Dear Stakeholder

I wish to inform you of the release of the draft '*Western Rock Lobster Fishery Ecological Risk Assessment 2005 Report – July 2005*' for a three-week public consultation period. Please find attached the report for your consideration.

This report provides background on the western rock lobster fishery, its governance, the reporting requirements for the Ecologically Sustainable Development process and the specifics of the risk assessment process applied. The outcomes of the hazard elicitation workshop with stakeholders and the subsequent risk assessments conducted by the experts have also been provided.

Please provide submissions on the draft report, either in writing or electronically, by close of business **Tuesday 2 August 2005**, addressed as follows:

ATTENTION: Mr Peter Trott
Rock Lobster Policy Officer
Department of Fisheries
3rd Floor, The Atrium
168 St George's Terrace
PERTH WA 6000

Or via email: ptrott@fish.wa.gov.au

If you have any further enquires related to the contents of the *Western Rock Lobster Fishery Ecological Risk Assessment 2005 Report – July 2005*', or the consultative process, please do not hesitate to contact Mr Rhys Brown (Executive Officer, Rock Lobster Industry Advisory Committee) or Mr Peter Trott (Rock Lobster Policy Officer) on (08) 9482 7394 or (08) 9482 7262 respectively.

I welcome your participation in this process.

Yours Sincerely

Peter Rogers
EXCUTIVE DIRECTOR

8 July 2005

Department of Fisheries
Government of Western Australia

THE UNIVERSITY OF MELBOURNE
Australia

Western Rock Lobster Fishery

Ecological Risk Assessment 2005

Draft Report

July 2005

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CONTEXT AND ACKNOWLEDGEMENTS

This report was prepared on behalf of the Western Australian Department of Fisheries by Professor Mark Burgman, School of Botany, University of Melbourne. Professor Burgman was involved because he is an ecologist, independent of the fishing industry and other interest groups. He was paid for this work by the Department of Fisheries. He was selected because he is a recognised ecological risk analyst. He was responsible for facilitating two workshops, interpreting the information from the workshops and subsequent correspondence with experts, and for providing the synthesis in this report.

The first two parts of the document provide background on the western rock lobster fishery and its governance. The third and fourth parts outline reporting requirements for the Ecologically Sustainable Development process and the specifics of the risk assessment process applied here. These sections are based substantially on reports written earlier by the Department of Fisheries and distributed to participants in the risk assessment process. They have been edited here to include only the details that were pertinent to this risk assessment. Parts 5, 6 and 7 provide the outcomes of the hazard elicitation workshop with stakeholders and the subsequent risk assessments conducted by the experts.

Tim Bray, Rhys Brown, Rachel Sinclair and Sharon Brown assembled and distributed background information, managed invitations and logistics and compiled information from the workshops. Nick Caputi, Rhys Brown, and Rick Fletcher commented on drafts of the report. The author is grateful for their contributions, and for those of all participants, but remains solely responsible for the opinions, analyses and interpretations presented in this report.

This report forms part of the assessment of the sustainability of the fishery, conducted in compliance with the Marine Stewardship Council requirements for ecological risk assessment.

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SECTION 1. THE INDUSTRY AND ITS GOVERNANCE

Part 1. Description of the Western Rock Lobster Fishery

The commercial fishery for western rock lobster is the most valuable single-species fishery in Australia (worth between $A200 and $A400 million annually) and usually represents about twenty per cent of the total value of Australia's fisheries.

This fishery also supports a significant recreational fishery with about 37,000 rock lobster licences issued in 2002/03 and around 80% of these licences used to catch 300-400 tonnes (approx. 4% of the total commercial and recreational catch). The licence entitles fishers to use two pots and/or dive for rock lobster and keep up to 8 lobsters per day.

As one of the first managed fisheries in Western Australia, data have been kept on the western rock lobster fishery since the early 1900s. The rock lobster fishery was declared limited entry in March 1963 when licence and pot numbers were frozen. Since 1963, boat numbers have declined from 836 to 565 (January 2004). The commercial catch has varied between 8,000t and 14,500t over the last 20 years mostly due to natural fluctuations in annual recruitment. The settlement of puerulus (one year old lobsters) is used to predict reliably recruitment levels and therefore catches three to four years ahead.

The current management package employs several measures to pursue the legislative objectives – at the heart of which is resource sustainability. The rock lobster management package is widely recognised as meeting this objective, but the extent to which some other fisheries management objectives are pursued has been a matter of debate.

An overall cap on effort, a Total Allowable Effort (TAE), is imposed by limiting the capacity of the fishery to a total number of usable pots. Relatively liberal transferability provisions allow market forces to determine the most efficient use of licences and available entitlement (pots). This system of management is known as an Individually Transferable Effort (ITE) system.

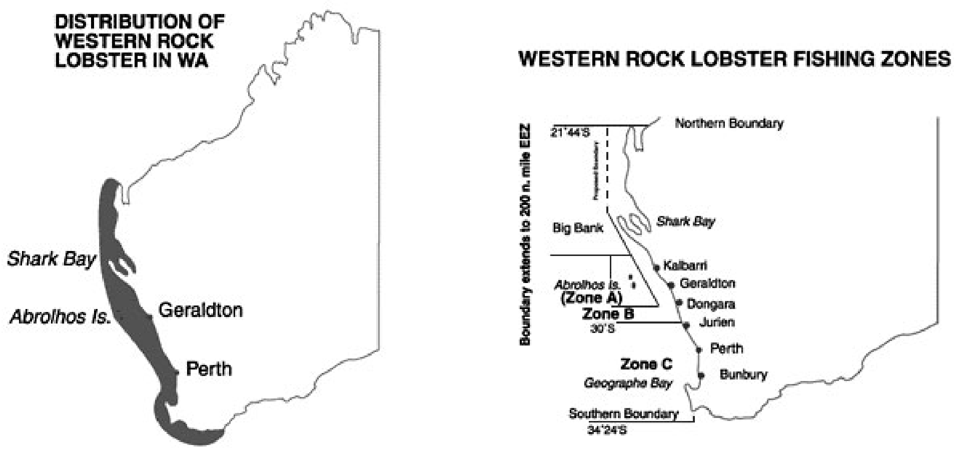


Figure 1.1. Western rock lobster fishing zones and distribution of western rock lobster.

Western rock lobsters are distributed from Augusta on the south coast of WA up to Exmouth north of Shark Bay (Fig. 1.1). The fishery is divided into access zones

(Figure 1.1). This distributes effort across the fishery, rather than permitting the fleet to concentrate effort on areas of seasonally high productivity, thereby avoiding higher than acceptable exploitation rates. Zonal management also enables management controls aimed at addressing zone specific issues. For example, there are currently different maximum size restrictions in the northern and southern regions of the fishery. A form of zonal management known as “closed areas” has been used in a number of instances. Rottnest and Quobba Point are closed to commercial fishing, and there are Fish Habitat Fish Protection Areas at Cottesloe, Yallingup and Lancelin Island. Other closed areas exist under the Marine Park management system administered by the Department for Conservation and Land Management (CALM).

Other management tools of note are those of a biological nature. Specifically, harvesting excludes females in breeding condition, and animals outside the limits of minimum and maximum carapace length. Gear restrictions that constrain the design and construction of the pots, including the requirement for escape gaps, also play a significant role in controlling exploitation rates.

Part 2. System of Government and Relevant Fisheries Legislation

The Government of Western Australia operates under the Westminster system in which the responsible Minister makes executive decisions. Insofar as the administration of fisheries in Western Australia is concerned, the relevant executive decision maker is the Minister for Fisheries.

The Department of Fisheries is established under the *Public Sector Management Act 1994* and is the department principally responsible for assisting the Minister for Fisheries in administering the following acts:

- *Fish Resources Management Act 1994 (FRMA);*
- *Pearling Act 1990;*
- *Fisheries Adjustment Schemes Act 1987;*
- *Fishing and Related Industries Compensation (Marine Reserves) Act 1997; and*
- *Fishing Industry Promotion Training and Management Levy Act 1994.*

Up-to-date versions of these acts can be accessed via www.fish.wa.gov.au. Of particular relevance to the management of fish resources is the *Fish Resources Management Act 1994* (FRMA). Section 3 of the FRMA establishes that:

> *"The objects of the Act are to conserve, develop and share the fish resources of the State for the benefit of present and future generations."*

The fish[1] resources that fall under the jurisdiction of the FRMA are described in an agreement between the Commonwealth and State Government's – the Offshore Constitutional Settlement. This agreement and explanation of it is contained within *Fisheries Management Paper No.77 – Offshore Constitutional Settlement 1995*.

Under the FRMA, there is a division of power between the Minister for Fisheries and the statutory office of the Executive Director of the Department of Fisheries. In broad terms, the Minister for Fisheries establishes the legal and policy framework for fisheries management, while the Executive Director (and staff) carries out the day-to-day administration of these frameworks.

2.1 Source and provision of Ministerial advice

To assist the Minister for Fisheries in managing the State's fish resources, the FRMA makes provision, under Part 4, for the establishment of Advisory Committees. For the western rock lobster fishery resource the relevant advisory committee is the Rock Lobster Industry Advisory Committee (RLIAC). However, the Minister is not limited to seeking advice only from RLIAC and can, for example, seek advice directly from stakeholders, the Department of Fisheries or Parliamentary colleagues.

RLIAC is one of three statutory advisory committees established under the FRMA. As a statutory committee the FRMA specifically and explicitly establishes RLIAC's composition (including the chairperson), functions, constitution and proceedings.

Section 29 of the FRMA specifies that there are 14 membership positions on RLIAC comprising of an independent chairperson, the Executive Director,

[1] Which as defined under the *FRMA 1994*, 'fish' represents all marine species including finfish, crustaceans, molluscs, algae, corals etc (i.e. not just commercially or recreationally important species) but excludes reptiles, birds, amphibians and mammals

commercial rock lobster fishers, a recreational rock lobster fisher and processing / marketers of rock lobster. In addition to the formal membership, RLIAC has a number of permanent observers who participate in the process at the direction of the Chairperson. Representatives from the Conservation Council of Western Australia and the Western Rock Lobster Council are permanent observers while a senior member of the Minister's staff also attends meetings.

Section 30 of the FRMA states that:

"(1) The functions of the Advisory Committee [RLIAC] are –

a. to identify issues that affect rock lobster fishing;

b. to advise the Minister on matters relating to the management, protection and development of rock lobster fisheries; and

c. to advise the Minister on matters relating to rock lobster fisheries on which the advice of the Advisory Committee is sought by the Minister.

(2) The Advisory Committee [RLIAC] may do all things necessary or convenient to be done for or in connection with the performance of its functions."

To provide additional non-legislative guidance for the operation of RLIAC, and other advisory committees, the Minister for Fisheries issued *Fisheries Management Guide No.3 – A guide for Management and Ministerial Advisory Committee (MACs) and the conduct of meetings issued by the Minister for Fisheries* as published in January 2003 by the Department of Fisheries. This Guide covers all critical operational aspects for advisory committees such as RLIAC. For example, the guide covers the role of members and observers, procedural matters, disclosure of interests and executive support for advisory committees.

In a manner consistent with Fisheries Management Guide No. 3, RLIAC has established a number of sub-committees to assist it. Collectively these sub-committees cover strategic management, cost recovery finance, stock sustainability research and development, compliance and marketing issues.

In addition to its longstanding sub-committees, RLIAC recently established two Scientific Reference Groups (SRG's) responsible for ensuring that RLIAC is provided with advice on how to ensure the western rock lobster resource is managed in a manner that is consistent with the principles of ecosystem based management (EBM).

All these subordinates of RLIAC have compositions and terms of reference set down by RLIAC and each subordinate reports directly to RLIAC and operates in a manner that is consistent with Fisheries Management Guide No. 3.

Traditionally, the focus of management, and therefore consultative processes, has been the commercial sector. However, the management and RLIAC processes have evolved to more explicitly recognize and include other stakeholders – in particular the recreational and conservation sectors. This process continues.

Discussion with stakeholders occurs through a variety of fora, but regular and well-known features of the RLIAC process include the annual coastal tour and stakeholder meetings held three to four times in a twelve-month period. The coastal tour is a day long forum with rock lobster stakeholders, including conservation representation, coordinated and organised by RLIAC. The tour is open to the public and held in October each year and visits three major rock lobster ports between Fremantle and Geraldton. This forum is widely recognised by rock lobster stakeholders as a mechanism for receiving the most up-to-date scientific advice on the status of the fishery within an ESD framework and discussing new and ongoing management issues in the context of the three-year planning process. Background material and the program for the upcoming coastal tour can be viewed and downloaded from www.fish.wa.gov.au around late September each year.

In recent years, RLIAC's consultation and communication with stakeholders has been further enhanced by conducting half day "Stakeholder meetings" prior to a meeting of RLIAC itself. Held quarterly, these stakeholder meetings provide regular opportunities for all rock lobster stakeholders to have direct input into the RLIAC process throughout the year.

RLIAC communication and engagement with stakeholders on the assessment of the annual technical report is through a variety of mediums:

- RLIAC News – published quarterly
- www.rocklobsterwa.com.
- Scheduled RLIAC meetings
- Scheduled Joint Stakeholder meetings
- Annual RLIAC coastal tour and accompanying background documentation and reports
- RLIAC Executive Officer

One of the purposes of these communication and consultation processes is to ensure stakeholders and the community more generally have access to relevant information, reports and advice that shape the advice RLIAC provides to the Minister. For example, reports from the Scientific Reference Groups are available through a variety of means. By making information available and by providing fora for discussion and exchange of ideas, RLIAC encourages input from stakeholders and the community into the management process.

2.2. Power to Manage the Western Rock Lobster Fishery

As the primary and statutory source of advice on all matters relevant to the management of the western rock lobster resource and use of it, RLIAC has an extensive network of expert advisers across its various subordinate committees, reference groups and processes that also provide opportunities for RLIAC to engage directly with stakeholders more broadly.

As the recipient of much advice from RLIAC on management issues, the Minister requires legislative power to turn knowledge and advice into action. Parts 5 and 6 of the FRMA deal with the general regulation of fisheries through the use of orders and regulations and the specific management of fisheries via the declaration or amendment of fisheries management plans. Principally, the Minister for Fisheries manages the western rock lobster resource by exercising powers provided under Parts 5 and 6 of the FRMA on the advice of the Rock Lobster Industry Advisory Committee. The administration of these arrangements becomes the responsibility of the Executive Director and the Department of Fisheries more generally.

For the western rock lobster resource there is a fisheries management plan determined by the Minister for Fisheries that limits the right to fish commercially for western rock lobster to those who hold an appropriate licence issued only by the Executive Director. The management plan establishes the area and sub areas (zones) of the fishery, the capacity, permissible gear type, open and closed seasons and rules for transferring licences or parts of licences. The management plan can be viewed at www.fish.wa.gov.au .

In addition to the management plan there are orders determined by the Minister that (amongst other things) manage access to special areas within the overall boundaries of the fishery. For example there is an order that generally prohibits commercial fishing in waters immediately surrounding Rottnest Island off the Perth metropolitan coast.

To complement the management plan and various orders there is a body of regulations approved by the Minister and determined by the Governor that applies specifically to western rock lobsters. In particular these regulations deal with the specifics of the sizes of lobsters that cannot be taken, the protection of lobsters in breeding condition, the dimensions of approved rock lobster fishing gear, bait types that cannot be used and the requirement to hold a recreational fishing licence to fish recreationally for western rock lobster. A process is currently underway to make the collection of orders and regulations available online.

To assist RLIAC and its subordinate committees and reference groups in developing management advice for the Minister, a fisheries management 'decision rules framework' for the western rock lobster fishery has been developed.

2.3 Source of funds to resource the management process

The costs of managing the Western Rock Lobster Fishery are met from a variety of sources, including in particular significant contributions each financial year from the:

- West Coast Rock Lobster industry through the established cost recovery process;
- State Government;
- Fisheries Research and Development Corporation;
- Industry Development Unit; and
- Development and Better Interests Fund

SECTION 2. ECOLOGICALLY SUSTAINABLE DEVELOPMENT

Part 3. Overview of the ESD reporting process

In Australia, the Ecologically Sustainable Development (ESD) reporting framework for fisheries was developed by the *Fisheries Research and Development Corporation ESD Subprogram*. This framework is outlined in a series of reports (including a "*How To*" *Guide*, Fletcher *et al.*, 2002; Fletcher 2005; Fletcher *et al.*, 2005), which makes the completion of ESD reports as efficient and effective as possible. They are available from the subprogram website www.fisheries-esd.com.

Four main processes are needed to complete an ESD report (see Figure 3.1 for summary)[2]. These include identifying issues; determining the importance of each of these issues using risk assessment; completing suitably detailed reports; and compiling sufficient background material to put these reports into context. Sections of the *Guide* outline in detail how to complete each of these major elements by providing detailed descriptions of the methodology, examples of outputs from case studies and, where necessary, the theoretical foundations of the methods.

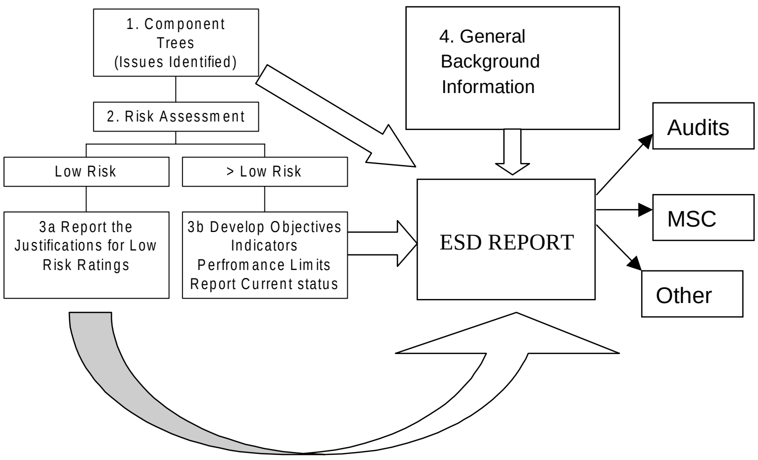


Figure 3.1. Summary of ESD framework processes. To undertake and ERA only steps one and two are completed.

The current study is an Ecological Risk Assessment (ERA) and does not cover the full ESD process. Consequently, only steps one and two were undertaken. They included the identification of issues and the analysis of the risk associated with each of these. These steps are outlined in detail in the Section 4.

3.1 First Step - Identifying the Issues

The first step in the ESD reporting process is to identify the issues relevant to the fishery being assessed. This step is equivalent to the 'hazard identification' process used in most risk assessment procedures. Essentially, stakeholders identify things of value in the system under consideration and specify how these values might be affected by activities. It may be supported by structured elicitation processes,

[2] These elements are equivalent to completing many of the elements of a standard risk analysis process - see full description below

checklists of hazards, logic trees or other conceptual tools that assist participants to structure the logic of cause and effect for each of the hazards.

For the ERA process for the western rock lobster, participants were assisted to identify the issues for the fishery through the use and modification of a set of "*generic component trees*" (see Figure 3.2 for an example). There is one *generic component tree* for each of the eight components of ESD (retained species, non-retained species, general ecosystem, indigenous issues, community and national wellbeing, impacts of the environment and governance). These generic component trees were used as a starting point. Each fishery may tailor them to suit individual circumstances, expanding some sub-components and collapsing or removing others, depending upon the fishing methods, areas of operation and the species involved.

For example, the generic component tree for "*general ecosystem issues*" (Figure 3.2) covers major categories of possible effects on the biological community, and on air, water and substrate quality by fisheries.

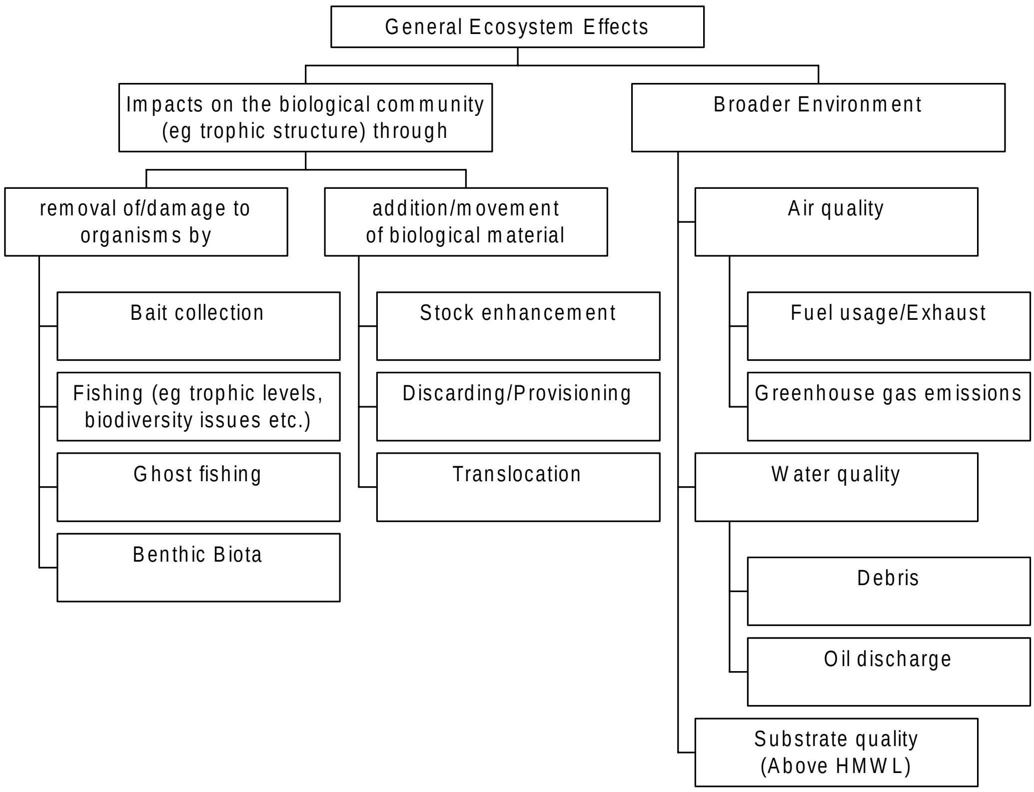


Figure 3.2. One of eight generic component trees (see Fletcher et al., 2002 for full details).

3.2 Second Step – Setting Priorities Using Risk Assessment tools

The generation of component trees for a fishery often results in a large number of issues being identified, the importance of which varies greatly. Consequently, in many cases it is be sensible to rank the issues so that the level of management actions and the details of the reports generated are aligned and are appropriate given the seriousness of the hazard.

To determine the priority of issues and the appropriate level of response, the second step outlined in the *Guide* is to apply the Risk Assessment methodology. This operates by completing an assessment of the 'risk' associated with each of the identified issues. The Risk Analysis tool used in this ESD process is based on the

AS/NZ Standard 4360, adapted for use within the fisheries context. It works by assigning a level of consequence - a level of impact ranging from negligible (eg, no measurable change) to catastrophic (eg, extinction of a species) - and a likelihood of this consequence occurring (from remote to likely) for each issue (hazard).

From the combination of consequence and likelihood, an overall level of *risk* is generated (from negligible to severe). This *risk* can assist in deciding whether an issue requires specific management or not.

To be of value for the ESD reporting process, it is not sufficient only to quote the levels of consequence and likelihood chosen and the subsequent risk ratings generated. In addition, appropriately detailed justifications for these levels and any related decisions are needed. The key element is that other parties who did not participate in generating the report need to be able to see the logic and assumptions behind the decisions.

Consequently, the major outputs from the ESD reporting process include the completion of appropriately detailed performance reports on each of the identified issues, including any justifications generated during the risk assessment process.

3.3 Third Step - Performance Reports

In general, two types of reports are completed on issues.

1. Where risks are considered to be acceptably low, typically specific management is not undertaken and the reports only need to justify this conclusion.
2. Where risks are high enough to warrant specific management actions, a full performance report that details all elements of the management system is required.

If an issue requires specific management actions then the performance reports should use Table 1 as a guide. This was not done as part of the current project. The performance reports developed previously are described in Fletcher et al. (2005).

Table 1. Performance report guide for issues that require specific management.

Performance Report Heading	***Description***
1. Rationale for Inclusion	*Why is this considered an issue?*
2. Operational Objective (plus justification)	*What outcome are you trying to achieve and why?*
3. Indicator	*What are you going to use to measure performance?*
4. Performance Measure/Limit plus (justification)	*What levels define acceptable and unacceptable performance and why?*
5. Data Requirements/Availability	*What monitoring programs are needed?*
6. Evaluation	*What is the current performance of the fishery for this issue?*
7. Robustness	*How robust is the indicator or the performance measure in assessing performance against the objective?*
8. Fisheries Management Response	
- Current	*What management actions are used currently to achieve acceptable performance?*
- Future	*What extra management is to be introduced?*
- Actions if Performance Limit is exceeded	*What will happen if the indicator suggests performance is not acceptable?*

9. Comments and Action	*Summarise what actions will happen in the coming years*
10. External Drivers	*What factors, outside of the fisheries agency control may affect performance against the objective?*

3.4 Fourth Step – background material

The provision of background material allows the other sections of the report to be placed in context. This material is also needed to complete the Risk Assessment process.

The material covered should include;

- the history of the fishery,
- where the fishery operates,
- the kind of fishing methods used,
- the major species, habitats and environment that could be affected, and
- summaries of the biological characteristics of the main species and habitats involved.

Like step 3, this step was not undertaken in the current project. Background material developed previously is provided in Fletcher et al. (2005). The descriptions in the *Guide* are detailed. The descriptions here are an overview of the process for those who require a general understanding. For those who take part in ESD reporting processes, it is recommended that the full documentation is obtained and referenced.

Part 4. Procedures used for Western Rock Lobster Risk Assessment

(Extracted from *How to Guide* for ESD – Fletcher et al., 2002)

4.1 Risk Analysis in the Fisheries Context

What is Risk?
"Risk is the chance of something happening that will have an impact on objectives (AS/NZS 4360- 1999)".

For a fisheries agency, 'risk' is the chance of something affecting the agency's performance against the objectives laid out in their relevant legislation. In contrast, for the commercial fishing industry, the term 'risk' generally relates to the potential impacts on their long-term profitability. For the general community, 'risk' could relate to a possible impact on their enjoyment[3] of the marine environment.

The aim for each of these groups is to ensure that the 'risk' of an unacceptable impact is kept to an acceptable level[4].

Thus, one of the first tasks is to determine whose objectives are being used to assess the risks. In general, where these assessments are being used to assess the management of a fishery, the objectives within the legislation of the management agency should be used.

The calculation of a risk in the context of a fishery may be determined within a specified time frame (e.g. the life of the management plan, the generation time of the target species, the term of the current government) or 'for the foreseeable future'.

The management of risk is useful in fisheries contexts because of the large number of potential issues and the impossibility of gaining a perfect understanding for any of these. The recent shift by many fisheries management committees to link their actions to the probability that stock assessment projections will meet agreed levels of performance is a good example of the application of techniques that acknowledge these uncertainties.

While not all elements of fisheries management are able to use quantitative simulation modelling to predict the probabilities of performance given a set of proposed management arrangements, there is value in utilising these principles across all relevant issues. The methods outlined below, developed to support the ESD reporting framework, use a formal risk assessment process that is consistent with the Australian Standard AS/NZS 4360:1999 Risk Management and the companion paper on Environmental Risk Management – Principles and Process (HB 203:2000).

4.2 The Risk Assessment Process

What is Risk Analysis?
"*Risk analysis involves consideration of the sources of risk, their consequences and the likelihood that those consequences may occur."*
AS/NZS 4360 – 1999

As stated above, the major objective for using a risk assessment technique is to assist in separating minor, acceptable risks from major, unacceptable risks. This assessment requires the determination of two factors for each issue – the potential consequence

[3] Broader community values include non-extractive and non-direct uses.
[4] In some cases there may be an opportunity to measure the chance of a beneficial outcome, particularly for social and economic issues.

arising from the activity on each sub-component, and the likelihood that this consequence will occur[5].

The combination of the level of consequence and the likelihood of this consequence is used to produce an estimated level of risk associated with the particular hazardous event/issue in question.

Determining the levels of consequence and likelihood should involve an assessment of the factors that may affect these criteria, evaluated in the context of existing control measures - management arrangements already in place. For example, in determining the risks from fishing for the spawning biomass of a species of prawn, a risk assessment would need to take into account the current management regime (such as whether there are any restrictions on boat numbers, closed seasons and areas, etc) in assigning the appropriate likelihood and consequence values.

Typically, assessments result in very different values depending upon whether management is, or is not, included. Assessment *must* include current arrangements because the point of the exercise is to evaluate the acceptability of current management.

Consequence

The risk assessment began by assessing possible consequence levels for the issues. The criteria used to assign a level of consequence can be:

- *Qualitative* – using a descriptive scale to represent the magnitude of potential consequences.
- *Semi-quantitative* – in these cases, the qualitative scales are given values. Usually, these numbers are not an accurate reflection of the actual magnitude of the consequence. They are used to rank judgements against one another.
- *Quantitative* – uses numerical values alone to assign the level.

In a qualitative system, the number of consequence levels generally varies between four and six. The lowest level of consequence is usually assigned a value of zero or one, reflecting a negligible consequence.

At the other end of the spectrum, the highest category is usually a catastrophic/irreversible consequence. Ideally, consequence estimates are based on data or physical understanding of the system. Usually, however, the assessment of the potential consequence of a hazard is based upon the judgment of individuals or a group that collectively have sufficient expertise to provide credible assessments. Expert judgement was used for most of the assessments in this analysis.

Likelihood

The likelihood of the consequence occurring within a specified time-frame is then assigned to one of a number of levels. Most systems use between four and six categories, varying from 'remote' to 'highly likely' or 'certain'. In doing so, participants consider the likelihood of the 'hazardous' *event* (i.e. the consequence) actually occurring, *not* the likelihood of the activity occurring. As with the consequence tables, the likelihood assessment may be based on qualitative categories or quantitative probabilities, depending upon the level of detail required for the analysis and the data available.

[5] Consequence and likelihood are sometimes described as impact and probability

Risk
The overall risk level for each hazard is generally calculated as the product of the consequence and likelihood levels (Risk = Consequence x Likelihood). Each issue can be assigned a *Risk Ranking* from this product, called the *Risk Value*, depending upon where the product (consequence x likelihood) falls within one of a number of predetermined categories.

In the *Guide* and in this application, as in AS/NZS 4360, five levels of risk were used: 'Extreme', 'High', 'Moderate', 'Low' and 'Negligible'.

The cut-off values between the Risk Rating levels, and the management actions that flow from the different rankings, may be: *"based on operational, technical, financial, legal, social, humanitarian or other criteria" (AS/NZS 4360)*. In particular, the outputs of the risk analysis should correspond to the types of risks present and the outcomes that would be expected to occur.

The cut-offs are essentially social judgements about the acceptability of risks. In this application, in the first and second workshops, participants were asked to specify threshold values representing cut-offs between the qualitative risk categories, with a particular focus on the boundary between low and moderate risks. The thresholds were revisited a number of times in the stakeholder (workshop 1) and expert workshops (workshop 2; see below). The other thresholds used in the assessments described below comply with the boundaries used in the first risk assessment.

4.3 Scope of Assessments

Risk assessment can be undertaken at a number of different levels of sophistication and detail. The level chosen greatly affects the complexity and cost. Qualitative assessments are usually the least expensive, while quantitative are generally the most expensive.

Sophistication
The use of qualitative criteria for assigning consequence and likelihood is, according to AS/NZS 4360, common as an initial screening activity to identify risks that require more detailed analyses. This is the purpose for which the risk assessment process is being used in this ESD Reporting Framework.

Therefore, the assessment used qualitative tables that were developed to assign levels of consequence and likelihood in the fisheries context. For some issues, the initial qualitative assessments will be followed by more detailed semi-quantitative or fully quantitative assessments, management responses, collection of additional field data or on-going monitoring.

Detail
Assessments may range from the very broad (e.g. impacts of the entire fishery on an ecosystem) to assessments of risks at micro-levels (e.g. rates of compliance for abalone bag limits in a single management zone).

This assessment used a relatively high level approach, evaluating the risk to each issue of 'having a fishery', thereby integrating many elements into each estimate of risk.

If the assessment of a risk for an issue was low, it was unnecessary to complete a finer scale assessment. However, if an overall level of risk was high enough for specific management to be required, a second-phase risk assessment may be necessary to identify the relative risks associated with each of the specific elements that led to the overall rating. Usually, this is based on some degree of disaggregation of the risk and the development of more detailed conceptual models for terms, ecological processes and activities.

Finer scale analyses assist in the development of appropriate management actions. Several more detailed assessments were needed to complete the ESD component reports for the western rock lobster fishery.

Scale

Risk assessment depends upon the clarity and applicability of the consequence and likelihood tables used to classify each of the issues. As part of the first risk assessment, this fishery developed suitable tables by adapting those used for environmental impacts. They included descriptions of levels of consequence to assist participants to determine the appropriate scale to assess each issue.

For target and non-target species, the consequence of being caught was assessed on the scale of the population of the species affected, rather than at the individual of level organisms. Similarly, possible ecosystem impacts were assessed at the level of the whole ecosystem, or the entire extent of the habitat, rather than at the level of individual patches.

4.4 Consequence Tables

The methodology recommended in the *Guide* developed for the fishery in the first risk assessment was used as a first stage filtering process. Therefore, only qualitative criteria[6] were developed for the consequence and likelihood tables. Several types of consequence tables (Table 4.1) were needed because the variety of issues - and the possible outcomes - differed both amongst the different component trees and, in some cases, within the same component tree.

Table 4.1. The General Consequence Table for use in ecological risk assessments related to fishing (adapted to specific issues).

Level	General
Negligible (0)	Very insignificant impacts. Unlikely to be even measurable at the scale of the stock/ecosystem/community against natural background variability.
Minor (1)	Possibly detectable but minimal or acceptable impact on structure/function or dynamics.
Moderate (2)	Maximum appropriate/acceptable level of impact (e.g. full exploitation rate for a target species)
Severe (3)	Wider and longer term impacts (e.g. recruitment overfishing)
Major (4)	Very serious impacts with relatively long time frames likely to be needed to restore conditions to acceptable levels
Catastrophic (5)	Widespread and permanent/irreversible damage or loss (e.g. extinctions)

[6] It is envisaged that this may develop into a semi-quantitative procedure over the coming years as information accumulates on probabilities and consequences that relate to the qualitative categories.

Thus, a series of Consequence Tables, each with six levels of impact ranging from negligible to catastrophic, were used to cover:

1. General (described below);
2. Target species/major non-retained species;
3. By-product/minor non-retained species;
4. Protected Species (a category under both State and Commonwealth environmental Acts);
5. Habitat issues; and
6. Ecosystem/trophic level effects.

Five more-detailed Consequence Tables are described in full below.

4.5 Likelihood Table

The Likelihood Table has qualitative criteria that range from 'remote' to 'likely' (Table 4.2).

Table 4.2. Likelihood Definitions

Level	Descriptor
Likely (6)	It is expected to occur
Occasional (5)	May occur
Possible (4)	Some evidence to suggest this is possible here
Unlikely (3)	Uncommon, but has been known to occur elsewhere
Rare (2)	May occur in exceptional circumstances
Remote (1)	Never heard of, but not impossible

4.6 Risk Rating Table

The matrix shown in Table 4.3 shows the resultant risk values, based upon the calculation of the Consequence x Likelihood (0-30). These risk values have been separated into five risk ranking categories (see Table 4.4 for separation points) from 'negligible' risk to 'extreme' risk.

Usually, only issues of sufficient risk or priority (i.e. 'moderate', 'high' or 'extreme' risk) require a full performance report. This includes all those issues that require specific management actions.

For the negligible and low risk issues, full performance reports are not needed. Nevertheless, a necessary element of the ESD Reporting framework is to document the rationale for classifying issues in these categories. These form part of this report, so that stakeholders can see why these issues were accorded these ratings (and potentially supply additional or alternative information to affect subsequent assessments).

Output from the Risk Assessment

The risk assessment includes the scores generated during the assessment process together with appropriate documentation/justification for the categories selected.

Table 4.3. Risk Matrix – numbers in cells indicate risk value, the colours/shades indicate risk rankings (see Table 4.4 for details)

		Consequence					
		Negligible	Minor	Moderate	Severe	Major	Catastrophic
Likelihood		0	1	2	3	4	5
Remote	1	0	1	2	3	4	5
Rare	2	0	2	4	6	8	10
Unlikely	3	0	3	6	9	12	15
Possible	4	0	4	8	12	16	20
Occasional	5	0	5	10	15	20	25
Likely	6	0	6	12	18	24	30

Table 4.4. Risk Rankings and Outcomes

Risk Rankings	Risk Values	Likely Management Response	Likely Reporting Requirements
Negligible	0	Nil	Short Justification Only
Low	1-6	None Specific	Full Justification needed
Moderate	7-12	Specific Management Needed	Full Performance Report
High	13-18	Possible increases to management activities needed	Full Performance Report
Extreme	>18	Likely additional management activities needed	Full Performance Report

The level of justification required depends on the risk level assigned to an issue. If a full performance report is not needed, this means that no specific management actions will be taken. If management actions are necessary, performance reports will be required to assess the performance of this management.

Finally, for issues that are rated as either ‘high’ or (especially) ‘extreme’ risk, the report will outline additional management measures (in addition to those already being applied) or acquisition of further information to more accurately quantify and manage the risks. These suggested outcomes are summarized in Table 4.4.

4.7 Detailed Consequence Table

The six detailed Consequence Tables were designed to assist in rating the issues. Most of the tables cover environmental issues because of the current priority to deal with them (i.e. to meet the Environment Australia requirements for *Environment Protection and Biodiversity Conservation Act 1999* assessments).

The criteria within each level of the tables are qualitative, based on the general table presented above, although in one instance (the Habitat Table), suggestions are provided for quantitative thresholds.

To assess the ecological impacts, the assessments were completed at the level of the relevant local population (unit stock), habitats, and ecosystems within the local bioregion - not at the levels individuals or 'patches'.

The consequences were scaled appropriately - from virtually 'nil' through to 'widespread' and 'irreversible'.

Several issues involve both social and ecological dimensions. The workshops (see below) endeavoured to focus exclusively on ecological issues. In two cases, the groups assessed the social dimension of an issue, to clearly differentiate it from the ecological context. Such social/political and other non-ecological issues are likely to be just as important as ecological processes and may affect the priority of an issue. In both cases, the groups provided separate assessments of ecological and social consequences.

In assessing the retained species, it was clear that there needed to be separate Consequence Tables for target species and by-product species. In contrast, the categories for major non-retained species were identical to those of target species because both were needed to assess the impacts of fishing on fish populations, so the same Consequence Table applied to both.

The 'Protected Species' (not threatened species) table was generated because the community expects a 'higher' level of protection for many of the species in this category than for other species.

Ecosystem issues generally fall into two categories - those that may affect the habitat in a direct fashion and those that may impact on ecosystem function indirectly. Hence two tables were used.

No tables were generated for the broader environmental impacts (which include impacts on air quality and water quality) because these issues were subject to other legislation and regulatory standards.

For the social and economic components, methods to determine relative levels of social dependence and sensitivity to change are available from the Bureau of Rural Sciences (using ABS statistics). These values could be used to identify towns/communities/regions at significant risk following changes to management arrangements. However, these considerations were beyond the scope of this ecological risk assessment.

The risk was assessed at the level of the species or the ecoregion, depending on the issue. The qualitative table describes the potential consequences that may occur to the species due to fishing. This extends from virtually no impact to complete extinction.

The target stock of most fisheries will probably experience at least a moderate level of consequence resulting from objectives to fully harvest species but not overfish them. For those stocks in which there is a chance that recruitment-overfishing may occur, a higher consequence level may be warranted. For example, abalone fisheries often have values in the 'severe' to 'major' categories, depending upon the effectiveness of management controls and compliance because they are especially prone to overfishing. Other species, such as prawns, have more robust dynamics.

Retained Species (Primary)

In assessing the risk of the fishery, the risk assessment integrated the following elements (which themselves may have a number of more detailed factors);

- the removals, by all sectors (i.e. commercial fishing, recreational fishing, indigenous, illegal and discards),
- species biological characteristics/dynamics that make it susceptible to fishing,,
- the current knowledge and understanding available on these issues (including distribution versus area fished),
- current management arrangements - their effectiveness and problems.

Table 4.5. Consequence categories for the Major Retained/Non-Retained Species

Level	Ecological (Retained: target/Non-retained: major)
Negligible (0)	Insignificant impacts to populations. Unlikely to be measurable against background variability for this population.
Minor (1)	Possibly detectable, but minimal or acceptable impact on population size and none on dynamics.
Moderate (2)	Full exploitation rate, but long-term recruitment/dynamics not adversely impacted.
Severe (3)	Affecting recruitment levels of stocks/or their capacity to increase.
Major (4)	Likely to cause local extinctions, if continued in longer term (i.e. probably requiring listing of species in an appropriate category of the endangered species list (eg IUCN category).
Catastrophic (5)	Local extinctions are imminent/immediate

Retained Species (By-Product)

These issues were assessed at the level of locally reproducing populations. The species relevant to this table are those in the by-product branches of the component trees or minor elements of the non-retained species, where there may not be a large amount of data. Consequence levels above the moderate level were assessed separately using Table 4.5 or by the collection of more information to determine if a lower consequence value was valid.

Assessing the risk of the fishery for each component integrated;

- only the species affected by the fishery,
- the relative impact of this fishery compared to the distribution of the species and other impacts on the stocks,
- the biological characteristics and dynamics of the species captured,
- the current knowledge and understanding of these issues and current management arrangements.

Table 4.6. Consequence categories for the By-Product Species/Minor Non-retained species.

Level	Ecological (RETAINED: By-product/Non-retained: other)
Negligible (0)	Area where fishing occurs is negligible compared to where the relevant stock of the species resides (< 1%)
Minor (1)	Take in this fishery is small (< 10%), compared to total take by all fisheries and these species are covered explicitly elsewhere by management prescriptions and/or legislation. Take and area of capture by this fishery is small, compared to known area of distribution (< 20%).
Moderate (2)	Relative area of, or susceptibility to capture is suspected to be less than 50% and species do not have vulnerable life history traits.
Severe (3)	No information is available on the relative area or susceptibility to capture or on the vulnerability of life history traits of this species. Relative levels of capture/susceptibility suspected/known to be greater than 50% and species should be examined explicitly.
Major (4)	Once a consequence reaches this point it should be examined using Table 4.5.
Catastrophic (5)	(See Table 4.5).

Protected Species

Table 4.7. Consequence levels for the impact of the fishery on protected species.

Level	Ecological
Negligible (0)	Almost none are impacted.
Minor (1)	Some are impacted but there is no impact on stock
Moderate (2)	Levels of impact are at the maximum acceptable level
Severe (3)	*Same as target species*
Major (4)	Same as target species
Catastrophic (5)	Same as target species

Protected species were assessed at the level of a locally reproducing population. This table was generated because the criteria for assessing the impact on protected species are more stringent than those for other species and ecological elements.

Habitat Issues

Table 4.8. Consequence levels for the impacts of fishing on habitats. The Table includes quantitative thresholds that were interpreted differently for three levels of susceptibility of habitat – standard, fragile, critical.

Level	Ecological (HABITAT)
Negligible (0)	Insignificant impacts to habitat or populations – probably not measurable. Activity only occurs in very small areas of the habitat, or the impact on the habitats from the activity is unlikely to be measurable against background variability (*For example, activities that affect << 1% of area of habitat or if operating on a larger area, have virtually no direct impact)*
Minor (1)	Measurable impacts on habitat(s) but these are very localised compared to total habitat area. *(For example, impacts affecting < 5%) of the area of habitat)*
Moderate (2)	There are likely to be more widespread impacts on the habitat but the levels are still acceptable given the area affected, the types of impact occurring and the recovery capacity of the habitat *(For example, impact on non-fragile habitats may be up to 50% - but for more fragile habitats, the percentage area affected may need to be < 20% and for critical habitats < 5%)*
Severe (3)	The level of impact on habitats may be larger than is sensible to ensure that the habitat will not be able to recover adequately, or it will result in substantial loss of function. *(For example, the activity makes a significant impact in the area affected and > 25 - 50 of habitat is being affected; for critical habitats < 10%)*
Major (4)	Habitat is affected which may endanger its long-term survival and result in severe changes to ecosystem function. *(For example, it may equate to 70 - 90% of the habitat being affected or removed by the activity; for more fragile habitats > 30% and for critical habitats 10-20%)*
Catastrophic (5)	Effectively the entire habitat is in danger of being affected in a major way/removed. *(For example, > 90% of the habitat area being affected; for fragile areas > 50% and for critical habitats > 30%).*

Habitat (attached species – e.g. seagrass/coral) was assessed at the regional habitat level, equivalent to the entire habitat occupied by the exploited stock.

Assessments of the acceptability of impacts relied on an inverse relationship between the level of potential impact on a habitat and the relative extent of the habitat over which the activity occurs. For example, the extent over which dredging, a relatively destructive form of fishing, was considered to be acceptable was much smaller than that for less destructive methods such as line fishing.

Determining an acceptable level of loss or disruption to habitat involved examining the impacts on the dynamics of the species, as well as the indirect impacts of the species reliant on the habitat. Some habitats were considered to be more fragile than others, which affected the levels of disturbance they were judged to be capable of withstanding sustainably. Furthermore, some habitats perform important functions such as juvenile fish habitats and these considerations were included in the determination of the levels of acceptable disturbance for each region/activity. Thus the table uses three categories of susceptibility – standard, fragile and critical – to cover these differences.

Ecosystem Issues

Table 4.9. Consequence levels for the impact of a fishery on the general ecosystem/trophic levels.

Level	Ecological (ECOSYSTEM)
Negligible (0)	General - Insignificant impacts on habitat or populations, unlikely to be measurable against background variability Ecosystem: interactions may be occurring but it is unlikely that there would be any change outside of natural variation
Minor (1)	Ecosystem: Captured species do not play a keystone role – only minor changes in relative abundance of other constituents.
Moderate (2)	Ecosystem: measurable changes to the ecosystem components without there being a major change in function (no loss of components).
Severe (3)	Ecosystem: Ecosystem function altered measurably and some function or components are locally missing/declining/increasing outside of historical range and/or allowed/facilitated new species to appear. Recovery measured in years.
Major (4)	Ecosystem: A major change to ecosystem structure and function (different dynamics now occur with different species/groups now the major targets of capture). Recovery measured in years to decades.
Catastrophic (5)	Ecosystem: Total collapse of ecosystem processes. Long-term recovery period may be greater than decades.

The indirect impacts due to flow-on effects of food chain interactions were assessed at the regional/bioregional level. Thus, this assessment was not completed for the area where the fishery operates, unless this was the entire extent of a community/bioregion.

It was difficult to estimate the changes to ecosystem and food chain dynamics from the removal of prey/predators. The qualitative criteria presented in the table are functionally equivalent to the criteria generated for a species – i.e. from no measurable impacts through to extinction.

Unlike the impacts on target species or even impacts on habitats, documented examples of ecosystem effects are fewer and more varied. In general, flow-on, trophic-related effects occur *after* the collapse of the target or non-target stock(s).

The only circumstances where trophic-related effects may occur before a collapse are those where the target stock plays a keystone role in the ecosystem – either as a ‘predator’– (e.g. sea otters, urchins and macroalgae – leading to either kelp beds or barren grounds, depending upon whether sea otters are present or not), or is the sole prey of a predator. This assessment aimed to evaluate the role of rock lobsters and the broader ecological consequences of their removal.

Part 5. Modifications to the Guide

This section outlines the specific procedures used in the current western Rock Lobster Risk Assessment (RLRA). The general techniques used to complete this ERA are described in the "*How To Guide*" (Fletcher et al., 2002)[7] and Fletcher (2005) and are outlined in Part 4 above. However, there are some additional processes and modifications used here based on a review of the CSIRO/AFMA ERA process and Burgman (2005).

The ERA process for the rock lobster fishery was broken into two steps. The first was a stakeholder workshop that focused on the identification and description of values and hazards with some prioritisation. The second step was an expert-based workshop (that stakeholders were invited to attend). The purpose of the second step was to assess formally hazards identified in the stakeholder workshop, to assess risks already identified through the previous ERA process and to identify and assess any hazards not covered elsewhere.

This fishery has the advantage of having already conducted an ERA, and therefore already had a list of hazards ready to be considered and assessed anew. Even so, the risk assessment should not be constrained by existing lists because there may be new hazards, hazards that have changed in their nature or hazards may have been overlooked in the previous assessment.

To avoid becoming constrained by the existing checklist of hazards, the first stakeholder workshop was designed to identify as many hazards as possible without reference to the existing list. The component trees were used to prompt thinking and to explore links between hazards.

The full lists of potential hazards identified by stakeholders and identified through the previous risk assessment process are provided below. Each hazard is cross referenced to a description and its risks are assessed.

5.1 During the Meetings

Facilitation and hazard identification

In the first stakeholder-based meeting and the second expert-based meeting, the participants used unstructured brainstorming to scope potential environmental hazards associated with the fishery. Then, component trees developed for the rock lobster fishery in 2000 were re-examined to determine if any further issues required assessment that were not identified in the original exercise.

Having identified numerous potential hazards, the stakeholders identified their top 10 and developed conceptual models (also known as influence diagrams) for several of them to clearly describe the nature of the potential hazard and to communicate clearly their thinking to the people involved in the subsequent, formal risk assessment. The participants drafted influence diagrams in small groups and presented them to the larger group for discussion and revision. Participants undertook a preliminary risk ranking exercise, assigning likelihoods and consequences to some of the hazards, and discussing the implications of values for the boundary between low and moderate hazards.

Other hazards identified for which a component tree was not developed have been described in text. Participants in the ERA workshops were free to add ideas about new or overlooked hazards at any point in the process.

[7] which is available in full from the website www.fisheries-esd.com but the relevant sections are appended here with permission

Re-examination of previously identified risks
The rationales for determining the risks from the previous risk assessment were made available to participants for examination. This included whether the level of understanding of the issue had altered, in terms of newly collected information, reinterpretation of old information or the discovery of previously unknown information.

Changes in management actions that may have reduced or increased risks were discussed. If there were changes, new risk rating scores were generated. If there were no changes in either of these categories, in general the risk scores and the ranks of different hazards remained the same.

Risk outcomes
Risks were rated using the standard processes outlined below. Whilst achieving a consensus at the meeting on the appropriate risk scores is preferable, differences of opinion arise inevitably. Alternative opinions were recorded, including the individuals who gave alternative opinions. The primary reasons for their judgements were also recorded, where provided. The different groups/individuals were asked to provide information or rationalisations to justify their positions. The median value for the group was used as the consensus position, although maxima and minima played a role in interpreting the group attitudes to risks.

5.2 After the Meetings

Participants in the first meeting were sent the material recorded at the meeting as confirmation of the outcomes. Participants in the second meeting were sent the material recorded at the first meeting as part of the background information. Individuals/groups who participated in the second meeting and who provided input that affected the scores were requested to provide justifications for their assertions, particularly where they had assigned relatively high or low scores.

When all the material had been collated, the draft ERA was circulated to all participants for comment and re-evaluation of scores. Any outlying values were highlighted and the people who made them were asked to consider their judgements, in the light of the collective judgement of the group, and to provide justification for their position if they felt that it was warranted.

Comments from participants were received and incorporated. The results outlined below summarise the assessments at the end of the process.

The final ERA will include the comments from external reviews and any responses to these comments in an appendix.

SECTION 3. ERA RESULTS

Part 6. Hazards

This section provides the full listing of hazards/issues identified by the stakeholder workshop and those identified during the previous risk assessment process. The hazards identified in these workshops were cross-referenced to hazards identified in the previous risk assessment (Table 6.1). For some of the hazards, the participants developed a conceptual model or component tree to describe better the nature of the hazard. Stakeholders developed these diagrams for risks they considered to be the most important.

Table 6.1. List of hazards identified during stakeholder workshop (workshop 1) and the associated risk assessment (workshop 2). The table cross-references the hazards to the sections where they are described in more detail, and to the ranking they were assigned in 2001 (if they were identified previously). The current median score is shown in bold face. The range of scores is shown in parentheses. These scores are presented and analysed later, including a discussion of their associated justifications. For several of the extreme scores (low and high), participants provided no specific justification (e.g., effects on the Central West Coast shallow environment).

Hazard	Section	2001 rating	2005 rating
1. Possibility that estimate of egg production is incorrect (effect on spawning biomass)	6.1.1	MODERATE	(low to) **MODERATE**
2. Increasing recreational fishing population (effect on spawning biomass)	6.1.3	MODERATE	**LOW** (to high)
3. Increase in fishing efficiency - shift to campaign fishing (effect on spawning biomass)	6.1.4	New hazard	**MODERATE** (low to extreme)
4. Mortality and loss of productivity from handling undersized and setose individuals (effect on spawning biomass)	6.1.5	LOW	**LOW** (to moderate)
5. Market decline and additional pressure of the resource (effect on spawning biomass)	6.1.6	New hazard	**LOW** (to moderate)
6. Effects of fishing on the genetic structure of the lobster population	6.1.2	New hazard	**LOW** (to moderate)
7. Removal of octopus (bycatch)	6.2.1	LOW	**LOW** (to moderate)
8. Removal of scale fish and sharks (bycatch)	6.2.2	LOW	**LOW** (to moderate)
9. Removal of deep sea crabs (bycatch)	6.2.3	LOW	**LOW**
10. Whale entanglements in pot ropes (ecological impact)	6.3.1	LOW	**LOW** (to moderate)
11. Whale entanglements in pot ropes (social impact)	6.3.1	New hazard	**MODERATE** (low to extreme)

12. Sea lion mortality in pots (without management)	6.3.2	MODERATE	**MODERATE** (low to extreme)
13. Sea lion mortality in pots (with management)	6.3.2	New hazard	**LOW** (to moderate)
14. Sea turtles	6.3.3	MODERATE	**LOW** (to moderate)
15. Manta rays	6.3.4	LOW	**LOW**
16. Moray eels	6.3.5	LOW	**LOW**
17. Sea horses	6.3.6	New hazard	**LOW**
18. Uncertainty in bycatch data	6.3.7	New hazard	**LOW** (to moderate)
19. Effect of fishing on the Abrolhos environment	6.4.1a	New Hazard	**LOW** (to high)
20. Effect of fishing on the Leeuwin-Naturaliste environment	6.4.1b	New hazard	**LOW** (to moderate)
21. Effect of fishing on the Central west coast shallow environment (including coastal development)	6.4.1c	New hazard	**MODERATE** (low to high)
22. Effect of fishing on the Central west coast deep environment	6.4.1d	New hazard	(low to) **MODERATE**
23. Effect of fishing on the Kalbarri – Big Bend environment	6.4.1e	New hazard	**LOW** (to moderate)
24. Ghost fishing	6.4.2	LOW	**LOW**
25. Fishing effects (pots and boats) on benthic biota (coral, limestone reefs, seagrass)	6.4.3	MODERATE	**LOW** (to moderate)
26. Effects on other fisheries of demand for bait	6.4.4	New hazard	**LOW** (to moderate)
27. Introduction of diseases or pathogens in bait	6.4.5	LOW	**LOW** (to moderate)
28. Changes in behaviour of attendants (birds, dolphins, sharks, sea lions, sea lice)	6.4.6	LOW	**LOW**
29. Illegal feeding of dolphins	6.4.7	LOW	**LOW**
30. Abrolhos Is marine issues	6.4.8		**LOW** (to moderate)
31. Abrolhos Is terrestrial bio-security	6.4.9		**LOW** (to moderate)
32. Dusky whaler shark entanglement in bait bands	6.4.10	LOW	**LOW** (to moderate)
33. Trawling effects on seagrass	6.5.1	New Hazard	**LOW**
34. Effects of aquaculture	6.5.2	New Hazard	**LOW**
35. Oil spills	6.6.1	New Hazard	**LOW**
36. Climate change	6.6.2	New Hazard	**LOW** (to moderate)

37. Jurisdictional issues	6.7.1	New Hazard	**LOW** (to moderate)

Table 6.2. List of hazards identified during first and second ecological risk assessment processes for which there was consensus among the expert group at the second workshop that the hazard was low and no further investigation or analysis was warranted.

Hazard	Section	Rating
Contributions to climate change	6.6.2	LOW
Additional food from bait in pots	6.4.1	LOW
Impacts on cormorant population	6.4.6	LOW
Addition of nutrients to the system	6.4.1	LOW
Removal of lobster biomass and effect on sea lions – loss of food	6.4.1	LOW
Disease introduction to dolphins		LOW
Removal of baldchin, dhufish and cod	6.2.2	LOW
Dolphin entanglement in pot ropes	6.3.1	LOW
Plastic ingestion / entanglement of marine spp.	6.4.10	LOW
No ecological baseline due to absence of closed areas	6.4 / 6.4.1	LOW
Reduction of food source resulting from intensive fishing of whites migration	6.4 / 6.4.1	LOW
Presence of oil fields	6.4 / 6.4.1	LOW
Coastal development	6.4 / 6.4.1	LOW

6.1 Rock Lobster sustainability

This section describes the hazards associated with retained species. It includes those identified through the stakeholder workshop and the previous risk assessment processes. The component tree is a useful reference for organising information about the nature of risks already identified that relate to retained species.

The western rock lobster is the main target species of the fishery which has a commercial range extending from Shark Bay to Bunbury (see Figure 1.1), and has an annual average commercial catch of about 10,500,000 kg (10 year average). It has been recognised that to maintain the biological sustainability and long-term economic success of commercial exploitation (by maintaining catches as close as possible to the annual average), the breeding stock needs to be maintained above a minimum level. In particular, the Abrolhos Island stock is considered to be a significance source of recruitment for the whole fishery.

To ensure that trends indicating a decline in breeding stock levels are not overlooked, data are collected from breeding stocks throughout the fishery. The spawning stock for the Coastal and Abrolhos Islands regions are collected and assessed both separately and as an aggregate (Chubb, 2000; Hall and Brown, 2000).

The operational objective is to ensure that the breeding stock[8] is sufficient to continue recruitment at levels that will replenish that taken by fishing, predation and

[8] The level of breeding stock should not be confused with the level of exploitable biomass; the latter is the component of biomass that is susceptible to harvesting.

other environmental factors by maintaining the spawning stock of western rock lobster at or above a level that minimises the risk of recruitment overfishing.

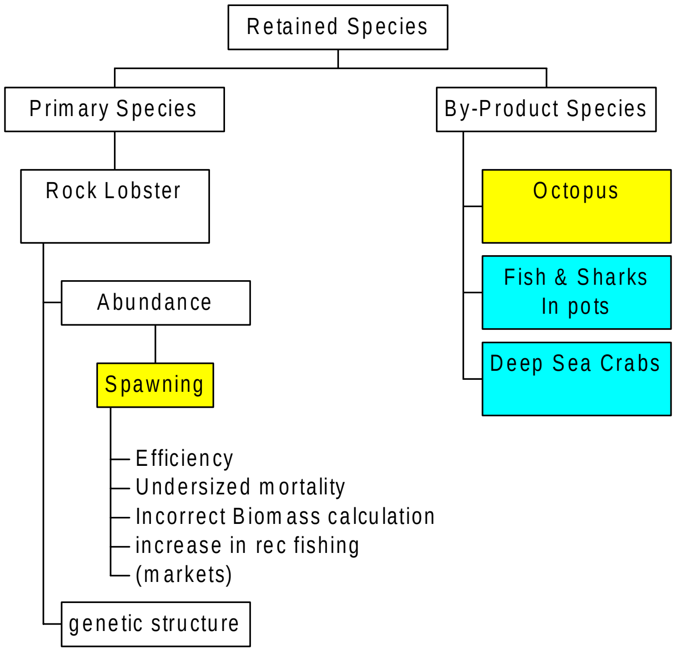


Figure 6.1. Revised Component Tree for the Retained Species related to the western rock lobster fishery.

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

With the help of the component tree, elements of the broad objective of rock lobster sustainability were disaggregated in the risk assessment workshops. Discussion resulted in the identification of the following more specific hazards.

6.1.1 Rock Lobster Sustainability (Spawning Stock Levels): the possibility that that the estimate of egg production is wrong and will have significant impact on the fishery.

While there is no direct relationship between the size of the WRL breeding (spawning) stock and subsequent levels of recruitment across the entire range of stock sizes, there will be a level of reduction in spawning stock (and therefore the level of egg production), if recruitment levels become adversely impacted. This phenomenon is often defined as recruitment over-fishing. Therefore, as a minimum, the breeding stock (or levels of egg production) should be maintained at levels above where these adverse impacts are likely to occur.

Given the importance of this indicator from both the perspective of the fishery's health and consequential (largely unknown) impacts on the related ecosystem, the basis for determining a safe level is a sensitive parameter determining sustainability. This hazard and its consequences are mapped in Figure 6.2.

[9] The level of breeding stock should not be confused with the level of exploitable biomass; the latter is the component of biomass that is susceptible to harvesting.

If egg production is lower than thought, it will lead to recruitment failure and reduced stock numbers. This may precipitate changes in ecosystem function and lead to reduced performance or, in the extreme, loss of the fishery.

At the expert workshop, one of the participants provided the group with information regarding this risk, described why the current egg production model had been chosen and how it related to the WRL fishery. The aim was to keep egg production at or above the level of egg production in the late 1970's / early 1980's. The expert workshop reviewed the additional background information. The original overall risk assessment assessed 'Impact on Breeding Stock' to be a moderate risk (C2 L5).

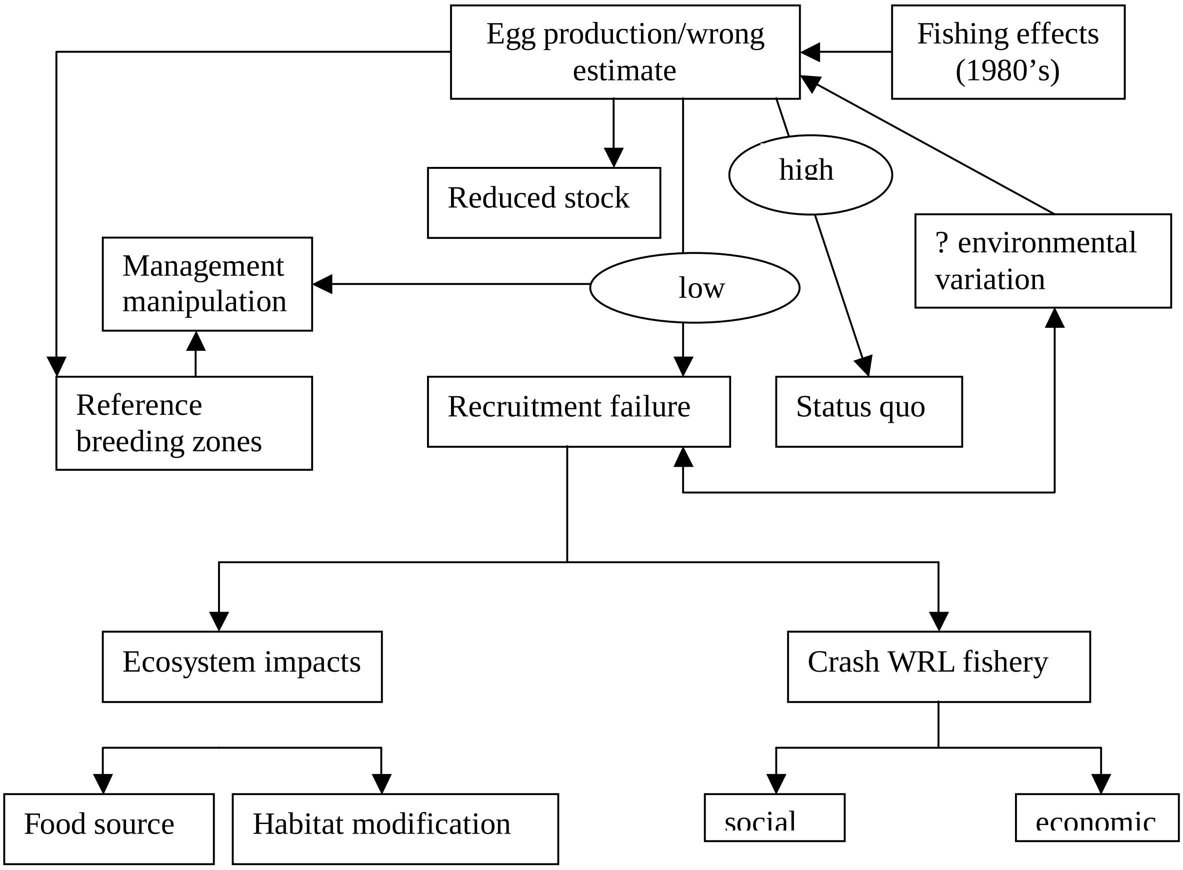


Figure 6.2. Influence diagram describing the risk that the egg production reference point is incorrect, leading to substantial impacts on the target species.

Figure 6.3 shows the range of opinion resulting from the current assessment for the possibility that egg production estimates are wrong and have a significant impact on the fishery. The majority of assessors (and the median) assessed the risk as moderate. None were higher. Several participants considered it to be a low risk.

The justification for the median outcome was that if the estimate of the safe level of egg production is wrong or the estimation method is wrong, this could lead to the stock being overfished and the effects may not be detected before causing lower average recruitment levels. Most participants considered it to be unlikely (Likelihood score of 3, L3) that the level is sufficiently wrong that the current spawning biomass will not continue to produce recruitment at historical levels over the next 5 years (representing recruitment overfishing with a consequence level of C3) particularly given that that the estimate of egg production (or lower) has produced appropriate levels of recruitment for the past 40 years.

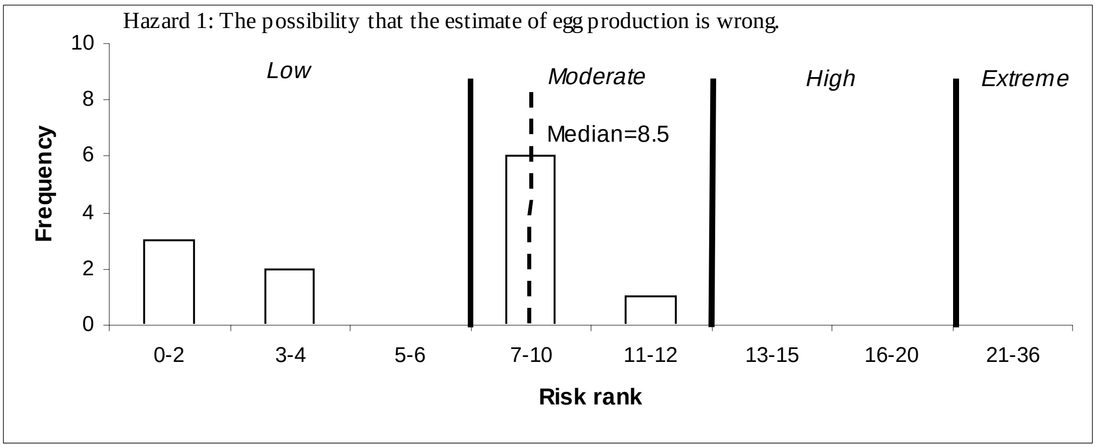


Figure 6.3. Results of the risk assessment for the possibility that the estimate of egg production is wrong and will have a significant impact on the fishery.

6.1.2 Rock Lobster Sustainability (Spawning Biomass): Increasing human population leading to increases in recreational fishing

Currently the management arrangements for the recreational sector limit the capacity of licensed individuals to fish for rock lobsters through bag and possession limits. However as a sector, the capacity of the recreational fishery is not capped. The stakeholder workshop identified growth of the human population and increased coastal access as sources of increased exploitation – particularly on shallow water stocks with resultant impacts on resource sustainability and potential downstream effects on local ecosystems.

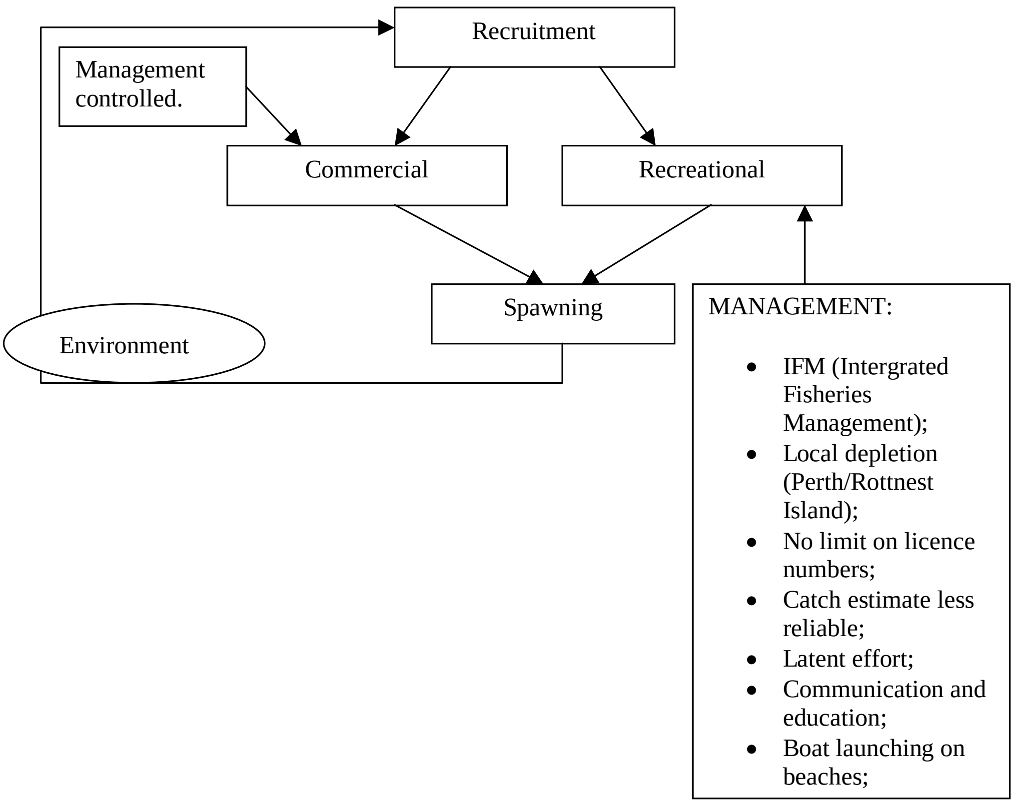


Figure 6.4. Influence diagram describing the risk from an increasing population of recreational fishers and coastal development.

With respect to increased coastal access, stakeholders identified this issue not only in terms of the potential increase in direct recreational fishing pressure but also in terms of the risk associated with degradation of the coastal environment and possibility that such degradation could adversely affect lobster populations (particularly juveniles) in coastal waters.

The recreational catch represents 3-4% of the total catch and is focused mainly in the metropolitan area. The introduction of Integrated Fisheries Management will attempt to place an overall limit on the total catch and/or effort for both the commercial and recreational sectors.

The stakeholder group listed the factors that contribute to recreational fishing pressure and noted its effects in conjunction with commercial fishing (Figure 6.4). The spread of opinion from experts was considerable (Figure 6.5), ranging from low to high. The frequencies of opinions were almost uniformly spread between these extremes. This result reflects poor definition of the issue and a lack of data available at the workshop on the direct and indirect impacts of the hazard. It emphasises the need to clarify the interactions between recreational and commercial fishing and to characterise the ecological impacts both locally and on the species as a whole.

Subsequent analyses have shown that irrespective of the efficacy of management processes, during the next five years the recreational catch is unlikely to increase substantially given forward projections based upon the long term growth in licence numbers and puerulus settlement levels. Moreover, given the limited capacity of the recreational sector to increase its catch during this period, it would only, at worst, temporarily affect the local density of inshore legal sized stocks (Minor - C1). The effects would not be large enough to impact substantially on spawning biomass such that it would impact on recruitment.

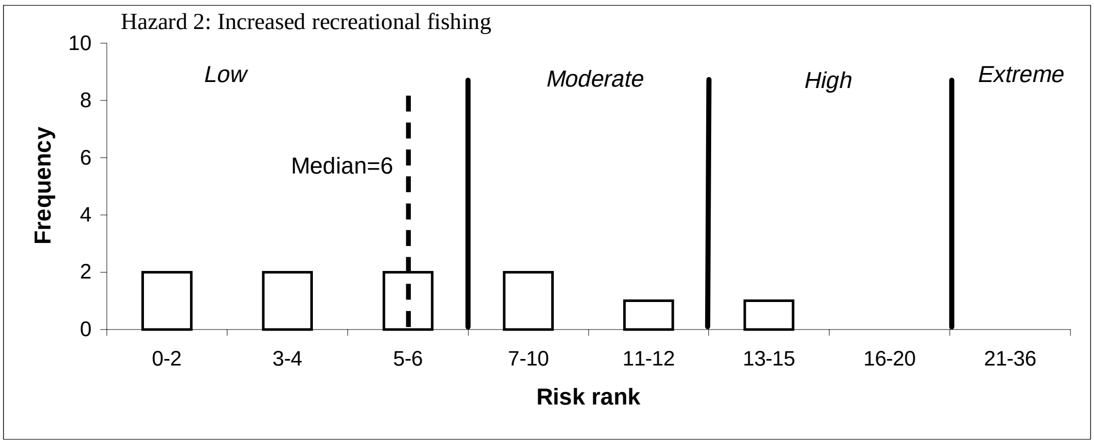


Figure 6.5. The effects of recreational fishing on the WRL, including coastal development.

6.1.3. Rock Lobster Sustainability (Spawning Stock): Efficiency changes in industry putting more pressure on stocks

The commercial harvest of western rock lobster has a variety of controls including limits on pot (trap) numbers per zone, the size and design of pots, season, time and the characteristics of animals that can be taken legally. The maintenance of the fishery stock indicates that these measures have been effective in the past. However, current stock assessments indicate that over the last 10 years, fishers have devoted considerable efforts towards those inputs not constrained by the management system, including particularly vessel and fish-finding technology. These changes have improved the fleet's fishing effectiveness and efficiency.

The investment in vessel technology has enabled the fleet to "campaign fish". With new technologies, the lobster fleet can react quickly to new information that identifies relatively abundant concentrations of the target species. Relatively large numbers of boats can concentrate on dense lobster populations, reducing local population sizes more quickly than has been possible in the past. The term "campaign fishing" refers to operations that are prepared to travel the extent of the zone in which they are entitled to fish to maximise catch rates on a day-to-day basis. These activities and their interactions with the lobster population are dynamic and complex (Figure 6.6).

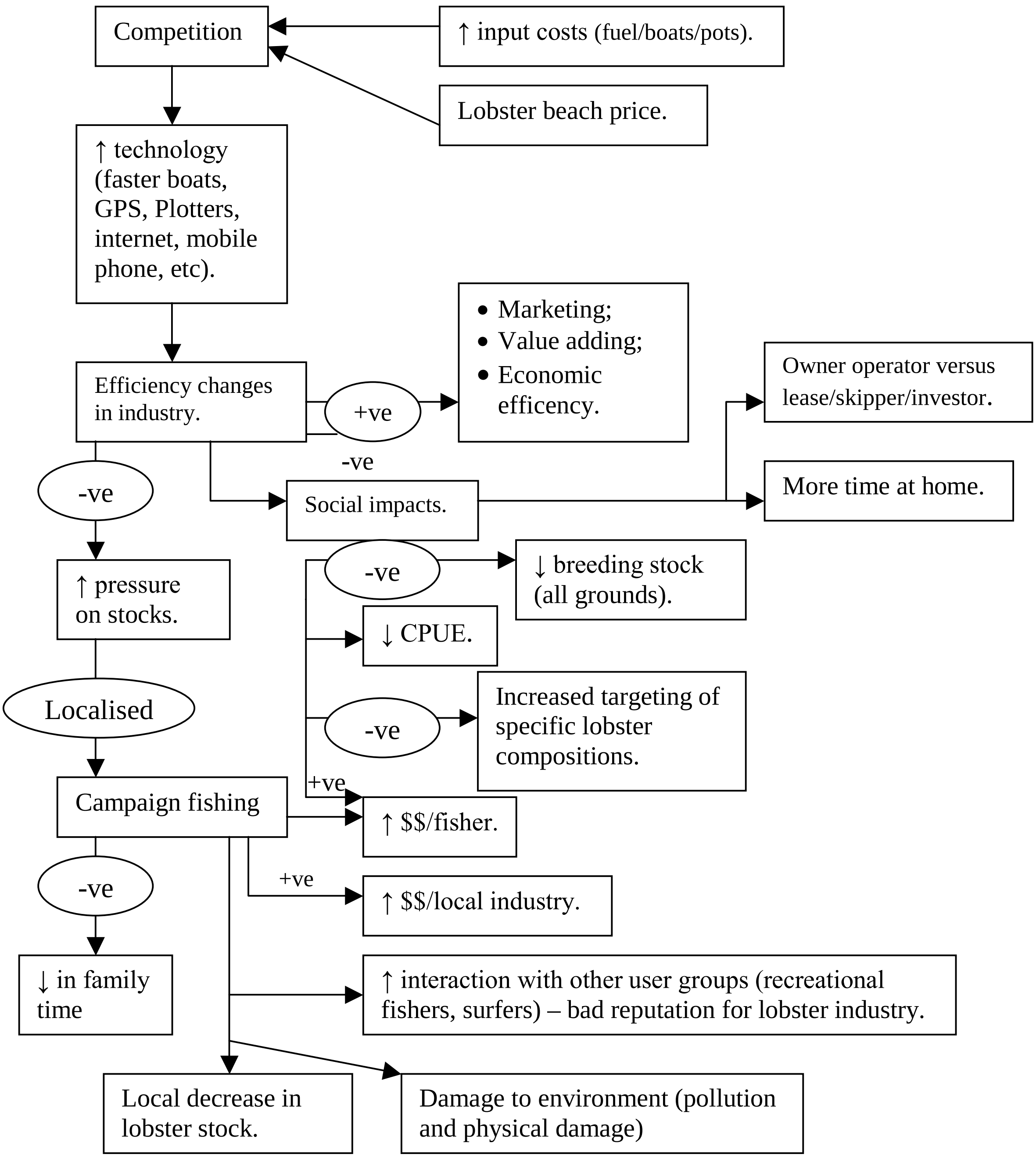


Figure 6.6. Influence diagram to describe the risk from efficiency gains by the fleet.

The system involves several feedback loops that have the potential to create both positive and negative consequences at several points. The stakeholder's meeting discussed scenarios when interactions involved beneficial (optimistic) outcomes, and scenarios for damaging (pessimistic) outcomes. The meeting assessed this hazard in the context of existing management prescriptions and considered potential impacts over the next 5 years. To facilitate discussion, small groups made up of a cross-section of stakeholder interests, assessed this hazard separately. There were substantial differences in the ranks generated by two of the groups. One took into consideration pot reductions and management measures (effort reduction) and ranked the likelihood as low. Another group felt the increase in efficiency would outstrip effort reductions and ranked the risk as high. The stakeholder group discussed the potential for fishery managers to adapt to new technologies and resolved to incorporate an assumption that current management practices remain static. The group raised particular concerns about the location of the recruitment pool and the potential for impacts in areas that are particularly heavily harvested (i.e., the Capes area, from Cape Naturaliste to Cape Leeuwin).

Caputi and Rossbach (2004) reported on fishing activity in the Capes area (Cape Naturaliste to Cape Leeuwin) where activity increased from about 5 boats that normally operate in the area to up to about 50 boats in some months over the last 2-3 years. They noted that lobster abundance in the region depends on the breeding stock from the whole fishery, a consequence of the south-flowing Leeuwin Current. The current was particularly strong in 1999 and 2000 resulting in good puerulus settlement during 1999/2000 and 2000/01, a good catch in 2002/03 and a record catch in 2003/04. Catches are expected to remain above average for the 2004/05 season and return to lower, more 'normal' levels in 2005/06 and 2006/07, as the Leeuwin Current has been weaker in recent years and the puerulus settlement has subsequently declined. The puerulus settlement in 2004/05 season has generally been below average so that catch rates in 2007/08 season are expected to remain average to below average. The expert group assumed static management practices, and the risk was judged by most participants to be moderate (Figure 6.7).

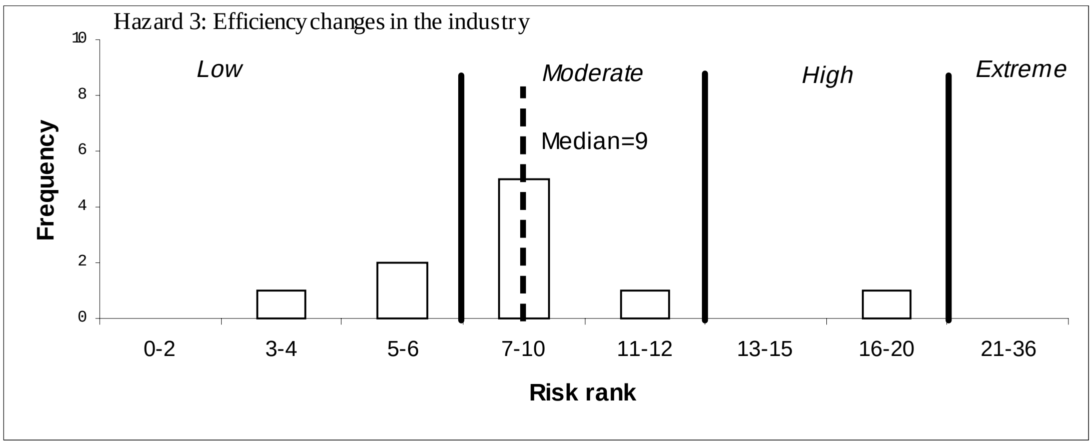


Figure 6.7. Risk from efficiency gains, assuming that current management remains static.

Increases in fishing efficiency of the commercial fleet are inevitable. Management arrangements and monitoring systems are designed to measure these increases. Depletion studies include direct investigations into catchabilities and fleet efficiencies. Independent monitoring of spawning biomass is designed to measure if these efficiencies have had an impact on the spawning stock levels. The management system operates to adjust effort levels periodically (including the present set of proposed adjustments) in line with any increases in efficiency. Hence, most participants judged it to be unlikely (L3) that the spawning biomass will decline to unacceptable levels (C3) during the next five year period. This moderate risk requires ongoing management.

6.1.4. Rock Lobster Sustainability (Spawning Biomass): Mortality and loss of productivity from handling undersized and setose individuals

Rules protect animals below a minimum carapace length (76mm) and females in breeding condition. As a result, it is commonplace for animals to be returned to the sea after capture. Fishers are obliged to return in less than 5 minutes any animal that cannot be legally retained.

Handling of lobsters can result in leg loss. Once legs are lost, animals become more vulnerable to predation or allocate energy into replacing the lost limb(s) before putting energy into growth or reproduction. The resultant impact on mortality and loss of production is unknown. There were no additional direct data on leg loss or its effects on survival or reproduction. The expert workshop discussed rates of leg loss, the effect of weather conditions, rates of loss at different times of year and strategies to minimise leg loss. The general conclusion was that the level of impact on the abundance of the lobster stock resulting from leg loss would, at most, be minor (C1). Participants judged it to be possible (L4) that this will occur, given current fishing practices, resulting in an assessment of the risk of this issue as low (Figure 6.8).

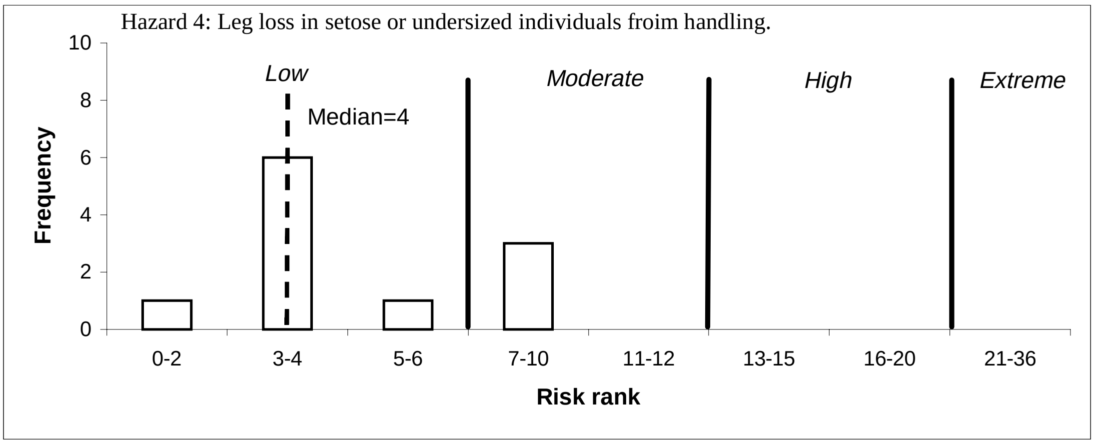


Figure 6.8. Risks resulting from mortality and loss of productivity from handling undersized and setose individuals

6.1.5 Rock Lobster Sustainability (Spawning Biomass): Market decline – effects on fishing

The stakeholder workshop commented that selling rock lobster to important and historically lucrative markets in Asia the USA and Europe is becoming more difficult because of unfavourable terms of trade and increasingly strong competition from other lobster producing nations (e.g. Cuba and Mexico). The competition is putting pressure on price. The stakeholder workshop noted that if fishing becomes less profitable, the response of individuals whose livelihoods depend upon the fishery may be to resist measures that would constrain catch, with the potential to compromise the sustainability of the fishery.

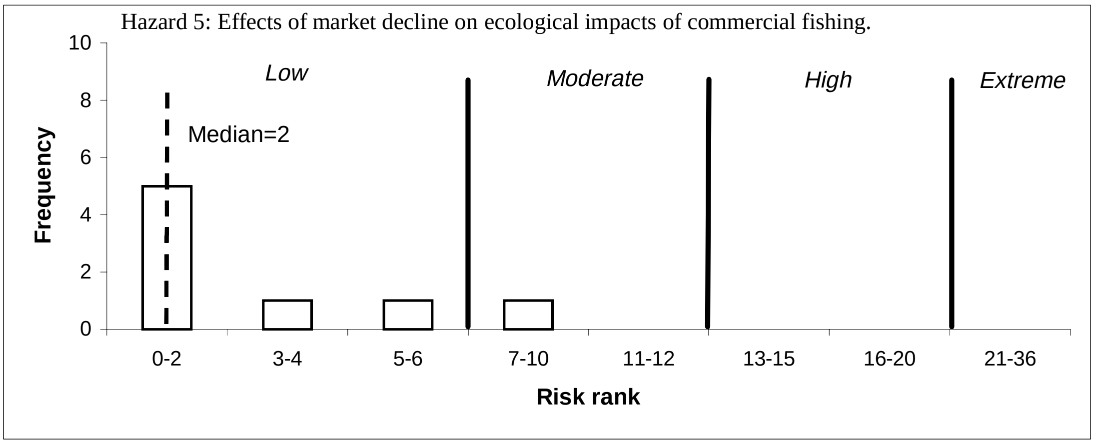


Figure 6.9. Risks to the rock lobster population resulting from market decline (external driver).

The expert workshop did not have access to economic models or economic data on the extent or expected growth in competition in traditional markets. The workshop skills did not include substantial economic expertise. The meeting discussed the effect of market declines in an effort-controlled industry and the ability of the industry to adjust harvest effort in response to price and catch.

Most participants ranked this hazard as low (Figure 6.9), but it is worth noting that 5 participants declined to make a judgement, reflecting the lack of experience and training in economic issues among the participants. The judgements were mostly based on the view that it is very unlikely (L2) that a significant market decline would result in fishers trying to cheat the system or change fishing practices, that these changes would increase exploitation to such an extent that they would generate greater levels of stock depletion (C1), given the compliance programs in place.

6.1.6 Rock Lobster Sustainability: Effects of commercial fishing on genetic structure of stock

This hazard relates to the possibility that fishing, as governed by the current management rules, is selecting lobsters in such a way that it could ultimately affect the species' genetic structure (Figure 6.10). The fishery selects against large, fast growing, late maturing lobsters. If selection is strong, it could result in a shift in lobster genotypes by affecting the frequency of genes for large size and fast growth.

While fishing selects animals that are legally vulnerable to fishing sooner than other animals of the same cohort, there are no data on the degree to which size and growth rates are heritable traits. The evidence that there has been an identifiable or important change the average size of mature females is equivocal. Most experts considered the hazard to be a low risk (Figure 6.11) either because they considered there to be only a rare possibility (L2) that this could occur to an extent that would severely (C3) affect the stock, or that it was possible (L3) that a minor (C1) impact could result.

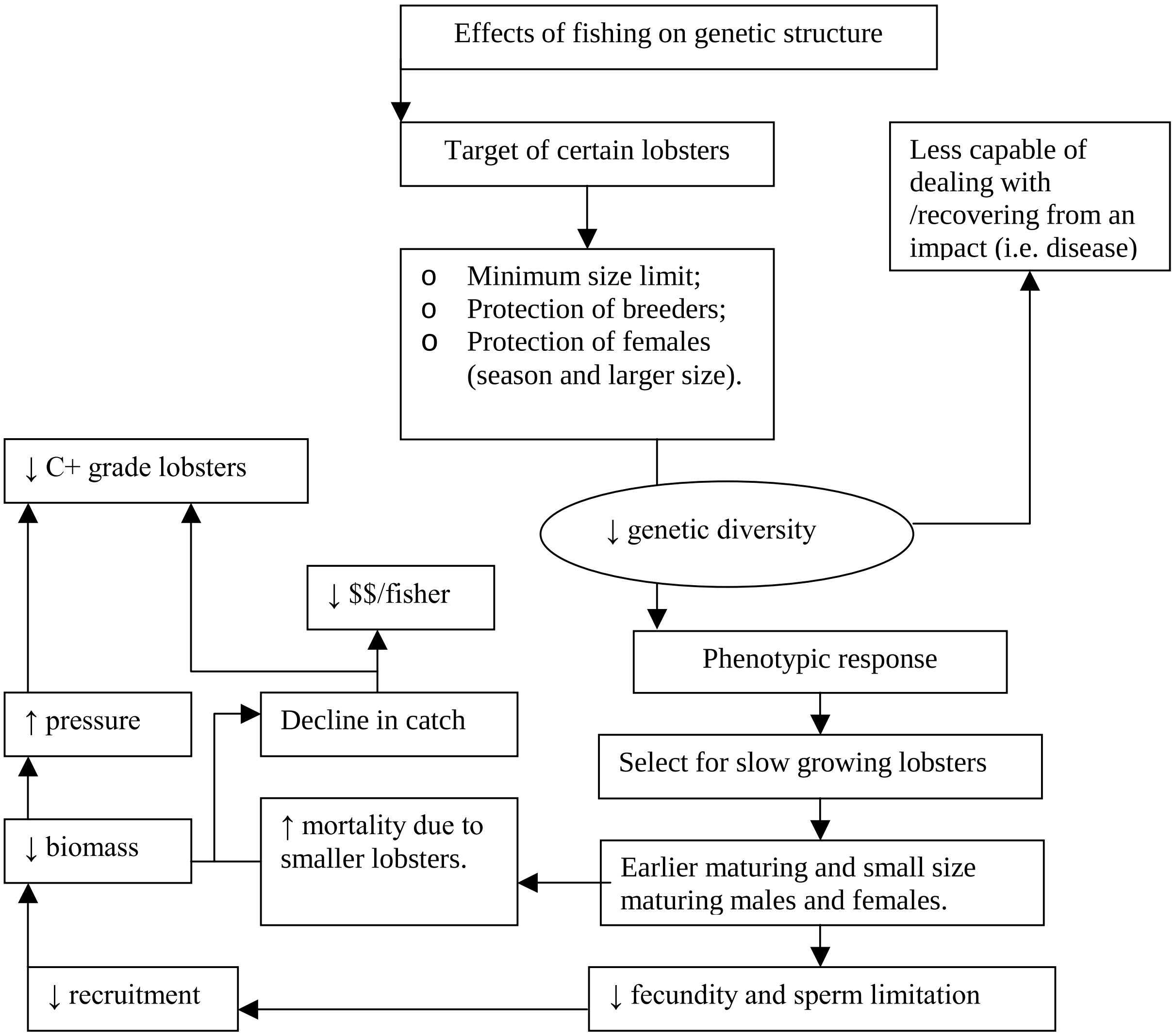


Figure 6.10. Influence diagram to describe the risk that fishing is limiting the genetic gene pool for western rock lobster.

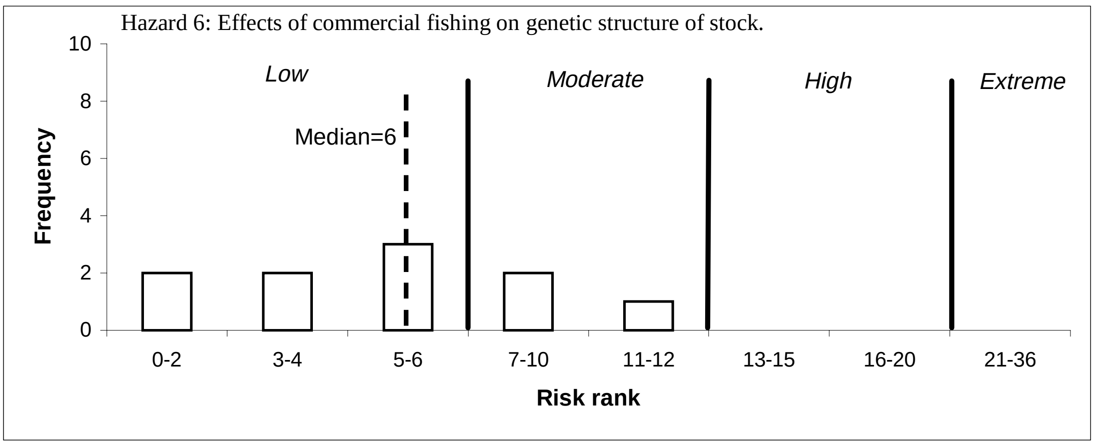


Figure 6.11. Effects of commercial fishing on WRL genetic structure.

6.2 Impacts on by-catch

6.2.1 Impacts on octopus populations

The octopus is a lobster predator and is likely to be an important element in the rock lobster's ecosystem. Octopuses have always been taken in rock lobster pots. *Octopus tetricus* is commonly caught by lobster fishers. *Octopus ornatus* is caught (infrequently) by fishers mainly in the northern region of the fishery (around Kalbarri) and usually in deep water (S. Slack-Smith, WA Museum, pers. comm.).

Interest in consumption of octopus in overseas and local markets has increased over the last one or two decades. Previously, this by-product was discarded or sold as bait. Increasingly, it is being retained for sale to processors. At the same time, interest as grown in octopus fishing by both recreational and commercial fishers outside the rock lobster fishery.

In the first risk assessment, the rating for possible changes to octopus populations was low (C1 L2). The reasoning was that octopuses have a short (1 year) lifespan and their recruitment appears to be highly variable (Joll 1977a). Furthermore, their habitat extends beyond the habitat utilised by the rock lobster fishery, into sea grass habitat, so that only a proportion of the populations would be exploited by the rock lobster fishery. Increases in the number escape gaps in the rock lobster pots have provided increased opportunity for octopus to escape from the pots.

Despite the low risk rating, lobster fishers are the main group impacting on octopus. There is potential for a dedicated octopus fishery. The first risk assessment concluded that the octopus catch should be monitored annually.

The expert workshop was advised that the reported catch rate has increased over the last few years but still remains a relatively small proportion of the number of octopus entering pots. Octopus have been caught by the fishery for 40 years and no evidence has emerged that the octopus stock has been affected. Catch rates are increasing. Most participants judged that it is unlikely (L3) that octopus are being fished near the maximum acceptable levels (C2), resulting in a median expert rank of a low risk. However, because the percentage of the octopus populations caught by the rock lobster fishers is not known and the workshop noted there was some evidence from Tasmanian fisheries that octopus catches in pots can have a detectable impact on octopus population abundances, 5 of 11 participants ranked it as moderate (Figure 6.12).

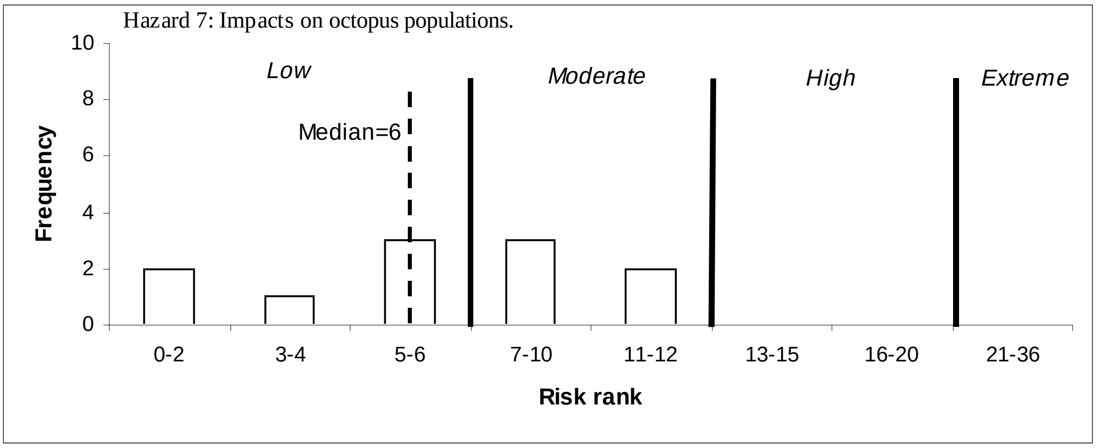


Figure 6.12. Risk of substantial octopus population decline resulting from by-catch.

6.2.2 Impacts on scalefish and sharks

Scalefish and sharks are taken by rock lobster fishers in pots and by wetlining. As the wetlining activity is a legitimate part of another fishery, only pot caught fish were considered here. However, rock lobster fishers take 7% of the total wetfish catch (Figure 6.13) including that by wetlining (Crowe et al., 1999) and their total annual catch is usually tens of tonnes. It includes prized recreational species such as cod and baldchin groper, as well as wobbegong sharks.

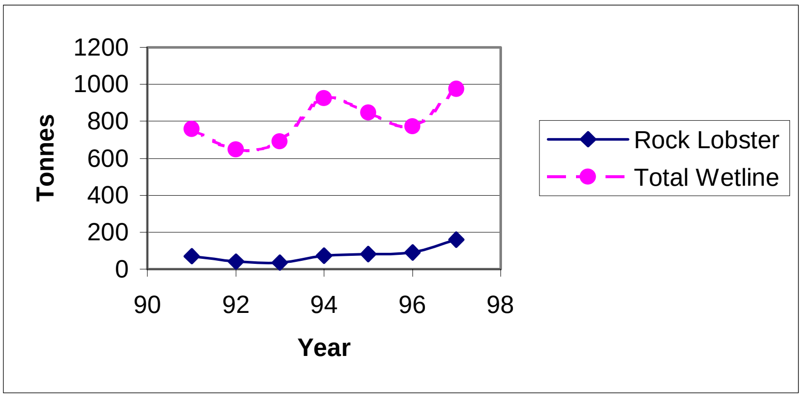


Figure 6.13. Catch of scalefish by lobster fishers (all methods –majority by line) compared to total amounts caught.

Frequently, the pot catch is the property of the crew and supplements their wages. Sometimes it is retained by the licensee and, depending on the species, sold, eaten or used as bait. The first risk assessment concluded that the impact of these activities on breeding stocks of scalefish and sharks was low (C1 L1).

The catch of scale fish taken in lobster pots (as distinct from those caught by lines on the same vessels) is not recorded. It would probably be necessary to make it a licence condition to collect it because it is beyond the scope of voluntary logbook detail. Anecdotally, it is a small percentage of the total scalefish catch.

The accuracy of records ('returns') of incidental catch has not been tested by independent surveys. Usually, the scalefish catch by wetlining and the pot catch are included together. The extent of under-recording of scalefish used as bait rather than sold or eaten, is unknown. Given that scalefish are attracted by rock lobster bait, several are predators of rock lobsters and that rock lobster fishers use such fish as bait, it is not considered practicable to reduce or prevent scalefish and sharks being taken in pots. In the wider context of the Western Australian scalefish catch, the volume of pot caught scalefish and shark (not that caught by line from lobster vessels) is relatively small to negligible.

The management of the wetline fishery for scalefish off the west coast, including the question of the retention of scalefish by rock lobster fishers (caught by any method), is currently the subject of an allocation review process (the Toohey Committee). It is expected that more refined management arrangements, including more explicit allocations amongst sectors, will be developed for all relevant commercial fisheries and recreational fisheries taking wet fish in this region, during the next 2 – 3 years. Most of the experts rated this risk as low (Figure 6.14), judging it unlikely (L3) or very unlikely (L2) there will be even a low impact (C1) on these species by their capture in pots.

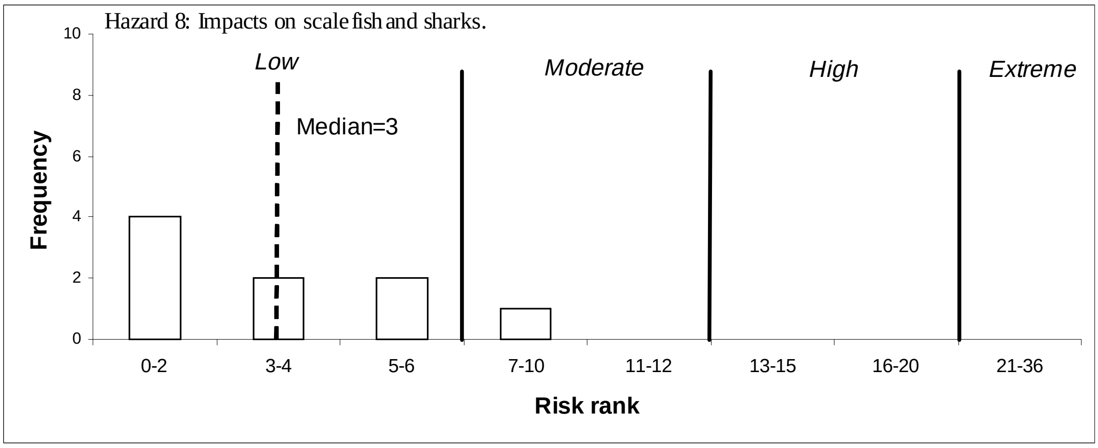


Figure 6.14. Risk of impacts to scalefish and sharks from bycatch taken by the rock lobster fishery.

6.2.3 Impact on Deep Sea Crabs

Deep-Sea crabs (particularly spiny (champagne) crabs, and including king and snow crabs), are taken in small numbers in rock lobsters pots. The spiny crab is considered to be vulnerable to overfishing. If rock lobster fishers were to target them, the catch could lead to the rapid collapse of this small fishery.

Total annual catch by the rock lobster fishery historically has been less than 10 tonnes per annum. In the three years before 2001, the catch was three to four times that figure, less than half the total amount of these crabs taken in W.A. The rock lobster fishery affects the population of spiny deep-sea crabs in the depth range of 150-200 m. The specialised deep-sea crab fishery has demonstrated that the core population is beyond 200 m, generally beyond the range of rock lobster fishing. Rock lobster fishers have been known to target spiny crabs on occasions when the price of rock lobster has been relatively low and the pot catch of spiny crabs has been greater than for lobsters (so the gross return per pot for spiny crabs has been greater). However, most spiny crabs are retained for consumption by boat crews and their families and are not sold.

A proposal to limit rock lobster fishermen from retaining any deep sea crabs altogether or alternatively imposing a daily catch limit (50 kg/boat) is currently with the Minister.

In the past, fishers tended to remove the claws of the crabs and discard the body, but legislation has been introduced requiring all spiny crabs to be landed whole. A minimum size limit of 92 mm CW has been introduced to protect the brood stock. At this minimum size limit, more than 90% of females are protected from harvest.

A joint FRDC research project, part of which includes a PhD project at Murdoch University, has found that deep sea crabs are very likely to survive capture and release when they are returned to the water in a timely fashion. On the basis of this information, the first risk assessment concluded the risk of possible changes to deep-sea crab populations was low (C2 L1)

The expert workshop in this risk assessment was advised that rock lobster fishers take less than 1% of the total deep sea crab population. The tagging exercises are complete and demonstrate that crab survival is very high following return to the water. The expert workshop ranked this hazard as low (Figure 6.15), most participants estimating that the lobster fishery is unlikely (L3) to have a minor impact (C1) or to exceed acceptable levels (C2) on the crabs stocks.

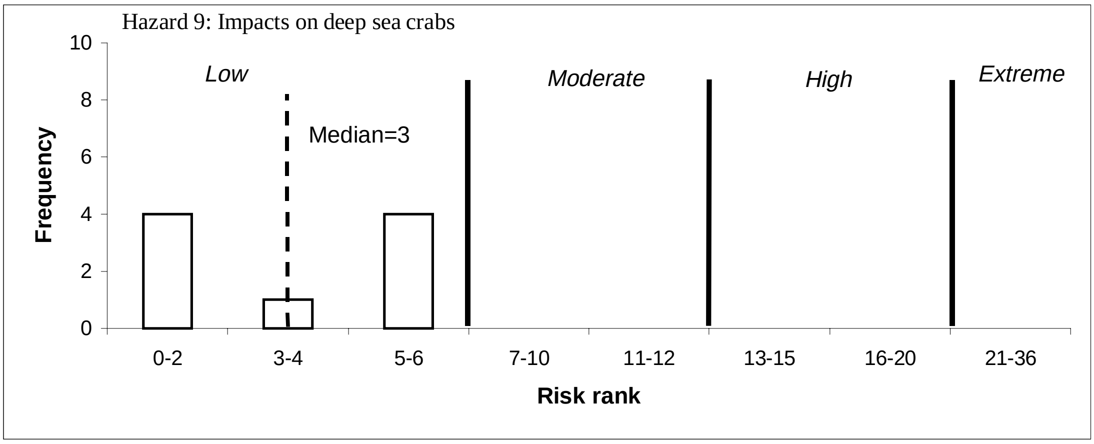


Figure 6.15. Risks of impact on deep sea crabs from bycatch taken by the rock lobster fishery.

6.3 Non-retained species

This section describes hazards that have been identified through the stakeholder workshop or previous risk assessment processes that relate to non- retained species. The component tree comes from the existing risk assessment document.

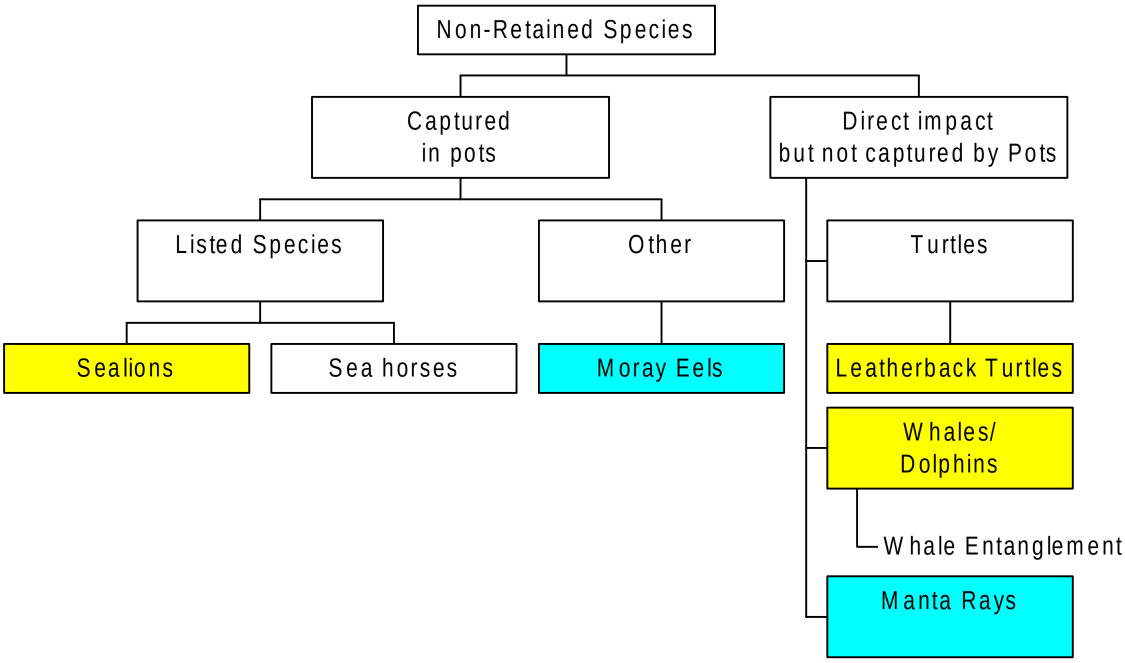


Figure 6.16 Revised component Tree for the Non-Retained Species.

Yellow boxes indicate that the issue was considered high enough risk at the February 2001 Risk Assessment workshop to warrant having a full report on performance. Blue boxes indicate the issue was rated a sufficiently low risk that only the justification for this decision was presented and no specific management was required.

6.3.1 Whale entanglements

Humpbacks and Southern Rights are listed federally as endangered species and are protected. The first risk assessment noted that there were 'rare' reports of migrating whales becoming entangled in rock lobster pot ropes. The meeting noted that CALM had encountered 13 whales entangled with rock lobster rope since 1985 (Doug Coughran, CALM, pers. comm.). None of these whales were found dead. The risk assessment concluded that the risk to threatened whale populations from rope entanglement was low (C1 L2 LOW). The Department of Fisheries commenced data gathering to monitor interactions with rock lobster gear.

The expert workshop in the second risk assessment noted the following:

- There were 29 entanglements of humpbacks since 1990 and 33 altogether.
- 24 of 29 (83%) were in commercial rock lobster gear.
- 96% of the known entanglements with rock lobster gear have occurred in the last 10 years.
- 46% of the known entanglements with rock lobster gear have occurred in the last 3 years
- 60% of the known entanglements with rock lobster gear have occurred in June.
- The number of entanglements of 2 to 3 a year (reported) will continue or increase. There would be more if the rock lobster fishing season overlapped whale migration.

There were no confirmed data on exact locations of the entanglements. There were no recorded mortalities associated with entanglement in rock lobster gear. It is likely that these figures are an understatement because CALM only includes information in the database if strict confirmation is received. There had been and there remains some uncertainty about the number of entanglements and about what happens to the whales once they are untangled. Attempting to release a whale entangled in fishing gear is extremely dangerous. Understanding of the movement patterns of humpback whales is improving and whale numbers are increasing.

The expert workshop noted that this hazard has ecological and public relations (icon species) dimensions. The workshop agreed to treat this hazard in two categories – social and ecological. Ecological risks were mostly considered to be low (Figure 6.17) because only two to three are affected per year from a population of thousands. Furthermore, the stock of whales is increasing by about 10% per year, making it very unlikely that the potential level of interaction by the lobster fishery is affecting the whale stocks measurably (L1) and this is unlikely (L3) to change in next five years (Figure 6.17).

Using social criteria, however, if whales become caught in pots regularly, it is likely to cause a major political or social problem (L4). The risks may increase with increasing populations of whales and therefore may rise to likelihood (L5) in the foreseeable future. Both of these scenarios were considered to be high risks (Figure 6.18).

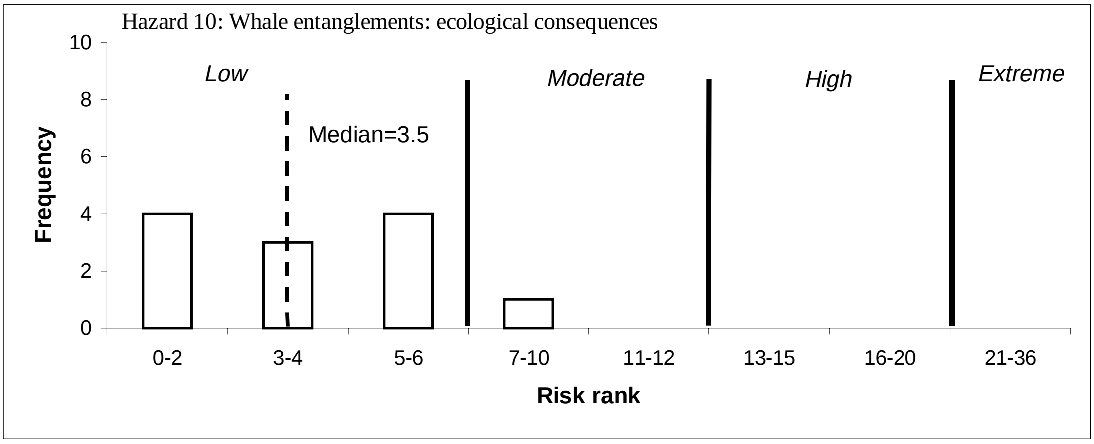


Figure 6.17. Ecological risks from whale entanglements in rock lobster fishery ropes.

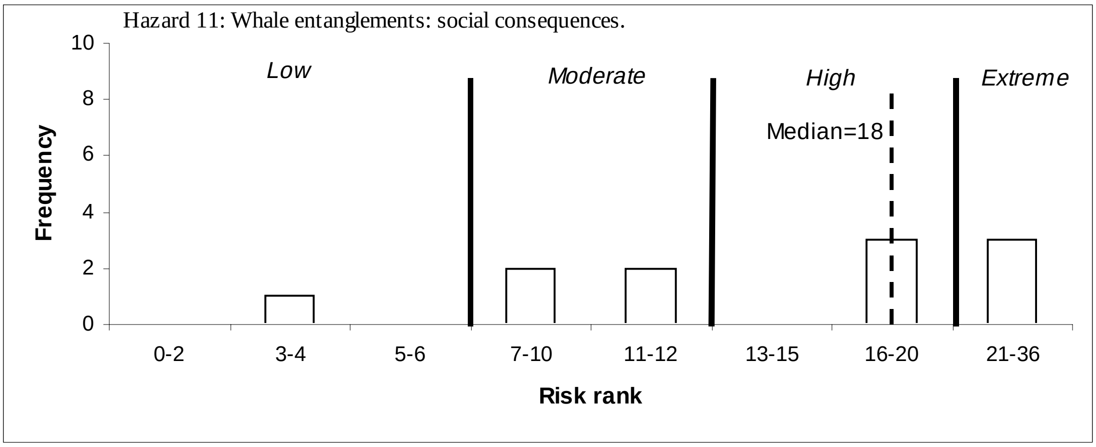


Figure 6.18. Social risks from whale entanglements in rock lobster fishery ropes.

6.3.2 Sea lion interaction with pots

Interactions of seals, sea lions and their pups with pots are recorded in most fisheries around the world. Some sea-lion pups are caught and drown in Western Australian rock lobster pots as they attempt to take either bait or rock lobsters. Dead pups have been reported where pots are set adjacent to the islands on which the species breeds. Sea lions are a listed threatened species and the MSC assessment of the fishery identified seals as an "icon species", both requiring formal strategies to deal with these interactions.

The previous risk assessment was informed of the results of a single survey that indicated that about 150 sea lion pups are born in the mid-west region around Beagle Is., North Fisher Is., and Buller Is. every 18 months and about 20 are born near Abrolhos Is. (mainly Middle group). Five tags were returned from dead pups from fishers out of 150 tag releases (N. Gales, formerly of CALM, pers. comm.). West coast populations of sea lions appear stable or slightly decreasing (N. Gales).

The first ecological risk assessment identified this issue as a moderate risk (sea lion pups entanglement in pots (C3 L4)) until further data could be collected to quantify the risk to the sea-lion population. The first assessment noted that the mortality rate from lobster potting was expected to be 'very small' and 'perhaps insignificant when compared to the reported highly variable mortality suffered by pups up to 5 months old in Western Australia'. This rate varied between 7 and 24%, and depending upon whether pupping occurred in summer or winter respectively

(Shaughnessy 1999). Significant non-fishery factors responsible for the high mortality rate of young sea lions are attacks on pups by territorial bulls and adverse environmental conditions (Shaughnessy 1999).

The expert workshop in this risk assessment was informed about the results of the Sea Lion Interaction Scientific Reference Group (SLSRG). They assessed the sea lion issues as follows:

- Australian sea lions breed in a range from Abrolhos Is. in WA to the Pages Islands in South Australia.
- Australian sea lions are non-selective benthic predators with a comparatively good diving capability that is also present in pups.
- Given the high abundance of undersize rock lobsters in shallow waters in the mid-west and Abrolhos region there is a very low chance of any effect of lobster removal on the food resources available to the sea lion population.
- At Kangaroo Island in South Australia, adult female sea lions dive to depths of up to 150m, but mostly dive in the 60-100m range. In Western Australia adult female sea lions have been recorded diving in 10-120m depths, and it is assumed that their foraging range includes continental shelf waters adjacent to where they live.
- Recent research on the development of diving in sea lion pups has shown that pups of 6-18months of age (the study ages) can dive extensively, and in South Australia dive to depths of at least 60m.
- The Australian sea lion's reproductive strategy is different from other pinnipeds.
- The breeding cycle is about 17.5 months, but the timing of breeding differs significantly (by months) from one colony to the next, with an asynchronous pattern of breeding across their range.
- Genetic analyses (female haplotype) indicated females display a strong breeding site fidelity.
- Males move relatively freely amongst regional colonies but probably do not migrate large distances, i.e. movements between WA and SA colonies would be very rare if at all.
- There is a history of localised extinction in Australia, e.g. Bass Strait, Islands around Albany, Carnac Is, Garden Is.
- Probability of recolonisation appears to be negligible because of female breeding site fidelity.
- Four main breeding colonies on the west coast of WA described as being Abrolhos Is (several islands), Beagle, North Fishermen and Buller Islands.
- Pup production at these sites is estimated to be a total of about 150 at the 3 mid-west islands and about 20 at the Abrolhos.
- There is a documented history of a substantially more abundant population of sea lions at the Abrolhos Is. The reduction to today's very low levels appears to be linked to culling / harvesting events by early explorers and whalers, and a likely low level of take until recent times.
- There is no evidence to suggest colonies in the Jurien area were subject to as high a level of culling / harvesting as occurred at the Abrolhos and it is therefore likely that the Jurien colonies are closer in size to population sizes along the coast prior to human induced mortality.
- The current maximum (reported) rate of interactions is 10 pup deaths per season, about 8% of the pup count.

The SLSRG assessed the data sets alongside the current body of knowledge on sea lions and concluded that:

- Pups are vulnerable to capture in rock lobster pots from the age they enter the water and start diving (approximately 5 months) to a point when they are too large to enter into a pot and drown (possibly about 24 months of age).
- Most accounts refer to pups caught being in the size range of 0.75 to 1m long, which is consistent with the estimated vulnerable age class.
- All known catches are close to shore in less than 11 fathoms, but recent tracking studies of pups in South Australia demonstrate that these catches could occur further offshore.
- The impact of recreational rock lobster pot fishing is unknown, but it is possible that it could contribute to some extent to pup mortality.
- It is not possible to extrapolate from existing data to provide a useful or accurate estimate of total mortality from the commercial rock lobster fishery, however, the current estimate is regarded as being a minimum estimate.
- As there are no data on age/sex specific survival data, and minimal data on other population parameters for Australian sea lions, any attempt to model the impact of fisheries accidental bycatch on sea lion populations would yield highly uncertain results that would be of little use to management.
- Efforts to collect the necessary population dynamics data that could be used for such models requires intensive research within the sea lion communities, an activity that would cause significant disturbance (including increased pup mortality) to the sea lions themselves.
- Given the low reported frequency of sea lion interaction with rock lobster gear, it is not feasible, or cost effective, to adopt an independent observer program to collect data that could reliably estimate the level of interaction.

The meeting discussed the proposed introduction of mandatory Sea Lion exclusion devices (SLEDs) in pots in areas of potential Sea Lion interaction (within, say, a 25 km radius of breeding colonies). The stakeholder workshop and the expert workshop viewed videos of the behaviour of sea lions in pots fitted with SLEDs. The expert workshop agreed to assess the risks to sea lion populations from rock lobster pots with SLEDs in operation ('with management', Figure 6.19) and without them (Figure 6.20). The risks to the populations, if the proposed devices were not implemented, were judged to be moderate with it possible (L3) that the current level of capture by the fishery is sufficient to stop the sea lions populations from increasing (C3, with some scores ranging from low to extreme) without SLEDs. The group judged that the risk would be largely ameliorated (C0) by the use of these devices.

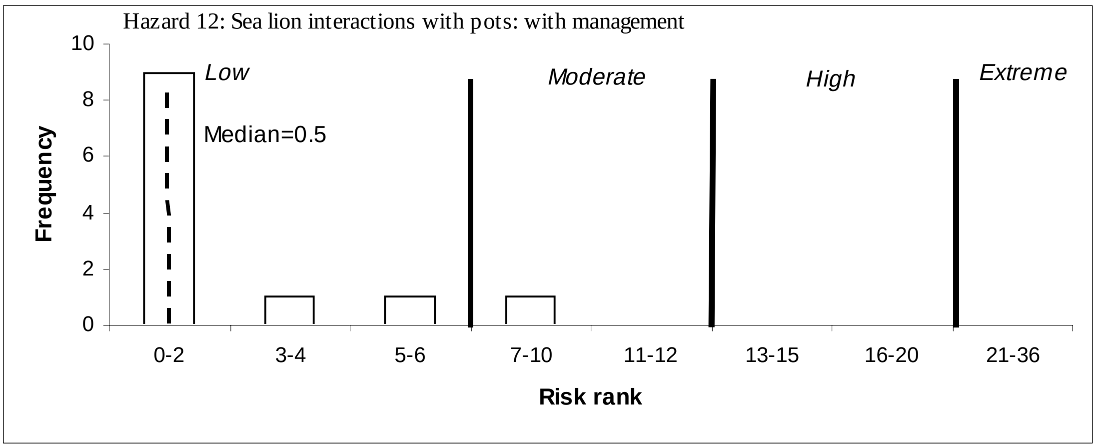


Figure 6.19. Risks to sea lion populations from interactions with rock lobster pots, assuming exclusion devices and other management strategies are implemented.

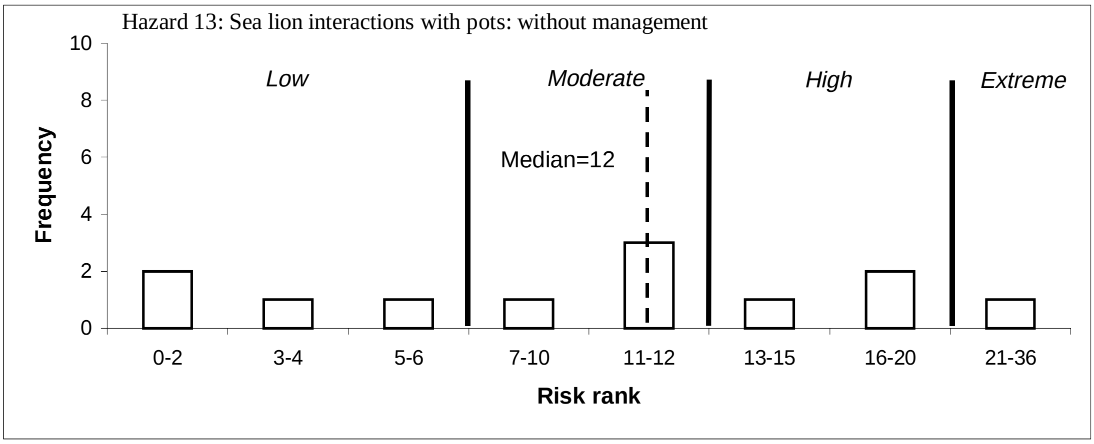


Figure 6.20. Risks to sea lion populations from interactions with rock lobster pots, assuming exclusion devices and other management strategies are not implemented.

6.3.3 Interaction with sea turtles

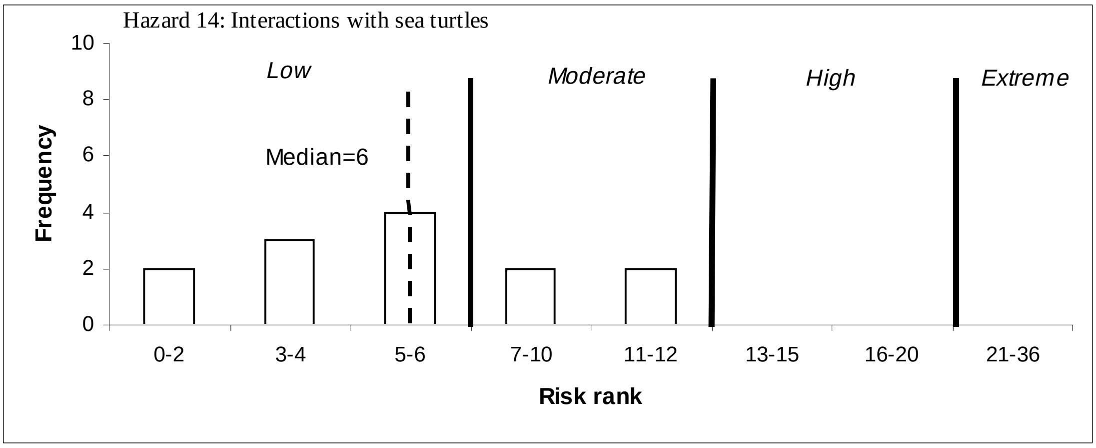
There are consistent reports of leatherback turtles being struck by vessels and becoming entangled in lobster pot ropes (i.e. 1-2 per year for both boat strikes by all vessels and rope entanglements). Mortalities due to rope entanglement or boat strikes occur in roughly equal numbers and all those examined were juveniles (R Prince, CALM, pers. comm.). This species is listed as "Vulnerable"[10] in the Commonwealth EPBC Act and as "Special Protected Fauna" under WA Legislation, creating an imperative to miminise all forms of mortality.

The first risk assessment was informed that museum records (dead or collected animals, some with photos) from 1972-91 indicate that 65% of all marine turtle deaths were associated with rock lobster activities. Some of the records in the WA Museum file were from media articles (N. Dunlop, pers. comm.). The first risk assessment considered the facts that there had been a continued reduction in the numbers of vessels in the rock lobster fleet from about 800 in the 1960s to less than 600 currently, and a reduction in the numbers of pots by 10% in the late 1980s and a further 18% in 1993/94 and concluded the risks to leatherback turtle populations from rope entanglement of turtles were moderate (C3 L4). The Department of Fisheries undertook to gather data to monitor interactions with rock lobster gear.

Rates of turtle entanglement were available from Department of Fisheries data from annual bycatch survey forms completed by approximately 35% of fishers for the 1999/2000, 2000/01 and 2001/02 seasons. These data indicated that as many as 17 interactions with all turtle species occurred in one year, a total of five deaths (1 leatherback and 4 unidentified turtles) were noted over the three years for which data were available. There were 12 reported entanglements of turtles (all species) and 1 death for the 1999/2000 fishing season, 17 entanglements and 3 deaths in 2000/01 and 5 entanglements and 1 death (leatherback) reported in 2001/02. Follow-up phone interviews with most of the fishers recording an interaction indicated that entangled turtles were greens or juvenile leatherbacks (because of their size), which supports the observation of Dr R. Prince (CALM, unpubl.) that only juvenile leatherbacks have been encountered in southern WA waters. Two fishers reported entanglements of

[10] The major impacts on these stocks are the capture of adults and the removal of eggs in the SE Asian region.

green turtles. Fishers indicated that turtle entanglements occurred throughout the fishery from south of Mandurah to north of the Abrolhos Islands and at depths ranging from 14 to 60 fathoms.



6.21. Risks to sea turtles from the rock lobster fishery

The stakeholder's meeting discussed the probability of mortality of entangled individuals released alive. There were no data on this outcome, or on the total number of turtles that enter the area of the fishery per year, and therefore no way of knowing the extent to which boat strikes and entanglement may affect the population. The expert group judged the risks to be low, given that even though the stocks of turtles are declining, and further impacts could result in a severe or major (C3-C4) consequence, the chance that the one or two turtles caught by the fishery will add appreciably to this problem is remote of very unlikely (L1-L2). Four participants however, ranked the risk as moderate (Figure 6.21). The monitoring programs now underway may assist in discriminating between these assessment alternatives.

6.3.4 Interaction with manta rays

The first risk assessment noted that there have only been 'rare' reports of manta rays running up against pot ropes and these ropes being caught between the ray's horns. Anecdotal evidence suggested that on rare occasions manta rays have subsequently become entangled in the ropes and dragged lobster pots a considerable distance. Manta rays are perceived by many as beautiful and benign fish with eco-tourism value. The first risk assessment judged the risks to manta ray populations from rope entanglement to be low (C1 L1) and recommend no specific management actions.

Department of Fisheries observers record interactions with manta rays and the level of incidence and any trends will continue to be monitored and reviewed. This risk assessment acknowledged that are the species are essentially tropical and most individuals are itinerant visitors. The expert workshop judged the risks to manta ray populations to be low (Figure 6.22).

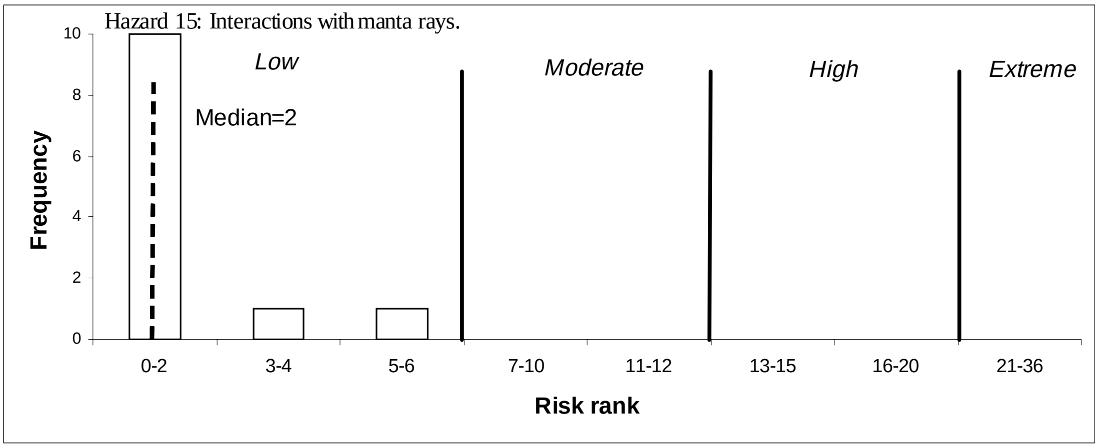


Figure 6.22. Risks to Manta Rays from interactions with the rock lobster fishery.

6.3.5 Interaction with Moray Eels

The first risk assessment noted that fishers catch a large number of moray eels in rock lobster pots. They are returned to the water and are not reported in catch logs. Whilst there has been no research to determine if their capture has any significant impact on the moray eel population or the ecosystem, the fact that large numbers are taken by lobster pots, which are an inefficient way of catching them, would suggest that the populations on the lobster grounds are large. They are of no value to fishermen and present a safety risk to crews while they are aboard the vessel; it is in fishermen's interests to return them to the water as soon as possible. On this basis, the risks to eel populations was considered to be low (C1 L1- LOW)

This risk assessment concurred with the observations and conclusions of the first risk assessment (Figure 6.23). There were no new substantial data and no indication of any changes in the behaviour of fishers or the sizes of eel populations.

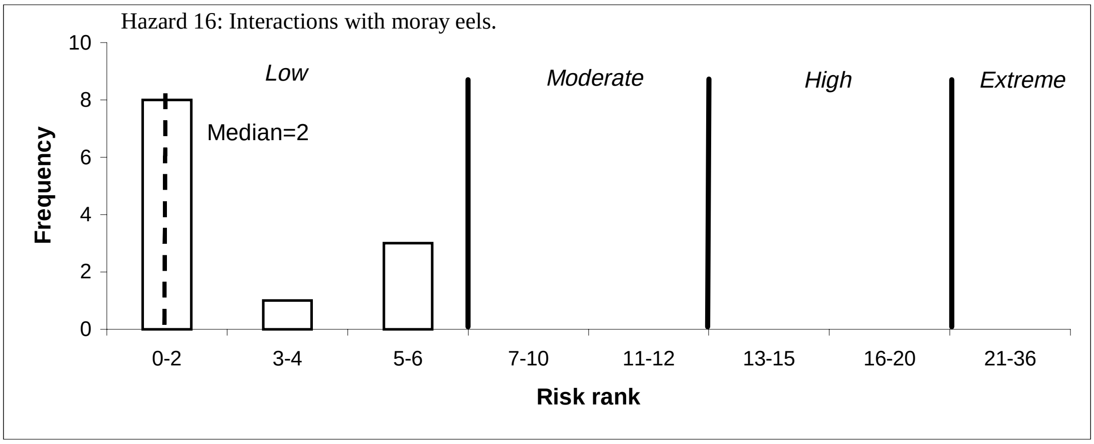


Figure 6.23. Risks to Moray Eels from interactions with the rock lobster fishery.

6.3.6 Sea horses

Sea horses are protected species under Australian the Environment Protection and Biodiversity Conservation Act. The hazard in this instance is that sea horses will use pot ropes as anchors. If they are attached to the rope when the pot is being hauled and do not let go, they may be killed. The stakeholder's meeting discussed this issue and concluded that while there is insufficient evidence to make a formal assessment, sea horse populations were sufficiently large and pot ropes were sufficiently scarce that it would be likely that only a negligible impact (C0) is occurring on the stock and therefore the fishery represents a low risk to sea horse populations. The expert meeting agreed (Figure 6.24).

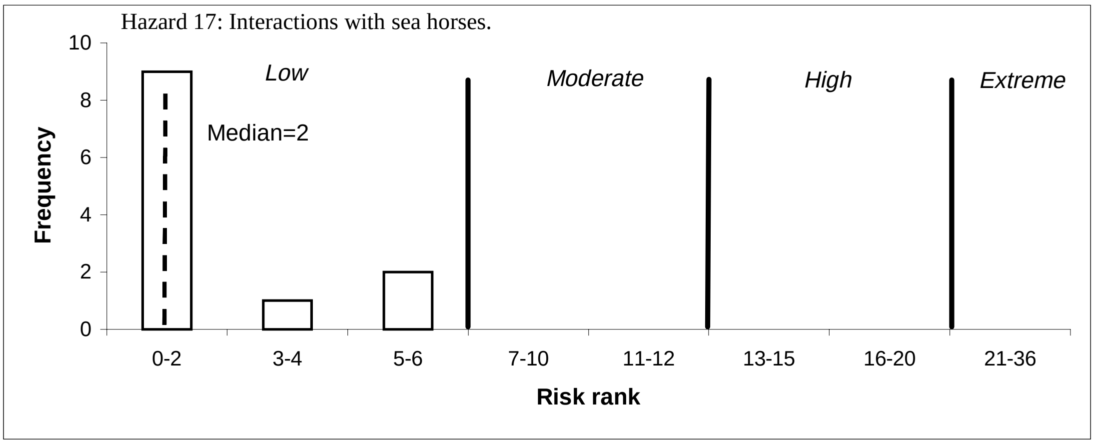


Figure 6.24. Risks to sea horse populations from interactions with the rock lobster fishery.

6.3.7 Uncertainty of bycatch data.

The Department of Fisheries collects, compiles and analyses data from the fishery on interactions with protected species through mandatory and voluntary forms of reporting. However there is no independent data collection. There is a risk that data sourced entirely from the fishery could under-report the true extent of interaction with protected species. The stakeholder's meeting discussed the possibility of including independent observers on vessels, to audit the reporting process. They concluded that the rarity of interactions with high profile and threatened species was too low to make this a worthwhile exercise. The expert group concluded that the risk to protected species from under-reporting leading to misdirection of management effort was low, although three people assigned it a moderate risk (Figure 6.25).

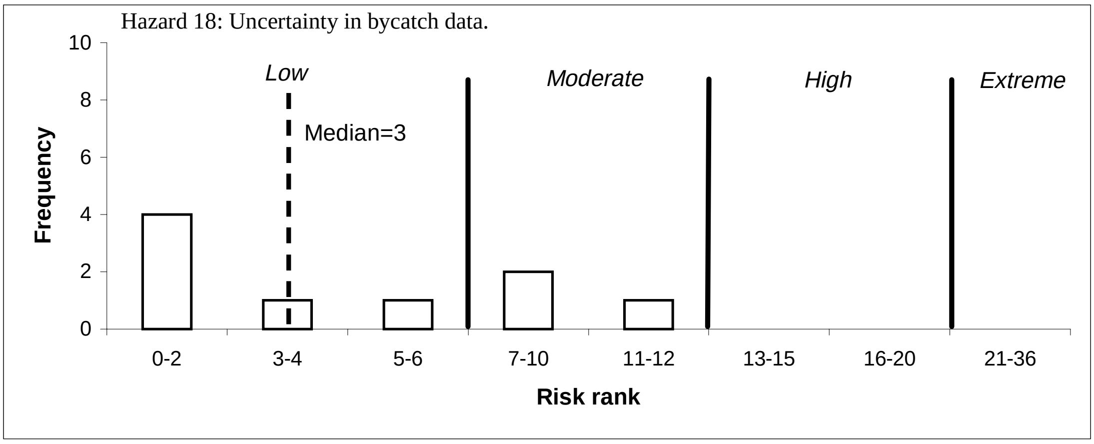


Figure 6.25. Risks to non-retained species resulting from uncertainty in bycatch data.

6.4 General environment

This section describes hazards identified through the stakeholder workshop or previous risk assessment that relate to the general environment. The component tree comes from the existing risk assessment document.

The workshop participants discussed the notion of widening the risk assessment to include hazards that are a consequence of fishing and associated activities, as well as those environmental processes that may affect the fishery. It was decided to take a broader view because regulators or the industry may be able to take proactive steps to mitigate a risk, even if it is not under their direct control. The workshop recognised that the separation of the issues is better dealt with at a management level once the risk has been fully scoped and assessed.

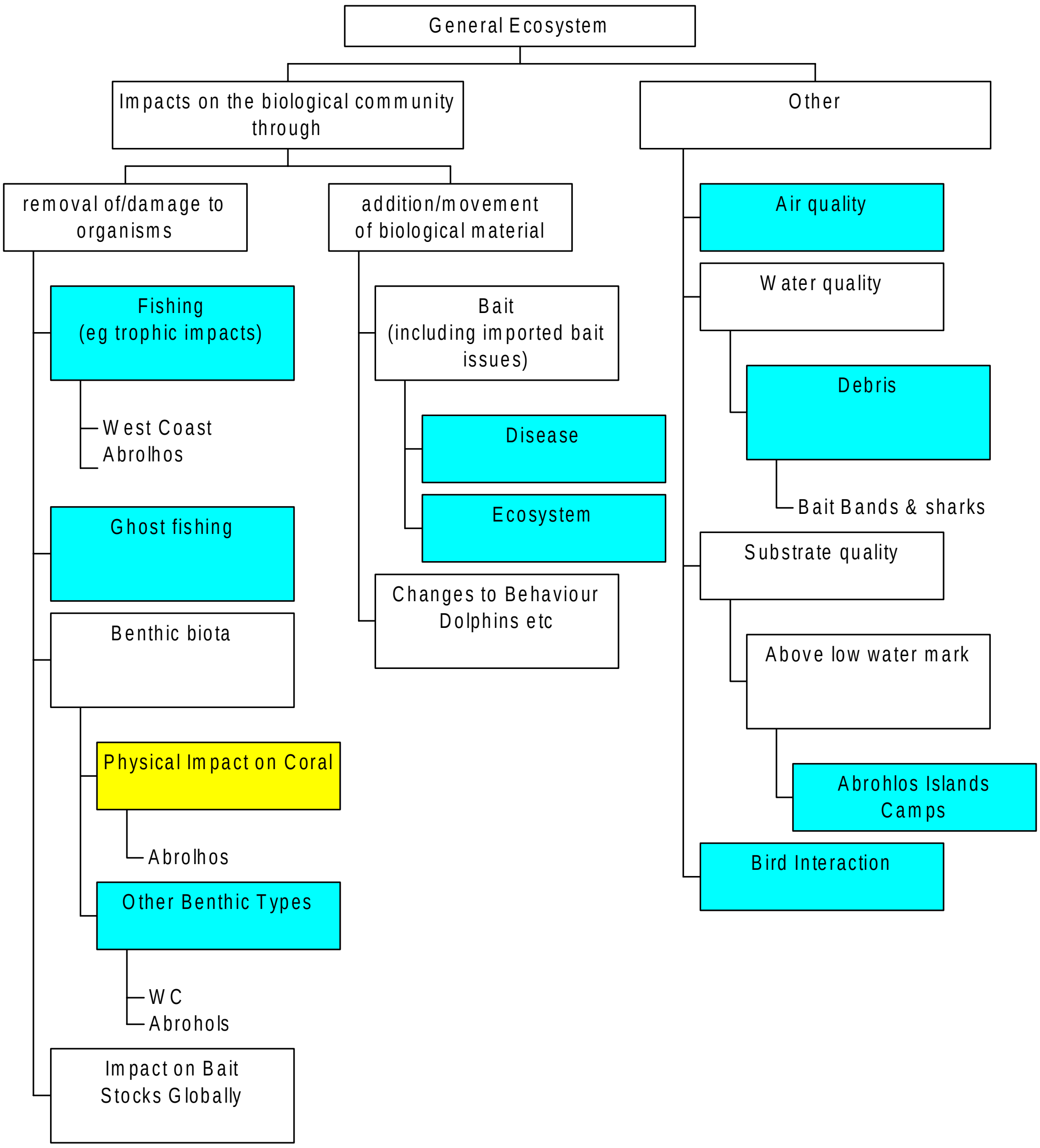


Figure 6.26. Revised component Tree for general ecosystem effects related to the western rock lobster fishery.

Yellow boxes indicate that the issue was considered high enough risk at the February 2001 Risk Assessment workshop to warrant having a full report on performance, Blue boxes indicate the issue was rated a low risk and only this justification was presented and no specific management was required.

6.4.1 Effects of lobster removal on ecosystems

The effect of removing rock lobsters on ecosystems remains one of the most important issues for the management of the fishery. For this reason, it was given detailed treatment and substantial background information has been compiled. In the first risk assessment, the hazard was broken into two elements;

- Effects on items eaten by lobsters (C1, L4, Ranking LOW)
- Effects on higher trophic levels (C1 L3 LOW)

The rationales for these judgements were based on the following information.

- The variation in total catch in last 30 years ranges from 7200 tonnes to 14400 tonnes, indicating a 50% fluctuation in annual abundance of the exploitable section of the stock (Penn, 2000).
- The abundance of the breeding stock indicates that it is currently as high now as it has been over the last 30 years (Penn, 2000) whilst juvenile levels are unaffected by fishing.
- Examination of abundance from puerulus to legal-size rock lobsters near Dongara undertaken by Phillips et al. (2001) have provided an indication of the ratio of biomass of undersize to legal-size lobsters of over 4 to 1, suggesting that removal of legal-size lobsters probably affects the overall biomass by about 10%.
- The current total biomass levels of lobsters are likely to be at least 80% to 90% of the unfished levels.
- Increases to the minimum size during the migration phase of the lobsters (Nov-Jan) and reduction in the number of pots have increased the number of lobsters migrating to deep water each year.
- The predators of the rock lobsters such as sharks have been reduced to about 35-40% of original biomass (Penn, 2000) hence there should be sufficient rock lobsters available as food for the remaining predators and they prey on many other species besides rock lobsters.
- The total removals of lobsters are in the order of 5kg/hectare/year, small compared to the total level of production in this system. In addition, any such impact is likely to be ameliorated by the addition of a similar quantity of bait.

The conclusion was that the management of the stocks of lobsters is sufficient by itself to ensure that there will no more than be minimal/negligible trophic level effects resulting from the rock lobster fishery. The justification for this conclusion rested on the total biomass of lobsters remaining in comparison to unfished levels, reviews of situations worldwide where fishing for lobsters has been associated with changes in ecosystems and a comparison to the circumstances in Western Australia.

It is worth noting here that the magnitude of annual variation of the exploitable stock is somewhat independent of the variation in total catch of rock lobsters in the last 30 years. Given a range of 7300 in total catch, and a sample size of 30 (years), the approximate 'average' annual standard deviation of the total catch is about 1800 (based on expectations of standard normal deviates; Sokal and Rohlf, 1995). The annual average variation of the catch (expressed as, say, 95% prediction intervals) is probably less than 33% of the long-term average catch. In addition, the catch is effectively a sample of the underlying statistical population (the exploitable stock). The variation in the catch confounds natural variation and 'sampling error'. The range of variation observed overestimates natural variation, to an unknown extent. All we can say is that natural variation in the exploitable stock is smaller.

Biomass Levels

Two quantitative studies provided information on the current biomass of lobsters off the Western Australian coast in comparison to unfished conditions. Trophic impacts (on organisms that are the prey of lobsters and those that prey on lobsters) are most likely to be affected by biomass reduction. Phillips et al. (2001) information from FRDC project 98/302 that examined puerulus settlement rates in comparison to subsequent recruitment into the fishery and beyond. Another study (see below) used the length frequency data collected as part of the fishery-independent monitoring program to estimate impacts.

Biomass levels based on puerulus modelling

This approach used estimates of the number of puerulus that settled in the Dongara region[11] each year during a 30-year period (1968-1998) to estimate the number of animals surviving from each cohort through time, making use of catch and effort data to estimate the parameters including natural mortality, density-dependent mortality and fishing mortality. The model then used the age-weight key determined by Morgan (1977) to estimate total biomass. This was done with and without fishing to determine the average reduction in biomass caused by fishing for any given level of puerulus settlement.

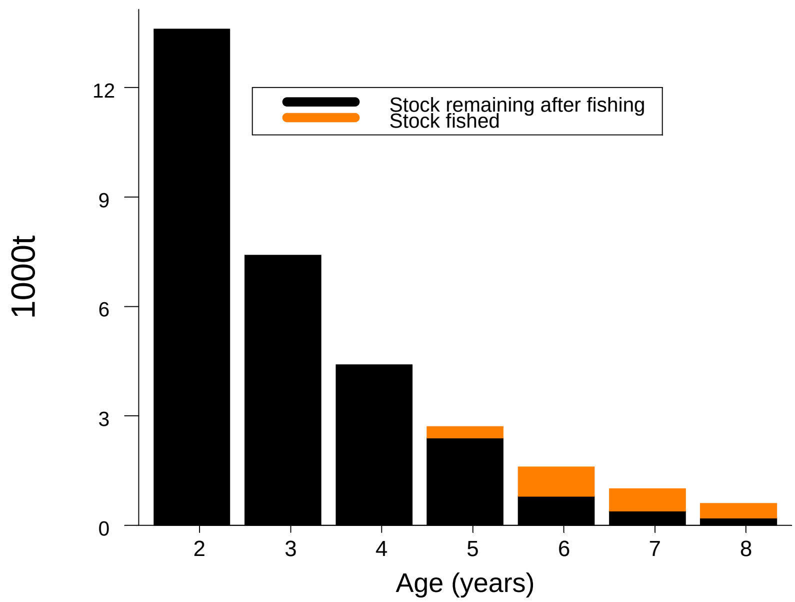


Figure 6.27. Plot of the biomass remaining of each year class at the end of the fishing season in comparison to that biomass that would have been there in the absence of any fishing. This scenario is calculated for average puerulus settlement of 338 million. The level of fishing is that experienced in 1991/92 (2.55 million pot lifts) and ignores the effect of the extra 93/94 management arrangements (e.g. 18% pot reduction).

[11] It is assumed that this region is typical of the lobster fishery given that it is in the middle of their distribution.

Biomass estimates were calculated using the minimum (60 million), maximum (1200 million), average (338 million) and median (600 million) puerulus recruitment levels that occurred during the previous 30 years. The basic pattern was the same for each scenario, with the distribution of biomass levels within each age class of lobsters showing that the majority of total lobster biomass is in the juvenile classes, even under unfished conditions (Fig. 6.27, Table 6.3).

This method allowed the reduction in total biomass due to fishing to be calculated (Table 6.4). Under all recruitment scenarios, the total percentage reduction in biomass due to fishing was less than 10% with the most likely reduction, based upon average conditions, being 7%.

Table 6.3. Biomass of each year class remaining at the end of the fishing season, and the biomass caught during that season, using an integral method based upon average (338 million) puerulus recruitment levels.

Age	Bio mass remaining (1000t)	Bio mass fished (1000t)	Weight/lobster (kg)
2	13.6	0	0.19
3	7.4	0	0.27
4	4.4	0	0.36
5	2.4	0.3	0.45
6	0.8	0.8	0.55
7	0.4	0.6	0.66
8	0.2	0.4	0.77

Table 6.4. The percentage of total biomass of legal size and the total reduction in biomass due to fishing at 4 levels of puerulus recruitment.

Recruitment (millions)	Legal Biomass (%)	Biomass Reduction (%) From Fishing
Low (60)	23	8.7
Average (338)	19.1	7.3
Median (600)	18.2	7.0
High (1200)	17.2	6.5

Length Monitoring Assessments

Information collected from the length-monitoring program completed each year provides the length distribution of lobsters in each zone of the fishery, from which the biomass for all length classes may be calculated. It also allows the determination of the biomass protected from fishing (either by size and/or setose rules), the unprotected (legally exploitable) biomass, and the amount removed by fishing activities.

Figures 6.28a and b show the length frequency distributions of lobsters in fishing areas A and C. While these distributions have been adjusted for the effects of escape gaps, the length classes less than 65 mm will still be under-represented and the sizes below 60 mm are not represented at all.

Using the modelling performed on single age classes (for the 4 puerulus settlement scenarios noted above) enabled a comparison between the total biomass of a first year cohort and the biomass of the same cohort in its second, third and fourth years until fully recruited into the fishery. These analyses made two simplifying assumptions; (a) within each scenario puerulus settlement is constant between years (which is a conservative approach), and (b) the biomass vulnerable to the fishery (B*) is represented by 4 year and older animals (which is known from the extensive catch sampling work over the past 20 years). Given this, it was possible to determine the relationship between the biomass vulnerable to the fishery and the total lobster biomass in each region. Table 6.5 summarises the calculations.

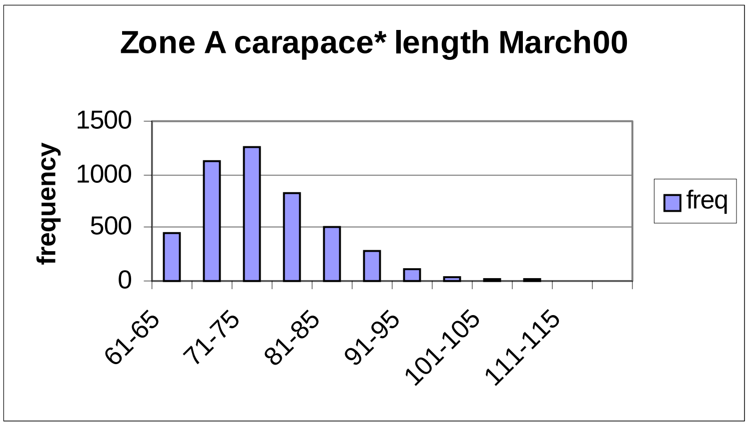


Figure 6.28a. Length frequency of lobsters within Zone A developed from monitoring data and modified for escape gap retention rates.

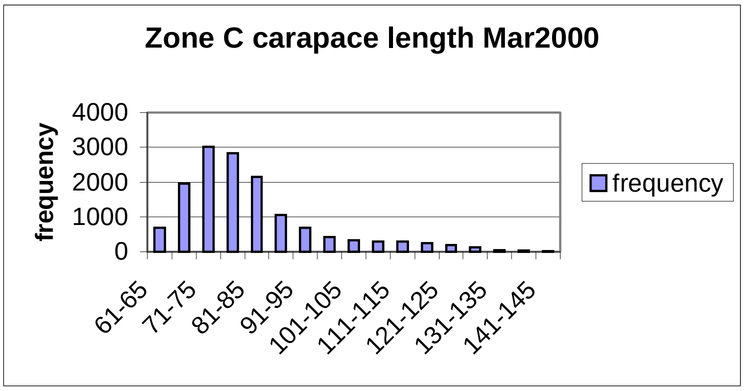


Figure 6.28b. Length frequency of lobsters within Zone C developed from monitoring data and modified for escape gap retention rates.

Averaging the ratios in the last line over all four scenarios indicates that B* was 27.7% of the total biomass in March 2000 (Table 6.5). Thus, the total biomass will be 3.6 times B*. For Zone B, the total rock lobster biomass is 21234 tonnes, and the catch of 1888 t therefore only represents about 9% of the total biomass (Table 6.5). This percentage is very similar to the values calculated above (6-9%).

Allowing for error in the calculations of both these estimates, it is clear that the total biomass remaining after fishing is likely to be greater than 90% of unfished levels and would certainly be greater than 80%. Such a drop is unlikely to have any substantial impact on other trophic levels unless lobsters are responsible for a very strong forcing role in community structure, and perhaps not even then. This possibility is explored below.

Table 6.5. Biomass of lobsters modelled using the 4 recruitment scenarios in Zone B.

Age	Scenario1 biomass	Scenario2 biomass	Scenario3 Biomass	Scenario4 biomass
2	13.6	19.6	4.7	16.7
3	7.4	9.5	3	8.5
4	4.4	5.5	2	5
5	2.3	2.9	1.1	2.6
6	0.8	1	0.4	0.9
7	0.4	0.4	0.2	0.4
8	0.2	0.2	0.1	0.2
yr2&3	21	29.1	7.7	25.2
yr4on	7.9	9.8	3.7	8.9
(B*)				
all ages	28.9	38.9	11.4	34.1
B*/ Total	0.273356	0.251928	0.324561	0.260997

The unexploited fraction of the rock lobster population is virtually all in the undersize classes of the population, which live inshore (in depths of 0-20m). The remainder of the species' range (20 to 100m) is populated mostly by the exploited fraction of the population. Thus, most of the impact of lobster removal, such as it is, will occur in the relatively deep water habitat. This consideration underlies stakeholder concerns about impacts in deep water environments and creates the motivation for ongoing studies into their fundamental ecology that are outlined in the next section.

<u>Trophic interactions</u>

Juvenile lobsters are found mostly in shallow water inshore areas where the fishery has very little impact (see above). Howard (1988) recorded a number of small predators of pueruli and post-pueruli including sand bass, sea trumpeters, brown-spotted wrasse and gold-spotted sweetlips. None of these fish are commercial species and little is known of their biology, but there has been almost no impact on the abundances of these life stages of lobsters. Octopus are important predators of larger lobsters (Joll, 1977b), but their numbers are being monitored (see earlier references in the document). In the deeper water, lobsters are generally larger in size and consequently have fewer predators. There are no known predators that rely on western rock lobster as their sole prey item (see food web in Figure 6.29).

Western rock lobsters are generalist feeders, known to consume a range of different plant and animal material. The major components are coralline algae, molluscs and crustaceans (Jernakoff et al. 1993, Joll and Phillips 1984), which are also eaten by other predators (Edgar, 1990). Small gastropod species, such as *Solemya* sp., are known to be eaten by juvenile western rock lobsters in areas where they occur in large numbers (Joll and Phillips 1994). This latter species has been studied by Rainer and Wadley (1991) and has been shown to have year-round recruitment and high production to biomass ratios, indicating that they have a high mortality, and therefore high turnover rates. Juvenile rock lobsters at Seven Mile Beach and Cliff Head showed a range of diets and feeding strategies, with diets at the former location varying greatly between seasons and between lobsters feeding in different habitats in the same season (Edgar 1990a). Edgar (1990a) further reported that the diet of *P. cygnus* reflected the abundance and size distribution of benthic macrofauna on all sampling occasions.

Rock lobsters significantly reduced the densities of a number of gastropod species found in seagrass areas (Edgar 1990a, b). Edgar (1990c) found that the western rock lobster caused autumn and winter declines in the seasonally abundant trochid gastropod *Cantharidus lepidus*, that settle in extremely high densities at Cliff Head in summer (Edgar 1990a). Other predators, such as the blue swimmer crab (*Portunus pelagicus*) are likely to be interspecific competitors for the same prey items (Edgar 1990b). Rock lobsters were shown by Edgar (1990a, b) to have substantially less impact on one of their key prey species at this study site than other seagrass-associated epifaunal predator species.

While the impact of larger lobsters (>80mm carapace length) on the population dynamics is not known, the bulk of the lobster biomass comprises lobsters less than the legal harvestable size.

Preliminary observations of the areas where the larger lobsters live in deeper waters suggest that these regions generally have simple habitats, composed mostly limestone reefs and sand. Removing a percentage of the larger lobsters in this region may result in less cannibalism on smaller recruiting lobsters. The description of habitats and the diet of lobsters in deeper waters could be confirmed by more rigorous study.

Harvesting has a negative impact on rates of recruitment at high stock levels. The solution to this issue has been to aim to manage the level of spawning biomass at optimum levels for the fishery.

Comparison to other systems

The western rock lobster does not appear to have the dominant forcing effect postulated for *Jasus lalandii* in South Africa or for *Homarus americanus* in Canada. In South Africa in areas where rock lobsters are absent or in low densities, benthic fauna is comprised of dense mussel beds, sea urchins, sea cucumber and many whelks but little macroalgae. In contrast, areas with large assemblages of rock lobsters had a dense flora of seaweeds but very few other benthic organisms (Barkai and Branch 1988, Barkai 1986, Barkai and Barkai 1985). Tarr et al's (1996) hypothesis that increased abundance of *J. lalandii* can cause high mortality of juvenile abalone has been supported by research reporting a negative correlation between the densities of rock lobster and sea urchins, and a positive correlation between juvenile abalone and sea urchins (Mayfield and Branch 2000). The juvenile abalone remain concealed under sea urchins and thus avoid predation. The indirect negative effects of *J. lalandii* on juvenile abalone pose a threat to the abalone industry, already under stress from poaching (Mayfield and Branch 2000).

In New Zealand, the abundance of *Jasus edwardsii* and the local sea urchin (*Evechinus chloroticus* – which is capable of forming barren grounds - Ayling, 1981) in a marine reserve at Goat Island near Leigh (north-eastern New Zealand) showed no clear pattern of change despite a striking increase in the number of rock lobsters within the reserve (Cole et al. 1990). In the Maria Island Reserve in Tasmania, Edgar and Barrett (1997) also reported increased densities of rock lobsters (*J. edwardsii*), and significant increases in densities of sea urchins and in the mean size of abalone between 1992 and 1993, shortly after the reserve was declared. Thus it would appear that temperate Australian and New Zealand rock lobster populations have a significantly less "influential" ecological role in determining community structure than their South African counterpart. Moreover, in Western Australia, there are no populations of subtidal sea urchins capable of creating “barren grounds”.

In Canada, Breen and Mann (1976), Mann and Breen (1977) and Mann (1977, 1982) suggested that the “barren grounds” off Nova Scotia were due to a lack of predation by the lobsters on the sea urchins (*Strongylocentrotus droebachiensis*) caused from the overfishing of lobsters in this region. However, subsequent studies have suggested that the lobsters could not have controlled the abundance of sea urchins and the increases and declines in urchins were due to variations in recruitment and disease levels respectively (Miller, 1985, Jennings & Kaiser, 1998). See also Elner & Vadas (1990).

Overall, the evidence from Western Australia is that large levels of lobster biomass remain after harvest, the interactions of the lobsters with both their prey species and their predators are weak, and the overall impact of the rock lobster fishery on the wider ecosystem through trophic effects is not likely to be substantial and may be managed by the prescriptions that maintains lobster biomass at its current levels.

Teleosts
Glaucosomidae
Glaucosoma hebraicum (Westralian dhufish)
Labridae
Choerodon rubescens (baldchin groper)
Sparidae
Chrysophrys auratus (pink snapper)
Carangidae
Large carangids (trevally)
Elasmobranchs
Orectolobidae
Orectolobus spp (wobbegong)
Triakidae
Mustelus antarcticus
Large epinephalids (cods)

Vertebrata
Otariidae
Australian sea lion
(*Neophoca cinerea*)

Invertebrata
Octopodidae
Octopus spp

Only < 26mm CL mean 14.3mm CL from Howard 1988
In order of importance in collections
Centropomidae
Psammoperca waigiensis (sand bass)
Teraponidae
Pelsartia humeralis (sea trumpeter)
Labridae
Pseudolabrus parilus (brown-spotted wrasse)
Haemulidae
Plectorhinchus flavomaculatus (gold-spotted sweetlips)
Serranidae
Epinephelides armatus (breaksea cod)
Epinephelus rivulatus (chinaman cod)

Western Rock Lobster

Amphibolis & macroalgae
(lobsters 8-25mmCL)

Coralline algae	34.5%
Molluscs	29%
Crustacea	7%
Detritus	3%
Other	1%
Worms	0.5%
Non-coralline algae	Trace
Seagrass	Trace
Unidentifed	23%

Amphibolis and reef top turf (25-40mmCL)
Heterozostera & *Halophila* meadows and around reef
(lobsters 40-70mmCL)

Seven Mile Beach	%vol	%freq
Coralline algae	41.3%	97.8%
Corallina cuvieri		
Metagoniolithon stelliferum		
Jania spp		
Metagoniolithon spp		
Seagrass	12.8%	98.7%
Amphibolis spp		
Halophila ovalis		
Heterozostera tasmanica		
Syringodium isoetifolium		
Non-coralline algae	10.3%	84.4%
Caulerpa cactoides		
Epiphytic red & green algae		
Molluscs	7.2%	96.2%
BIVALVIA		
Lucinidae		
Solemyidae		
Solemya sp.		
Mytilidae		
Musculus spp		
GASTROPODA		
Trochidae		
Prothalotia lepidus		
Komaitrochus pulcher		
Phasianellidae		
Tricolia spp		
Phasianella spp		
Cerithiidae		
Bittium spp		
Diala spp		
Columbellidae		
Pyrene scripta		
Dentimitrella sp.		
Nassariidae		
Nassarius fufula		
Rissoidae		
Eatoniella sp.		
Other organisms	3.8%	89.2%
Foraminifera		
Echinoderm		
(mostly echinoid fragments)		
Scales, bones and tissue of fish		
Tissue and spicules of sponges		
Ascidians		
Pycnogonids		
Hydrozoans		
Sand		
Unidentifiable material		
***Panulirus* exuviae**	2.5%	23.4%
Crustacea	2.2%	57.0%
Isopods		
Amphipods		
Small crabs particularly		
Halicarcinus spp		
"Worms"	1.4%	59.7%
Nereids		
Eunicid ploychaetes		
Sipunculids		
Digested material	18.5%	100%

Amphibolis and reef top turf (25-40mmCL)
Heterozostera & *Halophila* meadows and around reef
(lobsters 40-70mmCL)

Cliff Head	%vol	%freq
Molluscs	24.4%	93.8%
BIVALVIA		
Mytilidae		
Brachydontes ustulatus		
GASTROPODA		
Trochidae		
Prothalotia lepidus		
Similar suite of molluscs to Seven Mile Beach encountered but two spp above dominated with occurrence of others considerably more patchy		
Coaralline algae	18.7%	82.8%
Corallina cuvieri		
Metagoniolithon stelliferum		
Jania spp		
Metagoniolithon spp		
Panulirus exuviae	11.6%	41.6%
Other organisms	8.3%	81.8%
Foraminifera		
Echinoderm		
(mostly echinoid fragments)		
Scales bones and tissue of fish		
Tissue and spicules of sponges		
Ascidians		
Pycnogonids		
Hydrozoans		
Sand		
Unidentifiable material		
Seagrass	6.3%	88.0%
Amphibolis spp		
Halophila ovalis		
Heterozostera tasmanica		
Syringodium isoetifolium		
Non-coralline algae	3.4%	78.0%
Epiphytic red & green algae		
Crustacea	2.4%	50.2%
Isopods		
Amphipods		
Small crabs particularly		
Halicarcinus spp		
"Worms"	0.7%	45.9%
Nereids		
Eunicid ploychaetes		
Sipunculids		
Digested material	24.3%	100%

Figure 6.29. Predators and prey of the western rock lobster, *Panulirus cygnus*. Data collated from Joll and Phillips (1984), Edgar (1990a), Howard (1988) and unpublished Department of Fisheries records.

EcoSRG assessment

Subsequent to first risk assessment and the uncertainty around the risk rating of ecosystem effects, the Western Rock Lobster Fishery Effects of Fishing on the Ecosystem Scientific Reference Group (EcoSRG) was convened. It is an independent, expertise-based body, whose role is to provide advice on the effects of fishing on the ecosystem.

The EcoSRG accepted advice from DOF with respect to the following life history and behavioural aspects of western rock lobsters:

- The variation in total catch of rock lobsters in the last 30 years has been from 7200 tonnes to 14500 tonnes indicating a 50% fluctuation in annual abundance of exploitable section of the stock (Chubb, 2003).
- The abundance of the breeding stock indicates that its current biomass is as high now as it has been over the last 20 years whilst juvenile levels are unaffected by fishing.
- Examination of abundance from puerulus to legal-size rock lobsters near Dongara undertaken by FRDC project 98/302 (Phillips et al. 2001) has provided an indication of the ratio of biomass of undersize to legal-size lobsters of over 4 to 1 so that removal of legal-size lobsters probably affects the overall biomass by about 10%, probably much less than the impact of natural variations.
- Increases to the minimum size during the migration phase of the lobsters (Nov-Jan) and reduction in the number of pots have substantially increased the number of lobsters surviving the migration to reach deep water each year.
- The predators of the rock lobsters, such as sharks, have been reduced to about 35-40% of original biomass (Penn, 2000); hence there should be sufficient rock lobsters available as food for the remaining predators, keeping in mind that they prey upon many other species in addition to rock lobsters.
- The current estimates of the total biomass levels of lobsters suggest that they are at least 80% to 90% of the unfished levels (considering undersized and breeding females are protected by law).
- Lobsters in shallow water are opportunistic omnivores feeding on a wide range of prey; many prey are highly productive species with short life cycles.
- In shallow water, lobsters have a home range of about 800 m and many have individual foraging patterns, returning to their dens in the early morning.
- Tracking of juveniles in shallow water suggested that lobsters are attracted to baited pots from a downstream odour plume. Only a proportion of lobsters that visited the baited pots were caught.
- The total removals of lobsters are in the order of 5 kg/hectare/year.

The EcoSRG summarised the current important gaps in knowledge or areas of uncertainty as follows:

- There is only a limited understanding of density dependent mortality;
- There is a question about the relevance of studies from other parts of the world, most of which have been conducted in rocky habitats while the habitat of the western rock lobster varies from sand to limestone to rocky areas and the breakdown of these habitat types (% of area) is largely unknown.
- Much of the work published in the scientific literature is not of a scale sufficient to provide good levels of confidence when extrapolated to larger areas, i.e. they were often correlative or small-scale PhD studies.
- There is uncertainty about the virgin status of the stock – what were the size distributions like inshore and offshore?

- There was concern that the biomass argument discounted the role of large lobsters both in the deep and shallow water. The important issue here was the size of the lobsters and the impact or influence of these on the environment.
- The level of information available for the inshore areas of the fishery was reasonably strong in comparison with knowledge of deep water, although it did suffer from uncertainty about the virgin status of the stock.

Overall the EcoSRG assessed that there is a paucity of data from deep water such that the SRG was unable to determine the impact on the ecosystem of removing lobsters from deep-water habitats and that this should be a priority focus for research. The EcoSRG recognised that there are considerable opportunities for collaborative studies as part of the Jurien Bay Marine Park Management Plan and the SRFME Coastal Ecosystem processes. This being the case, the EcoSRG assessment should not be taken to mean that there is no need for further shallow water studies.

The particular ongoing requirement for certification that relates to the development and implementation of the EMS refers to the need for studies that are able to produce information on the impacts of fishing on the ecosystem that are at least as scientifically valid as those produced by studies of fished versus unfished areas. As a result, the use of fished versus unfished experimental design (a form of manipulative study) to examine the effects of removing lobsters on the environment has been widely discussed.

With reference to the identified knowledge gaps, in particular the absence of any basic natural history knowledge of the deep-water lobster related ecosystem, the design of a manipulative study at this point in time would be flawed. This being the case, there is a clear need to address the identified knowledge gaps in a coordinated and strategic way so as to allow for ongoing assessment of risk, to provide advice for management action and to enable the design of a manipulative study at a scale that will produce credible results. This strategy was strongly endorsed by the EcoSRG and accordingly is the basis of management action adopted in this EMS.

<u>Current risk analysis</u>

In this risk assessment, the identified hazards relate to the effect that long term removal has had or will have on the related ecosystem. The stakeholder group recommended that consideration needs to be given to both the simple tonnage removed from the system, and to the detailed characteristics of that removal e.g. size, sex ratio and when animals are taken.

Some stakeholders identified the absence of any substantial closed areas as an impediment to understanding the effect of fishing. This observation was premised on the view that in the absence of closed areas, it is impossible to judge how the environment functions in the absence of fishing. The stakeholder's meeting discussed the confounding influences that migration, the effects of other fisheries and other human activities would have on the processes within closed areas, limiting our ability to use them to understand the characteristics of populations prior to commercial harvesting. The fishery was described as a 'cultural' landscape. Substantial further work, perhaps employing different kinds of monitoring in an active adaptive management framework, could assist us better to understand and to model ecosystem impacts.

The stakeholder's meeting discussed the issue of the removal of large numbers of animals during the whites migration. The particular concern was that at that time lobsters are relatively vulnerable to predation. This raised the possibility that fishing may limit the availability of a seasonal and abundant source of food to predators such as large fish and sharks. Currently, there is no evidence that these predators are (or are not) being affected by this level of removal.

The expert group discussed the last risk assessment in which this hazard was separated into different components, i.e. effects on predators and effects on prey (see above). Some participants suggested, and the group agreed, that the hazard should be separated into geographical areas that provide some ecological context; they agreed on Abrolhos Islands, Leeuwin to Naturaliste (Capes region), central west coast shallow (< 40m), deep water or shelf (40+m), and north of Kalbarri. Nonetheless, two experts determined that with the limited information they had available on the different areas at the workshop they would only provide an overall assessment of a moderate risk.

6.4.1a Abrolhos Is.

The catch of lobsters from the Abrolhos has been relatively stable at about 1700 tonnes a year for over 30 years, and the proportion of undersized animals at this location is much higher than the proportion in coastal ecosystems. Therefore, only a very small proportion of lobsters are available to be removed by the fishery and then only for a few months of each year (the fishery operates for about 3.5 months). Lobsters do not play a keystone role in this largely coral reef environment and whilst this region has been fished for over 40 years it is still considered to be one of the most pristine coral reef systems in the world (e.g. CALM, 1994; Chubb et al., 2002; Webster et al., 2002; Roberts et al., 2002). Consequently, many experts considered it to be unlikely that in the next 5 years continued lobster catches at current levels could result in minor changes (C1) to the current species composition of this region resulting in a judgement of a low risk. Some participants placed a moderate or higher level risk for this region but did not provide any supporting rationale (Figure 6.30a).

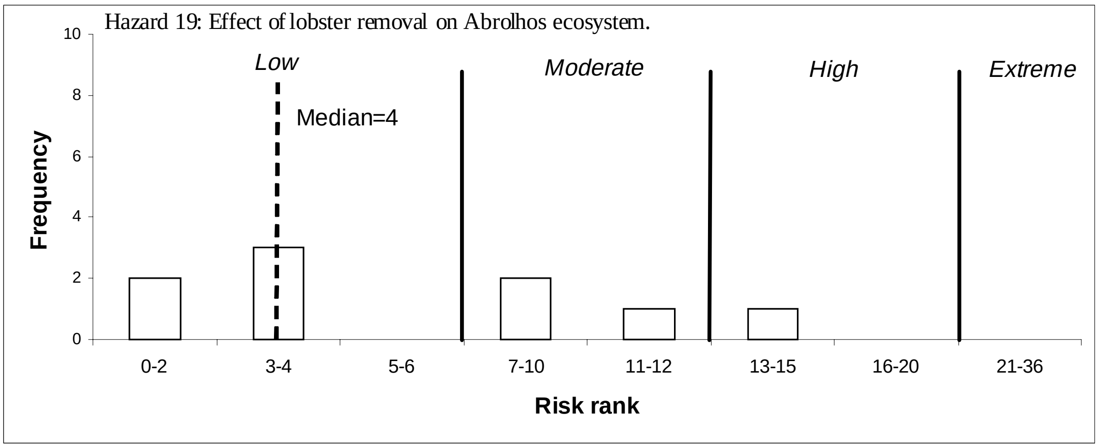


Figure 6.30a. Risks to the Abrolhos ecosystem of removal of rock lobsters.

6.4.1b Leeuwin-Naturaliste (Capes) region

Lobster fishing only occurs in this region sporadically. This is a result of the lobster abundance in the region being highly variable due to the extreme environmental shifts in recruitment patterns in this area combined with a relatively low base level of abundance compared to northern regions. Consequently, lobsters are generally not a major component of the environment of this region and it is likely to be rare for the fishery to cause substantial changes in their abundance. Thus, the risk to the ecosystem in this region from lobster fishing was considered by most experts to be low because declines in abundance occur naturally following the rare spikes in recruitment. It was considered to be unlikely (L3) that such changes could substantially affect other elements of the ecosystem beyond normal fluctuations/levels (C1).

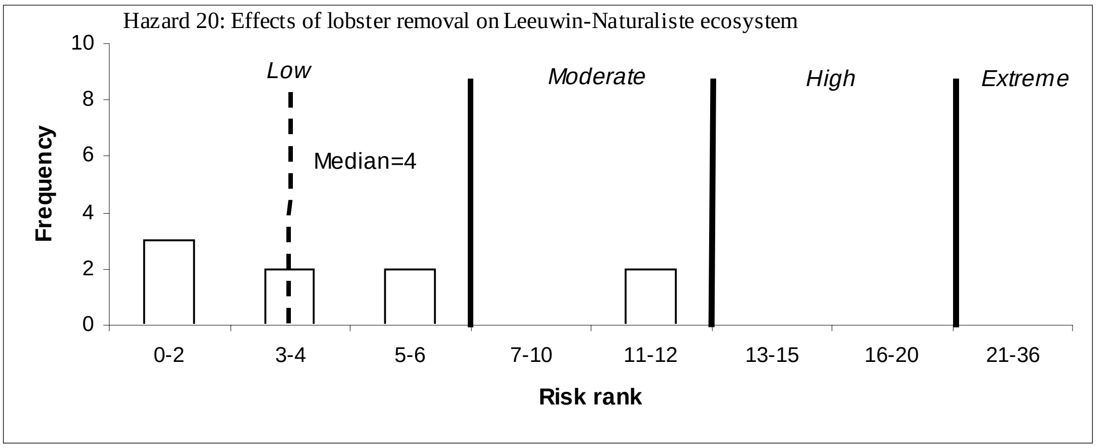


Figure 6.30b. Risks to the Leeuwin-Naturaliste ecosystem of removal of rock lobsters.

6.4.1c Central West -Shallow

The group was advised that the overall catch of the lobster fishery was between 9-15000 tonnes annually, with 5-7000 tonnes coming from shallow water ecosystems in this region. Some experts argued that while a seemingly large amount of lobsters are removed, the majority of lobster biomass actually remains (including a high proportion of undersized rock lobsters that reside in these shallow waters; see above). Furthermore, given the studies completed on the functional relationships and diet of lobsters undertaken by the CSIRO research in this area (presented above) which found that there were no inshore species that would be particularly vulnerable to large rather than small lobsters, and they are not associated with any sea-urchin complexes (or other keystone species) that could potentially cause major changes to species composition at this level of exploitation, there was the only the possibility (L1-L3) that this level of lobster removal may alter relative species abundances of the region to a minor or tolerable extent (C1-C2). Despite this view, a number of the group rated the hazard as a moderate risk based solely on the level of catch and a desire for more research. No specific rationales were presented as to how this may have affected the broader ecosystem.

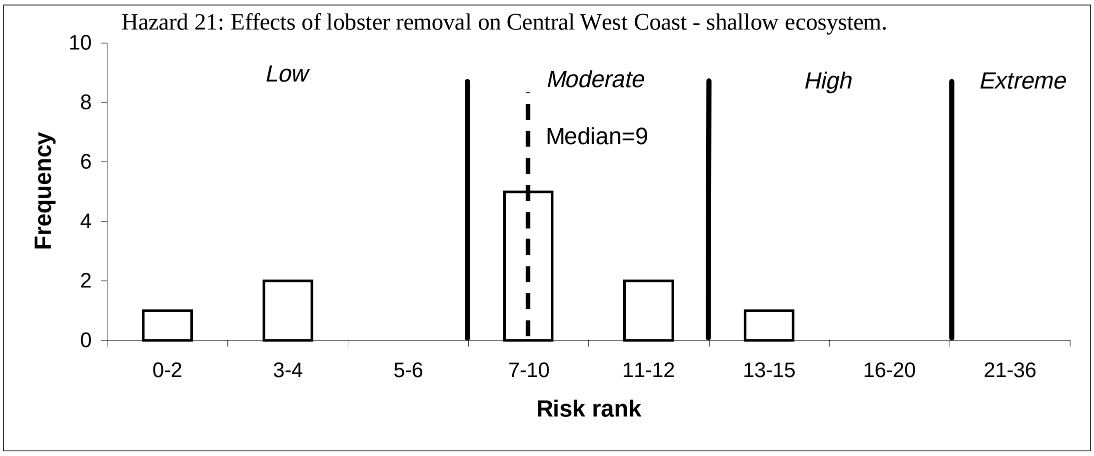


Figure 6.30c. Risks to the Central west coast shallow ecosystem of removal of rock lobsters.

6.4.1c Central West – Deep

This region experiences the largest potential change in size structure and relative abundance of large lobsters (the abundance of lobsters in this region is replenished each year during the annual whites migration). Furthermore, because we don't yet know the trophic relationships in this region, it is possible (L4) that the removals may be making some identifiable changes to species relative abundance (C2) in this region. There is, however, no suggestion that different species now exist in this location compared to previous years, an outcome that would suggest severe impacts may have occurred. Thus, this was considered by most of the group to be a moderate risk (Figure 6.30d). The deep water work currently underway may assist in either confirming or adjusting this risk by the next review when further information on this section of the fishery will be available.

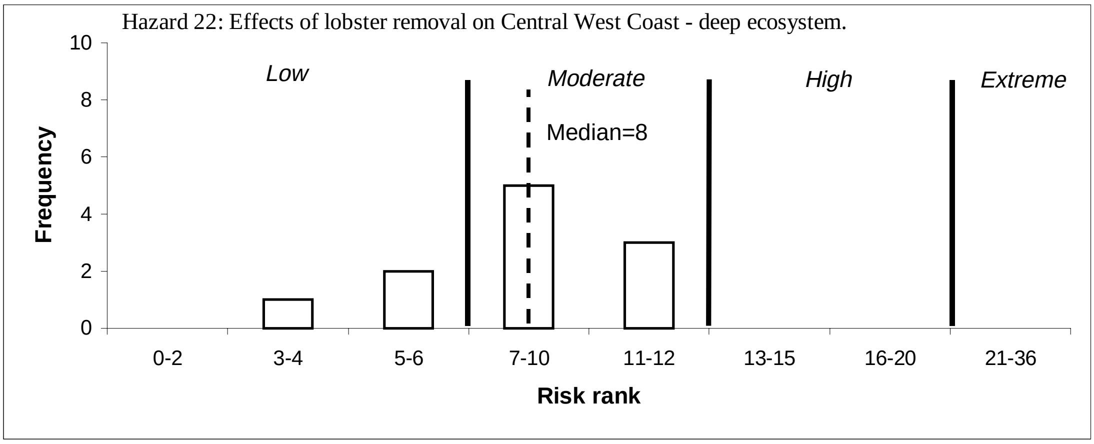


Figure 6.30d. Risks to the Central west coast deep ecosystem of removal of rock lobsters.

6.4.1c Kalbarri – Big Bank

Relatively few lobsters (100-200 t) are taken from the Big Bank area. Their removal is likely to have a negligible impact on the broader ecosystem of this region. The Kalbarri region is at the northern edge of the commercial fishery and therefore experiences relatively low levels of removals of lobsters. The overall risk for these regions was generally considered to be low by the group (Figure 6.30e). Some considered this to be a moderate risk but provided no reasons for this.

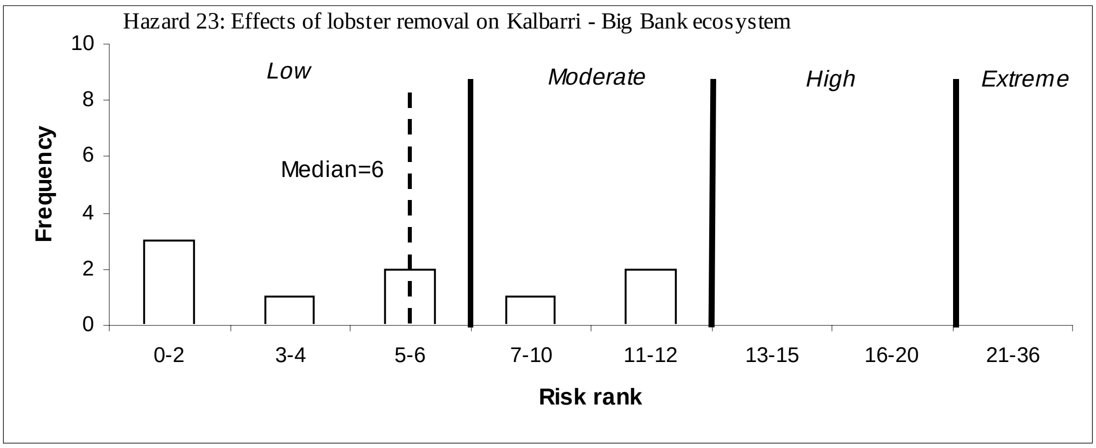


Figure 6.30e. Risks to the Kalbarri-Big Bank deep ecosystem of removal of rock lobsters.

6.4.2. Ghost fishing

Pots for western rock lobsters have a single, unobstructed entrance and a minimum of three escape gaps. The pots are made from steel or wooden bases with wooden slats or cane and tee-tree sticks on the other sides. These products decay readily. The number of commercial pots lost throughout the fishery each season is unknown but is currently being assessed. Fisheries Officers recovered about 30 pots on the south side of Rottnest Island following the 2000/01 season. Anecdotal evidence and underwater observation by Fisheries staff shows that rock lobsters (and other large animals) are rarely seen in any unbaited pot. Lobsters can move in and out of pots. Taken together, these factors led the first risk assessment to conclude that the chances of significant impacts of ghost fishing are low (C1 L1).

The expert group was informed that each season about 9000 rock lobster pots are lost. There are a number of causes including snagged pots, failure to re-locate pots, and floats cut by other vessels (both freight and fishing vessels). This lost gear has the potential to trap species within the pot or to entangle species in the slack rope. The expert workshop agreed with the first risk assessment that the risk from ghost fishing is low (Figure 6.31).

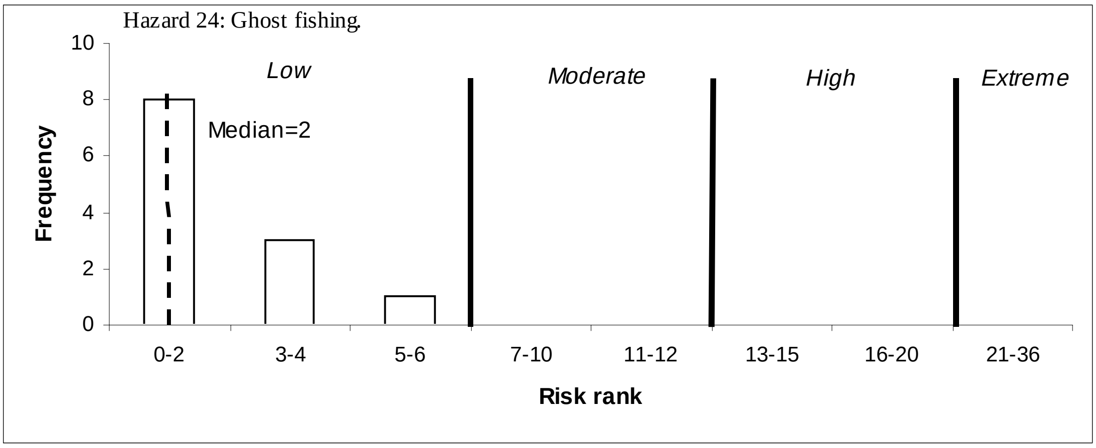


Figure 6.31. Risks of ghost fishing.

6.4.3. Damage to benthic biota from pots and vessels (Coral, Limestone reefs, Seagrass)

The coral habitat in the Abrolhos Islands and northern part of the western rock lobster fishery has enormous tourism potential because it is relatively unspoiled compared to many other areas in the world. There is a view that rock lobster fishing could damage coral through the use of pots and anchoring of boats, impacting on the coral ecosystem and potential for tourism.

The first risk assessment ranked the risks of potential change to coral abundance from rock lobster pots and boats as moderate (C3 L4). They reached this conclusion based on;

- The reductions in the numbers of pots and limits to pot size that have been introduced should have reduced any impact.
- Observations by Museum/Department of Fisheries divers indicate limited damage to corals due to pots relative to storm damage.
- Setting of pots is generally adjacent to corals not on the sensitive reef areas.

- Fishermen use permanent moorings rather than using anchors.
- Most of the accidental groundings of vessels in this area occur on the reef tops which are flat, hard limestone - not the sensitive branched corals.
- It is appropriate to compare the relative impacts that may be caused by boats versus storms on this habitat. Such an analysis suggests that this is insignificant.

A workshop was held on the issue of fishing impacts on the Abrolhos Islands in July 2001. A major report was compiled (FRDC 2000/166 Chubb et al. 2001). The following is the extract of this report that relates to rock lobster fishing.

<u>Extract from the Abrolhos Islands Workshop report</u>

Rock lobster fishing at the Abrolhos is undertaken for three and a half months of the year, from March 15 to June 30. Pots are soaked there for a week beforehand but are placed together (unbaited) in sandy sediments in areas defined and patrolled by compliance staff and so have no impact on the marine habitats during that period. On average 25%, 18% and 9% of the total potting effort at the Abrolhos occurs in depths of less than 20m at the Wallabi/North Island Group, the Easter Group and the Pelsaert Group respectively. Furthermore, much of that effort is directed at prime rock lobster habitats, most of which contain biological communities of low or moderate sensitivity. The moderately sensitive communities are the mixed macrophytes, stands of Sargassum and the coral-macroalgal assemblages, all of which are relatively resistant to the physical impacts of pot fishing.

Nevertheless, some effort was targeted at lobsters living in sensitive habitats where corals can have greater than 50% cover and comprise robust forms such as thick branching, tabulate and encrusting corals, delicate forms (eg thin branching, foliose and plating corals) and species-rich mixtures including massive and solitary forms depending upon their position in the habitat and the strength of water flow. Even though rock lobster fishers generally set their pots on edges (i.e., on sand but adjacent to reefs), there is potential for damage in these biological communities each time a pot is deployed and lifted. The physical impact of such activity would be the fracturing of the fragile corals such as the branching, tabulate and plating forms. Anecdotal evidence suggests that if damage occurs it happens where the pot settles after deployment. Pot ropes also may be tangled around fragile corals which may fracture when the pot is lifted.

Wright et al. (1988), using data from Hatcher et al. (1988), identified less than 10% of the Abrolhos reef area (total area) in which there was evidence of recent physical damage, or in which there was a significant potential for damage to benthic biota. The total area of high biological sensitivity (fragile) habitat for the Abrolhos was 9.2% according to Hatcher et al's (1988) habitat classifications (i.e. less than 10%). Fragile biological communities comprised 6.5%, 5.6% and 17.0% of the Wallabi/North Island, Easter and Pelsaert Groups respectively.

An estimated impact of potting on fragile habitat can be calculated using the 2001 seasonal potting densities and an assumption that each rock lobster pot will disturb an area of coral or sponge (fragile) habitat equivalent to 4 sq. metres each and every time it is set. The percentage of fragile habitat so disturbed would be between 0.1% and 0.3% of the surface area of such habitat in each island group (Table 6.6). Similar estimates of 0.2 – 0.4% of the surface area of moderately sensitive habitat would be affected (Table 6.6).

Due to the low densities of pots set in fragile areas during a season, disturbance is likely to be isolated rather than general. However, the actual extent to which damage is caused by pot fishing in these sensitive communities is unknown and is in need of investigation. The biological impact on the corals also needs to be quantified, given Harriot (1998) has recorded rapid rates of growth (mean of about 5-7cm/yr) for branching *Acropora formosa* and that the regeneration of coral colonies from fragments is possible (A. Heyward, pers. comm.). It also is important to note that rock lobster fishing is prohibited between July 1 and March 14, providing a recovery period of 8.5 months free of additional disturbance for any damaged habitat.

Table 6.6. Estimates of the percentage surface area of low, moderate and high sensitivity biological communities impacted by rock lobster pots (see text for assumptions).

Group	Low	Moderate	High
Wallabi/North Is.	0.36	0.39	0.31
Easter	0.27	0.26	0.11
Pelsaert	0.14	0.18	0.23

Rock lobster vessels do not move at night and are either tied alongside or are moored close to jetties. Rock lobster vessels rarely anchor at sea during the day. Boats that work the Abrolhos from the mainland either return to port each day or anchor in appropriate places overnight. The larger boats with large pot allocations tend to operate in the deeper waters surrounding the Abrolhos reefs. Thus, not all of the 149 vessels that have Abrolhos concessions work in the shallow water areas. However, boat activity in shallow water can cause damage to reef structures when the hulls of vessels “ground” occasionally when manoeuvring to lift or set pots. The frequency with which this happens is unknown and this type of physical damage is not confined to the rock lobster fleet. Pleasure craft may impact on the marine habitats. The physical impact of vessel “groundings” may be small when compared to the effects of violent storms on the marine habitats, although the spatial and temporal attributes of these differences sources of disturbance have not been quantified.

There is evidence that plastic bands used to hold bait cartons together and the cartons themselves are being thrown overboard by some industry members at the Abrolhos. For a number of years there has been an ongoing education programme to eliminate this polluting behaviour and, fortunately, this practice is no longer prevalent. Most Abrolhos fishers take all rubbish material back to their camps where either it is burnt or sent to the mainland for disposal, as is the case with engine oil, for example. The impact of the discard of rubbish at sea is likely to be minimal.

The rock lobster industry’s considerable use of imported bait each season was cause for some concern following the pilchard mortalities of recent years. Bait remaining in pots is, in some cases, discarded at sea but it is very quickly recycled by all manner of organisms. A risk assessment conducted by Jones and Gibson (1997) concluded there was very little likelihood of disease introduction through the use of imported baits. Bait use has no impact on the Abrolhos marine habitats.

The first risk assessment evaluated the risk of fishing activities on limestone habitat and concluded it was low (C1 L4) because;

- Reduction in the numbers of pots and limits to pot size should have reduced any impact.
- Setting of pots is generally adjacent to limestone reefs and during migration period setting of pots is on sand.
- Reef covered with algae that regenerates rapidly and subject to large variation due to storms.

- Reef system subject to erosion due to high energy system.
- Level of pot damage would be minimal relative to extensive reef system. For example, assessment of the area of reef near Dongara up to 30 m depth (Phillips et al., 2001) indicates an area of 382 million m^2 compared to the area affected by the pots in about pots 2 million potlifts per year of about 0.4%.

According to Hatcher et al. (1990), among biological communities, low energy coral assemblages are the most susceptible to physical damage because of their dominance by fragile branching corals. Communities dominated by macrophytes are much less sensitive to physical damage because of their flexible structure and relatively high growth rates.

The first risk assessment evaluated the risks of fishing activities to seagrass habitat as low (C1 L3) because;

- Reduction in the numbers of pots and limits to pot size should have reduced the impact.
- Pot presence is temporary (over night) and does not does not cause physical damage.

In ranking benthic biological community classes of the marine ecological units at the Abrolhos Islands according to their relative sensitivity to anthropogenic physical damage, Hatcher et al. (1990) ascribed seagrass a 'moderate' rank of 4 compared to 'high' rankings of 1 and 2 which were ascribed to coral assemblages. (Note this is not a comparable ranking of risk as used in the WRL risk assessment report as it looked at all forms of human activity).

The video evidence obtained from lifting substantially larger traps in similar habitats (Moran & Jenke 1989)[12] is that they almost always lift vertically. They do not scrape along the bottom. Unpublished video studies on the lobster fishery conducted in the 1980s (R.S. Brown, unpublished) found similar results. Thus, the smaller lobster pots almost never scrape across the substrate when they are pulled and therefore they pose no threat to benthic habitats such as seagrass.

The stakeholders in this risk assessment meeting discussed whether the focus of damage should be on the structural elements of the reef (the limestone and granite), or on the biological elements. It concluded that the biological components were the legitimate focus, at least from the perspective of the lobster fishery. The meeting reiterated the findings of the Abrolhos Islands workshop report that most potting was on the outside areas where the reef is robust, and that fishers target sand areas adjacent to reefs.

In the light of the new information, the expert group rated the risks to benthic biota from pots and boats as low.

[12] Fisheries Research Report, Fisheries Dept. WA, No 82, 29pp

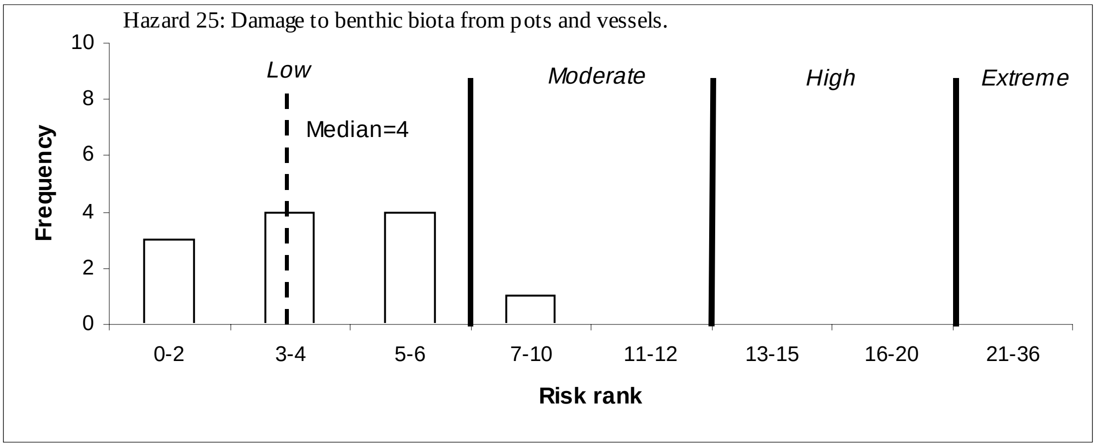


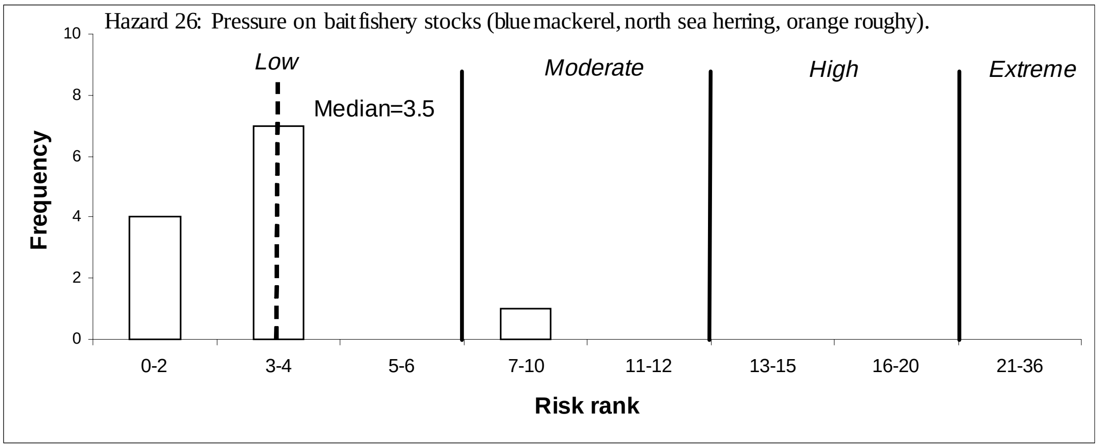
Figure 6.32. Risks of unacceptable damage to benthic biota including coral, limestone reefs and seagrass from pots and vessels.

6.4.4. Bait stocks putting pressure on other fishery stocks e.g. blue mackerel, north sea herring, orange roughy

In the 1995-96 season, about 14,000 tonnes of bait was used to catch 9,900 tonnes of western rock lobsters (i.e. 1.4 kg of bait per kilogram of lobster) (Jones and Gibson 1997). This ratio of bait to catch is typical in the western rock lobster fishery, equating to the addition of about 5-7 kg/ha over the area of operation.

The bait is obtained from a variety of sources, however the possibility that the lobster fishery is placing excess commercial pressure on wide capture bait fisheries needs to be considered. The stakeholder's meeting agreed that if bait were sourced from a fishery that was itself demonstrably non-sustainable, such that the demand from the lobster fishery could result in a collapse of the bait fishery, or in the loss of a species or its habitat, then the industry would almost certainly move to reduce or eliminate its demand for that resource. This would need to be assessed on a fishery-by-fishery basis.

The group discussed the possibility of auditing the source of bait and assessing the consequences of the fishery's bait consumption on other fisheries. More comprehensive information would assist a more reliable assessment of this hazard. The bait used has included mackerel, North Sea herring, and heads and frames of orange roughy from New Zealand (B. Jones, pers. comm.), although the annual bait audits indicate the bait used varies from season to season. The use of hides and hocks has been banned in recent years. The experts ranked the risks on bait stocks in other locations to be low (Figure 6.33), based on the assumptions that the species used are not considered to be currently under threat, or that the relative tonnages required are unlikely to add significantly to their exploitation.



6.33. Risks to other fishery stocks resulting from demand from the rock lobster fishery for bait (e.g. blue mackerel, north sea herring, orange roughy)

6.4.5. Introduction of pathogens and disease in bait

Jones and Gibson (1997) undertook a bait import risk assessment, modelled on the Office Internationale des Epizooties (OIE) recommended methods, and concluded that the risk of introducing an exotic disease capable of producing a large scale fish kill is either very low or does not exist at all. On this basis the first risk assessment concluded the risks were low (C4 L1). The stakeholders reiterated that, given that the majority of the bait is imported, there is some risk that this bait could introduce pathogens and disease. Thus, if an introduction of a disease did occur it could produce a severe to major impact (C3-C4), as occurred in the pilchard mortality event, but the chances of this occurring are remote (L1). Consequently, the experts ranked the risks on local bait stocks from introduced pathogens to be low (Figure 6.34).

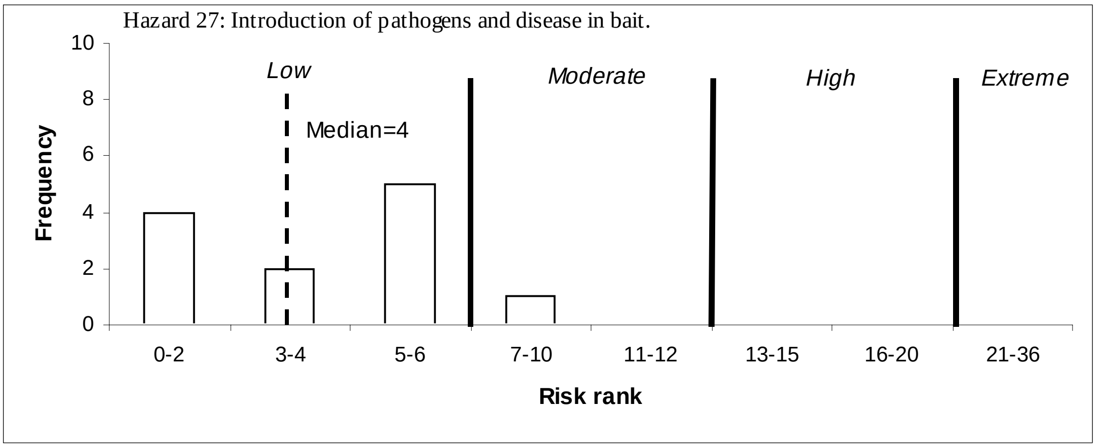


Figure 6.34. Risks of introducing pathogens and disease through bait.

6.4.6. Risks of changes in behaviour of attendant sea animals (sea birds, dolphins, sharks, sea lions and sea lice) leading to unacceptable impact on populations.

Attendant animals may modify their behaviour to take advantage of bait. The first risk assessment judged this risk to be low (C4 L1) because bait is only available for part of the year and additional food should enhance breeding success.

Sea birds, dolphins, sharks and seals are known to feed on discards of bait or lobster that cannot be legitimately retained under current management arrangements. Sea lice feed on the bait in pots. The stakeholders identified this as a potential hazard. There may be important behavioural changes whereby there is a reliance upon this source food, which has the potential to support larger populations of these species, making them vulnerable to starvation and the introduction of disease. There is evidence that the populations of some bird populations have grown exponentially over the last decade, faster than is possible by reproduction alone, indicating substantial levels of migration. The expert group, however, agreed with the first assessment, that the risk of behavioural changes is low (Figure 6.35).

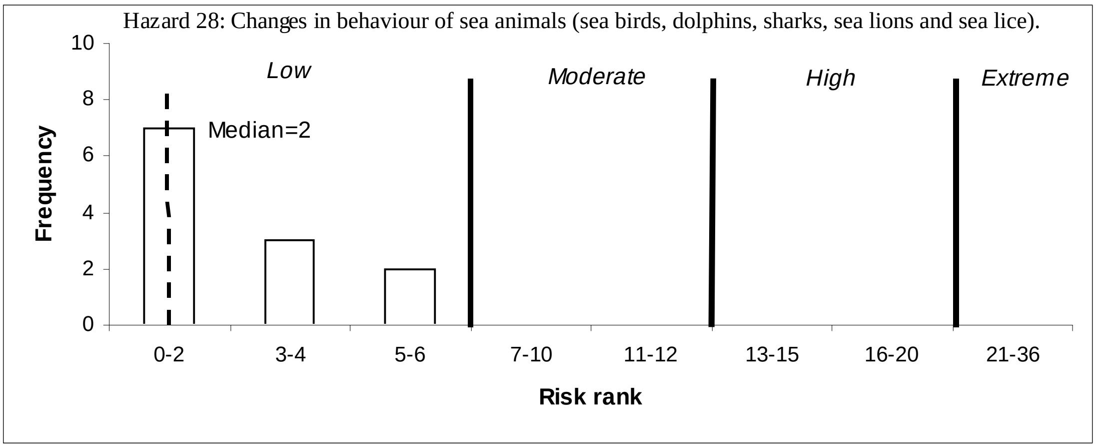


Figure 6.35. Risks of changes in behaviour of sea animals (sea birds, dolphins, sharks, sea lions and sea lice) leading to unacceptable impact on populations.

6.4.7. Illegal feeding of dolphins (unused baits)

Feeding dolphins with unused bait may introduce or modify their behaviour. The practice is illegal and the first risk assessment rated it as low (C1 L1).

Some unintended feeding occurs as a consequence of the need to discard bait. The stakeholder's meeting identified this issue, noted that dolphins target boats and that frozen bait, typically discarded, is less attractive than thawed bait.

Both the stakeholder and expert meetings discussed the difficulty in quantifying the extent or seriousness of the risk. The meeting noted that this hazard also applies to sea lions. The experts agreed with the first assessment and rated the risk as low (Figure 6.36).

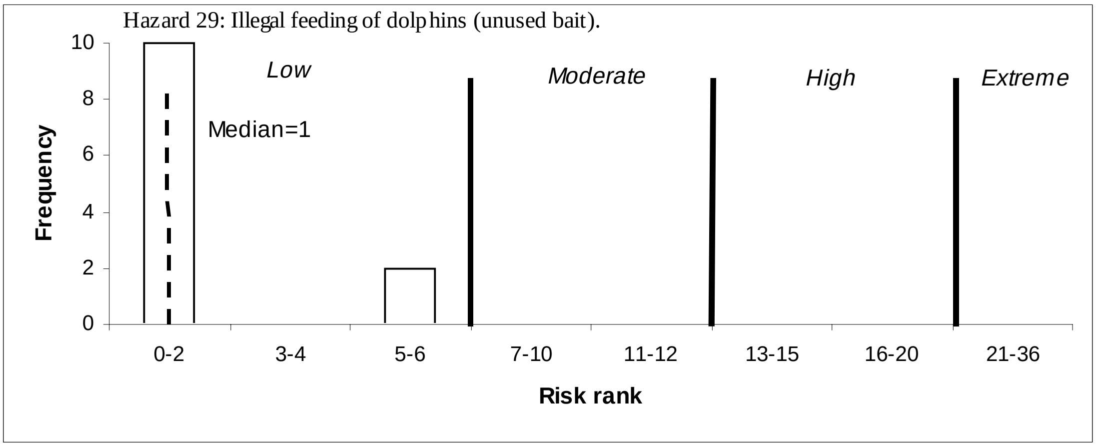


Figure 6.36. Risks to dolphins arising from illegal feeding (unused baits).

6.4.8. Abrolhos Islands marine environmental issues

Abrolhos Islands are populated by fishermen during the lobster fishing season (March-June). Fishing camps may cause unacceptable elevation of nutrients (inorganic nitrate, organic nitrate, ortho-phosphate, organic phosphate). Dumping of domestic waste into ocean at Abrolhos Island may impact on marine biodiversity. Lastly, pots and vessels may have direct physical impacts on coral.

The latter issue was addressed in the discussion of the effects of pots and vessels on benthic biota, above (part 6.4.3). The last risk assessment rated the risk of dumping of domestic waste into ocean at Abrolhos Island as moderate (C1 L6). The assessment undertook to review the practice and to phase it out over the following five years. It is now prohibited.

To evaluate the effects of elevated nutrients, a study was undertaken in May 1998 of one area in the Abrolhos Islands heavily populated by fishermen during the lobster fishing season (Marine Science Associates and Environmental Contracting Services, 1998). No pattern of elevation of nutrients was seen on the Rat Island home reef compared to a nearby control reef but some small elevation of nutrient levels occurred adjacent to Rat Island where domestic outfalls were discharged. A semi-quantitative evaluation of coral cover and algal abundance suggested that reefs at Rat Island within a few hundred metres of high-density fishing camps did not show any clear adverse impact of human activity. The study quoted Johannes et al. (1983) and Crossland et al. (1984) as stating that nutrient levels in the water column at the Abrolhos Islands are highest during autumn and spring. The studies addressed the source of nutrients in the lagoon, pointing out that these values were above incident seawater.

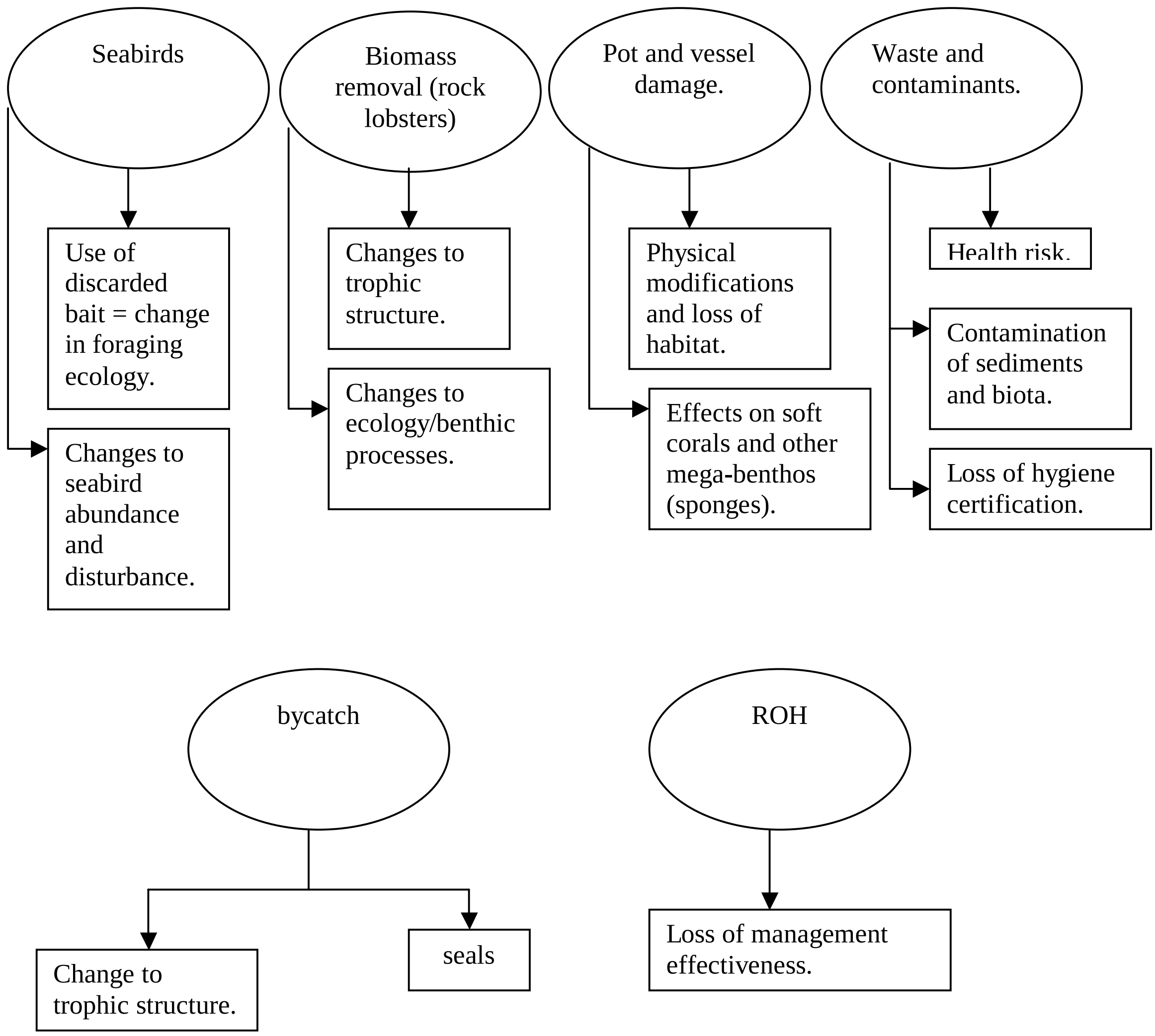


Figure 6.37. Influence diagram for marine issues specific to the Abrolhos Is.

The hazards identified here are similar to those identified for the fishery as a whole. However, the stakeholder workshop thought it important to identify them specifically for the Abrolhos Is. given the significance of this area to the fishery from an egg production perspective, the uniqueness of the environment, at least partly due to the influence of warm waters, and the growing public interest in the management of this area.

The expert group discussed again the issues of damage to coral and other benthic communities from pots and boats covered above in 6.4.3) and the implications of elevated nutrients close to fishing camps. Groups of experts were given the opportunity to rank this hazard separately and their conclusions were widely divergent. Discussion resolved a misunderstanding about the focus of attention, on shallow or a combination of shallow and deep water habitats. The experts then ranked the risk of human activities in the vicinity of the Abrolhos to marine environmental values in shallow water. The risk was judged overall to be low, although four participants ranked it as moderate (Figure 6.38).

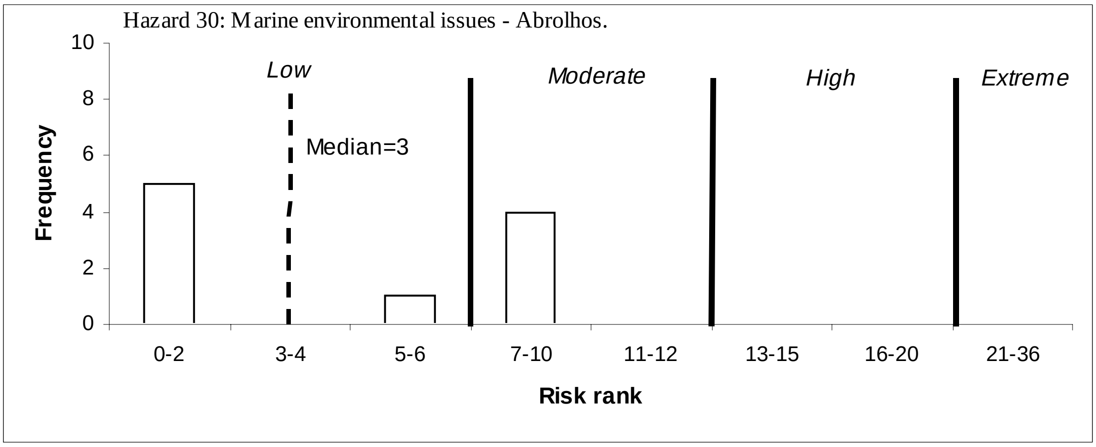


Figure 6.38. Risks arising from marine issues specific to the Abrolhos Is.

6.4.9. Abrolhos terrestrial bio-security

Licensed rock lobster fishermen with Zone A endorsement for the Abrolhos Islands are allowed to establish permanent camps on the islands to assist them in fishing the adjoining waters. Twenty two of the 122 islands in the Abrolhos have camps. The total number of camps on the islands is 140. Associated with these camps are jetties, moorings and pontoons. In addition, there are three airstrips and 4 schools. The camps are occupied only during the Abrolhos season (15th March-30th June), and can be used outside the Abrolhos rock lobster season only for maintenance and repairs.

The terrestrial flora and fauna of the islands have persisted and provide important reference areas for ecological interactions. Many of the islands, including those occupied by fishermen, have bird nesting and breeding areas, and some species are of international significance. Other important fauna include the tammar wallaby (*Macropus eugenii*), *Abrolhos pointed-button quail (Turnix viaria scintillans), brush bronzewing (Phaps* elegans), Abrolhos dwarf bearded dragon (*Pogona minor minima*), and Houtman Abrolhos spiny-tailed skink (*Egernia stokesii stokesii*). The flora includes a number of communities which are of conservation interest, including the mangrove *Avicennia marina*, *Atriplex cinerea* dwarf shrubland, and saltbush flats.

The stakeholder meeting outlined pathways by which human activities could impact on terrestrial values (Figure 6.39). The location and geographic nature of the Abrolhos Islands presents challenges that do not exist to the same extent on the mainland. Consequently the hazards associated with not managing these risks appropriately are magnified. The diagrams below summarise the most important of these and their consequences.

The stakeholder meeting clarified that the most critical elements of the hazard stemmed from the introduction of plants and animals to the Abrolhos Islands (mice, rats, cats, weeds and other species). The meeting was advised that rats have been eradicated from Rat Island. It was noted that there is a CALM report comparing inhabited to uninhabited islands.

The expert meeting discussed the pathways outlined by the stakeholder meeting and concluded that terrestrial biosecurity risks from the rock lobster fishery are low. Two participants ranked them as moderate (Figure 6.40).

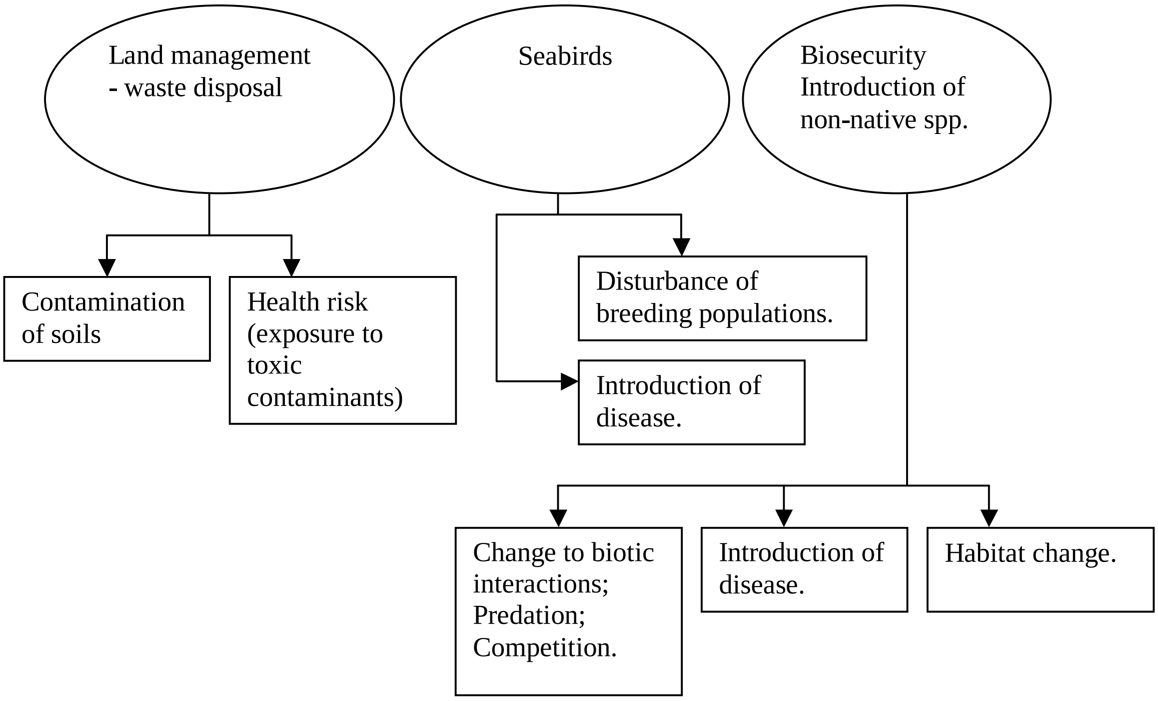


Figure 6.39. Influence diagram for terrestrial biosecurity associated with the Abrolhos Is.

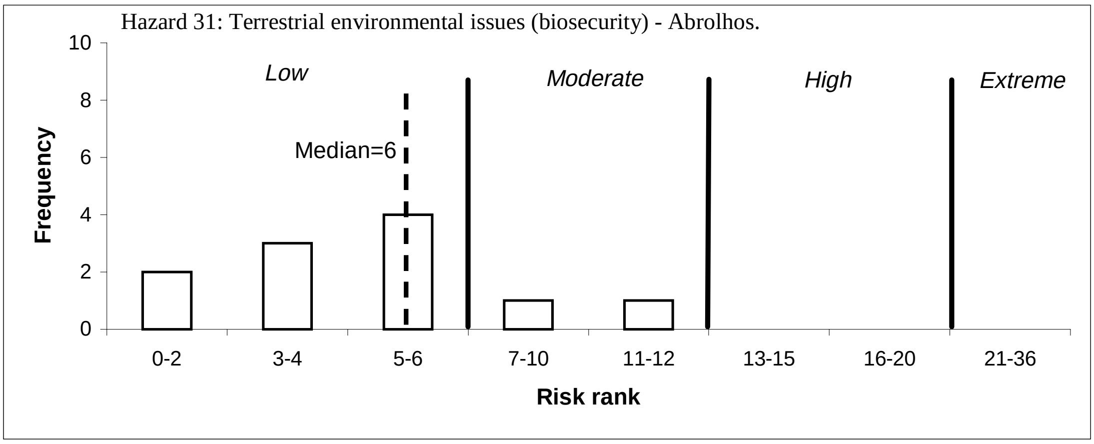


Figure 6.40. Risks arising from terrestrial biosecurity associated with the Abrolhos Is.

6.4.10. Impact of discarded bait bands on shark populations (dusky whalers)

The Department of Fisheries has received complaints that rock lobster fishers discard bait bands (the synthetic band used to wrap cardboard bait boxes) and other fishing related debris into the marine environment. Investigations indicate that while bait is banded, most fishers properly dispose of bait bands. It seems likely that most of the bait bands found washed up on beaches and in the water come from other sources. It is acknowledged that it is possible that bands are occasionally lost overboard, especially in windy or rough conditions. Floats and other fishing gear occasionally are lost, particularly as a result of vessels (usually not rock lobster vessels) running over pot lines.

Possible indicators of bait bands were considered including:

- A periodic survey count of bait bands and other fishing debris (floats etc) found on beaches between Augusta and Carnarvon.

- Reports from litter counts (beach sweep) by school groups.
- Reports on wildlife entrapped in bait bands and other fishing debris.
- The weight of rubbish removed council bins near rock lobster fishing jetties.
- The annual count of complaints about rock lobster fishing debris made to the Minister for Fisheries.
- Other fishermen's observations (in logbooks).
- Random surveys of bait boxes taken aboard and material returned at the end of a day's fishing, of boats returning without bait boxes etc.

In the context that much of the observed beach fishing debris is likely to be from other sources, no single indicator was identified that could be used as an auditable, quantifiable measure.

The industry encourages behaviour that will minimise discarded bait bands and other fishing debris. It has ensured waste disposal bins are available at all points where commercial rock lobster boats tie up and ensured fishers are aware of the related public perceptions and sensitivities. The Minister for Fisheries and Department of Fisheries continues to remind fishermen of their obligations in this regard. In the last risk assessment, the Agency undertook to discuss with industry representatives the options for better management of the bait band issue.

The stakeholder workshop discussed the potential impacts of bait bands on dusky whalers, in particular. They constructed an influence diagram to describe the exposure of the species to the hazard (Figure 6.41).

Dusky whaler sharks are slow growing, have low fecundity and do not mature until approximately 18 years of age, making them particularly vulnerable to overfishing. There is a legitimate fishery for shark species that primarily targets juveniles for their meat. However, in recent years the high price of shark fin has seen a fishery develop for larger sharks. Additional mortality from bait bands adds to the vulnerability of this species. The stakeholders suspected there is a relationship that intensifies the interaction of lobster vessels and sharks in the Abrolhos Is. zone that increases the likelihood of entanglement in bait bands.

The meeting noted that the initial risk assessment process considered the related, broader risk of entanglement and ingestion of bait bands and plastics from fishing vessels by a variety of marine species. The meeting noted that research staff onboard commercial vessels recorded that bait bands generally came in with fishermen. The stakeholder meeting estimated that more than 95% of bands are returned but that bands persist for prolonged periods. Many of those found may have been in the water for a long time. The stakeholder meeting discussed the possibility of disaggregating the hazard to include social and ecological implications.

The expert group considered the effects of bait bands on whaler populations. Some of the participants elected to score social implications, in addition to ecological ones. Groups of experts were given the opportunity to score this hazard independently. The responses were divergent. One group commented that the bait bands affected pups, not adults, and that the proportion of the population affected was likely to be low. The opinions of other groups differed, based on different judgements about the proportion of the population likely to be affected and the consequences of the impacts for longer term population growth.

Because these stocks currently are overfished, the potential consequence level was judged by most participants to be severe (C3) but the chances of this activity adding substantially to this pressure was judged to be rare (L2). Thus the overall expert group ranked the risk as low, although four participants scored the risk as moderate (Figure 6.42).

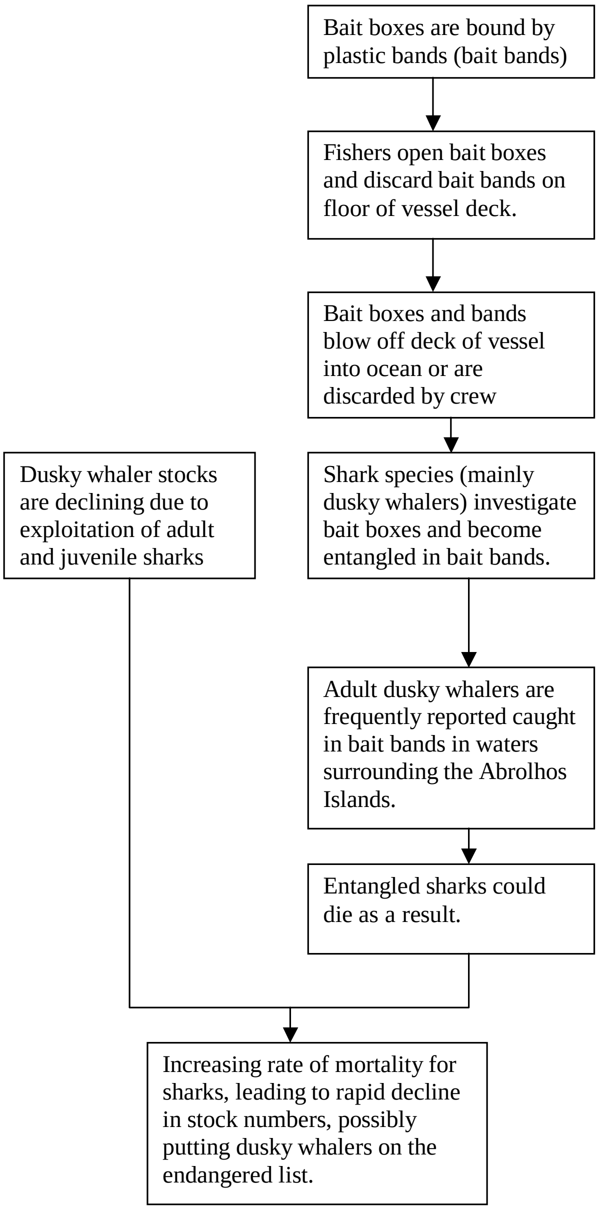


Figure 6.41. Influence diagram describing risk to dusky whaler sharks from bait bands.

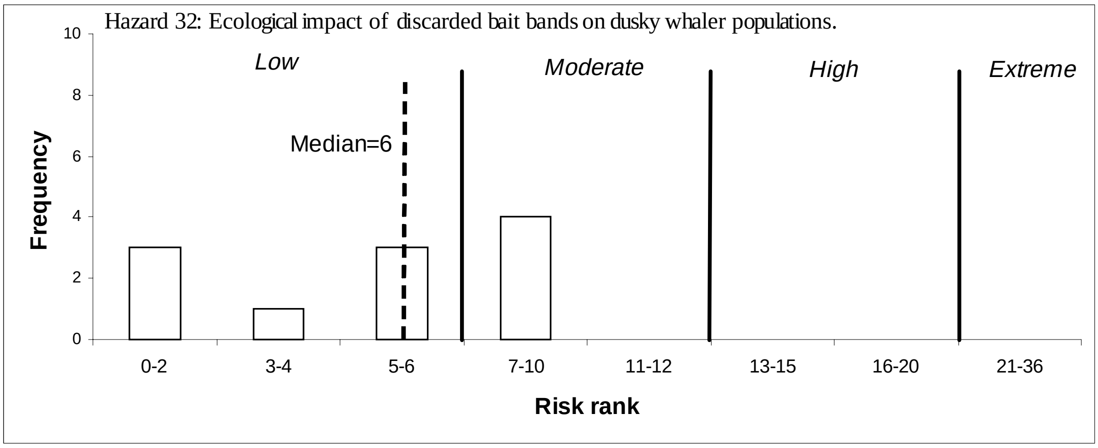


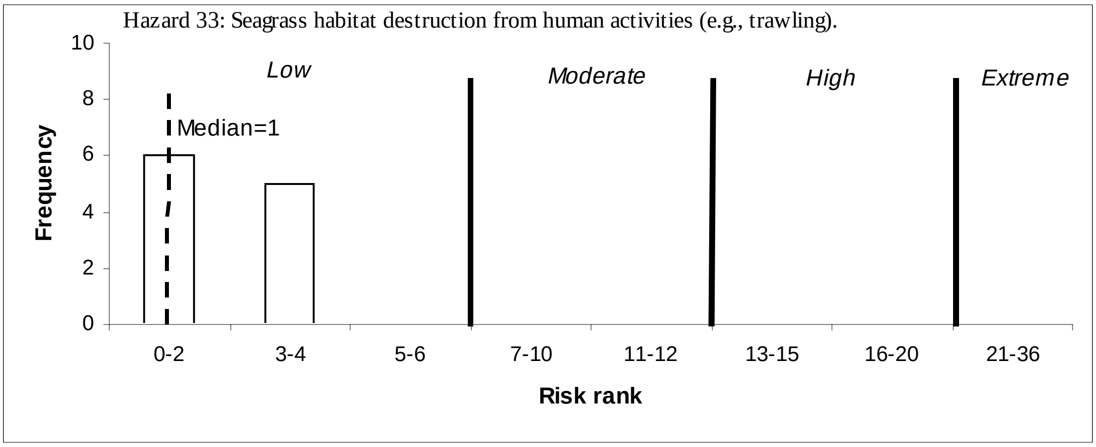
Figure 6.42. Risks to dusky whaler populations arising from interactions with discarded bait bands.

6.5 Other management issues

The stakeholder group broadened the set of hazards considered by the risk assessment to include issues for other fisheries or sectors managed or partly managed by the Department of Fisheries. The idea was to ensure that interactions between activities that may have combined or cumulative ecological effects could be judged in context with risk lobster fishery activities.

6.5.1 Seagrass / habitat destruction through human impact (i.e., from trawling)

The stakeholders meeting commented that other fisheries, particularly those that trawl, have the potential to impact on the habitat of rock lobsters. These effects have not been measured or quantified. There is the potential for seagrass beds to be uprooted, for bottom sediments to be resuspended, and for benthic fauna and other flora to be substantially disturbed, damaged or killed. The extent and severity of these activities could be quantified to some extent, by auditing the activities of the trawlers. This could provide a basis for assessing the ecological and economic costs of trawling on the risk lobster fishery. The expert workshop observed that all significant sea grass areas were closed to trawling. On the basis of these restrictions, the expert group concluded the risk was low (Figure 6.43).



6.43. Risks of unacceptable seagrass habitat destruction from human activities, principally trawling.

6.5.2. Aquaculture activities associated with modification of habitat (collecting from wild, rearing and returning to wild, primarily introduction of disease)

The stakeholder meeting observed that aquaculture of rock lobster species has been heavily researched in recent years. The meeting considered that aquaculture activities may create a hazard in the form of disease introductions, chemical contamination, and the release of genetically dissimilar individuals into the wild.

The expert meeting noted that there is currently no direct proposal before the West Australian Government to consider that cultured lobster be introduced into the natural environment. If there were, it would be necessary to evaluate the magnitude of the risk that disease could be introduced along with them. A Ministerial Policy Guideline exists that directly evaluates this matter. On the basis that there is no imminent plan for the development of aquaculture activities, the expert group concluded that the risk was low (Figure 6.44).

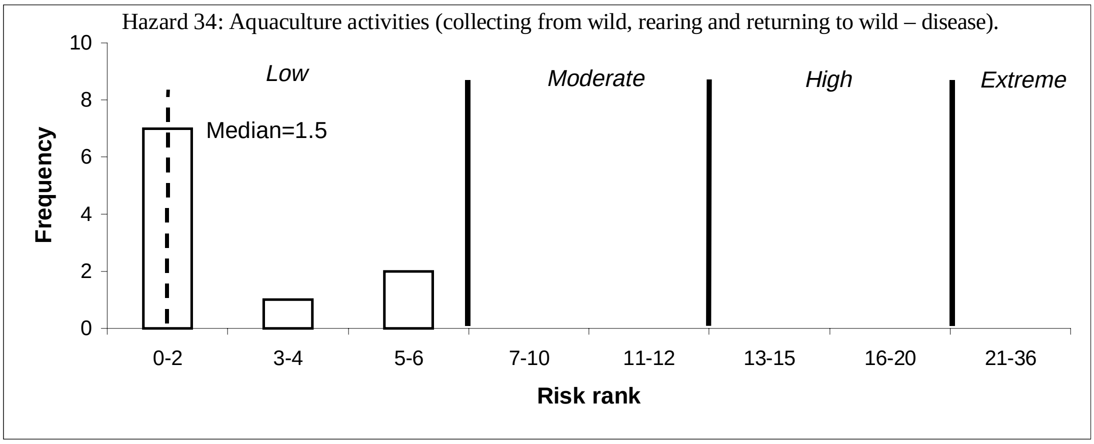


Figure 6.44. Risks to the fishery from aquaculture activities.

6.6 External drivers

The stakeholder meeting broadened the range of hazards considered, to include those that are not directly attributable to the effects of rock lobster fishing activities, but that might affect the ecology and function of the fishery. These 'external drivers' were considered because the stakeholders wanted to evaluate the possibility of proactive negotiation or intervention by the industry, the agency or other interest groups.

6.6.1. Oil spills

The risk of a substantial oil spill within the geographic distribution of the western rock lobster has been identified as a hazard to the fishery rather than a hazard that exists because of the fishery. Other agencies and organizations have implemented contingency plans for oil spills, if they occur, including prevention measures and clean up procedures.

However, these hazards are judged relative to the issues that are most relevant to the industries that conduct the risk assessments, namely oil exploration and production corporations and shipping companies and shipping regulators. The stakeholder workshop identified three major sources of risk to the rock lobster industry in particular, and their potential consequences (Figure 6.45). The meeting agreed that risks were exacerbated by production and transport activities close to lobster habitat, particularly productive and sensitive habitat such as the Abrolhos. The meeting suggested that risks associated with activities conducted adjacent to these areas could be reduced by using alternative routes for transporting oil.

The expert meeting discussed the capacity of the fishery and the management system to adapt in the event of a substantial oil spill in the vicinity of, say, the Abrolhos. The meeting was informed about the oil spill combat committee in place that has models to predict behaviour/impact of spills, and contingency plans to deal with spills of different kinds. The meeting noted that many oil types evaporate or break down relatively quickly and may result in little long-term effect. There is a Department of Fisheries process in place to assess the risk of oil spill impacts on all of the States' fisheries. On the basis of this advice, the expert group ranked the risk as low (Figure 6.46).

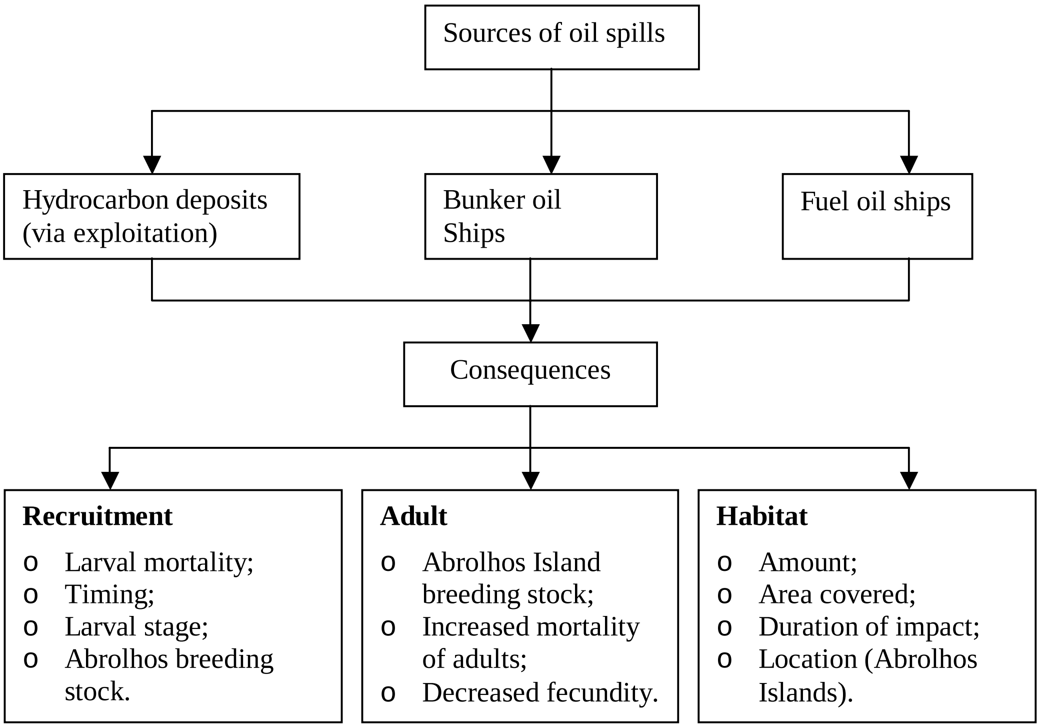


Figure 6.45. Influence diagram describing the risk from oil spill to the fishery.

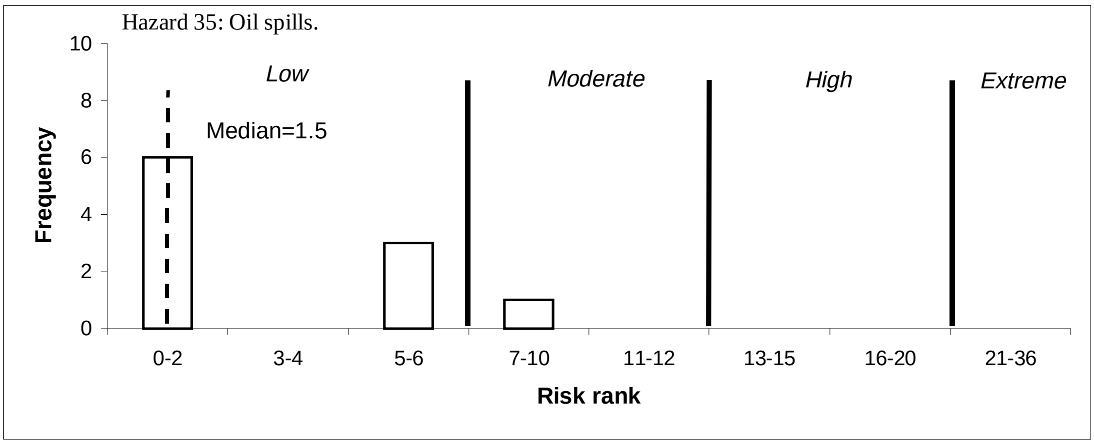


Figure 6.46. Risk to the fishery from oil spills.

6.6.2 Climate change effects on western rock lobster productivity.

As is the case for the oil spill risk identified above, climate change presents a risk to the fishery rather than being a direct result of the fishery. The hazard described here relates to the important role that environmental factors (e.g. Leeuwin Current and prevailing winds) have in the overall productivity of the species and the distribution of recruitment along the west coast of Western Australia.

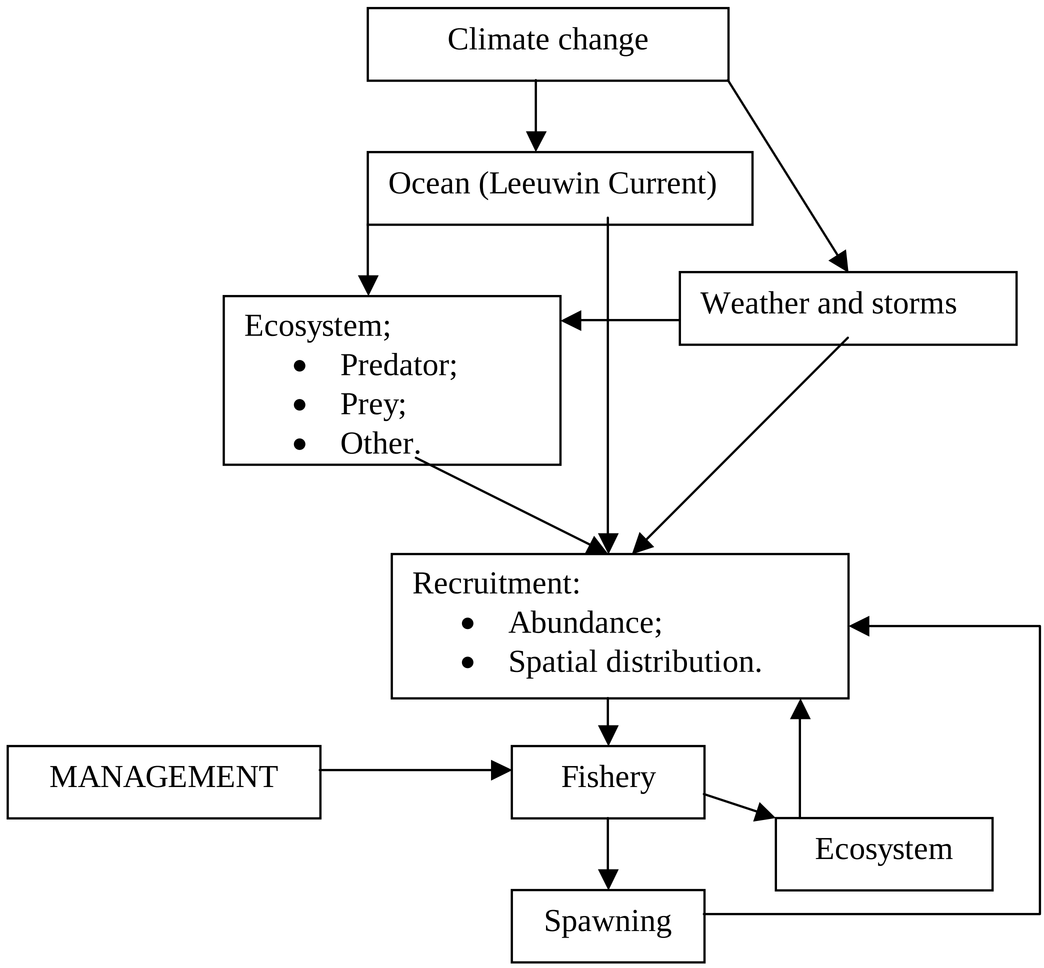


Figure 6.47. Influence diagram describing the risk resulting from possible environmental shifts.

The stakeholder meeting judged that changes in productivity and distribution of lobster outside of normal variations could have impacts on the sustainability parameters of the wild capture fisheries and local environments (Figure 6.47). The high abundance of lobsters in the Capes region is a recent example of how environmental factors influence the fishery.

The degree to which the Leeuwin Current and other important environmental factors are susceptible to influence from climate change is largely unknown. The stakeholder's meeting discussed the possibility of simulating several, plausible climate change scenarios. These scenarios could be used to evaluate the usefulness of alternative management rules in ensuring that harvest levels remain steady and at sustainable levels, if and when climate change occurs to the extent that it has important effects on the lobster fishery.

During the first risk assessment process a separate but related hazard was identified, that industry is contributing to global warming. This hazard relates primarily to the fact that industry is a significant fossil fuel user. This hazard was assessed as low.

The expert meeting commented that, in assessing this hazard, the group would be trying to judge something outside of the control of the management system. The group should be ranking the ability of the management system to adapt to any climate change. Further general discussion about the relevance of the issue took place. The group ultimately judged the risk to be low, although four participants judged it to be moderate (Figure 6.48). It is unclear if the ranks reflect the impact on the lobster fishery or management's ability to adjust.

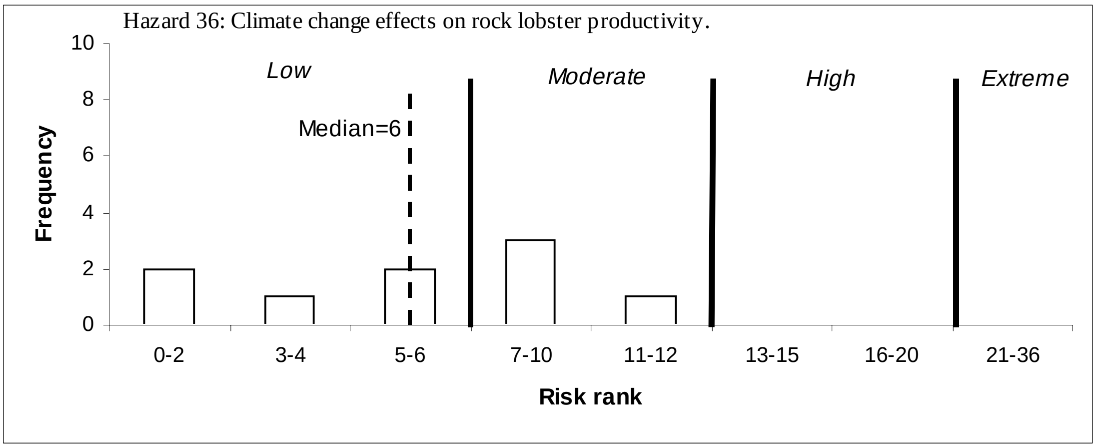


Figure 6.48. Risks to rock lobster productivity from climate change.

6.7 Governance

This section describes hazards that have been identified through the stakeholder workshop or previous risk assessment processes that relate to governance.

6.7.1 Jurisdictional issues across agencies e.g. CALM, Dept Fisheries and Federal and State governments.

Now that the fishery is managed within an ESD framework, many of the issues such as the ecosystem effects of fishing and its interactions with marine mammals and reptiles do not fall entirely within the jurisdiction of the Department of Fisheries. Interest in these areas comes from other State departments as well as Commonwealth departments.

The stakeholder's meeting noted that where there is no clear leadership or responsibility, there is a risk that an issue will be dealt with in a suboptimal way. This includes the possibility of slow response times in dealing with risk. The stakeholder's meeting agreed that many of the issues, and the responsiveness of the agencies concerned, were determined by government resourcing. There were no easy solutions, but the meeting perceived that risks to the fishery emerge because agencies can be slow to allocate responsibilities and to act, when cross-jurisdictional matters arise.

The expert meeting was advised that the West Coast Rock Lobster Fishery is managed by one agency (Department of Fisheries). There could be a risk regarding social and economic aspects of the fishers, but from an ecological perspective, risks were marginal as governance was with one body, which had a clear and strong management/sustainability focus. Expert participants commented that where jurisdictions overlap, they were not aware of any lack of willingness to take action by any agencies.

The expert meeting noted the example of the retention of the Abrolhos Islands (terrestrial) in the Fisheries portfolio. One expert believed this was not an ideal governance arrangement, because it meant that Fisheries were managing the terrestrial as well as the marine environment. He commented that there had been a proposal for some 20 years to turn non-inhabited islands into national parks but it hadn't happened. Participants commented that while there were some jurisdictional overlaps that may result in some governance inefficiencies, it did not create a risk to the ecology of the system. Management plans can be amended rapidly; for instance, s-43 orders can be gazetted in days – thus, there is the ability to take action quickly.

On the basis of this advice, the expert group ranked the risk as low, although four participants ranked it as moderate (Figure 6.49).

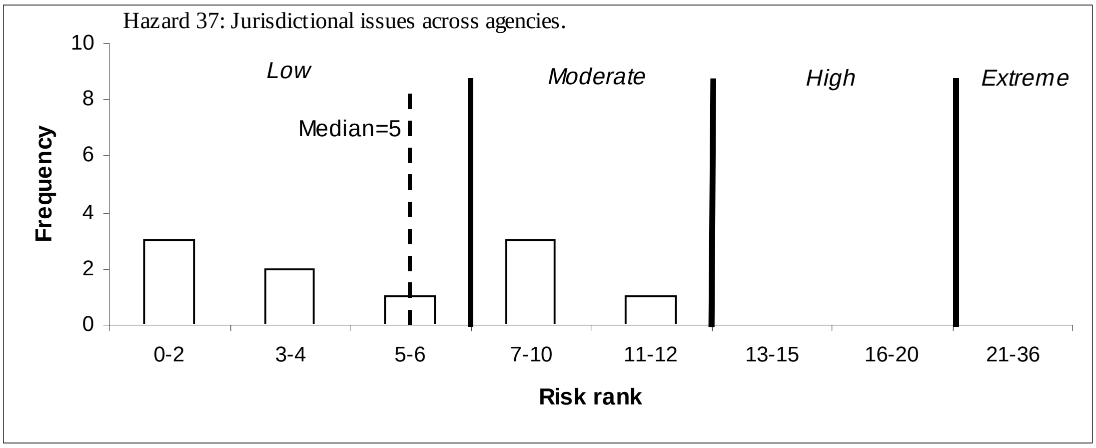


Figure 6.49. Risks to the rock lobster fishery resulting from jurisdictional issues between agencies.

Part 7. Discussion

This report differs in structure and content from the first risk assessment in retaining the breadth of participant opinion, and in providing some assessment of social factors and external drivers. Experts from a range of fields were able to consider the qualitative arguments from stakeholders and in some cases, see the ideas mapped on influence diagrams. They assessed background information and any additional data compiled since the first assessment was made. They discussed some of the most serious hazards in small groups, but then contributed their assessments individually and anonymously (from one another). They were later given the opportunity to reassess their likelihood and consequence assignments, judging them against the choices made by the other experts.

7.1 Risk ranks

Table 7.1 summarises the judgements for the 37 hazards evaluated in this risk assessment. The hazards are ranked first by their median score, second by their maximum score, and third by their minimum score. None of the hazards had a median score of EXTREME, although a few individual assessments reached at least HIGH.

The six hazards in Group A had a median rank of High or Moderate. The social implications of whale entanglement were considered to be the largest risk. Several participants classified the risk as high or extreme. This is clearly an issue for the management authority to anticipate and to consider explicitly. The median risk to sea lion populations accords with the judgement made in the previous risk assessment. However, risk mitigation measures including especially the implementation of sea lion exclusion devices, is expected to substantially reduce the risk (see Group C in Table 7.1).

Changes in the efficiency of the fleet and the adoption of campaign fishing is seen as a moderate risk, the third most important in the list. It has not been considered previously. This hazard is already measured regularly through the monitoring of fishing effort and other assessment mechanisms. The objective of these efforts is to map the important causal processes, to enable management controls to be tailored accordingly.

The estimate of egg production was considered by both stakeholders and the experts to be an important variable, conditioning judgements about sustainable harvest and the maintenance of the stock. The expert workshop spent considerable time discussing this hazard. The topic may deserve explicit treatment in a separate review, to establish the reliability of estimates and information that may better support them, in a transparent and accessible form.

The remaining hazards ranked as moderate include the broad ecosystem-level effects on the Central West Coast shallow and deep ecosystems. For the shallow region, however, detailed justifications were only provided for a low level of risk, raising doubts about the moderate level generated. Both of these regions and the associated ecosystem consequences of lobster harvesting are the focus of dedicated research efforts. The deepwater research began after the previous risk assessment. The judgements in Table 7.1 confirm the importance of that work, in the eyes of both stakeholders and experts.

Table 7.1. Ranked risk assessments for 37 hazards based on the judgements of 13 experts.

Hazard	*Median*	*Max*	*Min*	*Rank*
Group A				
11. Whales (social)	18	25	4	High
12. Sea lions (unmanaged)	12	24	0	Mod
3. Efficiency changes	9	20	4	Mod
21. Central west coast-shallow	9	15	1	Mod
1. Wrong egg production	8.5	12	2	Mod
22. Central west coast-deep	8	12	4	Mod
Group B				
2. Recreational fishing	6	15	0	Low
7. Octopus	6	12	1	Low
14. Sea turtles	6	12	1	Low
6. Effects on genetic structure	6	12	0	Low
23. Kalbarri - Big Bank	6	12	0	Low
31. Abrolhos terrestrial bio-sec.	6	12	0	Low
36. Climate change	6	12	0	Low
32. Bait bands: dusky whalers	6	10	0	Low
Group C				
37. Jurisdictional issues	5	12	0	Low
19. Abrolhos ecosystem	4	15	1	Low
20. Leeuwin - Naturaliste	4	12	1	Low
4. Leg loss from handling	4	10	2	Low
25. Benthic biota	4	8	1	Low
27. Bait pathogens and disease	4	8	0	Low
10. Whales (ecological)	3.5	10	0	Low
26. Bait stocks	3.5	9	0	Low
18. Uncertainty in bycatch	3	12	0	Low
30. Marine issues-Abrolhos	3	10	0	Low
8. Scalefish and sharks	3	8	0	Low
5. Market decline	2	9	0	Low
13. Sea lions (managed)	0.5	10	0	Low
Group D				
9. Deep sea crabs	3	6	0	Low
15. Manta rays	2	6	0	Low
16. Moray eels	2	6	0	Low
17. Sea horses	2	6	0	Low
24. Ghost fishing	2	6	0	Low
28. Attendant behaviour	2	6	0	Low
35. Oil spills	1.5	8	0	Low
34. Aquaculture	1.5	6	0	Low
29. Feeding dolphins	1	6	0	Low
33. Trawling	1	4	0	Low

The eight hazards in Group B have median ranks of ‘low’ but are scored at 6, on the boundary between low and moderate. In each case, at least one person and in most instances, several people, ranked these hazards as moderate. In most cases, no justification was provided for extreme (high or low) scores. The impacts of recreational fishing were difficult to assess given the information available, reflected in the wide range of opinions about the potential for such a hazard. Clarification of the available information on this issue with the group would have probably assisted with their assessments. Similarly the wide variation in assessment for the Abrolhos islands ecosystem suggests that the issue may have been assessed differently by some participants; but without clear rationales for the higher levels, it is difficult to reconcile.

The discussion among the experts suggested that the effects of fishing on octopus and sea turtles are difficult to estimate because of a lack of knowledge of the sizes or extents of populations impacted by harvesting activities. All 'listed' species, including sea turtles are monitored more intensively than in the past, the results of which may help clarify this issue prior to the next review. Octopus catches and catch rates are being monitored annually and these data could be assessed in more detail prior to the next review. Similarly, monitoring of the frequency of bait bands found on dusky whalers will provide more specific information on this issue. However, the changes proposed for the dedicated shark fishery on this species are likely to have a substantial impact, providing some assurance that the extent and severity of effects on this vulnerable species are acceptable.

The remaining hazards in Group B include the effects of fishing on rock lobster population genetic structure and its effects on one ecosystem. The ecosystem effects are subsumed within broader scale studies currently underway. It may be worth considering whether there is any information that could be used to make a clearer assessment of the likelihood that the fishery exerts some selective pressure on growth. Some knowledge of the magnitude of heritability and selection would assist both management of the stock in the long term and prediction of the ecological consequences of fishing.

Climate change effects on productivity were also on the margin between low and moderate risks. Lack of specific knowledge limited the ability of the experts in the workshop to make specific predictions about how lobster productivity will change as sea temperatures and flow pattern change, themselves highly unpredictable events. However, it may be possible (and beneficial for the industry) to develop several alternative scenarios ('futures') to examine how the current governance processes, industry structure, flexibility and ecosystem tolerances would cope with such changes, were they to happen.

Hazards ranked together under Group C had lower than marginal low ranks (i.e., their median scores were 5 or below), but at least one person ranked them as moderate. The status of these hazards should be reviewed again at the next cycle of the risk assessment. Hazards ranked in group D had maximum ranks of low. That is, none of the experts considered them to be moderate risks. The best strategy for these hazards is not to devote further effort towards justification or review, unless stakeholders raise them during the next cycle of the risk assessment.

7.2. Evaluation of outcomes against the previous risk assessment

A total of thirteen hazards were considered explicitly in the last cycle of the risk assessment but were not given specific treatment here because they were rated as low risks last time and the stakeholders and experts saw no reason to give them more detailed treatment (Table 6.2). Most were discussed under the headings defined for the hazards listed in Tables 6.1 and 7.1 (Table 6.2).

The component trees and consequence tables provided useful starting points for discussion in both the stakeholder and expert workshops. They provided a natural platform for constructing influence diagrams for specific hazards, which may in turn form the basis for more detailed models of cause and effect. In the previous assessment, four issues were ranked as moderately risky: sea lion interactions with pots, fishing effects on breeding stock that impair recruitment at levels that will replenish harvest and natural mortality, rope entanglement of leatherback turtles, possible decline in coral habitat in the Abrolhos, dumping of domestic waste into ocean at Abrolhos Is.

With management, sea lion interactions with pots and domestic water dumping at the Abrolhos are now considered low risks. Uncertainty about effects on breeding stock remains, in a modified form, under the heading of uncertainty about the estimate of egg production, ranked as a moderate risk. Concerns about the effects of vessels and pots on Abrolhos coral have been alleviated by further observations and clarification of the extent of interactions of fishing activities with this habitat. Concerns about broader ecosystem effects in the Abrolhos remain. Entanglement of leatherback turtles remains a (marginally) concerning hazard (Group B).

This cycle of the risk assessment differed from the earlier implementation by including some social factors and some external drivers, factors that are not controlled by the fishery or its management, but may have a substantial influence on it. The stakeholders meeting in particular saw value in discussing and ranking these issues, so that opportunities for proactive intervention, negotiation or planning might mitigate the risks to the fishery. One of these issues, whale entanglements, appeared in Group A and one, climate change, appeared in Group B.

Another feature that may develop in future iterations of the risk management cycle was the decision to evaluate hazards with and without management. This was performed here for the interaction of sea lions with lobster pots where the specific management arrangements have not yet been finalised. Without the proposed increased level of management, the risk was moderate (as it was in the last cycle). With increased management, the risk was reduced to very low levels. Risk mitigation measures and residual risk estimates are common place in risk assessments in other domains and may make a useful addition to the fishery risk assessment, if applied more broadly to those areas where new management measures are being proposed or old management arrangements are being reviewed. If there was no difference in the risk levels with or without management this would raise serious questions about their efficacy.

7.3 Levels of agreement

In general, there was good agreement between experts noting that they represented a range of fields but were able to input on most hazards. Their final rankings reflected the outcome of consideration of evidence, discussion and the deliberations of their peers (Figure 7.1). The average Spearman's rank correlation between pairs of assessors was about 0.5 with most values clustering between 0.3 and 0.7.

In risk assessment exercises in general, average rank correlations between assessors of about 0.5 are typical of situations in which much of the ambiguity and other superficial misunderstandings about hazards have been resolved (Burgman 2005).

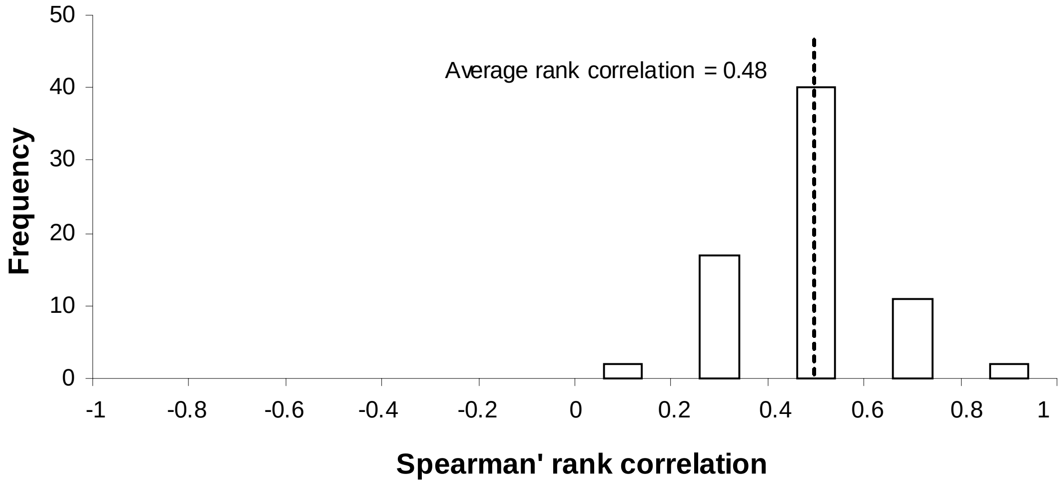


Figure 7.1. Agreement between pairs of experts, measured by the rank correlation calculated between hazard lists for each pair of experts. This analysis excludes one assessor of the 13 involved who declined to provide judgements for most of the hazards and therefore have been an outlier.

7.4 Management implications

Potential management responses range from continuing fundamental ecological studies, through increased monitoring, to explicit management prescriptions. Several successful interventions resulting from the previous risk assessment are evident in the deliberations in this cycle. In the opinions of the experts, risks from sea lion interactions with pots and from dumping domestic waste at the Abrolhos have been substantially mitigated as a consequence of management prescriptions (for waste dumping), or research results that are intended to lead to new prescriptions (for SLEDs). Other assessments of risk have been mitigated by data acquisition and improved understanding (for the impact of pots and vessels on coral at the Abrolhos).

The next cycle of the risk assessment will again consider the lists of hazards in Tables 6.1 and 6.2, together with background information and additional data collected between this point and the time of the next assessment. The assessments here should influence priorities for new studies, monitoring effort and management interventions.

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