model was laudable, but at some point it stopped and was not replaced. New work is developing an integrated model, but is embryonic - only preliminary results were available in 2002. At a critical time in the history of the NZ fishery, current assessment technology had not been developed to provide badly needed information about the state of the stock.

During research for the review we heard some discussion of funding for “model development” vs routine assessments. These should not be seen as separate processes: models should evolve constantly from year to year as an integral part of the assessment process. The 1996 report identified technique development as ongoing with funding from the IMC (Fishery Management Committee) as part of the assessment process. The major conclusion to be drawn from this section is that such continuing work must be supported explicitly.

4. Northern Zone Rock Lobster Fishery And Environment Australia Guidelines

4.1 Overview

Environment Australia (EA) has prepared Guidelines for the *Ecologically Sustainable Management of Fisheries* which support newly amended requirements under the *Wildlife Protection (Regulation of Exports and Imports) Act 1982*. In essence, the EA

Guidelines have been developed to satisfy the Commonwealth Government's desire for a demonstrably ecologically sustainable fishery. They do not necessarily require the preparation of a formal statutory fishery management plan, but can comprise non-statutory management arrangements or management policies and programs. The Guidelines do, however, stipulate that a fishery management regime should have the following attributes:

- be documented and publicly available;
- be developed through a consultative process involving all stakeholders and the general public;
- ensure that a range of expertise is utilised in fishery management committees and in stock assessments;
- be strategic, containing objectives and measurable performance criteria;
- provide for the periodic review of the performance of the management arrangements;
- be able to control the level of harvest using input and/or output controls;
- contain means of enforcing critical management arrangements;
- be able to assess, monitor and avoid, remedy or mitigate any adverse impacts on the fishery and wider marine environment in which the species resides;
- require compliance with relevant threat abatement plans, recovery plans and the National policy on Fisheries Bycatch; and
- comply with relevant international or regional conventions and management regimes to which Australia is a signatory.

The Guidelines are summarised in Table 2.

According to the Director, Sustainable Fisheries Section, EA, the most topical area of the Guidelines across fisheries sectors is bycatch and how this is to be mitigated and sustainably managed (Flanigan, pers.comm.).

The Commonwealth Government has developed a national bycatch policy. The core objectives of the policy are to reduce bycatch, to improve protection for vulnerable or

threatened species, and to minimise adverse effects of fishing on the aquatic environment. The policy has an overarching objective to ensure that bycatch species populations are maintained at sustainable levels. Of relevance to South Australia, the policy makes reference to research into the impact of fishing gear (such as rock lobster pots) on habitat (i.e. sponges, bryozoans) to assess and quantify impacts.

Table 2 A summary of the EA Guidelines for the Ecologically Sustainable Management of Fisheries

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.	
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.
<i>Information Requirements, Assessment and Management Responses</i>	Reliable information system; mix of fishery independent and dependent research and monitoring; robust stock assessment including dynamics and status; established stock distribution and spatial structure; reliable estimates of stock removals (commercial, recreational and indigenous); sound estimate of potential productivity of stock and proportion able to be harvested; inclusion of reference points (target and/or limit) that trigger management actions (including a biological bottom line); strategies controlling take level; practices that do not threaten by-product species.
Objective 2	Where the fished stock(s) are below a defined reference point, fishery to be managed to promote recovery to ecologically viable levels within nominated timeframe.
<i>Information Requirements, Assessment and Management Responses</i>	Precautionary timed recovery strategy linked to reference points and stock biology; zero-targeted catch, temporary fishery closures, quota reduction for at risk stock (i.e. below biological and/or effort bottom line).
PRINCIPLE 2: Fishing operations should be managed to minimise their impact on the structure, productivity, function and biological diversity of the ecosystem.	
Objective 1	The fishery is conducted in a manner that does not threaten bycatch species.
<i>Information Requirements, Assessment and Management Responses</i>	Reliable information on bycatch composition and abundance; risk analysis as to vulnerability; measures to avoid capture/mortality of bycatch if unsustainable; monitoring bycatch indicator group; trigger management measures when perturbations to number of indicator species.
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.
<i>Information Requirements, Assessment and Management Responses</i>	Reliable information on interactions with endangered, threatened or protected species and ecological communities; impact assessment of fishery on species and communities; measures to avoid capture/mortality of species and communities.
Objective 3	The fishery is conducted in a manner that minimises the impact of fishing operations on the ecosystem generally.
<i>Information Requirements, Assessment and Management Responses</i>	Appropriate information available; risk analysis (appropriate to size of fishery) into susceptibility of ecosystem components to fishery – impacts on ecological community, food chains, physical environment; measures to protect ecosystem; trigger management responses when monitoring ecosystem indicators reach a certain level (precautionary approach).

5. Strategic Research and Monitoring Plan and the EA Guidelines

This section compares research and assessment requirements identified in Breen (1996) and Zacharin (1997) and with the requirements of the EA Guidelines.

A summary of the research priorities recommended by Breen (1996) is shown in Table 3 below. In addition, general recommendations were made to enhance stock assessment and research planning and review procedures.

Table 3. Summary of Breen (1996) research and monitoring recommendations.

Research Requirements	Priority			
	Auto	High	Medium	Low
Commercial catch and effort data	x			
CPUE estimates	x			
Pot catch data (egg pre-recruitment abundance)	x			
Length frequencies	x			
Upgrading YPR EPR analyses	x			
Upgrading surplus-production analyses	x			
Refining the Walters/McGarvey model	x			
Estimating fishing power for refining CPUE estimates		x		
Obtaining temperature data time series for refining CPUE		x		
Obtaining larval settlement time series for monitoring		x		
Writing up Population Dynamics and model results		x		
Obtaining illegal catch estimates for production modelling		x		
Exploring age or size-structured production models		x		
Exploring feasibility of an adaptive management experiment		x		
Testing and development work to choose best analytical techniques		x		
Non-specific assessment work as required by managers		x		
Specific data collection for YPR and EPR analysis			x	
Estimating recreational catch for production analysis			x	
Adaptive management experiment			x	
Estimating natural mortality rate				x
Research surveys (fishery independent data)				x
Juvenile studies				x
Tagging to measure exploitation rate				x
Condition index studies (variation in growth and its causes)				x
Oceanic larval studies				x
Market sampling (measuring lobsters landed)				x
Ageing (validation method)				x
Escape gaps and ghost fishing				x
Habitat enhancement and artificial habitats				x

Breen's (1996) suggestions did not focus specifically on South Australia's Northern Zone fishery, however, he did discuss differences between the Northern and Southern Zones. The recommended core priority research directions were for the period 1996-1998 and focused on fishery monitoring, collection and analysis of biological data, and modelling approaches. More recent research and monitoring activities relating to the Northern Zone fishery have been reported in McGarvey *et al.* (1998), Prescott *et al.* (1999), Prescott and Xiao (2001) and Prescott (2001a). This research was undertaken in the context of the *Management Plan for the South Australian Northern*

Zone Rock Lobster Fishery. That Plan included, as an appendix, a five-year strategic research plan for 1997-2002.

We have generally assessed the research priorities in Breen (1996) and Zacharin (1997) against the specific Principles and Objectives of the EA Guidelines (Table 2). Many of the guidelines are not specific, particularly where they use words such as “acceptable”, and the extent to which they are met by the processes and activities can be unclear. Areas are outlined below where priority research and monitoring recommendations have not been identified, or have been considered a low priority, and consequently may not meet the Guidelines.

In doing this part of the report we examined a Western Australian Policy for implementing Ecologically Sustainable Development principles in fisheries (Fletcher 2002).

5.1 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.

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

Information requirements

- The current information collection and monitoring arrangements appear generally to meet the guideline. The compulsory logbooks and the voluntary catch sampling both appear to be reliable as inputs to assessment, especially when indices are standardised with other variables such as area, depth, month and fisher.
- There is some mix of fishery-dependent and fishery-independent data, for instance the larval settlement data are fishery-independent, but most data are fishery-dependent, because these data are voluminous, inexpensive and reliable. Fishery-independent data would be very expensive to collect and would be subject to some of same bias to which the fishery data are subject (systematic changes in catchability of lobsters, non-random location of fishing gear, etc.).

Assessment

- The recent assessments (not the 2002 assessment) are reviewed by Breen & McKoy (2002). The guideline is generally met, but assessments should be improved. There is no process in place to “identify any reduction in biological diversity” but this may be a minor issue in this target fishery.
- The distribution and spatial structure of the stock is pretty well established, except that stock-recruit relations with other areas are mostly unknown (as is the case for many spiny lobster fisheries worldwide). Relations between stocks and the recruitment processes are not well known.
- There are reliable estimates of removals by the commercial fishery. Recreational, indigenous and illegal catches are less well documented, but existing information suggests they are small compared with commercial removals. Non-commercial removal estimates should be used in stock assessments.
- The level of potential productivity of this stock is probably understood within broad limits.

Management responses

- The existing management plan incorporates reference points (not quite as well defined as they could be) that trigger action on the part of the Management Committee but do not trigger specifically defined action. Biological bottom line is undefined. The strategy controlling the catch level is undefined. (See below for suggestions).
- In this fishery, bycatch is small relative to the target species and probably does not threaten the species involved (but see below).

Objective 2

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

- It is clear when the stock is below the defined reference levels. Because there is no catch strategy, it is not clear how managers should respond in this situation. In 2002, *ad hoc* management action was taken with no analysis of its likely effect. (See below for suggestions.)
- Assessments do not routinely provide forward projections of biomass under alternative catch levels.

- Notwithstanding, it is clear from the history that managers can respond effectively to reduce catches when necessary, by reducing the season length or increasing the closed seasons, reducing the pot holdings or buying licences.

5.2 Principle 2

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

Objective 1

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

Information Requirements

- Reliable information on the composition of main bycatch is collected through the voluntary catch sampling system, except that Prescott & Xiao (2001) suggest this system was not well designed for non-fish bycatch. The Octopus bycatch is also recorded through the compulsory system.
- Catch rates are low for all but a few species that include Octopus, leatherjackets and wrasses. Roughly 300 000 fish are estimated killed each year (Prescott & Xiao 2001) in the NZ. These authors point out that the Octopus bycatch is valuable and that Octopus are a significant predator of lobsters in pots.

Assessments

- No specific risk analyses have been conducted with respect to vulnerability of bycatch species to fishing. Information collected on Octopus extends over many years and should enable general trends in their abundance to be evaluated.
- The giant crab *Pseudocarcinus gigas* is a bycatch species of major importance, but forms a partially overlapping fishery: lobster fishers can obtain an endorsement to land crabs, and some crab targeting occurs. Thus assessment of this species should occur under the Guidelines directly rather than as a bycatch problem.
- No formal monitoring of indicators is currently conducted.

Management responses

- Measures to avoid bycatch have not been explored, except that excluders are used to prevent the entry of juvenile Australian sea lions (*Neophoca cinerea*) (Prescott & Xiao 2001). The fishery is already highly targeted on rock lobsters, with escape gaps increasingly in use to prevent capture of sub-legal sized lobsters.
- The current management plan has no defined management measures in response to bycatch trends.

Objective 2

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

Information Requirements

- Interactions between the lobster fishery and Australian sea lions are recorded on the voluntary catch sampling forms (Prescott & Xiao 2001). There is a potential for juveniles to become entrapped in the pots, but excluders are used to prevent this.
- Interactions between lobster fishing and shallow algal communities appears to be minimal (Casement & Svane 1999).
- More potential exists for interaction with deeper-water communities, but Prescott & Xiao (2001) estimate that NZ pots contact 0.0003% of the habitat in a typical season. No formal impact has been done.

Assessments

- There are no assessments relevant to this objective in the Northern Zone rock lobster fishery.

Objective 3

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

Information requirements

- Information is sparse with respect to the potential for ecosystem interactions. The nature of lobster potting is generally “clean”: bycatch is small compared with the target species, lobster populations are managed so that populations remain abundant (minimising trophic effects), and physical effects on the bottom are probably small because of the small footprint of a pot. Information has been collected and evaluated in nearby and similar fisheries in shallow water which suggests no measurable impact on algal communities (Casement and Svane 1999).

Assessments

- No risk assessment has been reported.

Management responses

- The current management plan does not define indicators or prescribe action with respect to ecosystem effects.

5.3 Summary

The current Northern Zone fishery management plan (Zacharin 1997) and the associated strategic research plan comply with most aspects of the EA Guidelines.

Compliance with Principle 1 would be improved if non-commercial catch estimates were used in the assessment, and especially if the “management procedure” were defined (see below).

Compliance with Principle 2 may be less important for the lobster fishery than for other types of fisheries, especially trawling, because of the targeted nature, limited bycatch and small impacts of potting. Notwithstanding this, the fishery is vulnerable to strict interpretation of the Guidelines, because no analyses have been made of bycatch species, and information about the effects on deepwater communities is sparse. Under the precautionary principle, lack of scientific evidence is not a reason to postpone protective measures, so a healthy strategy for the fishery would be to collect the information that can be collected.

It would be prudent to conduct analyses on the existing bycatch data, especially for *Octopus*, to expand the monitoring effort on bycatch species, and conduct basic studies on the effect of potting on deepwater rocky habitat. The only known endangered species interaction is with Australian sea lions, so interactions with this species should be fully documented.

6. Research and Monitoring Requirements for Non-Target Species

The most important non-target species in this fishery are *Octopus*, giant crab (*Pseudocarcinus gigas*) and two kinds of fishes. The available information on the fishery interaction with these species is summarized in McGarvey *et al.* (1998), Prescott *et al.* (1999) and Prescott and Xiao 2001. The fisheries biology of giant crab in Southern Australia is discussed in Levings *et al.* (1996). Data have been collected on catches of these species in the voluntary catch- sampling program.

Given the relatively small numbers caught in relation to the likely populations (particularly for the fish species) more directed research on the population dynamics

of these species and the effects of rock lobster fishing on them would probably be a low priority. However, because the Guidelines might be interpreted strictly at some stage, the bycatch should be characterised. Improvement of the forms should be considered to ensure that bycatch is recorded as fully as is necessary. Interactions with sea lions should be documented and analysed. A limited program of identification, measuring and possibly ageing of bycatch fishes (from specimens brought in by fishers) should be considered as a benchmark study.

After the initial phase of this study, the sampling intensity of bycatch in the cells of interest should be evaluated and augmented if necessary by a small, focussed observer program.

7. Recommendations for strategic Research and Monitoring, 2002-2007.

We discuss our recommendations, summarised in Table 4, under five broad headings:

- collecting data (Monitoring),
- processing the monitoring data,
- developing assessment capability by finishing development of the integrated length-based model, developing a catch forecasting model, and then continuing refinement and development,
- conducting assessments, and
- addressing the concerns of the EA Guidelines (Ecosystem Effects).

We can make only rough estimates of the resources required to do the projects we recommend be done. Much of the projected work is a continuation of past work, thus SARDI and SARLRC are far better placed to estimate the requirements. Uncertainty of priorities with respect to the EA Guidelines must be noted. Where finite new work is recommended, i.e. one-year programs, further work may be necessary depending on the results.

Finally, five years is a long time to plan this kind of work, given the rapidity of changes in assessment methodology worldwide and the constantly shifting regulatory environment. Our suggestions are best viewed as realistic for the next two years only.

7.1 Monitoring

Catch: should continue to be collected through the logbook scheme for commercial catch. Catch in numbers as well as weight has proven valuable in the past. Non-commercial estimates should be obtained (they are listed in the EA Guidelines) -

recreational surveys should be worked up, indigenous catches should be estimated and Compliance should be asked to provide actual illegal estimates.

Catch rate is the single most important indicator from the fishery. Effort should continue to be collected through the logbook scheme along with variables required in standardisation. The spatial scales at which data are collected should be examined.

Pre-recruits recorded on the logbook scheme provide a valuable index, and they should continue to be collected.

Information collected in the voluntary catch sampling scheme is essential to good assessment of this fishery. This includes length frequencies, for use in the length-based model, pre-recruits, providing an independent estimate of pre-recruit strength, and bycatch species and weights, which will become increasingly important under the EA Guidelines. Some direct involvement by biologists is probably required for training and quality control.

Larval settlement rates collected independently of the commercial fishery may have limited utility until a sufficiently long time series is established, but should be continued until the program can be evaluated.

Temperature data collected by the fishery may be valuable, depending on the existing coverage and on what alternative sources of bottom water temperature data exist.

The database is relatively new, is undocumented, and contains unchecked data (McGarvey *et al.* 1998). Some new work should be done to correct these shortcomings.

Technological changes leading to possible change in fishing power should be surveyed every few years.

7.2 Data processing

For use in assessments, the CPUE data must usually be standardised unless standardisation is also integrated, as Maunder (2001) suggests. This will involve four series: pre-recruits and legal fish from each of the compulsory and voluntary schemes. Length frequencies will need to be weighted by the catch taken from each cell used in the model, which could be as fine as area/month/depth.

7.3 Developing assessment capability

This will involve, first, completing the development of a suitably integrated model, as recommended by Breen & McKoy (2002), and second, maintaining state-of-the-art capability through continual revision of the model.

No output from the developing model has been reviewed. Breen and McKoy (2002) suggest that the ideal model should:

- have a fine spatial scale (area),
- have a fine temporal scale (one month),
- use most of the data (catch, CPUE from both sources, pre-recruit indices from both sources, length frequencies and the tag-recapture data),
- incorporate important aspects of the fishery and biology (e.g., size-specific selectivity), and
- present realistic uncertainty estimates, perhaps through Bayesian inference.

Catch forecasting should also be explored. The NZ data include an apparently robust series of pre-recruit indices, some larval settlement data, trends in mean weight. McGarvey & Matthews (2001) suggest a correlation between recruitment and climatic conditions. These relations should be explored further with a model.

7.4 Assessment

For specific recommendation see Breen & McKoy (2002). An assessment should be conducted in 2003, when the new model is operational, and at such intervals may be required by the Fishery Management Committee. (Assessments need not be annual if the management procedures approach is adopted; see below). Such assessment should be peer-reviewed from outside.

There is a continuing need for ad hoc projects to be conducted as required to support the Fishery Management Committee's needs.

7.5 Investigate and evaluate management procedures

A management procedure is “a fully specified feedback control system applied as part of a fishery management system” (McAllister *et al.* 1999) and specifies:

- what data will be collected,
- how they will be collected and processed,
- what estimates will be made from the data, and
- how those estimates will be used to set harvest controls.

This approach differs from the traditional one, and from the current NZ management plan, which specifies what data will be collected, and specifies a set of reference levels for biological indicators, but does not specify how changes in the indicators will translate to allowable catch, season length, pot-lifts or other control variables. Instead, when biological indicators fall outside the reference levels, the current plan specifies a list of actions which are specific with respect to notifications and considerations, but not specific with respect to how the fishery should be controlled.

The current plan is a typical example of traditional management, which uses regular assessments to track the state of the stock, but uses an ad hoc approach to decision-making each time that stock assessments suggest a management change is required. The management procedures approach is a movement away from the traditional approach, with careful specification of how the fishery will be controlled, based on agreed performance indicators.

Under this approach, specified indicators from the fishery (in this case there are several that could be used simultaneously) are used in a decision rule, which specifies the catch (or season length, depending on how the rule is formulated). Each year the harvest control rule is evaluated and produces a result that is implemented automatically. Consultation and debate is thus shifted away from annual discussions of what to do, and onto the choice and appropriateness of the harvest control rule or decision rule.

The advantages of this approach over the traditional pattern of regular or periodic stock assessments, each followed by a decision process, are (loosely based on Geromont *et al.* 1999):

- uncertainty in all facets of the assessment and management process can be addressed,
- harvest decision rules can be developed that are robust to uncertainty,
- the process leads to explicit definition of management objectives,
- all participants in the fishery can become involved in the choice of rule,
- a long-term view is forced,
- management procedures move away from regular assessments, freeing resources for other research, and

- the process is more understandable to fishers than the traditional approach.

The management procedure (or “decision rule”) approach was developed in South Africa (Butterworth *et al.* 1997; Cochrane *et al.* 1998), has been adopted by the International Whaling Commission (Kirkwood 1997), and has spread widely (see reviews by Butterworth & Punt 1999; McAllister *et al.* 1999).

Adoption of a management procedure can be made only after extensive simulation testing (see McAllister *et al.* 1999). This work should be conducted if the FMC approves of this direction.

The management procedure or decision rule approach would move towards compliance with the EA Guidelines under Principle 1, Objectives 1 and 2, Management Response.

7.6 Ecological Effects

A group of specific projects aimed at compliance with the EA Guidelines is hard to assign with a priority, because priority depends on how pressing the EA Guidelines are. These projects seem necessary to address bureaucratic rather than real issues, but those issues may become troublesome if not addressed. Two projects should be considered.

First, there should be a descriptive study that could be used as the benchmark in a risk analysis for bycatch species other than crabs. This project should do a characterisation of bycatch of major fish species (leather jackets and wrasses) - and *Octopus* - examine the data for changes in catch rates over time, analyse the area/depth/seasonal characteristics of the bycatch, in conjunction with the industry try to obtain information on the species composition, lengths (and ages) of the fishes caught.

Second, a desktop study should explore the potential for interactions between the NZ lobster fishery and the environment. This would be based on a literature survey and discussions with knowledgeable researchers of South Australian marine ecosystems. It should consider items such as the potential for fishing to disturb food web dynamics through the removal of high-level predators, the potential to alter fish community diversity through the selective removal of species, effects on the physical environment, and the potential for lobster pots to damage fragile deepwater communities. Results of the study may well be negative or inconclusive, but the study would address concerns expressed in Objectives 1 and 2 of Principle 2 of the EA Guidelines.

7.7 Notes on Table 4.

The “skills” shown do not necessarily denote separate people, *viz* a modeller could also be a statistician and a biologist.

Ongoing FTEs are shown only for the ongoing part of a program. Non-commercial catch estimates, for instance, will take less time to collect after the first year.

Note 1: The frequency of assessments should be determined by the FMC; it can be less if a management procedure is implemented and must be more frequent otherwise.

Note 2: The priority for the Ecological effects projects depends on how pressing the EA Guidelines are. More work may evolve out of these two projects.

Table 4. Recommended programs, with estimated timings.

	Priority	Type	Timing	ongoing FTEs	other FTEs	Skills
Monitoring Program						
logbook catch and effort	highest	extant	ongoing	0.60		keypunching
				0.20		co-ordinator
				0.10		database admin.
voluntary catch sampling	high	extant	ongoing	0.20		keypunching
				0.25		co-ordinator
				0.10		database admin.
				0.15		biologist
non-commercial catch estimates	high	new	ongoing	0.05	0.10	biologist
larval settlement	high	extant	ongoing	0.20		biologist
temperature data	medium	extant	ongoing	0.05		biologist
documenting database and addressing errors	high	new	2003		0.25	database admin.
fishing power survey	high	new	2003		0.10	biologist
Data processing						
standardised indices	high	extant	ongoing	0.15		statistician
weighted length frequencies	high	extant	ongoing	0.05		statistician
all other data	high	extant	ongoing	0.05		statistician
Developing assessment capacity						
integrated model	highest	extant	2002-03		0.75	modeller
revising model, new development	high	new	2003-06	0.20		modeller
catch forecasting	medium	new	2003-04		0.20	modeller
Assessment						
assessment proper	high	extant	see note 1		0.30	modeller
assessment process	high	extant	see note 1		0.10	biologist
ad hoc projects as required	high	extant	ongoing	0.10		modeller
Management Procedure Evaluation						
design and evaluation	high	new	2003-04		0.60	modeller
Ecological effects						
bycatch characterisation	see note 2	new	1 year		0.2	biologist
desktop study of ecosystem effects	see note 2	new	1 year		0.2	biologist

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