R04/1072 | 1/04/2008

Australian Government
Australian Fisheries Management Authority

Ecological Risk Assessment for Effects of Fishing

REPORT FOR THE DEMERSALTRAWL SUB-FISHERY OF THE HEARD AND MCDONALD ISLANDS FISHERY

Authors
Ross Daley
Catherine Bulman
Dave Stevenson
Alistair Hobday
Miriana Sporcic
Michael Fuller

CSIRO

Natural Heritage Trust
Helping Communities Helping Australia
An Australian Government Initiative

This fishery ERA report should be cited as:

Daley, R., Bulman, C., Stevenson, D., Hobday, A., Sporcic, M., and Fuller, M.(2007). Ecological Risk Assessment for the Effects of Fishing: Report for the Demersal Trawl Sub-fishery of the Heard and McDonald Islands Fishery. Report for the Australian Fisheries Management Authority, Canberra.

This work is copyright. Except as permitted under the *Copyright Act 1968 (Commonwealth)*, no part of this publication may be reproduced by any process, electronic or otherwise, without prior written permission from either CSIRO Marine and Atmospheric Research or AFMA. Neither may information be stored electronically in any form whatsoever without such permission.

Notes to this document:

This fishery ERA report contains figures and tables with numbers that correspond to the full methodology document for the ERAEF method:

> Hobday, A. J., A. Smith, H. Webb, R. Daley, S. Wayte, C. Bulman, J. Dowdney, A. Williams, M. Sporcic, J. Dambacher, M. Fuller, T. Walker (2008). Ecological Risk Assessment for the Effects of Fishing: Methodology. Report R04/1072 for the Australian Fisheries Management Authority, Canberra.

Thus, table and figure numbers within the fishery ERA report are not sequential as not all are relevant to the fishery ERA report results.

Additional details on the rationale and the background to the methods development are contained in the ERAEF Final Report:

> Smith, A., Hobday, A., H. Webb, R. Daley, S. Wayte, C. Bulman, J. Dowdney, A. Williams, M. Sporcic, J. Dambacher, M. Fuller, D. Furlani, T. Walker. (2007). Ecological Risk Assessment for the Effects of Fishing: Final Report R04/1072 for the Australian Fisheries Management Authority, Canberra.

Executive Summary

This assessment of the ecological impacts of the Heard and McDonald Islands Demersal Trawl Fishery was undertaken using the ERAEF method version 9.2. ERAEF stands for "Ecological Risk Assessment for Effect of Fishing", and was developed jointly by CSIRO Marine and Atmospheric Research, and the Australian Fisheries Management Authority. ERAEF provides a hierarchical framework for a comprehensive assessment of the ecological risks arising from fishing, with impacts assessed against five ecological components – target species; by-product and by-catch species; threatened, endangered and protected (TEP) species; habitats; and (ecological) communities.

ERAEF proceeds through four stages of analysis: scoping; an expert judgement based Level 1 analysis (SICA – Scale Intensity Consequence Analysis); an empirically based Level 2 analysis (PSA – Productivity Susceptibility Analysis); and a model based Level 3 analysis. This hierarchical approach provides a cost-efficient way of screening hazards, with increasing time and attention paid only to those hazards that are not eliminated at lower levels in the analysis. Risk management responses may be identified at any level in the analysis.

Application of the ERAEF methods to a fishery can be thought of as a set of screening or prioritization steps that work towards a full quantitative ecological risk assessment. At the start of the process, all components are assumed to be at high risk. Each step, or Level, potentially screens out issues that are of low concern. The Scoping stage screens out activities that do not occur in the fishery. Level 1 screens out activities that are judged to have low impact, and potentially screens out whole ecological components as well. Level 2 is a screening or prioritization process for individual species, habitats and communities at risk from direct impacts of fishing. The Level 2 methods do not provide absolute measures of risk. Instead they combine information on productivity and exposure to fishing to assess potential risk – the term used at Level 2 is risk. Because of the precautionary approach to uncertainty, there will be more false positives than false negatives at Level 2, and the list of high risk species or habitats should not be interpreted as all being at high risk from fishing. Level 2 is a screening process to identify species or habitats that require further investigation. Some of these may require only a little further investigation to identify them as a false positive; for some of them managers and industry may decide to implement a management response; others will require further analysis using Level 3 methods, which do assess absolute levels of risk.

This assessment of the Heard and McDonald Islands Demersal Trawl Fishery includes the following:

- Scoping
- Level 1 results for all components
- Level 2 results for the target and bycatch/byproduct species components,

Fishery Description

Gear:	Otter trawl (minimum 120mm for Patagonian toothfish and 90 mm for Mackerel icefish)
Area:	Heard and McDonald Islands Demersal Trawl Fishery
Depth range:	400 to 1300m
Fleet size:	2-3 vessels
Effort:	2004/5 Patagonian toothfish: 21,668 hours; Mackerel icefish: 6,363 hours*
Landings:	2744 t Patagonian toothfish (2004/5); 1851 t Mackerel icefish (2004/5)
Discard rate:	256 t of byproduct/bycatch species retained and mealed onboard or discarded/released alive, ~1% of total catch (2001/04 unofficial AAD observer database records)
Main target species:	Patagonian toothfish, Mackerel icefish
Management:	Quota management system for 2 species/stocks and 6 bycatch species/groups
Observer program:	observer program operating since beginning of fishery in 1997

* Source: CCAMLR Statistical Bulletin no18 , May 2006, although these figures differ to AAD figures.

Ecological Units Assessed

Target species:	2
Byproduct species:	77
Bycatch Species:	8
TEP species:	82
Habitats:	-
Communities:	12

Level 1 Results

Habitats for this fishery were not assessed using most recent ERAEF methodology. Although a significant amount of relevant data is held by the AAD, it was not made available to CSIRO. Instead AAD are currently undertaking more detailed (Level 3) studies of benthic habitats and additional work is proposed for this region by the AAD in the future.

Risk scores were between 1-4 across all 32 hazards (fishing activities) and four ecological components assessed. A number of hazards (fishing activities) were eliminated at Level 1 (risk scores 1 or 2). The hazard given further consideration at Level 2 (risk scores of $\geq$3) was:

- Fishing (direct impacts on target, bycatch/byproduct and communities)

One risk, external impacts from other fisheries, was rated as major (risk scores 4). No risks rated as severe (5) or intolerable (6).

One ecological component was eliminated at Level 1: TEP. It is important to note that the worst case scenario considered for TEP species was the impact of capture fishing on black-browed albatross. This bird species has the smallest population size for any in the region – around 1,200. However, it is almost certain that an annual catch of 1% (12 birds per year) would not prevent this fishery from meeting its main objective for TEP species - ensure TEP species do not further approach extinction or become extinct. Observer data shows that the number of birds killed in the entire history of the demersal trawl sub-fishery around Heard Island is less than 12 birds. Most of these birds collided with the boat and did not interact with either the warp wires or the net.

Level 2 Results

Of the 87 species assessed at Level 2, expert over rides were used on one species. Of the 52 species assessed to be at high risk, 37 had more than 3 missing attributes.

Target species

The target species examined included tooth fish and icefish. Tooth fish is the principle target species in the demersal trawl sub-fishery; icefish is principally caught in the mid-water sub-fishery however is also retained from this subfishery when caught. The toothfish was evaluated as at high potential risk but has a comprehensive management plan with precautionary catch limits based on detailed assessments.

Byproduct/bycatch species

A larger than expected number of byproduct species was evaluated as high risk. However most of these species are fishes that are caught in only small quantities. These high risk scores reflect uncertainty about spatial distribution and missing information; most importantly, the poorly documented taxonomy and distribution of fish species in this remote region. The species at highest risk in this sub-fishery are sleeper sharks and skates. There has been a study of sleeper sharks in the Southern Ocean but it does not include yield estimates. There have limited studies of skates in the region. A maximum allowable catch is in place for skates but it is not clear that this catch level is sustainable. Skates are extraordinarily vulnerable (Musick, *et al.*, 2000) and are considered one of the most threatened groups of all marine species worldwide. There have been local and near extinctions overseas (Dulvy *et al.*, 2000; Stevens *et al.*, 2000).

Observer data indicates about 20 t of benthic invertebrates and 75 t of rocks have become tangled in the gear and removed over the last five years. Invertebrates include sponges, hard and soft corals which form substrate/habitat for other. This suggests that risks to habitats should be assessed.

Habitats

See Level 1 Results.

Communities

The community component was not assessed at Level 2 for this sub-fishery, but should be considered in future assessments when the methods to do this are fully developed.

Summary

Two ecological issues emerge from the ERAEF assessment of the HIMI demersal trawl fishery. These are uncertainty related to the benthic impacts of trawling in the area and the ecological sustainability of significant catches of skates and sleeper sharks. There are genuine concerns for skates worldwide because of their low productivity and a high proportion of endemic species

Managing identified risks

Using the results of the ecological risk assessment, the next steps for each fishery will be to consider and implement appropriate management responses to address these risks. To ensure a consistent process for responding to the ERA outcomes, AFMA has developed an Ecological Risk Management (ERM) framework.

TABLE OF CONTENTS

Fishery ERA report documents to be completed

List of Summary documents

List of Scoping documents

List of Level 1 (SICA) documents

List of Level 2 (PSA) documents

List of Figures

List of Tables

1. Overview

Ecological Risk Assessment for the Effects of Fishing (ERAEF) Framework

The Hierarchical Approach

The Ecological Risk Assessment for the Effects of Fishing (ERAEF) framework involves a hierarchical approach that moves from a comprehensive but largely qualitative analysis of risk at Level 1, through a more focused and semi-quantitative approach at Level 2, to a highly focused and fully quantitative "model-based" approach at Level 3 (**Figure 1**). This approach is efficient because many potential risks are screened out at Level 1, so that the more intensive and quantitative analyses at Level 2 (and ultimately at Level 3) are limited to a subset of the higher risk activities associated with fishing. It also leads to rapid identification of high-risk activities, which in turn can lead to immediate remedial action (risk management response). The ERAEF approach is also precautionary, in the sense that risks will be scored high in the absence of information, evidence or logical argument to the contrary.

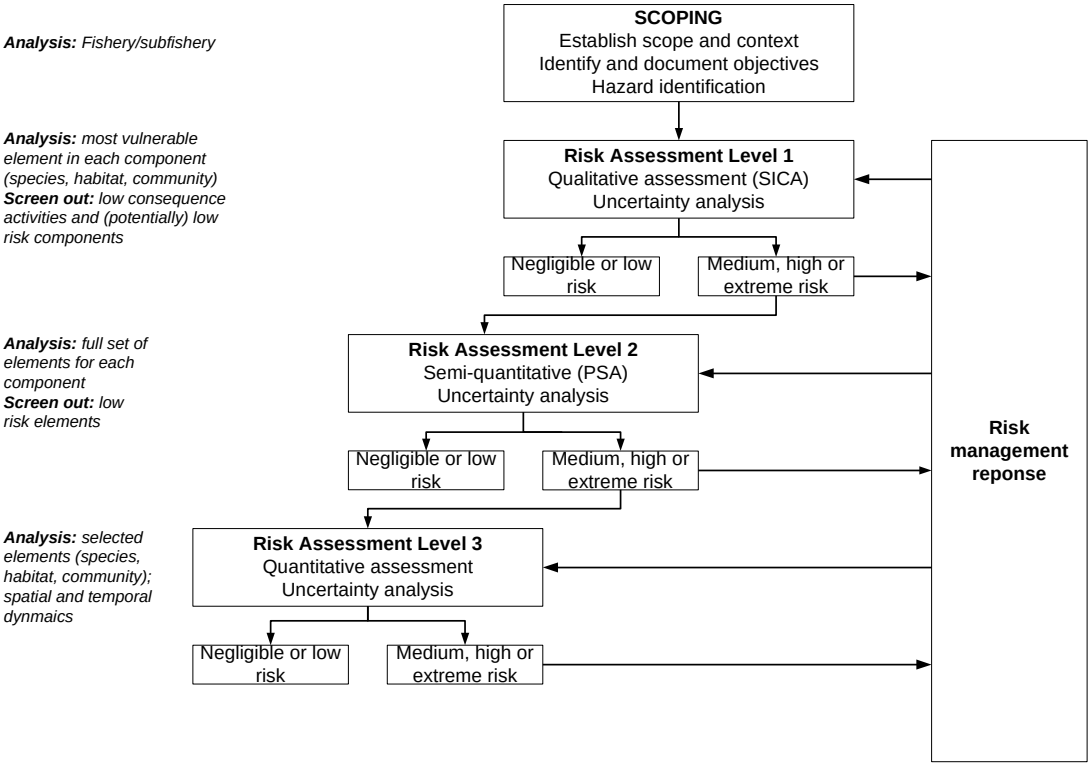


Figure 1. Overview of ERAEF showing focus of analysis for each level at the left in italics.

Conceptual Model

The approach makes use of a general conceptual model of how fishing impacts on ecological systems, which is used as the basis for the risk assessment evaluations at each level of analysis (Levels 1-3). For the ERAEF approach, five general ecological

components are evaluated, corresponding to five areas of focus in evaluating impacts of fishing for strategic assessment under EPBC legislation. The five *components* are:

- Target species
- By-product and by-catch species
- Threatened, endangered and protected species (TEP species)
- Habitats
- Ecological communities

This conceptual model (**Figure 2**) progresses from *fishery characteristics* of the fishery or sub-fishery, → *fishing activities* associated with fishing and *external activities*, which may impact the five ecological components (target, byproduct and bycatch species, TEP species, habitats, and communities); → *effects of fishing and external activities* which are the direct impacts of fishing and external activities; → *natural processes and resources* that are affected by the impacts of fishing and external activities; → *sub-components* which are affected by impacts to natural processes and resources; → *components*, which are affected by impacts to the sub-components. Impacts to the sub-components and components in turn affect achievement of management objectives.

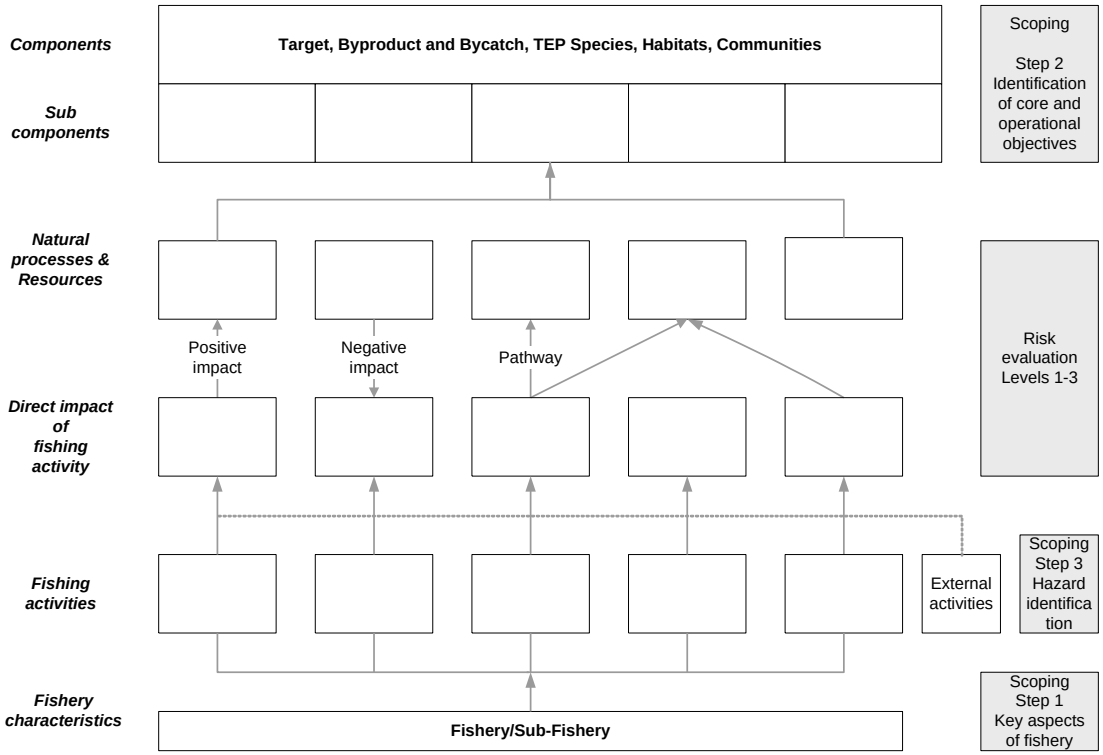


Figure 2. Generic conceptual model used in ERAEF.

The external activities that may impact the fishery objectives are also identified at the Scoping stage and evaluated at Level 1. This provides information on the additional impacts on the ecological components being evaluated, even though management of the external activities is outside the scope of management for that fishery.

The assessment of risk at each level takes into account current management strategies and arrangements. A crucial process in the risk assessment framework is to document the rationale behind assessments and decisions at each step in the analysis. The decision to proceed to subsequent levels depends on

- Estimated risk at the previous level
- Availability of data to proceed to the next level
- Management response (e.g. if the risk is high but immediate changes to management regulations or fishing practices will reduce the risk, then analysis at the next level may be unnecessary).

A full description of the ERAEF method is provided in the methodology document (Hobday et al 2006). This fishery report contains figures and tables with numbers that correspond to this methodology document. Thus, table and figure numbers within this fishery ERAEF report are not sequential, as not all figures and tables are relevant to the fishery risk assessment results.

ERAEF stakeholder engagement process

A recognized part of conventional risk assessment is the involvement of stakeholders involved in the activities being assessed. Stakeholders can make an important contribution by providing expert judgment, fishery-specific and ecological knowledge, and process and outcome ownership. The ERAEF method also relies on stakeholder involvement at each stage in the process, as outlined below. Stakeholder interactions are recorded.

Scoping

In the first instance, scoping is based on review of existing documents and information, with much of it collected and completed to a draft stage prior to full stakeholder involvement. This provides all the stakeholders with information on the relevant background issues. Three key outputs are required from the scoping, each requiring stakeholder input.

1. Identification of units of analysis (species, habitats and communities) potentially impacted by fishery activities (section 2.2.2; Scoping Documents S2A, S2B and S2C).
2. Selection of objectives (section 2.2.3; Scoping Document S3) is a challenging part of the assessment, because these are often poorly defined, particularly with regard to the habitat and communities components. Stakeholder involvement is necessary to agree on the set of objectives that the risks will be evaluated against. A set of preliminary objectives relevant to the sub-components is selected by the drafting authors, and then presented to the stakeholders for modification. An agreed set of objectives is then used in the Level 1 SICA analysis. The agreement of the fishery management advisory body (e.g. the MAC, which contains representatives from industry, management, science, policy and conservation) is considered to represent agreement by the stakeholders at large.
3. Selection of activities (hazards) (section 2.2.4; Scoping Document S4) that occur in the sub-fishery is made using a checklist of potential activities provided. The checklist was developed following extensive review, and allows repeatability

between fisheries. Additional activities raised by the stakeholders can be included in this checklist (and would feed back into the original checklist). The background information and consultation with the stakeholders is used to finalize the set of activities. Many activities will be self-evident (e.g. fishing, which obviously occurs), but for others, expert or anecdotal evidence may be required.

Level 1. SICA (Scale, Intensity, Consequence Analysis)

The SICA analysis evaluates the risk to ecological components resulting from the stakeholder-agreed set of activities. Evaluation of the temporal and spatial scale, intensity, sub-component, unit of analysis, and credible scenario (consequence for a sub-component) can be undertaken in a workshop situation, or prepared ahead by the draft fishery ERA report author and debated at the stakeholder meeting. Because of the number of activities (up to 24) in each of five components (resulting in up to 120 SICA elements), preparation before involving the full set of stakeholders may allow time and attention to be focused on the uncertain or controversial or high risk elements. The rationale for each SICA element must be documented and this may represent a challenge in the workshop situation. Documenting the rationale ahead of time for the straw-man scenarios is crucial to allow the workshop debate to focus on the right portions of the logical progression that resulted in the consequence score.

SICA elements are scored on a scale of 1 to 6 (negligible to extreme) using a “plausible worst case” approach (see ERAEF Methods Document for details). Level 1 analysis potentially result in the elimination of activities (hazards) and in some cases whole components. Any SICA element that scores 2 or less is documented, but not considered further for analysis or management response.

Level 2. PSA (Productivity Susceptibility Analysis)

The semi-quantitative nature of this analysis tier should reduce but not eliminate the need for stakeholder involvement. In particular, transparency about the assessment will lead to greater confidence in the results. The components that were identified to be at moderate or greater risk (SICA score > 2) at Level 1 are examined at Level 2. The units of analysis at Level 2 are the agreed set of species, habitat types or communities in each component identified during the scoping stage. A comprehensive set of attributes that are proxies for productivity and susceptibility have been identified during the ERAEF project. Where information is missing, the default assumption is that risk will be set high. Details of the PSA method are described in the accompanying ERAEF Methods Document. Stakeholders can provide input and suggestions on appropriate attributes, including novel ones, for evaluating risk in the specific fishery. The attribute values for many of the units (e.g. age at maturity, depth range, and mean trophic level) can be obtained from published literature and other resources (e.g. scientific experts) without full stakeholder involvement. This is a consultation of the published scientific literature. Further stakeholder input is required when the preliminary gathering of attribute values is completed. In particular, where information is missing, expert opinion can be used to derive the most reasonable conservative estimate. For example, if the species attribute values for annual fecundity have been categorized as low, medium and high on the set [<5, 5-500, >500], estimates for species with no data can still be made. Estimated

fecundity of a species such as a broadcast-spawning fish with unknown fecundity, is still likely greater than the cut-off for the high fecundity categorization (>500). Susceptibility attribute estimates, such as "fraction alive when landed", can also be made based on input from experts such as scientific observers. The final PSA is completed by scientists because access to computing resources, databases, and programming skills is required. Feedback to stakeholders regarding comments received during the preliminary PSA consultations is considered crucial. The final results are then presented to the stakeholder group before decisions regarding Level 3 are made. The stakeholder group may also decide on priorities for analysis at Level 3.

Level 3

This stage of the risk assessment is fully-quantitative and relies on in-depth scientific studies on the units identified as at medium or greater risk in the Level 2 PSA. It will be both time and data-intensive. Individual stakeholders are engaged as required in a more intensive and directed fashion. Results are presented to the stakeholder group and feedback incorporated, but live modification is not considered likely.

Conclusion and final risk assessment report

The conclusion of the stakeholder consultation process will result in a final risk assessment report for the individual fishery according to the ERAEF methods. It is envisaged that the completed assessment will be adopted by the fishery management group and used by AFMA for a range of management purposes, including addressing the requirements of the EPBC Act as evaluated by Department of the Environment and Heritage.

Subsequent risk assessment iterations for a fishery

The frequency at which each fishery must revise and update the risk assessment is not fully prescribed. As new information arises or management changes occur, the risks can be re-evaluated, and documented as before. The fishery management group or AFMA may take ownership of this process, or scientific consultants may be engaged. In any case the ERAEF should again be based on the input of the full set of stakeholders and reviewed by independent experts familiar with the process.

Each fishery ERA report will be revised at least every four years or as required by Strategic Assessment. However, to ensure that actions in the intervening period do not unduly increase ecological risk, each year certain criteria will be considered. At the end of each year, the following trigger questions should be considered by the MAC for each sub-fishery.

- Has there been a change in the spatial distribution of effort of more than 50% compared to the average distribution over the previous four years?
- Has there been a change in effort in the fishery of more than 50% compared to the four year average (e.g. number of boats in the fishery)?
- Has there been an expansion of a new gear type or configuration such that a new sub-fishery might be defined?

- Responses to these questions should be tabled at the relevant fishery MAC each year and appear on the MAC calendar and work program. If the answer to any of these trigger questions is yes, then the sub-fishery should be re-evaluated.

2. Results

The focus of analysis is the fishery as identified by the responsible management authority. The assessment area is defined by the fishery management jurisdiction within the AFZ. The fishery may also be divided into sub-fisheries on the basis of fishing method and/or spatial coverage. These sub-fisheries should be clearly identified and described during the scoping stage. Portions of the scoping and analysis at Level 1 and beyond, is specific to a particular sub-fishery. The fishery is a group of people carrying out certain activities as defined under a management plan. Depending on the jurisdiction, the fishery/sub-fishery may include any combination of commercial, recreational, and/or indigenous fishers.

2.1 Stakeholder engagement

2.1 Summary Document SD1. Summary of stakeholder involvement for fishery

Demersal trawl subfishery of the Heard and McDonald Islands Fishery

Fishery ERA report stage	Type of stakeholder interaction	Date of stakeholder interaction	Composition of stakeholder group (names or roles)	Summary of outcome
Scoping	Phone calls and email	July-October	Bob Stanley, AFMA logbook manager. Geoff Tuck, CSIRO	Provided information for scoping stage of fishery ERA report
	Meeting. MSC Icefish review committee general meeting at IASOS	October 27, 2003	MSC Committee, various IASOS staff and students	ERA methods discussed. Agreement to provide some information to the MSC group if request received.
	Email and phone calls	April 20-26, 2004	Campbell Davies led a small group reviewing fishery ERA report	Draft reviewed by AAD scientists. Comments on out dated information and suggestions for additional information made. Experts were identified for additional input. Dick Williams (general expertise) Andrew Constable (general expertise) Tim Lamb (observers) Esmee van Wick (fish by-catch) Graham Robertson and Barbara Wienecke (Sea bird bycatch mitigation) Nick Gales (Marine mammal ecology and fishery interactions)
	Meeting, SAFAG	April 28, 2004	See minutes of meeting	e.g. April 24, feedback on preferred objectives was provided Hazards agreed on.
Level 2 (PSA)	Email and face-to-face	April 2004	Bruce Deagle and AWRU at UTas	Provided some taxa data for diving depths for birds and seals for use in PSA
Scoping	Emails and meeting	June 2006	AAD	Feedback on scoping for subfisheries.
Level 1 and 2	Stakeholder meeting	27 June 2006	AAD, Industry reps, AFMA	ERA methods and results presented. New composition of group and assessment team and methodology, resulted in necessity to revisit initial steps in process-AFMA to clarify. Level 2 results not discussed. CSIRO to amend Level 1 and Level 2 where appropriate.

2.2 Scoping

The aim in the Scoping stage is to develop a profile of the fishery being assessed. This provides information needed to complete Levels 1 and 2 and at stakeholder meetings. The focus of analysis is the fishery, which may be divided into sub-fisheries on the basis of fishing method and/or spatial coverage. Scoping involves six steps:

Step 1 Documenting the general fishery characteristics
Step 2 Generating "unit of analysis" lists (species, habitat types, communities)
Step 3 Selection of objectives
Step 4 Hazard identification
Step 5 Bibliography
Step 6 Decision rules to move to Level 1

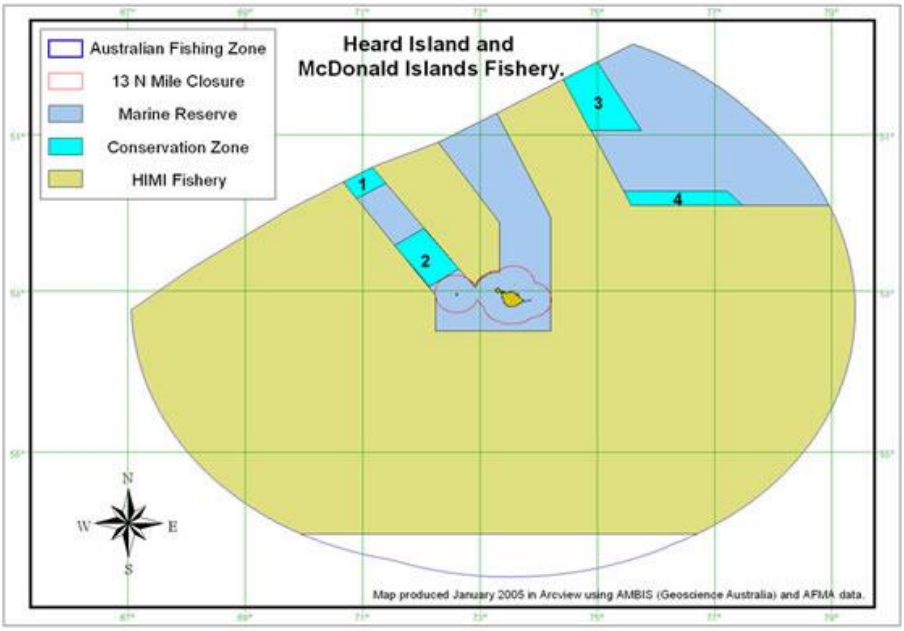
2.2.1 General Fishery Characteristics (Step 1).

The information used to complete this step may come from a range of documents such as the Fishery's Management Plan, Assessment Reports, Bycatch Action Plans, and any other relevant background documents. The level and range of information available will vary. Some fisheries/sub-fisheries will have a range of reliable information, whereas others may have limited information.

Scoping Document S1. General Fishery Characteristics

Sub-fishery Name: Demersal trawl
Fishery Name: Heard and McDonald Islands Fishery
Date of assessment: April 2004 (updated June 2006)

General Fishery Characteristics	
Fishery Name	Heard Island and McDonald Islands (HIMI) Fisheries *(CCAMLR Statistical Division 58.5.2)*
Sub-fisheries	There are currently four sub-fisheries based on fishing methods, the first of which could be considered as two sub-fisheries because two species are targetted: 1. **Demersal otter board trawling** for *Dissostichus eleginoides* Patagonian toothfish and *Champsocephalus gunnari* Mackerel icefish. 2. **Mid-water trawling** for *C. gunnari* Mackerel icefish. This method is considered experimental, and has had limited application over the past few years. 3. **Demersal longlining** for *D. eleginoides* Patagonian toothfish began in May 2003 season under scientific permits. 4. **Pot and trap fishing.** An experimental trap fishery for Patagonian toothfish began in 2005. These methods may significantly reduce seabird and marine mammal interactions that are common issues with longline fisheries although not in the HIMI fishery to date. The advantage of pots and traps over trawling is that they lessen the impact on the benthic habitats. It is thought that these methods could access a different age group of toothfish stocks, as they are capable of being used over the rough bottom that trawling cannot access. The impact of trap fishing on bycatch species will need to be evaluated.
Sub-fisheries assessed	This assessment only considers demersal otter board trawling but treats *Dissostichus eleginoides* Patagonian toothfish and *Champsocephalus gunnari* Mackerel icefish separately where necessary.
Start date/history	Fishing activity in the region had been sparse until recently. There are records of Soviet and Polish vessels fishing *Champsocephalus gunnari* Mackerel icefish in the region in the 1970s and some research surveys were conducted by AAD in the early 1990s.

	The Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR) came into force in 1982, as part of the Antarctic Treaty System, with the aim of regulating exploitation rather than outright protection. CCAMLR was established at a time when commercial interests in krill were growing rapidly; it began to be truly effective as a management regime in 1991 when the first catch limits were set. From the outset CCAMLR was based on the principle that management of fisheries should include not just the target species but also dependent and associated species and their ecological relationships. Commercial fishing for *D. eleginoides* and *C. gunnari* by Australian operators commenced in March 1997 using demersal and midwater trawls in accordance with CCAMLR Conservation Measures 109/XV and 110/XV (1996) respectively(now CM 41-08 and 42-02). Subsequently, licensed Australian vessels have attempted to take the TAC set by CCAMLR each year but due to fluctuations in abundances, they have not always caught the icefish limit (Williams *et al.* 2002). (Source: http://www.afma.gov.au/fisheries)
Geographic extent of fishery	The fishery operates in sub-Antarctic waters adjacent to Heard Island and the McDonald Islands. Heard Island and McDonald Islands (HIMI) are external territories of Australia located in the Southern Indian Ocean about 4,000 km south-west of Perth. The islands lie south of the Polar Front. The Islands are listed on the Register of the National Estate as the only unmodified example of a sub-Antarctic island ecosystem. In addition, the Islands and the 12 nautical mile territorial sea around them are on the World Heritage List and form part of the Heard Island Wilderness Reserve that is managed by the Australian Antarctic Division (AAD) and is closed to fishing. In recognition of the Islands' importance, fishing is prohibited within 13 nautical miles of the Islands, providing a buffer zone of one nautical mile. The fishery extends from 13 nautical miles offshore to the edge of the 200 nautical mile Australian Economic Exclusive Zone (EEZ) around the Islands and is managed by the Australian Fisheries Management Authority. The fishery lies in CCAMLR Statistical Division 58.5.2.  (Source: http://www.afma.gov.au/fisheries/antarctic/himi/default.htm)
Regions or Zones within the fishery	There are 3 main trawl grounds A, B and C for Patagonian toothfish that will not be identified further to retain confidentiality of the licensed operators of the fishery. The grounds are on the Heard Island plateau between 450 m and 700 m deep (Williams *et al.*

	2002). Icefish are fished on the shallower parts of the plateau particularly on the southeast slope and Gunnari Ridge (Meyer *et al*. 2000). Until 1998 they were also abundant on Shell Bank (Williams *et al* 2002) but this area has been closed since then due to concern that it was not able to sustain a fishery and the potential for overlap between the icefish fishery and the foraging activities of icefish predators (Meyer *et al.* 2000).
Fishing season	The fishing season for both target species is from 1 December to 30 November each year.
Target species and stock status	**Patagonian toothfish (*Dissostichus eleginoides*)** The Patagonian toothfish (*Dissostichus eleginoides*) is widely distributed throughout large areas of the Antarctic oceans. It is a demersal species found at depths up to 2,500 metres, although it is reported to be pelagic throughout some periods of its life (eggs to young juveniles). Patagonian toothfish occur throughout the Plateau from shallow depths to 1800m. Younger fish, less than 500mmTL, occur in less than 500m and as they grow they move deeper into depths to 800m, where they can become locally abundant. Older fish move into depths >1000m where they are more usually caught by longline. Stock status of uncertain but the spawning stock biomass at the beginning of 2005/6 was about 43 000 tonnes (2005 Fishery Report: *D. eleginoides* Heard Island (Division 58.5.2)). Illegal fishing also threatens the fish targeted by the licensed fishery adding to the uncertainty of the stock status. **Mackerel icefish (*Champsocephalus gunnari*)** Mackerel icefish (*Champsocephalus gunnari*) is found in the Atlantic and Indian sectors of the Southern Ocean. In the Atlantic, it has been found at Bouvet Island and at all the islands of the Scotia Arc (South Georgia, South Sandwich, South Orkney, and South Shetland Islands) as well as the northern part of the Antarctic Peninsula. In the Indian Ocean sector, it is found on the northern part of the Kerguelen Plateau and banks between Iles Kerguelen and Heard Island. There it is confined to waters less than 500m, but usually occurs shallower than 300m (Williams *et al.* 2002). Icefish are abundant on the shallower parts of the Heard Plateau particularly on the southeast part, Gunnari Ridge (Meyer *et al*. 2000) and until 1998 was abundant on Shell Bank (Williams *et al* 2002). Analyses indicate that the stocks on the Plateau and Shell Bank have different size structure and recruitment patterns and therefore are considered as separate. In contrast to the reports of the early 1970s, they are now found rarely on the other shallow banks i.e. Pike and Aurora, and other parts of the Plateau (Williams *et al.* 2002). Older juveniles and adults form large aggregations predominantly in the demersal or mid-water range of the water column. The HIMI region is the only area where Mackerel icefish are targeted in the AFZ. Stock size for the Plateau and Gunnari Ridge in 2004, was estimated to be about 24,000 tonnes (Fishery Report: *C. gunnari* Heard Island (Division 58.5.2).
Bait Collection and usage	n/a
Current entitlements	Only three boats can participate in the HIMI Fishery. Any boat with a minimum quota of 25.5% of the Statutory Fishing Rights (SFR) can participate. AFMA Annual Report 2001-2002; MSC 2006
Current and recent TACs, quota trends by method	

Year	Agreed TAC (Tonnes)	
	Patagonian toothfish	Mackerel icefish
2000/1	2995	1150
2001/2	2815	885
2002/3	2879	2980

2003/4	2873	292
2004/5	2787	1864
2005/6	2584	1210

The TACs for bycatch currently in place for Division 58.5.2 (the CCAMLR code for the region including HIMI) for 2005-2006 are:

Species	**TAC (tonnes)**
Channichthys rhinoceratus Unicorn icefish	150
Lepidonotothen squamifrons Grey rockcod	80
Skates and rays	120
Macrourus spp.	360
Other species	50

CCAMLR 2005/6 Schedule of Conservation Measures; SAFAG 2005; AFMA HIMIF TAC D4 2005

Current and recent fishery effort trends by method

Year	Effort (hours)	
	Patagonian toothfish	Mackerel icefish
2000/1	536	123
2001/2*	23	6
2002/3	814	602
2003/4	1020	100
2004/5*	21668	6363

These figures are official CCAMLR figures but appear to be incorrect (AAD).

(Source: CCAMLR Statistical Bulletin no18 , May 2006)

Current and recent fishery catch trends by method

Year	Catch (Tonnes)		
	Patagonian toothfish[1]	IUU (from longlining)	Mackerel icefish[2]
2000/1	2980	2004	1136
2001/2	2756	3489	865
2002/3	2844	1512	2345
2003/4	2864	637	78
2004/5	2744	0-265[3]	1851

[1] Total catch of toothfish including the midwater and longline catches
[2] Total catch of icefish including midwater trawl catches
[3]Estimated but expected to be accurate

	Channichthys rhinoceratus Unicorn icefish	*Lepidonotothen squamifrons* Grey rockcod	Skates and rays	*Macrourus* spp.	Sharks	Other fish species
2000/1	1.0 (4.2)	0.01 (3.9)	0 (7.7)	0 (2.3)	0 (0.1)	0 (0.4)
2001/2	2.9 (1.6)	0.55 (1.8)	0 (5.3)	0 (5.1)	0 (0)	0.2 (0.3)
2002/3	20.9 (26.9)	0.42 (0.4)	40.8 (49.9)	4.4 (4.2)	0.001(0.01)	0.6 (1)
2003/4	13.5 (6.3)	2.9 (0.4)	69.1 (56.8)	44.7 (35.6)	0.01 (0.01)	2.0 (1.4)
2004/5	34.5 (46.3)	2.5 (2.0)	78.7 (78.4)	69.7 (49.9)	0.52 (0.01)	3.3 (1.2)

Figures in () are unofficial estimates from AAD database records.

(Source: CCAMLR Statistical Bulletin no18 , May 2006)

Current and recent value of fishery ($)	**Patagonian toothfish** $27.4 million (estimated assuming to be ex-vessel at $10/kg). Actual values are unavailable as AFMA is unable to release this information to maintain operator confidentiality. 96/97 $20 million, 97/98 $36 million, 98/99 $36 million, 99/00 $30 million, 00/01 $30 million (estimated). Note: value assumed to be ex-vessel. **Icefish** $3.6 million (estimated using to be ex-vessel at $2 kg). Accurate estimates unavailable to maintain operator confidentiality AFMA is unable to release this information. Source: AFMA
Relationship with other fisheries	The Antarctic Fisheries are both managed within the context of the Australian Government's policy position within CCAMLR. Accordingly the fishery is more stringently managed than CCAMLR regulations. CCAMLR is the International Convention for the Conservation of Antarctic Marine Living Resources and Australia is one of the 24 member nations. CCAMLR is charged with ensuring the conservation and sustainable use of Antarctic living marine resources, with the exception of whales (ICRW) and seals (CCS). **IUU** Illegal fishing has been a concern in the Toothfish fishery but not the icefish fishery. IUU targets the northern and central part of the Kerguelen Plateau and the north-eastern part of the HIMI AFZ**.** Australia is committed to combating illegal fishing in the EEZ around HIMI, and the region is the focus of growing national and international efforts to combat illegal fishing. A voluntary International Plan of Action for Illegal, Unreported and Unregulated (IUU) Fishing has been developed through the Food and Agriculture Organisation of the United Nations, within the framework of the Code of Conduct for Responsible Fisheries, and further measures may be adopted by the Commission for the Conservation of Antarctic Marine Living Resources. Source: http://ccamlr.org **Longline fishery** Demersal longlining operations began in 2002/3. Longlining operations generally occur on the deeper slope where larger fish occur. **Longline fisheries of other nations** Adjacent to the HIMI fishery, longlining is conducted in the French EEZ around the Îles Kerguelen for Patagonian toothfish. Since 2000/2001 catches of Patagonian toothfish have varied between 5312 t and 5838 t and those of skates and rays between 119 and 856 t. Longline fishing is thought to have less impact on benthic habitats than bottom trawling, although it may have greater impacts on the bycatch of some non-target species, such as skates (Rajiformes spp.) and rat-tails (*Macrourus* spp.), as well as bycatch of seabirds and mammals.
Gear	
Fishing gear and methods	Demersal otter board trawling is used in both the Patagonian toothfish and Mackerel icefish fisheries. Trawls use rockhopper gear to minimize snagging of the footrope, which reduces the benthos entering the net.
Fishing gear restrictions	Gear is restricted to trawling and longlining in the HIMI EEZ. Trawl nets are limited to a mesh size of not less than 120mm in every part of the net for Patagonian toothfish and not less than 90mm when targeting mackerel icefish to enable juvenile fish to escape. Bobbins must be at least 520 mm in diameter and rockhopper rubber discs must be at least 400mm in diameter. Other mitigation measures under Conservation Measure 25-03 see Regulations. (Source: HIMI Fishery Conditions on Statutory Fishing Rights (SFRS) 2004/5 season.)
Selectivity of gear and fishing methods	Trawl nets for Patagonian toothfish have mesh size of 120mm and for mackerel icefish have mesh size of 90mm. No other net specifications available.

<table>
<tr><td>Spatial gear zone set</td><td>Demersal trawling is conducted on the continental slope of the plateau.</td></tr>
<tr><td>Depth range gear set</td><td>When targeting Patagonian toothfish, gear is deployed in mid-upper slope depths. When targeting Icefish, gear is deployed usually less than 400m.</td></tr>
<tr><td>How gear set</td><td>Demersal trawlers tow a net along the ocean floor, in depths up to about 1,500 metres. The net is towed behind the vessel by long wires (the warps) and is deployed and retrieved from the stern of the vessel by winches. The net opening (the mouth) is spread horizontally by the outward force acting on the otter boards as they are towed through the water. The bottom of the net opening, the footrope, is weighted bringing the net opening close to the bottom and has ground gear, principally bobbins commonly known as “rockhopper” gear, attached to enable the gear to be towed across the substrate with minimal hook-ups. The top of the mouth, the headline, is lifted vertically by floats. Vessels are generally equipped with electronic units to allow the proximity of the nets to the seabed to be monitored.

Demersal trawling relies on herding fish inward toward the path of the oncoming net mouth, rather than the speed of the tow. As the fish swim away from the warps and the net wings, they are enclosed and fall back towards the tapered body of the net. As the gear is hauled up toward the vessel the fish are contained in the end section of the net, the codend, which is fastened with a rope to release the catch on the vessel deck.
(Source: AFMA)</td></tr>
<tr><td>Area of gear impact per set or shot</td><td>Demersal trawling for icefish has been estimated to impact about 120 km^2 or about 1% of habitat within the biological units devised by Meyer et al. (2000). This estimate was verified by the MSC but no data presented in report due to confidentiality issues.
(MSC Assessment Report 2006)
Trawling for toothfish is over a broader area but still represents a relatively small % of the habitat possibly no more than 4-5%.
(Source: AAD database)</td></tr>
<tr><td>Capacity of gear</td><td>Not available</td></tr>
<tr><td>Effort per annum all boats</td><td>
<table>
<tr><td>Year</td><td>No. demersal tows *</td></tr>
<tr><td>2001</td><td>6468</td></tr>
<tr><td>2002</td><td>6093</td></tr>
<tr><td>2003</td><td>9882</td></tr>
<tr><td>2004</td><td>7408</td></tr>
<tr><td>2005</td><td>5969</td></tr>
</table>
*This data was extracted from AAD database and while not necessarily accurate, gives an indication of the trend of effort.
(Source: Unofficial data from AAD database)</td></tr>
<tr><td>Lost gear and ghost fishing</td><td>Lost gear occurs rarely and operators are required to attempt to retrieve it. Operators also recover illegal fishing gear, some of which may have drifted into the region. No gear reported lost during 2004/5.
(Source: Assessment Report 2003; SAFAG 23, May 2005)</td></tr>
<tr><td colspan="2">Issues</td></tr>
<tr><td>Target species issues</td><td>Major uncertainties concerning Patagonian toothfish (Dissostichus eleginoides):
1. biological aspects include distribution of stocks, age at maturity, lifespan, location of spawning grounds,
2. genetic transfer between stocks, emigration/immigration rates between stocks,
3. stock delineation at Heard Island (Williams et al. 2002). Genetic studies suggest no distinction between Indian sector stocks and that a metapopulation of toothfish may</td></tr>
</table>

	exist (Fishery Report TOP 58.5.2 2005) 4. dependence of other predators on Patagonian toothfish as prey items. IUU fishing on toothfish is of concern because it has the potential to undermine attempts to manage fish stocks. **Major uncertainties concerning Mackerel icefish** (*Champsocephalus gunnari*): 1. biological aspects including lifespan,, location of spawning grounds (although these are the best known of the set listed here), 2. distribution of stocks, 3. dependence of other predators on Mackerel icefish as prey items (Moore *et al.* 1998).
Byproduct and bycatch issues and interactions	The HIMI Fishery is conducted in a manner that poses only limited risk to bycatch species, protected species and the broader marine ecosystem. Whilst current bycatch levels are low by weight there is some uncertainty as to the impacts of the fishery on bycatch species, in particular sleeper sharks, skates and rays, and benthic communities. Environment Australia (EA) considers that the management arrangements in place are sufficiently precautionary and work is ongoing to further minimise the overall risk to bycatch species. Interaction with protected species is minimal and there are some measures in place to minimise the impact of trawling on benthic communities and the marine environment. The combination of management arrangements, data gathering and proposed research, provides confidence in the fishery's ability to maintain low bycatch levels and minimise interaction with protected species and the ecosystem. (Source: EA Assessment of the HIMI Fishery) Bycatch or byproduct is not considered a major issue in sub-Antarctic fisheries. There is close to 100% observer coverage on all trips to the regions, which has resulted in accurate catch and bycatch reporting. This allows for most hauls to be observed, and the monitoring of catch taken. Most of the non-target fishes are retained for milling into meal which is dumped on return to port and is thus classified as byproduct in the terms of this assessment even though not sold. The data collection to date indicates that in the HIMI Fishery the average total bycatch and byproduct from all areas and irrespective of target species over the period 1996/97 to 2002/03 was 1.16% of the total catch by weight (WG-FSA-03/73). The range was between 0.85% and 2.77% (1997). For 2003/4 and 2004/5, the average bycatch has been about 0.04%. The major bycatch species are skates and rays, and macrourids**.** Source: CCAMLR Document WG-FSA-03/73; Bycatch Action Plan 2003; CCAMLR Statistical Bulletin no18 , May 2006 http://www.ccamlr.org/pu/e/pubs/sa/abs03.pdf **Major uncertainties concerning other deepwater species, such as Unicorn Icefish and Grey Rockcod:** 1. biological aspects including lifespan, age at maturity, location of spawning grounds, 2. distribution of stocks, 3. stock size, 4. dependence of other predators on these deepwater species as prey items.
TEP issues and interactions	Interactions causing injury or death to seabirds and marine mammals have been extremely low to date in Antarctic trawl operations, and SAFAG's assessment is that the current fishing operations do not pose a significant threat to seabird or marine mammal populations. CCAMLR Conservation Measure 25-03 specifically sets out mitigation measures to minimise incidental mortality of seabirds and marine mammals from trawling. If the number of reported incidents of seabird or marine mammals increases substantially, AFMA will review mechanisms to reduce the level of interactions. AFMA is continuing to investigate appropriate assessment methods for these species. However, IUU fishing is a concern because it may involve the use of fishing techniques that can cause the death of non-target species as by-catch. **Marine mammals** Currently the low number of reported incidents involving death or serious injury to

marine mammals is a positive factor in the fishery. For example: in the Antarctic fisheries only two seal fatalities were recorded in a 3 year period (Wienecke and Robertson 2002). However, if the number of reported incidents of marine mammal interactions increases substantially, AFMA will review mechanisms to reduce the level of interactions. AFMA is continuing to investigate appropriate assessment methods for these species. Observers will continue to monitor seal activities from the vessel, through their environmental observations. A review of management arrangements may be undertaken if such interactions were to substantially increase.
In the HIMI fishery the current operators have adopted a code of conduct for minimisation of seal interactions, the code includes the following measures:

- winch must not be stopped when shooting net and bridles. If the winch is stopped the net must be recovered and checked for seals
- the net must be checked for gilled fish and all fish removed prior to the shot
- net deployment not to occur from one hour before civil twilight until one hour after civil twilight

Seabirds-general
In the 2004/5 season, 13 seabirds were killed during trawling operations, of which 12 were as a result of interaction with midwater trawl gear and only 1from demersal trawl gear. Currently the low number of reported incidents involving death or serious injury to seabirds is a positive factor favouring the fishery. However, if the number of reported incidents of seabird interactions increases substantially, AFMA will review mechanisms to reduce the level of interactions. AFMA is continuing to investigate appropriate assessment methods for these species. To reduce the incentive for seabirds to congregate around vessels, AFMA will maintain the minimisation of lighting on the vessel and the prohibition on discharge of waste products, including offal (waste products from fish processing) or unwanted dead fish.

Fatalities of seabirds from trawling:

	1/12/1997-30/11/2004		1/12/2004-10/5/2005	
Seabird spp.	Icefish	Toothfish	Icefish	Toothfish
Black-browed Albatrosses	2	nil	7 (m/w)	nil
Southern giant petrels	1	nil		
White-chinned petrels	4	1	5 (m/w)	1
Cape petrels	1	6		
Antarctic prions	nil	2		

(Source: SARAG 26, May 2006; Robertson et al. 2005)

Longline fishing is currently listed as a key threatening process for seabirds under the Endangered Species Protection Act 1992. Under this Act, a Threat Abatement Plan (TAP) for the Incidental Catch of Seabirds During Oceanic Longline Fishing Operations has been developed for fisheries around mainland Australia (EA Assessment 2002). CCAMLR Conservation Measures 24-02 and 25-02 specifically provide for longlining mitigation measures to minimise incidental mortality of seabirds from longlining operations.

Penguins
Interactions between penguins and the trawl gear are not seen as serious concerns (Wienecke and Robertson 2002). However, there is concern for the potential impact on penguin species of the Mackerel icefish fishery at Heard Island. Three species of penguins (King, Gentoo and Macaroni) are known to take *C. gunnari* as prey items. King penguins in particular take significant amounts (17% by weight of total diet) at the end of a 4-5 month fasting period. The birds are raising chicks at this time and the scarcity of other prey items increases the importance of Mackerel icefish as prey items during this period. However, the data has only been collected for one year (1992) and may not be applicable in all years (Moore *et al.* 1998).

Habitat issues and interactions	**Benthic damage by trawl gear** The impacts of demersal and mid-water trawl fishing on habitats have to date not been assessed in detail for the Antarctic fisheries. Demersal trawling is thought to have more impact on habitats than mid-water trawling. Rockhopper gear is used on the trawls to minimise damage from ground gear. **Habitat Protection** A Commonwealth Marine Protected Area has been established in the HIMI region. There is already a sizeable area set aside in the HIMI Fishery where no fishing can occur (within 13 nautical miles of the Islands). The protected zone is discussed in the section 'Initiatives and Strategies'. http://www.afma.gov.au/information/publications/fishery/baps/default.htm
Community issues and interactions	No specific issues identified. However, the importance of the Antarctic community is recognised by the CCAMLR approach to ecosystem-based management. AFMA has recognised and incorporated this approach in their management strategies for the HIMI fishery. In addition, the management of the HIMI islands as Wilderness Reserves by the AAD; the prohibition on fishing within 13 nautical miles of the islands; the establishment of the HIMI Marine Reserve in 2002 and the continued monitoring of top predators both in terms of diet, reproductive rates and overall abundance are seen as key actions in the preservation of community ecosystems. A specific allowance is made for predator needs by adopting a limit reference point for the fishery of not less than 75% median escapement of the spawning biomass over a two year projection. However, this assumes that the biomass is known and that it does not fall below a sustainable level. The information available on each species will be reviewed annually by SARAG and CCAMLR with the aim of continuing to develop specific bycatch limits based on population assessments. This review will incorporate data from the monitoring program including observer data and shot-by-shot logbook information recorded by industry, and will include information learned from fisheries in other parts of the world (e.g. sleeper sharks). AAD, in conjunction with SARAG, monitored the tag and release of sleeper sharks, investigated the use of new monitoring technologies and conducted a risk assessment for sleeper sharks. This was completed by AAD and submitted to SAFAG in 2002 and CCAMLR in 2003 (see CCAMLR document WG-FSA-03/6). A tagging program for skates began in 2001. Preliminary results indicated that recaptures of tagged *B. eatonii* was about 2%, lower than that of *D. eleginoides* (10%) (van Wijk and Williams 2003: CCAMLR Document WG-FSA-03/73). Also, estimates of growth rates indicated that the species was likely to be a slow-growing and long-lived one.
Discarding	AFMA requires that no offal is to be discarded and bycatch is mealed where possible and discarded on land, to avoid possible provisioning effects.
Management: planned and those implemented	
Management Objectives	The objectives of *Heard Island and McDonald Islands Management Plan for 2002* are: 1. to manage the Fishery efficiently and cost effectively for the Commonwealth, 2. to ensure that the exploitation of the resources of the Fishery and the carrying on of any related activities are conducted in a manner consistent with the principles of ecologically sustainable development and the exercise of the precautionary principle, and in particular, the need to have regard to the impact of fishing activities on non-target species and the long-term sustainability of the marine environment, 3. to maximise economic efficiency in the exploitation of the resources of the Fishery, 4. to ensure AFMA's accountability to the fishing industry and to the Australian community in management of the resources of the Fishery, 5. to reach Government targets for the recovery of the costs of AFMA in relation

	to the Fishery, 6. to ensure, through proper conservation and management, that the living resources of the Australian Fishing Zone (AFZ) are not endangered by over-exploitation, 7. to achieve the best use of the living resources of the AFZ, and 8. to ensure that conservation and management measures in the Fishery implement Australia's obligations under international agreements that deal with fish stocks, and other relevant international agreements. AFMA Annual Report 2001-2002
Fishery management plan	The HIMI fishery was first managed under the HIMI Exploratory Fishery Interim Management Policy November 1996 to August 1997. This was replaced by the HIMI Management Policy 1998 to 2000, which was extended to November 2001. Now the fishery is managed under the HIMI Fishery Management Plan 2002 and a supporting framework of regulations, permit conditions and directions. The HIMI fishery falls within the area covered by CCAMLR and is therefore subject to the Conservation Measures set by CCAMLR. Australia's minimum international obligations under CCAMLR are to manage the fishery in accordance with those measures but AFMA may impose additional ones. However these are not stated in the Management Plan. The HIMI Management Plan was assessed under the Environmental Protection and Biodiversity Act 1999. MSC Assessment Report HIMI Mackerel Icefish 2006 In April 2006 the HIMI Mackerel Icefish Fishery was certified by the Marine Stewardship Council.
Input controls	HIMI Fisheries is managed under a system of input and output controls designed to manage catches of the target and non-target species. Input controls are: • a limit of three boats through a SRF quota system where operators must have a minimum holding of 25.5% of quota to access the fishery • "move-on" provisions for bycatch species under Conservation Measure 33-02 (see Regulations) • mesh-size is restricted to greater than 120 mm for Patagonian toothfish fishery and greater than 90mm for Mackerel icefish fishery (Conservation Measures 22-02 and 22-03) • other bottom gear restrictions. CCAMLR 2005/6 Schedule of Conservation Measures; MSC Assessment Report HIMI Mackerel Icefish 2006
Output controls	Output controls are: • annual review and setting of total allowable catches: (TAC) 2005/2006 for Patagonian toothfish is 2584 tonnes (Conservation Measure 41-08) and for Mackerel icefish is 1210 tonnes (Conservation Measure 42-02)) • Move –on provisions if, in hauls larger than 100 kg of icefish, more than 10% of the fish are less than legal limits (240mm) (Conservation Measure 42-02)) • catch limits of bycatch species: fishing shall cease if by-catch of any species in either targetted fishery reaches its limit as specified in Conservation Measure 33-02 (Conservation Measure 41-08 and 42-02) • if 50% of catch limit is reached for any non-target species, AFMA will review operating practices with SFR holders • carry-over provision for Patagonian toothfish-any overcatch will be carried into subsequent year and deducted from operators' quota at a rate of 2 for 1. CCAMLR 2005/6 Schedule of Conservation Measures; MSC Assessment Report HIMI Mackerel Icefish 2006
Technical measures	**Mesh size** Under AFMA requirements the mesh-size of the trawl nets used must not be less than - 120 mm for targeting Patagonian toothfish - 90 mm for targeting mackerel icefish. CCAMLR 2005/6 Schedule of Conservation Measures

Regulations

Australia, through its work in CCAMLR, has undertaken assessments on potentially commercial bycatch species (i.e. grey rockcod (*Lepidonotothen squamifrons*) and unicorn icefish (*Channichthys rhinoceratus)*) based on the results of random stratified trawl surveys. Based on these assessments, TACs have been set even though they are presently non-target species. CCAMLR has also agreed to apply a general precautionary catch limit for other non-target species for which no assessment has been undertaken.

Under Conservation Measure 25-03 (2005) the following regulations apply:

- The use of net monitor cables on vessels in the Convention area is prohibited.
- Vessels operating in the Convention area should at all times arrange the location and level of lighting so as to minimise illumination directed out from the vessel consistent with the safe operation of the vessel.
- Discharge of offal shall be prohibited during shooting and hauling of gear.
- Nets should be cleaned prior to shooting to remove items that might attract birds
- Vessels should adopt shooting and hauling procedures to minimise the time the net is lying on the surface of the water with the meshes slack. Net maintenance should not be carried out with the net in the water.
- Vessels are encouraged to develop gear configurations that will minimise the chance of birds encountering the parts of the net to which they are most vulnerable.

Under Conservation Measure 33-02 (2005) the following regulations apply:

- There will be no directed fishery for any other species other than Patagonian toothfish and Mackerel icefish in Division 58.5.2 in 2005/6 fishing year.

- The TACs for bycatch currently in place for Division 58.5.2 for 2005-2006 are:

Species	TAC (tonnes)
Channichthys rhinoceratus Unicorn icefish	150
Grey rockcod *Lepidonotothen squamifrons*	80
Skates and rays	120
Macrourus spp.	360
Other species	50

- If, in the course of a directed fishery, the bycatch in any one haul of *Channichthys rhinoceratus*, *Lepidonotothen squamifrons*, *Macrourus* species, *Somniosus* species or skates and rays is equal to or greater than two tonnes, the fishing vessel shall not fish using that method of fishing at any point within five nautical miles of the location where the bycatch exceeded two tonnes for a period of at least five days.

- If in the course of a directed fishery, the bycatch in any one haul of any other by-catch species for which bycatch limitations apply is equal to or greater than one tonne, the fishing vessel shall not fish using that method of fishing at any point within five nautical miles of the location where the bycatch exceeded two tonnes for a period of at least five days.

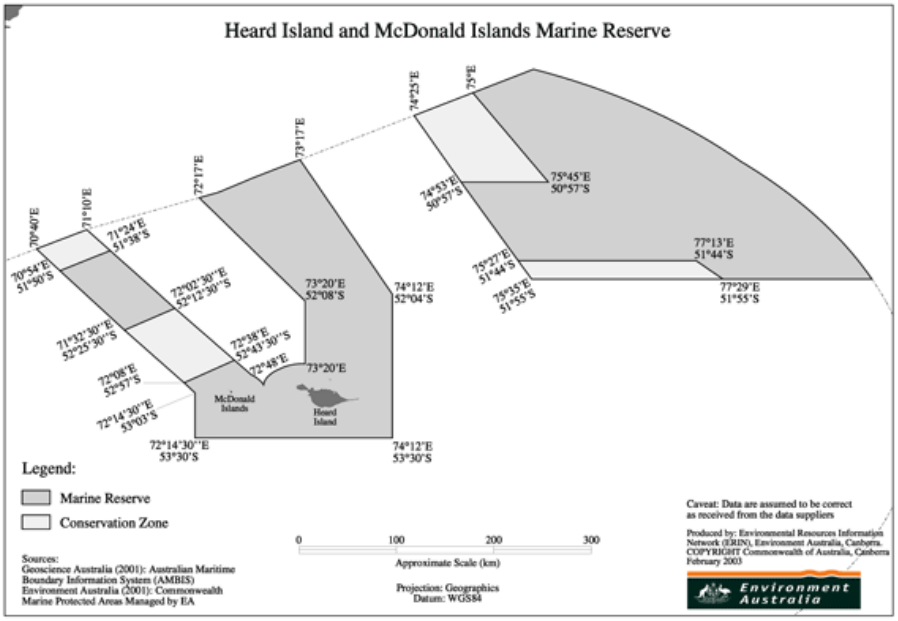
Under Conservation Measure 41-08:

Defines the limits of the fishery for D. eleginoides in 58.5.2 for access, catch limit, season, by-catch, mitigation, observers, and data.

Under Conservation Measure 42-02 (2005)

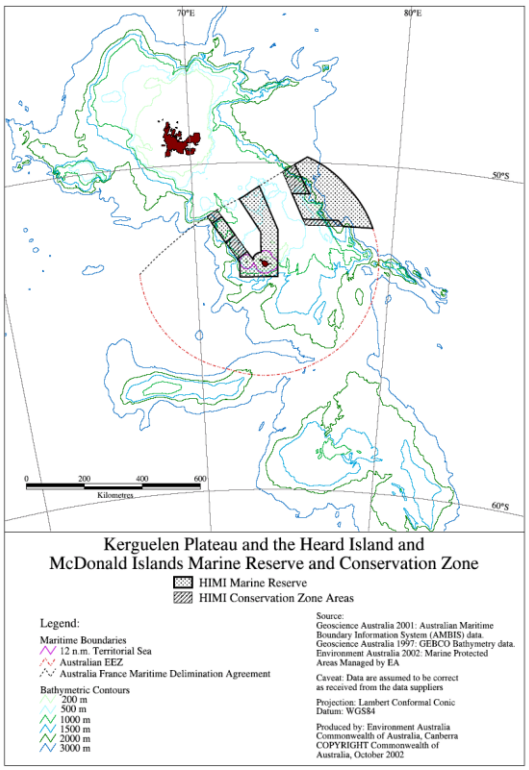
- In any one haul where 100 kg or more of Mackerel icefish are caught and juvenile (less than 240 mm total length) Mackerel icefish constitute 10% or greater of the catch by number, the vessel is not allowed to use that fishing

	method within 5 nm of that site for at least 5 days CCAMLR 2005/6 Schedule of Conservation Measures
Initiatives and strategies	The objective of the ***Antarctic Fisheries Bycatch Action Plan 2003*** is: To ensure that the impacts of the fishery's bycatch on the ecosystem are sustainable and consistent with legislative requirements. Six strategies have been developed to achieve this objective: 1 Develop and review non-target species catch limits to ensure catches are within sustainable limits 2 Minimise the bycatch of non-target species, including sharks , skates and rays, 3 Evaluate any fishing impacts on seabirds and marine mammals 4 Develop mitigation measures to minimise seabird and marine mammal catches in the longline fishery 5 Develop mitigation measures to minimise seabird and marine mammal interaction in the trawl fishery 6 Assess the benthic/ecological impacts of fishing on habitats. AFMA Antarctic Fisheries Bycatch Action Plan 2003. Other significant programs that are applicable to the HIMI fishery are the **Threat Abatement Plan (TAP) for the Incidental Catch of Seabirds During Oceanic Longline Fishing Operations** and the **Recovery Plan for Albatrosses and Giant Petrels**. The **Catch Documentation Scheme** was established in 2001 by CCAMLR to track catches of toothfish sold in participating countries. It is used to estimate and eliminate IUU catch. In addition to the previous controls and regulations, further conditions accompany the statutory fishing rights: Boat eligibility Personal consumption and jellymeat (in the toothfish fishery) VMS requirements Boat marking Transhipping and carrying Product labelling Notification requirements CCAMLR inspection Carriage of observers Data collection officers Safety assessment Contingency arrangements for breakdown of the meal plant and disposal of fish meal MSC Assessment Report HIMI Mackerel Icefish 2006 **Heard Island and McDonald Islands Marine Reserve** In October 2002 the Heard Island and McDonald Islands (HIMI) Marine Reserve was declared under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act).



(Source: http://www.deh.gov.au/coasts/mpa/heard/maps/index.html)

The Heard Island and McDonald Islands (HIMI) Marine Reserve is located in Australia's remote subantarctic waters, approximately 4000 kilometres south-west of the Australian mainland and 1000 kilometres north of Antarctica. It covers an area of approximately 65,000 square kilometres or 6.5 million hectares, and includes Heard Island and the McDonald Islands, the surrounding 12 nautical mile territorial sea, plus an extended marine area (including the seabed and subsoil to a depth of 1000 metres) which extends in parts to the 200 nautical mile Exclusive Economic Zone (EEZ) boundary. Details of boundaries can be found at:
http://www.heardisland.aq/protection/marine_reserve/reserve_boundary.html.



	(Source: http://aadc-maps.aad.gov.au/aadc/mapcat/maps_on_lineage.cfm?map_lineage_id=1&format=table) Classified as an IUCN Category 1a Strict nature reserve managed primarily for scientific research or environmental monitoring, the Reserve comprises the world's largest fully protected marine Reserve. The purposes for declaring the Marine Reserve, as outlined in the Marine Reserve Proposal, are to: a. protect conservation values of Heard Island and McDonald Islands, the territorial sea and the adjacent Exclusive Economic Zone (HIMI EEZ) including: • the World Heritage and cultural values of the Territory of Heard Island and McDonald Islands • the unique features of the benthic and pelagic environments • representative portions of the different marine habitat types • marine areas used by land-based marine predators for local foraging activities b. provide an effective conservation framework which will contribute to the integrated and ecologically sustainable management of the HIMI region as a whole c. provide a scientific reference area for the study of ecosystem function within the HIMI region d. add representative examples of the HIMI EEZ to the National Representative System of Marine Protect Areas. (Source: http://www.heardisland.aq/protection/marine_reserve/index.html) *Management of the HIMI Marine Reserve* Administration of the HIMI Marine Reserve is the responsibility of the Australian Antarctic Division. The EPBC Act requires that management must be based on IUCN category Ia reserve management principles, and be not inconsistent with Australian World Heritage management principles. The Management Plan for the HIMI Marine Reserve was enacted in 2005 and addresses a broad range of management issues. It includes a similarly broad range of measures to address these issues, such as from the cleaning of clothing and gear to prevent unwanted 'alien' species, to where and how visitors can go to the toilet. The new management plan replaces the previous Heard Island Wilderness Reserve Management Plan (PDF) in force for the HIMI Territory since 1996 under the Environment Protection and Management Ordinance 1987. (Source: http://www.heardisland.aq/protection/management_plan/index.html)
Enabling processes	There are detailed management plans for Patagonian toothfish and Mackerel icefish. Catches and landings are monitored by logbooks and observer data. Stock assessments on target and some non-target species are conducted annual by SAFAG. The By-catch Action Plan is reviewed biannually and outcomes are reported against performance indicators.
Other initiatives or agreements	The declaration and ongoing management of the Heard Island and McDonald Islands (HIMI) Marine Reserve contributes to the implementation of several international conservation agreements, including: World Heritage Convention Ramsar Convention Bonn Convention China/Australia Migratory Birds Agreement Japan/Australia Migratory Birds Agreement Australia/France Treaty on Maritime Cooperation Convention on Biological Diversity Agreement on the Conservation of Albatrosses and Petrels Convention on the Conservation of Antarctic Marine Living Resources International Convention for the Prevention of Pollution from Ships (MARPOL) Convention on the International Trade in Endangered Species International Convention for the Regulation of Whaling

	United Nations Convention on the Law of the Sea (Source: http://www.heardisland.aq/protection/legislation/International_Agreements.html#CCAMLR)
Data	
Logbook data	All Australian operators are required to complete electronic catch and effort logbooks with total coverage. Data verified through observer program and catch documentation scheme. Currently there are 4 logbooks: C1v2006 CCAMLR Fine-scale Catch and Effort Data for Trawl Fisheries C2v2006 CCAMLR Fine-scale Catch and Effort Data for Longline Fisheries C5v2006 CCAMLR Fine-scale Catch and Effort Data for Pot Fisheries TACv2006 CCAMLR 5 day, 10 day or monthly Catch and Effort Report ANT05 (Antarctic Waters Catch Details Log) for trawl and ANT02 for Vessel and gear details. CCAMLR publish catch statistics for all Antarctic fisheries in their jurisdiction annually in the Statistical Bulletin series.
Observer data	There is 100% observer coverage during all fishing activities. All wildlife interactions are also monitored. Observer data are maintained by AAD and a copy held by AFMA.
Other data	The most recent surveys were conducted by AAD. They conducted a random-stratified survey in June 2005 to survey juvenile Patagonian toothfish (Constable *et al.* 2005a) and Mackerel icefish (daytime only) (Constable *et al.* 2005b) on the Heard Island Plateau and Shell Bank to 1000m. The purpose of the surveys was to provide information to CCAMLR for short-term stock assessments. It also assessed the sensitivity of the assessment to a number of other factors such as growth parameters, effect of excluding older cohorts, risk of adult fish and revised mortality rates. (Source: WG_FAS_05/30&39, http://www.afma.gov.au/fisheries/antarctic/himi/publications/default.htm#fap)

2.2.2 Unit of Analysis Lists (Step 2)

The units of analysis for the sub-fishery are listed by component:

- Species Components (target, byproduct/discards and TEP components). [Scoping document S2A Species]
- Habitat Component: habitat types. [Scoping document S2B Habitats]
- Community Component: community types. [Scoping document S2C Communities]

Scoping Document S2A Species

Each species identified during the scoping is added to the ERAEF database used to run the Level 2 analyses. A CAAB code (Code for Australian Aquatic Biota) is required to input the information. The CAAB codes for each species may be found at http://www.marine.csiro.au/caab/

Target species *Heard and McDonald Islands Demersal Trawl Fishery*
This list is obtained by reviewing all available fishery literature, including logbooks, observer reports and discussions with stakeholders. Target species are as agreed by the fishery.

Species Number	Taxa	Family name	Scientific name	Common Name	CAAB code
765	Teleost	Nototheniidae	*Dissostichus eleginoides*	Patagonian toothfish	37404792
1390	Teleost	Channichthyidae	*Champsocephalus gunnari*	Mackerel icefish	37407791

Byproduct species *Heard and McDonald Islands Demersal Trawl Fishery*

Byproduct refers to any part of the catch which is kept or sold by the fisher but which is not a target species. This list is obtained by reviewing all available fishery literature, including logbooks, observer reports and discussions with stakeholders.

Species Number	Taxa	Family name	Scientific name	Common name	CAAB code
826	Chondrichthyan	Squalidae	Etmopterus granulosus	Southern lantern shark	37020021
302	Chondrichthyan	Rajidae	Bathyraja irrasa	Skate	
304	Chondrichthyan	Rajidae	Bathyraja murrayi	Skate	
1981	Invertebrate		Porifera - undifferentiated	Sponges	10000000
2773	Invertebrate		Actinaria - undifferentiated	Coral-soft	14410000
3397	Invertebrate		Arcoida - undifferentiated	Molluscs-bivalves	23224000
40	Invertebrate	Onychoteuthidae	Onykia ingens	Squid	23623005
1284	Invertebrate	Ommastrephidae	Martialia hyadesi	Squid-flying squid	23636003
46	Invertebrate	Ommastrephidae	Todarodes filippovae	Squid-southern ocean arrow squid	23636011
3396	Invertebrate		Cirroteuthidae - undifferentiated	Squid	23651000
2009	Invertebrate	Class Crinoidea	Crinoidea - undifferentiated	Starfish-crinoids	25001000
2011	Invertebrate		Ophiuroidea - undifferentiated	Brittlestars	25160000
1321	Invertebrate	Bathyteuthidae	Bathyteuthis abyssicola	Squid	26632001
1328	Invertebrate	Pasiphaeidae	Pasiphaea sp.	Carid shrimp	28745901
2020	Invertebrate	Nephropidae	Nephropidae - undifferentiated	Scampi-lobsters	28786000
2956	Invertebrate	Crustacea	Bugs	Bug	
2951	Invertebrate		Gorgonocephalidae	Coral	
2948	Invertebrate		Pennatulacea	Coral-soft	
2784	Invertebrate		Octopus (pelagic)	Octopus	
2938	Invertebrate		Holothurian	Sea cucumber	
2962	Invertebrate	Polychaeta	Aphrodite sp.	Worm	
35	Teleost	Nemichthyidae	Labichthys yanoi	Snipe eel	37076004
36	Teleost	Notacanthidae	Notacanthus chemnitzii	Spiny eel	37083002
37	Teleost	Bathylagidae	Bathylagus antarcticus	Deep sea smelt	37098002
2805	Teleost	Bathylagidae	Bathylagus sp.		37098800
2902	Teleost	Stomiidae	Stomias sp.	Scaly dragonfishes	37112800

Species Number	Taxa	Family name	Scientific name	Common name	CAAB code
270	Teleost	Myctophidae	Electrona carlsbergi	Lanternfish	37122104
372	Teleost	Alepisauridae	Alepisaurus brevirostris	Short-nosed lancet fish	37128002
273	Teleost	Anotopteridae	Anotopterus pharao	Daggerfish	37129001
2069	Teleost	Himantolophidae	Himantolophidae - undifferentiated	Football fishes	37215000
274	Teleost	Ceratiidae	Ceratias tentaculatus	Seadevil	37220003
275	Teleost	Moridae	Antimora rostrata	Morid cod	37224008
276	Teleost	Moridae	Halargyreus johnsonii	Morid cod	37224009
277	Teleost	Moridae	Lepidion microcephalus	Ribaldo (market name -morid cod) : smallhead cod	37224010
278	Teleost	Melanonidae	Melanonus gracilis	Melanonid	37224015
2074	Teleost	Carapidae	Carapidae - undifferentiated	Pearlfishes	37229000
280	Teleost	Zoarcidae	Melanostigma gelatinosum	Eelpout	37231001
336	Teleost	Macrouridae	Macrourus carinatus	Whiptail ; Bigeye grenadier	37232036
536	Teleost	Macrouridae	Cynomacrurus piriei	Rattail/whiptail/grenadier	37232054
1479	Teleost	Macrouridae	Macrourus whitsoni	[A whiptail]	37232753
537	Teleost	Melamphaidae	Poromitra crassiceps	Bigscale	37251004
1013	Teleost	Oreosomatidae	Neocyttus rhomboidalis	Spiky oreo	37266001
631	Teleost	Oreosomatidae	Pseudocyttus maculatus	Smooth oreo	37266003
644	Teleost	Lampridae	Lampris immaculatus	Southern moonfish	37268002
768	Teleost	Nototheniidae	Lepidonotothen squamifrons	Grey rockcod ; an icefish	37404793
1509	Teleost	Nototheniidae	Notothenia coriiceps	[An icefish]	37404798
770	Teleost	Channichthyidae	Channichthys rhinoceratus	Unicorn icefish	37407792
773	Teleost	Gempylidae	Paradiplospinus gracilis	Snake mackerel/gemfish	37439005
640	Teleost	Centrolophidae	Icichthys australis	Smooth driftfish	37445015
1472	Teleost	Achiropsettidae	Achiropsetta sp. (grey)	Southern flounder	
1473	Teleost	Achiropsettidae	Mancopsetta sp.	Southern flounder	
2933	Teleost	Astronesthidae	Astronesthes sp.		
638	Teleost	Bathydraconidae	Bathydraco antarcticus	An Antarctic dragonfish	
2936	Teleost	Bothidae	Pseudoachiropsetta milfordi		
574	Teleost	Congiopodidae	Zanclorhynchus spinifer	Spiny horsefish	
576	Teleost	Cyclopteridae	Paraliparis gracilis	Snailfish/lumpfish	
766	Teleost	Harpagiferidae	Harpagifer georgianus georgianus	Spiny plunderfish	

Species Number	Taxa	Family name	Scientific name	Common name	CAAB code
2960	Teleost	Liparidae	Liparidae - undifferentiated		
2937	Teleost	Lophiformes	Anglerfish Indet		
1467	Teleost	Macrouridae	Macrouridae	Whiptail	
2845	Teleost	Macrouridae	Macrourus holotrachys		
1457	Teleost	Melanostomiidae	Melanostomias sp.	Scaleless dragonfish	
1462	Teleost	Moridae	Lepidion sp.	Morid cod	
2925	Teleost	Moridae	Paralaemonema sp.		
1461	Teleost	Muraenolepididae	Muraenolepis sp.	Moray cod (undifferentiated)	
558	Teleost	Myctophidae	Gymnoscopelus bolini	Lanternfish	
1458	Teleost	Myctophidae	Gymnoscopelus sp.	Lanternfish	
2957	Teleost	Myctophidae	Nasolychnus sp.		
2977	Teleost	Nemichthyidae	Nemichthyidae		
2958	Teleost	Notosudidae	Scopelosaurus sp.		
2863	Teleost	Nototheniidae	Notothenia (Gobionotothen) acuta		
2867	Teleost	Nototheniidae	Notothenia (Notothenia) rossii rossii		
2868	Teleost	Nototheniidae	Nototheniops mizops		
788	Teleost	Paralepididae	Magnisudis prionosa	Barracudina	
557	Teleost	Stomiidae	Stomias gracilis	Scaly dragonfish	
3400	Teleost	Macrouridae	Coryphaenoides sp.	Serrulate whiptail	

Bycatch species *Heard and McDonald Islands Demersal Trawl Fishery*

Bycatch as defined in the Commonwealth Policy on Fisheries Bycatch 2000 refers to:

- that part of a fisher's catch which is returned to the sea either because it has no commercial value or because regulations preclude it being retained; and
- that part of the 'catch' that does not reach the deck but is affected by interaction with the fishing gear

In sub-Antarctic fisheries, discarding is generally not permitted and the terms bycatch and byproduct have specific meaning which differ to some other fisheries (see glossary).

Species Number	Taxa	Family name	Scientific name	Common name	CAAB code
972	Chondrichthyan	Lamnidae	Lamna nasus	Porbeagle shark	37010004
257	Chondrichthyan	Squalidae	Somniosus antarcticus	Sleeper shark; Southern sleeper shark	37020036
2709	Invertebrate	Subclass Zoantharia (Hexacorallia)		Coral	11228000
80	Invertebrate	Lithodidae	Lithodes murrayi	Crab-Subantarctic king crab	28836005
1446	Invertebrate	Lithodidae	Paralomis sp.	Crab-King crab (undifferentiated)	
1445	Invertebrate	Cnidaria	Medusae	Jellyfish	
298	Invertebrate	Periphyllidae	Periphylla periphylla	Jellyfish	
2789	Invertebrate	Salpidae	Salpidae	Salp	

TEP species *Heard and McDonald Islands Demersal Trawl Fishery*
Highlight species that are known to interact directly with the fishery. TEP species are those species listed as Threatened, Endangered or Protected under the EPBC Act.

TEP species are often poorly listed by fisheries due to low frequency of direct interaction. Both direct (capture) and indirect (e.g. food source captured) interaction are considered in the ERAEF approach. A list of TEP species has been generated for each fishery and is included in the PSA workbook species list. This list has been generated using the DEH Search Tool from DEH home page *http://www.deh.gov.au/*

For each fishery, the list of TEP species is compiled by reviewing all available fishery literature. Species considered to have potential to interact with fishery (based on geographic range & proven/perceived susceptibility to the fishing gear/methods and examples from other similar fisheries across the globe) should also be included.

Species Number	Taxa	Family name	Scientific name	Common name	CAAB code
1427	Marine bird	Spheniscidae	Aptenodytes forsteri	Emperor penguin	40001001
785	Marine bird	Spheniscidae	Aptenodytes patagonicus	King penguin	40001002
787	Marine bird	Spheniscidae	Eudyptes chrysocome	Rockhopper penguin	40001003
1426	Marine bird	Spheniscidae	Eudyptes chrysolophus	Macaroni penguin	40001004
1513	Marine bird	Spheniscidae	Pygoscelis adeliae	Adelie penguin	40001009
1511	Marine bird	Spheniscidae	Pygoscelis antarctica	Chinstrap penguin	40001010
819	Marine bird	Spheniscidae	Pygoscelis papua	Gentoo penguin	40001011
1032	Marine bird	Diomedeidae	Thalassarche bulleri	Buller's albatross	40040001
1034	Marine bird	Diomedeidae	Thalassarche chlororhynchos	Yellow-nosed albatross, Atlantic yellow-	40040003
1035	Marine bird	Diomedeidae	Thalassarche chrysostoma	Grey-headed albatross	40040004
753	Marine bird	Diomedeidae	Diomedea epomophora	Southern royal albatross	40040005
451	Marine bird	Diomedeidae	Diomedea exulans	Wandering albatross	40040006
1085	Marine bird	Diomedeidae	Thalassarche melanophrys	Black-browed albatross	40040007
1008	Marine bird	Diomedeidae	Phoebetria fusca	Sooty albatross	40040008
1009	Marine bird	Diomedeidae	Phoebetria palpebrata	Light-mantled albatross	40040009
799	Marine bird	Diomedeidae	Diomedea sanfordi	Northern royal albatross	40040012
1031	Marine bird	Diomedeidae	Thalassarche carteri	Indian yellow-nosed albatross	40040014
1428	Marine bird	Diomedeidae	Diomedea amsterdamensis	Amsterdam albatross	40040018

Species Number	Taxa	Family name	Scientific name	Common name	CAAB code
1690	Marine bird	Procellariidae	Pachyptila spp.	Prions	40041000
595	Marine bird	Procellariidae	Daption capense	Cape petrel	40041003
314	Marine bird	Procellariidae	Fulmarus glacialoides	Southern fulmar	40041004
939	Marine bird	Procellariidae	Halobaena caerulea	Blue petrel	40041005
1052	Marine bird	Procellariidae	Lugensa brevirostris	Kerguelen petrel	40041006
73	Marine bird	Procellariidae	Macronectes giganteus	Southern giant-petrel	40041007
981	Marine bird	Procellariidae	Macronectes halli	Northern giant-petrel	40041008
1532	Marine bird	Procellariidae	Pachyptila crassirostris	Fulmar prion	40041010
488	Marine bird	Procellariidae	Pachyptila desolata	Antarctic prion	40041011
1430	Marine bird	Procellariidae	Pagodroma nivea	Snow petrel	40041015
492	Marine bird	Procellariidae	Pelecanoides georgicus	South Georgian diving petrel	40041016
1006	Marine bird	Procellariidae	Pelecanoides urinatrix	Common diving-petrel	40041017
1041	Marine bird	Procellariidae	Procellaria aequinoctialis	White-chinned petrel	40041018
494	Marine bird	Procellariidae	Procellaria cinerea	Grey petrel	40041019
504	Marine bird	Procellariidae	Pterodroma lessoni	White-headed petrel	40041029
1047	Marine bird	Procellariidae	Pterodroma macroptera	Great-winged petrel	40041031
1048	Marine bird	Procellariidae	Pterodroma mollis	Soft-plumaged petrel	40041032
1057	Marine bird	Procellariidae	Puffinus griseus	Sooty shearwater	40041042
1060	Marine bird	Procellariidae	Puffinus tenuirostris	Short-tailed shearwater	40041047
553	Marine bird	Procellariidae	Thalassoica antarctica	Antarctic petrel	40041048
917	Marine bird	Hydrobatidae	Fregetta tropica	Black-bellied storm-petrel	40042002
555	Marine bird	Hydrobatidae	Garrodia nereis	Grey-backed storm petrel	40042003
556	Marine bird	Hydrobatidae	Oceanites oceanicus	Wilson's storm petrel (subantarctic)	40042004
1695	Marine bird	Fregatidae	Fregata spp.	Frigate birds	40050000
1437	Marine bird	Chionididae	Chionis minor nasicornis/minor	Black-faced sheathbill	40126001
1696	Marine bird	Laridae	Catharacta spp.	Skuas	40128000
325	Marine bird	Laridae	Catharacta skua	Great skua	40128005
973	Marine bird	Laridae	Larus dominicanus	Kelp gull	40128012
1023	Marine bird	Laridae	Sterna paradisaea	Arctic tern	40128032
292	Marine bird	Laridae	Sterna vittata	Antarctic tern (NZ)	40128035
589	Marine bird	Laridae	Catharacta lonnbergi lonnbergi	Subantarctic skua (southern)	

Species Number	Taxa	Family name	Scientific name	Common name	CAAB code
1670	Marine bird		Leucocarbo atriceps nivalis	Imperial shag (Heard Island)	
1474	Marine bird	Phalacrocoracidae	Phalacrocorax nivalis	Heard Island cormorant	
896	Marine mammal	Balaenidae	Eubalaena australis	Southern right whale	41110001
256	Marine mammal	Balaenopteridae	Balaenoptera acutorostrata	Minke whale	41112001
261	Marine mammal	Balaenopteridae	Balaenoptera borealis	Sei whale	41112002
265	Marine mammal	Balaenopteridae	Balaenoptera musculus	Blue whale	41112004
268	Marine mammal	Balaenopteridae	Balaenoptera physalus	Fin whale	41112005
984	Marine mammal	Balaenopteridae	Megaptera novaeangliae	Humpback whale	41112006
1439	Marine mammal	Balaenidae	Balaenoptera bonaerensis	Antarctic minke whale	41112007
935	Marine mammal	Delphinidae	Globicephala melas	Long-finned pilot whale	41116004
937	Marine mammal	Delphinidae	Grampus griseus	Risso's dolphin	41116005
832	Marine mammal	Delphinidae	Lagenorhynchus cruciger	Hourglass dolphin	41116007
971	Marine mammal	Delphinidae	Lagenorhynchus obscurus	Dusky dolphin	41116008
61	Marine mammal	Delphinidae	Lissodelphis peronii	Southern right whale dolphin	41116009
1002	Marine mammal	Delphinidae	Orcinus orca	Killer whale	41116011
1091	Marine mammal	Delphinidae	Tursiops truncatus	Bottlenose dolphin	41116019
833	Marine mammal	Phocoenidae	Australophocoena dioptrica	Spectacled porpoise	41117001
968	Marine mammal	Physeteridae	Kogia breviceps	Pygmy sperm whale	41119001
969	Marine mammal	Physeteridae	Kogia simus	Dwarf sperm whale	41119002
1036	Marine mammal	Physeteridae	Physeter catodon	Sperm whale	41119003
269	Marine mammal	Ziphiidae	Berardius arnuxii	Arnoux's beaked whale	41120001
959	Marine mammal	Ziphiidae	Hyperoodon planifrons	Southern bottlenose whale	41120002
988	Marine mammal	Ziphiidae	Mesoplodon grayi	Gray's beaked whale	41120007
989	Marine mammal	Ziphiidae	Mesoplodon hectori	Hector's beaked whale	41120008
990	Marine mammal	Ziphiidae	Mesoplodon layardii	Strap-toothed beaked whale	41120009
1098	Marine mammal	Ziphiidae	Ziphius cavirostris	Cuvier's beaked whale	41120012
293	Marine mammal	Otariidae	Arctocephalus gazella	Antarctic fur seal	41131002
263	Marine mammal	Otariidae	Arctocephalus tropicalis	Subantarctic fur seal	41131004
295	Marine mammal	Phocidae	Hydrurga leptonyx	Leopard seal	41136001
296	Marine mammal	Phocidae	Leptonychotes weddelli	Weddell seal	41136002
297	Marine mammal	Phocidae	Lobodon carcinophagus	Crabeater seal	41136003

Species Number	Taxa	Family name	Scientific name	Common name	CAAB code
993	Marine mammal	Phocidae	Mirounga leonina	Elephant seal	41136004
1441	Marine mammal	Phocidae	Ommatophoca rossii	Ross seal	41136005

Scoping Document S2B1 & 2. Habitats

Not assessed.

Scoping Document S2C1. Demersal Communities

In ERAEF, communities are defined as the set of species assemblages that occupy the large scale provinces and biomes identified from national bioregionalisation studies. The biota includes mobile fauna, both vertebrate and invertebrate, but excludes sessile organisms such as corals that are largely structural and are used to identify benthic habitats. The same community lists are used for all fisheries, with those selected as relevant for a particular fishery being identified on the basis of spatial overlap with effort in the fishery. The spatial boundaries for demersal communities are based on IMCRA boundaries for the shelf, and on slope bioregionalisation for the slope (IMCRA 1998; Last et al. 2005). The spatial boundaries for the pelagic communities are based on pelagic bioregionalisation and on oceanography (Condie et al. 2003; Lyne and Hayes 2004). Fishery and region specific modifications to these boundaries are described in detail in Hobday et al. (2007) and briefly outlined in the footnotes to the community Tables below.

Demersal communities in which fishing activity occurs the HIMI Demersal trawl fishery (x). Shaded cells indicate all communities within the province.

Demersal community	Cape	North Eastern Transition	North Eastern	Central Eastern Transition	Central Eastern	South Eastern Transition	Central Bass	Tasmanian	Western Tas Transition	Southern	South Western Transition	Central Western	Central Western Transition	North Western	North Western Transition	Timor	Timor Transition	Heard & McDonald Is	Macquarie Is
Inner Shelf 0 – 110m [1,2]																			
Outer Shelf 110 – 250m [1,2,]																			
Upper Slope 250 – 565m [3]																			
Mid–Upper Slope 565 – 820m[3]																			
Mid Slope 820 – 1100m[3]																			
Lower slope/ Abyssal > 1100m[6]																		x x x	
Reef 0 -110m[7, 8]																			
Reef 110-250m[8]																			
Seamount 0 – 110m																			
Seamount 110- 250m																			
Seamount 250 – 565m																			
Seamount 565 – 820m																			
Seamount 820 – 1100m																			
Seamount 1100 – 3000m																			
Plateau 0 – 110m																			
Plateau 110- 250m[4]																		x	x
Plateau 250 – 565m[4]																		x	x
Plateau 565 – 820m[5]																		x	x
Plateau 820 – 1100m[5]																		x	

[1] Four inner shelf communities occur in the Timor Transition (Arafura, Groote, Cape York and Gulf of Carpentaria) and three inner shelf communities occur in the Southern (Eyre, Eucla and South West Coast). At Macquarie Is: [2]inner & outer shelves (0-250m), and [3]upper and midslope communities combined (250-1000m). At Heard/McDonald Is: [4]outer and upper slope plateau communities combined to form four communities: Shell Bank, inner and outer Heard Plateau (100-500m) and Western Banks (200-500m), [5]mid and upper plateau communities combined into 3 trough (Western, North Eastern and South Eastern), southern slope and North Eastern plateau communities (500-1000m), and [6] 3 groups at Heard Is: Deep Shell Bank (>1000m), Southern and North East Lower slope/abyssal, [7]Great Barrier Reef in the North Eastern Province and Transition and [8] Rowley Shoals in North Western Transition.

Scoping Document S2C2. Pelagic Communities.

Pelagic communities that overlie the demersal communities in which fishing activity occurs in the HIMI Demersal trawl fishery (x). Shaded cells indicate all communities that exist in the province.

Pelagic community	Northeastern	Eastern	Southern	Western	Northern	Northwestern	Heard and McDonald Is[2]	Macquarie Is
Coastal pelagic 0-200m[1,2]								
Oceanic (1) 0 – 600m								
Oceanic (2) >600m								
Seamount oceanic (1) 0 – 600m								
Seamount oceanic (2) 600–3000m								
Oceanic (1) 0 – 200m								
Oceanic (2) 200-600m								
Oceanic (3) >600m								
Seamount oceanic (1) 0 – 200m								
Seamount oceanic (2) 200 – 600m								
Seamount oceanic (3) 600–3000m								
Oceanic (1) 0-400m								
Oceanic (2) >400m								
Oceanic (1) 0-800m								
Oceanic (2) >800m								
Plateau (1) 0-600m								
Plateau (2) >600m								
Heard Plateau 0-1000m[3]							x	
Oceanic (1) 0-1000m							x	
Oceanic (2) >1000m								
Oceanic (1) 0-1600m								
Oceanic (2) >1600m								

[1] Northern Province has five coastal pelagic zones (NWS, Bonaparte, Arafura, Gulf and East Cape York) and Southern Province has two zones (Tas, GAB). [2] At Macquarie Is: coastal pelagic zone to 250m. [3] At Heard and McDonald Is: coastal pelagic zone broadened to cover entire plateau to maximum of 1000m.

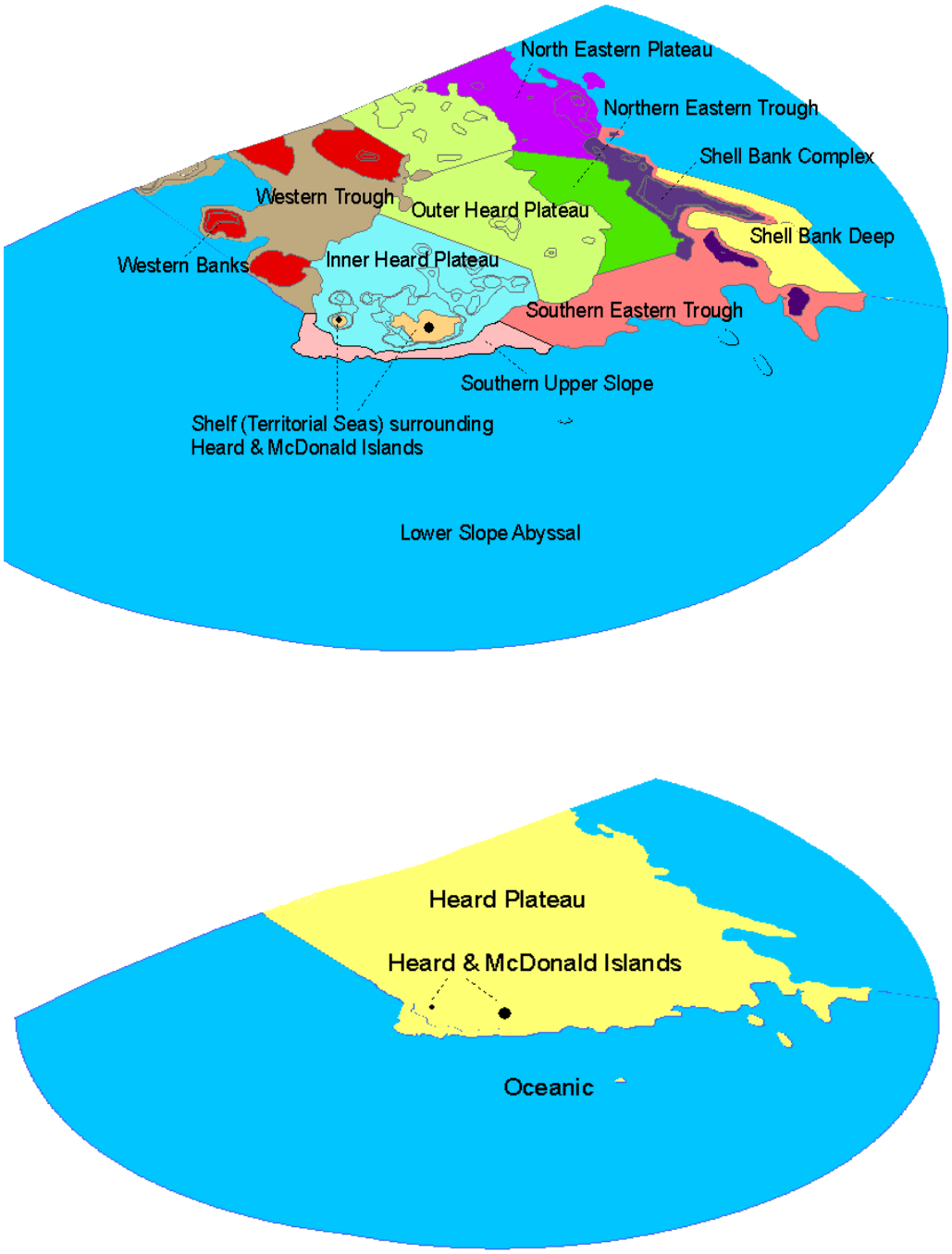


Fig S1. (a) Demersal and (b) pelagic communities in the Heard and McDonald Islands Fisheries.

2.2.3 Identification of Objectives for Components and Sub-components (Step 3)

Objectives are identified for each sub-fishery for the five ecological components (target, bycatch/byproduct, TEP, habitats, and communities) and sub-components, and are clearly documented. It is important to identify objectives that managers, the fishing industry, and other stakeholders can agree on, and that scientists can quantify and assess. The criteria for selecting ecological operational objectives for risk assessment are that they:

- be biologically relevant;
- have an unambiguous operational definition;
- be accessible to prediction and measurement; and
- that the quantities they relate to be exposed to the hazards.

For fisheries that have completed ESD reports, use can be made of the operational objectives stated in those reports.

Each 'operational objective' is matched to example indicators. **Scoping Document S3** provides suggested examples of operational objectives and indicators. Where operational objectives are already agreed for a fishery (Existing Management Objectives), those should be used (e.g. Strategic Assessment Reports). The objectives need not be exactly specified, with regard to numbers or fractions of removal/impact, but should indicate that an impact in the sub-component is of concern/interest to the sub-fishery. The rationale for including or discarding an operational objective is a crucial part of the table and must explain why the particular objective has or has not been selected for in the (sub) fishery. Only the operational objectives selected for inclusion in the (sub) fishery are used for Level 1 analysis (**Level 1 SICA Document L1.1**).

Scoping Document S3. Components and Sub-components Identification of Objectives

(Note: Operational objectives that are eliminated are shaded out)

Component	Core Objective	Sub-component	Example Operational Objectives	Example Indicators	Rationale
	"What is the general goal?"	*As shown in sub-component model diagrams at the beginning of this section.*	*"What you are specifically trying to achieve"*	*"What you are going to use to measure performance"*	*Rationale flagged as 'EMO' where Existing Management Objective in place, or 'AMO' where there is an existing AFMA Management Objective in place for other Commonwealth fisheries (assumed that squid fishery will fall into line).*

Component	Core Objective	Sub-component	Example Operational Objectives	Example Indicators	Rationale
Target Species	Avoid recruitment failure of the target species Avoid negative consequences for species or population sub-components	1. Population size	1.1 No trend in biomass 1.2 Maintain biomass above a specified level 1.3 Maintain catch at specified level 1.4 Species do not approach extinction or become extinct	Biomass, numbers, density, CPUE, yield	1.1 Target species managed to maintain biomass above set levels 1.2 EMO and AMO – maintain ecologically viable stock levels 1.3 TACs for each species set by biological reference points based on EMO. Catch levels vary yearly as determined by the TACs. 1.4 Covered by 1.2
		2. Geographic range	2.1 Geographic range of the population, in terms of size and continuity does not change outside acceptable bounds	Presence of population across the Southern Ocean	2.1 Individual stocks assumed to be isolated and therefore independent. The stocks at HIMI, Kerguelen and in the High seas (CCAMLR Statistical Division 58.5.2) are possibly interdependent.
		3. Genetic structure	3.1 Genetic diversity does not change outside acceptable bounds	Frequency of genotypes in the population, effective population size (N_e), number of spawning units	3.1 Not currently monitored. No reference levels established. Mitochondrial DNA work has shown that separate stocks are found in the Macquarie, Heard, and South Georgia regions.
		4. Age/size/sex structure	4.1 Age/size/sex structure does not change outside acceptable bounds (e.g. more than X% from reference structure)	Biomass, numbers or relative proportion in age/size/sex classes Biomass of spawners Mean size, sex ratio	4.1 Covered in general by 1.2 EMO and AMO. The size range of Patagonian toothfish suggests that the fishery is not targeting recruitment or spawning grounds.

Component	Core Objective	Sub-component	Example Operational Objectives	Example Indicators	Rationale
		5. Reproductive Capacity	5.1 Fecundity of the population does not change outside acceptable bounds (e.g. more than X% of reference population fecundity) 2 Recruitment to the population does not change outside acceptable bounds	Egg production of population Abundance of recruits	5.1 Covered by 1.2 EMO and AMO. Reproductive capacity in terms of egg production may be easier to monitor via changes in Age/size/sex structure. 5.2 Covered by 1.2 EMO and AMO. May be easier to monitor via changes in Age/size/sex structure in the fishery. For Mackerel icefish move on provisions exist when a haul contains more than 100 kg of Mackerel icefish where more than 10 % are smaller than 240 mm total length. The vessel must not fish within 5 nm of that site for at least 5 days.
		6. Behaviour /Movement	6.1 Behaviour and movement patterns of the population do not change outside acceptable bounds	Presence of population across space, movement patterns within the population (e.g. attraction to bait, lights)	6.1 Covered by 1.2 EMO and AMO. However the possible links between the HIMI, Kerguelen and Crozet stocks and their respective degree of independence from each other require further investigation.

Component	Core Objective	Sub-component	Example Operational Objectives	Example Indicators	Rationale
Byproduct and Bycatch	Avoid recruitment failure of the byproduct and bycatch species Avoid negative consequences for species or population sub-components	1. Population size	1.1 No trend in biomass 1.2 Species do not approach extinction or become extinct 1.3 Maintain biomass above a specified level 1.4 Maintain catch at specified level	Biomass, numbers, density, CPUE, yield	1.1 Objective too general and covered by 1.2 and 1.3 1.2 Covered by EMO and AMO that ensures the fishery does not threaten bycatch species. 1.3 EMO/AMO – Annual reviews of all information on bycatch species with the aim of developing species specific bycatch limits. Use of 'move on provisions' to limit exploitation of bycatch stocks in localised areas. 1.4Maintaining bycatch/byproduct levels not a specific objective. The protection of bycatch by TACs based on precautionary principles is the preferred method. "Move on provisions" are enforced if bycatch exceeds set limits.
		2. Geographic range	2.1 Geographic range of the population, in terms of size and continuity does not change outside acceptable bounds	Presence of population across space	2.1 Not currently monitored. No specific management objective based on the geographic range of bycatch/byproduct species.

Component	Core Objective	Sub-component	Example Operational Objectives	Example Indicators	Rationale
		3. Genetic structure	3.1 Genetic diversity does not change outside acceptable bounds	Frequency of genotypes in the population, effective population size (N_e), number of spawning units	3.1 Not currently monitored. No reference levels established. No specific management objective based on the genetic structure of bycatch species.
		4. Age/size/sex structure	4.1 Age/size/sex structure does not change outside acceptable bounds (e.g. more than X% from reference structure)	Biomass, numbers or relative proportion in age/size/sex classes Biomass of spawners Mean size, sex ratio	4.1 EMO – move on provisions require that if bycatch in any one haul exceeds set limits (2 tonnes grey rockcod and unicorn icefish, 1 tonne all other species) then the vessel must not use that fishing method within 5 nm of that site for at least 5 days.
		5 Reproductive Capacity	5.1 Fecundity of the population does not change outside acceptable bounds (e.g. more than X% of reference population fecundity) Recruitment to the population does not change outside acceptable bounds	Egg production of population Abundance of recruits	5.1 Beyond the generality of the EMO "Fishing is conducted in a manner that does not threaten stocks of byproduct / bycatch species", reproductive capacity is not currently measured for bycatch/byproduct species and is largely covered by other objectives.
		6. Behaviour /Movement	6.1 Behaviour and movement patterns of the population do not change outside acceptable bounds	Presence of population across space, movement patterns within the population (e.g. attraction to bait, lights)	6.1 Trawling does not appear to attract bycatch species or alter their behaviour and movement patterns, resulting in the attraction of species to fishing grounds.

Component	Core Objective	Sub-component	Example Operational Objectives	Example Indicators	Rationale
TEP species	Avoid recruitment failure of TEP species Avoid negative consequences for TEP species or population sub-components Avoid negative impacts on the population from fishing	1. Population size	1.1 Species do not further approach extinction or become extinct 1.2 No trend in biomass 1.3 Maintain biomass above a specified level 1.4 Maintain catch at specified level	Biomass, numbers, density, CPUE, yield	1.1 EMO - The fishery is conducted in a manner that avoids mortality of, or injuries to, endangered, threatened or protected species (EA Assessment 2002). 1.2 A positive trend in biomass is desirable for TEP species. 1.3 Maintenance of TEP biomass above specified levels not currently a fishery operational objective. 1.4 The above EMO states '.must avoid mortality/injury to TEPs.
		2. Geographic range	2.1 Geographic range of the population, in terms of size and continuity does not change outside acceptable bounds	Presence of population across space, i.e. the Southern Ocean.	2.1 Change in geographic range of TEP species may have serious consequences e.g. population fragmentation and/or forcing species into sub-optimal areas.
		3. Genetic structure	3.1 Genetic diversity does not change outside acceptable bounds	Frequency of genotypes in the population, effective population size (N_e), number of spawning units	3.1 Because population size of TEP species is often small, TEPs are sensitive to loss of genetic diversity. Genetic monitoring may be an effective approach to measure possible fishery impacts.

Component	Core Objective	Sub-component	Example Operational Objectives	Example Indicators	Rationale
		4. Age/size/sex structure	4.1 Age/size/sex structure does not change outside acceptable bounds (e.g. more than X% from reference structure)	Biomass, numbers or relative proportion in age/size/sex classes Biomass of spawners Mean size, sex ratio	4.1 Monitoring the age/size/sex structure of TEP populations may be a useful management tool allowing the identification of possible fishery impacts and that cross-section of the population most at risk.
		5. Reproductive Capacity	5.1 Fecundity of the population does not change outside acceptable bounds (e.g. more than X% of reference population fecundity) Recruitment to the population does not change outside acceptable bounds	Egg production of population Abundance of recruits	5.1 The reproductive capacity of TEP species is of concern to the HIMI Fishery because potential fishery induced changes in reproductive ability (e.g. reduction in prey items may critically affect seabird brooding success) may have immediate impact on the population size of TEP species.

Component	Core Objective	Sub-component	Example Operational Objectives	Example Indicators	Rationale
		6. Behaviour /Movement	6.1 Behaviour and movement patterns of the population do not change outside acceptable bounds	Presence of population across space, movement patterns within the population (e.g. attraction to bait, lights)	6.1 Trawling operations may attract TEP species and alter behaviour and movement patterns, resulting in the habituation of TEP species to fishing vessels The overall effect may be to prevent juveniles from learning to fend for themselves therefore increasing the animals' reliance on fishing vessels. Subsequently this could substantially increase the risk of injury/mortality by collision, entrapment or entanglement with a vessel or fishing gear.
		7. Interactions with fishery	7.1 Survival after interactions is maximised 7.2 Interactions do not affect the viability of the population or its ability to recover	Survival rate of species after interactions Number of interactions, biomass or numbers in population	7.1, 7.2, EMO – The fishery is conducted in a manner that avoids mortality of, or injuries to, endangered, threatened or protected species. Includes the prohibition on discarding offal (bycatch, fish processing waste, unwanted dead fish), gear restrictions and reduced lighting levels to minimise interactions and attraction of the vessel to TEP species. (EA Assessment 2002)

Component	Core Objective	Sub-component	Example Operational Objectives	Example Indicators	Rationale
Habitats	Avoid negative impacts on the quality of the environment Avoid reduction in the amount and quality of habitat	1. Water quality	1.1 Water quality does not change outside acceptable bounds	Water chemistry, noise levels, debris levels, turbidity levels, pollutant concentrations, light pollution from artificial light	1.1 EMO control the discharge or discarding of waste (fish offal and poultry products and brassicas) and limit lighting on the vessels. MARPOL regulations prohibit discharge of oils, discarding of plastics.
		2. Air quality	2.1 Air quality does not change outside acceptable bounds	Air chemistry, noise levels, visual pollution, pollutant concentrations, light pollution from artificial light	2.1 Not currently perceived as an important habitat sub-component, trawling operations not believed to strongly influence air quality.
		3. Substrate quality	3.1 Sediment quality does not change outside acceptable bounds	Sediment chemistry, stability, particle size, debris, pollutant concentrations	3.1 EMO – The fishery is conducted, in a manner that minimises the impact of fishing operations on benthic habitat Controls on bobbin and disc size requirements to minimise benthic impacts (EA Assessment 2002). The current MPA and conservation areas reserve large areas of the known habitat types from fishing disturbance.

Component	Core Objective	Sub-component	Example Operational Objectives	Example Indicators	Rationale
		4. Habitat types	4.1 Relative abundance of habitat types does not vary outside acceptable bounds	Extent and area of habitat types, % cover, spatial pattern, landscape scale	4.1 Trawling activities may result in changes to the local habitat types in the fishing grounds. The current MPA and conservation areas reserve large areas of the known habitat types from fishing disturbance.
		5. Habitat structure and function	5.1 Size, shape and condition of habitat types does not vary outside acceptable bounds	Size structure, species composition and morphology of biotic habitats	5.1 Trawling activities may result in local disruption to pelagic and benthic processes.
Communities	Avoid negative impacts on the composition/function/distribution/structure of the community	1. Species composition	1.1 Species composition of communities does not vary outside acceptable bounds	Species presence/absence, species numbers or biomass (relative or absolute) Richness Diversity indices Evenness indices	1.1 EMO – The fishery is conducted, in a manner that minimises the impact of fishing operations on the ecosystem generally. Preliminary assessments of benthic impacts by AFMA have been based on AAD trawl data and quantitative monitoring of benthic bycatch. AFMA have further planned research for benthic impacts through their 5 year Strategic Research Plan (EA Assessment 2002).

Component	Core Objective	Sub-component	Example Operational Objectives	Example Indicators	Rationale
		2. Functional group composition	2.1 Functional group composition does not change outside acceptable bounds	Number of functional groups, species per functional group (e.g. autotrophs, filter feeders, herbivores, omnivores, carnivores)	2.1 The presence/abundance of 'functional group' members may fluctuate widely, however in terms of maintenance of ecosystem processes it is important that the aggregate effect of a functional group is maintained.
		3. Distribution of the community	3.1 Community range does not vary outside acceptable bounds	Geographic range of the community, continuity of range, patchiness	3.1 Demersal trawling operations have unknown impacts on the benthos in the fishing grounds. AFMA have planned further research on benthic impacts to clarify this issue. The current MPA and conservation areas reserve large areas of the known habitat types from fishing disturbance.
		4. Trophic/size structure	4.1 Community size spectra/trophic structure does not vary outside acceptable bounds	Size spectra of the community Number of octaves, Biomass/number in each size class Mean trophic level Number of trophic levels	4.1 Trawling activities for target species have the potential to remove a significant component of the predator functional group. Increased abundance of the prey groups may then allow shifts in relative abundance of higher trophic level organisms.
		5. Bio- and geo-chemical cycles	5.1 Cycles do not vary outside acceptable bounds	Indicators of cycles, salinity, carbon, nitrogen, phosphorus flux	5.1 Trawling operations not perceived to have a detectable effect on bio and geochemical cycles.

2.2.4 Hazard Identification (Step 4)

Hazards are the activities undertaken in the process of fishing, and any external activities, which have the potential to lead to harm.

The effects of fishery/sub-fishery specific hazards are identified under the following categories:

- capture
- direct impact without capture
- addition/movement of biological material
- addition of non biological material
- disturbance of physical processes
- external hazards

These fishing and external activities are scored on a presence/absence basis for each fishery/sub-fishery. An activity is scored as a zero if it does not occur and as a one if it does occur. The rationale for the scoring is also documented in detail and must include if/how the activity occurs and how the hazard may impact on organisms/habitat.

Scoping Document S4. Hazard Identification Scoring Sheet

This table is completed once for each sub-fishery. **Table 4** provides a set of examples of fishing activities for the effects of fishing to be used as a guide to assist in scoring the hazards.

Sub-fishery Name: Demersal trawl
Fishery Name: Heard and McDonald Islands Fishery
Date of assessment: April 2004 (updated June 2006)

Direct impact of Fishing	Fishing Activity	Score (0/1)	Documentation of Rationale
Capture	Bait collection	0	Trawl fishery no baits used.
	Fishing	1	
	Incidental behaviour	0	No ports, no landings, no recreational fishing recorded.
Direct impact without capture	Bait collection	0	Trawl fishery no baits used.
	Fishing	1	Damage to benthos, fish escaping net.
	Incidental behaviour	0	
	Gear loss	1	Nets are towed on bottom and gear loss has been reported.
	Anchoring/ mooring	0	Not recorded.
	Navigation/steaming	1	
Addition/ movement of biological material	Translocation of species (boat launching, reballasting)	1	No bait fishing but translocation of species via ballast water or as hull or organisms fouling sea water piping systems is a potential risk.
	On board processing	0	Fish processed on board but all unwanted bycatch is ground and stored as fishmeal onboard vessel.
	Discarding catch	0	Ground and stored as fishmeal. May only be discharged in emergency and then under strict conditions.
	Stock enhancement	0	
	Provisioning	0	No bait or berley used in fishery
	Organic waste disposal	1	Sewage disposal not covered by regulations? Disposal of certain food scraps, brassicas and poultry products prohibited, other food scraps disposed of according to MARPOL regulations.
Addition of non-biological material	Debris	1	MARPOL regulations enforced. Vessel operators have installed signs to remind/educate crew members with regard to proper processes.
	Chemical pollution	1	Regulated by MARPOL
	Exhaust	1	Types of fuels being burnt e.g.: MDO (marine diesel oils) vs HFO (heavy fuel oil)
	Gear loss	1	Several instances of major gear loss and numerous minor ones.
	Navigation/ steaming	1	Navigation/steaming introduces noise to environment. Depth sounders/ acoustic net positioning systems have potential to disturb marine species.

Direct impact of Fishing	Fishing Activity	Score (0/1)	Documentation of Rationale
	Activity/ presence on water	1	Presence of vessel introduces noise/stimuli to environment. Birds attracted to presence of vessel.
Disturb physical processes	Bait collection	0	Trawl fishery no baits used.
	Fishing	1	Benthos disturbed by nets
	Boat launching	0	Vessels operate from established ports.
	Anchoring/ mooring	0	No records of vessels anchoring in sub-Antarctic AFZ.
	Navigation/ steaming	1	Due to depth benthos unlikely to be affected. Wake mixing of surface waters does occur.
External Hazards (specify the particular example within each activity area)	Other capture fishery methods	1	IUU fishing vessels using longlines. Longline fisheries for toothfish. Area too remote for indigenous or recreational fishers.
	Aquaculture	0	None
	Coastal development	0	None
	Other extractive activities	0	None known.
	Other non-extractive activities	0	None known.
	Other anthropogenic activities	1	Tourist shipping and landings by tourists

Table 4. Examples of fishing activities (Modified from Fletcher et al. 2002).

Direct Impact of Fishing	Fishing Activity	Examples of Activities Include
Capture		Activities that result in the capture or removal of organisms. This includes cryptic mortality due to organisms being caught but dropping out prior to the gear's retrieval (i.e. They are caught but not landed)
	Bait collection	Capture of organisms due to bait gear deployment, retrieval and bait fishing. This includes organisms caught but not landed.
	Fishing	Capture of organisms due to gear deployment, retrieval and actual fishing. This includes organisms caught but not landed.
	Incidental behaviour	Capture of organisms due to crew behaviour incidental to primary fishing activities, possible in the crew's down time; e.g. crew may line or spear fish while anchored, or perform other harvesting activities, including any land-based harvesting that occurs when crew are camping in their down time.
Direct impact, without capture		This includes any activities that may result in direct impacts (damage or mortality) to organisms without actual capture.
	Bait collection	Direct impacts (damage or mortality) to organisms due to interactions (excluding capture) with bait gear during deployment, retrieval and bait fishing. This includes: damage/mortality to organisms through contact with the gear that doesn't result in capture, e.g. Damage/mortality to benthic species by gear moving over them, organisms that hit nets but aren't caught.
	Fishing	Direct impacts (damage or mortality) to organisms due to interactions (excluding capture) with fishing gear during deployment, retrieval and fishing. This includes: damage/mortality to organisms through contact with the gear that doesn't result in capture, e.g. Damage/mortality to benthic species by gear moving over them, organisms that hit nets but are not caught.
	Incidental behaviour	Direct impacts (damage or mortality) without capture, to organisms due to behaviour incidental to primary fishing activities, possibly in the crew's down time; e.g. the use of firearms on scavenging species, damage/mortality to organisms through contact with the gear that the crew use to fish during their down time. This does not include impacts on predator species of removing their prey through fishing.
	Gear loss	Direct impacts (damage or mortality), without capture on organisms due to gear that has been lost from the fishing boat. This includes damage/mortality to species when the lost gear contacts them or if species swallow the lost gear.
	Anchoring/ mooring	Direct impact (damage or mortality) that occurs and when anchoring or mooring. This includes damage/mortality due to physical contact of the anchor, chain or rope with organisms, e.g. An anchor damaging live coral.
	Navigation/ steaming	Direct impact (damage or mortality) without capture may occur while vessels are navigating or steaming. This includes collisions with marine organisms or birds.
Addition/ movement of biological material		Any activities that result in the addition or movement of biological material to the ecosystem of the fishery.
	Translocation of species (boat movements, reballasting)	The translocation and introduction of species to the area of the fishery, through transportation of any life stage. This transport can occur through movement on boat hulls or in ballast water as boats move throughout the fishery or from outside areas into the fishery.

Direct Impact of Fishing	Fishing Activity	Examples of Activities Include
	On board processing	The discarding of unwanted sections of target after on board processing introduces or moves biological material, e.g. heading and gutting, retaining fins but discarding trunks.
	Discarding catch	The discarding of unwanted organisms from the catch can introduce or move biological material. This includes individuals of target and byproduct species due to damage (e.g. shark or marine mammal predation), size, high grading and catch limits. Also includes discarding of all non-retained bycatch species. This also includes discarding of catch resulting from incidental fishing by the crew. The discards could be alive or dead.
	Stock enhancement	The addition of larvae, juveniles or adults to the fishery or ecosystem to increase the stock or catches.
	Provisioning	The use of bait or berley in the fishery.
	Organic waste disposal	The disposal of organic wastes (e.g. food scraps, sewage) from the boats.
Addition of non-biological material		Any activities that result in non-biological material being added to the ecosystem of the fishery, this includes physical debris, chemicals (in the air and water), lost gear, noise and visual stimuli.
	Debris	Non-biological material may be introduced in the form of debris from fishing vessels or mother ships. This includes debris from the fishing process: e.g. cardboard thrown over from bait boxes, straps and netting bags lost. Debris from non-fishing activities can also contribute to this e.g. Crew rubbish – discarding or food scraps, plastics or other rubbish. Discarding at sea is regulated by MARPOL, which forbids the discarding of plastics.
	Chemical pollution	Chemicals can be introduced to water, sediment and atmosphere through: oil spills, detergents other cleaning agents, any chemicals used during processing or fishing activities.
	Exhaust	Exhaust can be introduced to the atmosphere and water through operation of fishing vessels
	Gear loss	The loss of gear will result in the addition of non-biological material, this includes hooks, line, sinkers, nets, otter boards, light sticks, buoys etc.
	Navigation /steaming	The navigation and steaming of vessels will introduce noise and visual stimuli into the environment. Boat collisions and/or sinking of vessels. Echo-sounding may introduce noise that may disrupt some species (e.g. whales, orange roughy)
	Activity /presence on water	The activity or presence of fishing vessels on the water will noise and visual stimuli into the environment.
Disturb physical processes		Any activities that will disturb physical processes, particularly processes related to water movement or sediment and hard substrate (e.g. boulders, rocky reef) processes.
	Bait collection	Bait collection may disturb physical processes if the gear contacts seafloor-disturbing sediment, or if the gear disrupts water flow patterns.
	Fishing	Fishing activities may disturb physical processes if the gear contacts seafloor-disturbing sediment, or if the gear disrupts water flow patterns.

Direct Impact of Fishing	Fishing Activity	Examples of Activities Include
	Boat launching	Boat launching may disturb physical processes, particularly in the intertidal regions, if dredging is required, or the boats are dragged across substrate. This would also include foreshore impacts where fishers drive along beaches to reach fishing locations and launch boats. Impacts of boat launching that occurs within established marinas are outside the scope of this assessment.
	Anchoring /mooring	Anchoring/mooring may affect the physical processes in the area that anchors and anchor chains contact the seafloor.
	Navigation /steaming	Navigation /steaming may affect the physical processes on the benthos and the pelagic by turbulent action of propellers or wake formation.
External hazards		Any outside activities that will result in an impact on the component in the same location and period that the fishery operates. The particular activity as well as the mechanism for external hazards should be specified.
	Other capture fishery methods	Take or habitat impact by other commercial, indigenous or recreational fisheries operating in the same region as the fishery under examination
	Aquaculture	Capture of feed species for aquaculture. Impacts of cages on the benthos in the region
	Coastal development	Sewage discharge, ocean dumping, agricultural runoff
	Other extractive activities	Oil and gas pipelines, drilling, seismic activity
	Other non-extractive activities	Defence, shipping lanes, dumping of munitions, submarine cables
	Other anthropogenic activities	Recreational activities, such as scuba diving leading to coral damage, power boats colliding with whales, dugongs, turtles. Shipping, oil spills

2.2.5 Bibliography (Step 5)

All references used in the scoping assessment are included in the References section.

Key documents can be found on the AFMA web page at www.afma.gov.au and include the following:

- Assessment Report
- Management Plan
- Management Regulations
- Management Plan and Regulation Guidelines
- AFMA At a glance web page http://www.afma.gov.au/fisheries/etbf/at_a_glance.php
- Bycatch Action Plans
- Data Summary Reports (logbook and observer)

Other publications that may provided information include

- BRS Fishery Status Reports
- Strategic Plans

2.2.6 Decision rules to move to Level 1(Step 6)

Any hazards that are identified at Step 4 Hazard Identification as occurring in the fishery are carried forward for analysis at Level 1.

In this case, 14 out of 26 possible internal activities were identified as occurring in this fishery. Two out of 6 external activities were identified. Thus, a total of 16 activity-component scenarios will be considered at Level 1. This results in 80 total scenarios (of 160 possible) to be developed and evaluated using the unit lists (species, habitats, communities).

2.3 Level 1 Scale, Intensity and Consequence Analysis (SICA)

Level 1 aims to identify which hazards lead to a significant impact on any species, habitat or community. Analysis at Level 1 is for whole components (target; bycatch and byproduct; TEP species; habitat; and communities), not individual sub-components. Since Level 1 is used mainly as a rapid screening tool, a "worst case" approach is used to ensure that elements screened out as low risk (either activities or components) are genuinely low risk. Analysis at Level 1 for each component is accomplished by considering the most vulnerable sub-component and the most vulnerable unit of analysis (e.g. most vulnerable species, habitat type or community). This is known as credible scenario evaluation (Richard Stocklosa e-systems Pty Ltd (March 2003) Review of CSIRO Risk Assessment Methodology: ecological risk assessment for the effects of fishing) in conventional risk assessment. In addition, where judgments about risk are uncertain, the highest level of risk that is still regarded as plausible is chosen. For this reason, the measures of risk produced at Level 1 cannot be regarded as absolute.

At Level 1 each fishery/sub-fishery is assessed using a scale, intensity and consequence analysis (SICA). SICA is applied to the component as a whole by choosing the most vulnerable sub-component (linked to an operational objective) and most vulnerable unit of analysis. The rationale for these choices must be documented in detail. These steps are outlined below. Scale, intensity, and consequence analysis (SICA) consists of thirteen steps. The first ten steps are performed for each activity and component, and correspond to the columns of the SICA table. The final three steps summarise the results for each component.

Step1: Record the hazard identification score (absence (0) presence (1) scores) identified at step 3 at the scoping level (Scoping Document S3) onto the SICA table
Step 2: Score spatial scale of the activity
Step 3: Score temporal scale of the activity
Step 4: Choose the sub-component most likely to be affected by activity
Step 5: Choose the most vulnerable unit of analysis for the component e.g. species, habitat type or community assemblage
Step 6: Select the most appropriate operational objective
Step 7: Score the intensity of the activity for that sub-component
Step 8: Score the consequence resulting from the intensity for that sub component
Step 9: Record confidence/uncertainty for the consequence scores
Step 10. Document rationale for each of the above steps

Step 11. Summary of SICA results
Step 12. Evaluation/discussion of Level 1
Step 13. Components to be examined at Level 2

2.3.1 Record the hazard identification score (absence (0) presence (1) scores) identified at step 3 in the scoping level onto the SICA Document (Step 1)

Record the hazard identification score absence (0) presence (1) identified at Step 3 at the scoping level onto the SICA sheet. A separate sheet will be required for each component (target, bycatch and byproduct, and TEP species, habitat, and communities). Only those activities that scored a 1 (presence) will be analysed at Level 1

2.3.2 Score spatial scale of activity (Step 2)

The greatest spatial extent must be used for determining the spatial scale score for each identified hazard. For example, if fishing (e.g. capture by longline) takes place within an area of 200 nm by 300 nm, then the spatial scale is scored as 4. The score is then recorded onto the SICA Document and the rationale documented.

Spatial scale score of activity

<1 nm:	1-10 nm:	10-100 nm:	100-500 nm:	500-1000 nm:	>1000 nm:
1	2	3	4	5	6

Maps and graphs may be used to supplement the information (e.g. sketches of the distribution of the activity relative to the distribution of the component) and additional notes describing the nature of the activity should be provided. The spatial scale score at Step 2 is not used directly, but the analysis is used in making judgments about level of intensity at Step 7. Obviously, two activities can score the same with regard to spatial scale, but the intensity of each can differ vastly. The reasons for the score are recorded in the rationale column of the SICA spreadsheet.

2.3.3 Score temporal scale of activity (Step 3)

The highest frequency must be used for determining the temporal scale score for each identified hazard. If the fishing activity occurs daily, the temporal scale is scored as 6. If oil spillage occurs about once per year, then the temporal scale of that hazard scores a 3. The score is then recorded onto the SICA Document and the rationale documented.

Temporal scale score of activity

Decadal (1 day every 10 years or so)	Every several years (1 day every several years)	Annual (1-100 days per year)	Quarterly (100-200 days per year)	Weekly (200-300 days per year)	Daily (300-365 days per year)
1	2	3	4	5	6

It may be more logical for some activities to consider the aggregate number of days that an activity occurs. For example, if the activity “fishing” was undertaken by 10 boats during the same 150 days of the year, the score is 3. If the same 10 boats each spend 30 non-overlapping days fishing, the temporal scale of the activity is a sum of 300 days, indicating that a score of 6 is appropriate. In the case where the activity occurs over many days, but only every 10 years, the number of days by the number of years in the cycle is used to determine the score. For example, 100 days of an activity every 10 years averages to 10 days every year, so that a score of 3 is appropriate.

The temporal scale score at Step 3 is not used directly, but the analysis is used in making judgments about level of intensity at Step 7. Obviously, two activities can score the same with regard to temporal scale, but the intensity of each can differ vastly. The reasons for the score are recorded in the rationale column.

2.3.4 Choose the sub-component most likely to be affected by activity (Step 4)

The most vulnerable sub-component must be used for analysis of each identified hazard. This selection must be made on the basis of expected highest potential risk for each 'direct impact of fishing' and 'fishing activity' combination, and recorded in the 'sub-component' column of the SICA Document. The justification is recorded in the rationale column.

2.3.5 Choose the unit of analysis most likely to be affected by activity and to have highest consequence score (Step 5)

The most vulnerable 'unit of analysis' (i.e. most vulnerable species, habitat type or community) must be used for analysis of each identified hazard. The species, habitats, or communities (depending on which component is being analysed) are selected from **Scoping Document S2 (A – C)**. This selection must be made on the basis of expected highest potential risk for each 'direct impact of fishing' and 'fishing activity' combination, and recorded in the 'unit of analysis' column of the SICA Document. The justification is recorded in the rationale column.

2.3.6 Select the most appropriate operational objective (Step 6)

To provide linkage between the SICA consequence score and the management objectives, the most appropriate operational objective for each sub-component is chosen. The most relevant operational objective code from **Scoping Document S3** is recorded in the 'operational objective' column in the SICA document. Note that SICA can only be performed on operational objectives agreed as important for the (sub) fishery during scoping and contained in **Scoping Document S3**. If the SICA process identifies reasons to include sub-components or operational objectives that were previously not included/eliminated then these sub-components or operational objectives must be re-instated.

2.3.7 Score the intensity of the activity for the component (Step 7)

The score for intensity of an activity considers the direct impacts in line with the categories shown in the conceptual model (**Figure 2**) (capture, direct impact without capture, addition/movement of biological material, addition of non-biological material, disturbance to physical processes, external hazards). The intensity of the activity is judged based on the scale of the activity, its nature and extent. Activities are scored as per intensity scores below.

Intensity score of activity (Modified from Fletcher et al. 2002)

Level	Score	Description
Negligible	1	remote likelihood of detection at any spatial or temporal scale
Minor	2	occurs rarely or in few restricted locations and

Level	Score	Description
		detectability even at these scales is rare
Moderate	3	moderate at broader spatial scale, or severe but local
Major	4	severe and occurs reasonably often at broad spatial scale
Severe	5	occasional but very severe and localized or less severe but widespread and frequent
Catastrophic	6	local to regional severity or continual and widespread

This score is then recorded on the **Level 1 (SICA) Document** and the rationale documented.

2.3.8 Score the consequence of intensity for that component (Step 8)

The consequence of the activity is a measure of the likelihood of not achieving the operational objective for the selected sub-component and unit of analysis. It considers the flow on effects of the direct impacts from Step 7 for the relevant indicator (e.g. decline in biomass below the selected threshold due to direct capture). Activities are scored as per consequence scores below. A more detailed description of the consequences at each level for each component (target, bycatch and byproduct, TEP species, habitats, and communities) is provided as a guide for scoring the consequences of the activities in the description of consequences table (see **Table 5** Appendix B).

Consequence score for ERAEF activities (Modified from Fletcher et al. 2002).

Level	Score	Description
Negligible	1	Impact unlikely to be detectable at the scale of the stock/habitat/community
Minor	2	Minimal impact on stock/habitat/community structure or dynamics
Moderate	3	Maximum impact that still meets an objective (e.g. sustainable level of impact such as full exploitation rate for a target species).
Major	4	Wider and longer term impacts (e.g. long-term decline in CPUE)
Severe	5	Very serious impacts now occurring, with relatively long time period likely to be needed to restore to an acceptable level (e.g. serious decline in spawning biomass limiting population increase).
Intolerable	6	Widespread and permanent/irreversible damage or loss will occur-unlikely to ever be fixed (e.g. extinction)

The score should be based on existing information and/or the expertise of the risk assessment group. The rationale for assigning each consequence score must be documented. The conceptual model may be used to link impact to consequence by showing the pathway that was considered. In the absence of agreement or information, the highest score (worst case scenario) considered plausible is applied to the activity.

2.3.9 Record confidence/uncertainty for the consequence scores (Step 9)

The information used at this level is qualitative and each step is based on expert (fishers, managers, conservationists, scientists) judgment. The confidence rating for the consequence score is rated as 1 (low confidence) or 2 (high confidence) for the activity/component. The score is recorded on the SICA Document and the rationale documented. The confidence will reflect the levels of uncertainty for each score at steps 2, 3, 7 and 8.

Description of Confidence scores for Consequences. The confidence score appropriate to the rationale is used, and documented on the SICA Document.

Confidence	Score	Rationale for the confidence score
Low	1	Data exists, but is considered poor or conflicting No data exists Disagreement between experts
High	2	Data exists and is considered sound Consensus between experts Consequence is constrained by logical consideration

2.3.10 Document rationale for each of the above steps (Step 10)

The rationale forms a logical pathway to the consequence score. It is provided for each choice at each step of the SICA analysis.

SICA steps 1-10. Tables of descriptions of consequences for each component and each sub component provide a guide for scoring the level of consequence (see Table 5, Appendix B)

2.3.1 Level 1 (SICA) Documents

L1.1 - Target Species Component

Direct impact of fishing	Fishing activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
Capture	Bait collection	0									
	Fishing	1	4	5	Population Size	Patagonian toothfish *Dissostichus eleginoides*	1.1	3	3	2	Fishing occurs widely across the Heard Plateau-a minimum of 123 nm and a maximum of 240 nm separate the three fishing grounds A, B and C. Fishing occurs between 200-300 days. Population size most likely to be affected before major changes in geographic range or genetic structure. Patagonian toothfish principle target of demersal trawls however mackerel icefish are targetted on the plateau. =>intensity moderate =>Consequence moderate as stocks are fully exploited and TAC levels being annually reviewed and adjusted to sustain fishery =>Confidence high, based on data collection by observers and research conducted in the fishery to date.
	Incidental behaviour	0									
Direct impact without capture	Bait collection	0									
	Fishing	1	4	5	Population Size	Patagonian toothfish *Dissostichus eleginoides*	1.1	3	2	2	Fish escape through net meshes and population size most likely to be affected if post-capture survival is low =>intensity moderate =>Consequence minor, tagging surveys successful therefore assume good post-capture survival after escapement =>Confidence high, based on data collected by observers and research conducted in the fishery to date.
	Incidental behaviour	0									

Direct impact of fishing	Fishing activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
	Gear loss	1	4	3	Population Size	Patagonian toothfish *Dissostichus eleginoides*	1.1	2	2	2	Annual gear loss small. Gear loss has potential to alter species composition by direct interactions with species particularly benthic species => intensity minor, due to limited numbers of vessels in fishery, and management controls requiring attempt to retrieve lost gear =>Consequence minor. The types of gear recorded as lost are either small or have a minimal risk of entangling toothfish =>Confidence high, as observers present on all trips and report all gear lost.
	Anchoring/ mooring	0									
	Navigation/ steaming	1	4	5	Behaviour/movement	Patagonian toothfish *Dissostichus eleginoides*	6.1	1	1	2	Navigation/steaming occurs between 200-300 days across the Heard Plateau. Population size most likely impacted =>intensity negligible as unlikely for deepwater demersal species to collide with vessel =>consequence negligible =>Confidence high logic.
Addition/ movement of biological material	Translocation of species	1	6	5	Population size	Patagonian toothfish *Dissostichus eleginoides*	1.1	1	2	1	Translocation of species via ballast, hull fouling could occur daily. Population size most likely to be affected before major changes in geographic range or genetic structure. =>Intensity negligible the likelihood of temperate water species surviving and establishing as a threat to Patagonian toothfish in sub-Antarctic waters is considered negligible =>However consequence scored as minor due to the potential for the spread of fish borne disease. =>Confidence low due to absence of data on susceptibility of Patagonian toothfish to fish borne diseases.
	On board processing	0									
	Discarding catch	0									
	Stock enhancement	0									

Direct impact of fishing	Fishing activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
	Provisioning	0									
	Organic waste disposal	1	4	6	Behaviour/movement	Patagonian toothfish *Dissostichus eleginoides*	6.1	1	1	2	Vessels do not dispose of any plastic rubbish, or poultry products and comply strictly with MARPOL regulations therefore organic waste discharge could only be accidental; target species live at depths >400m therefore unlikely to alter behaviour of fish =>intensity negligible =>consequence negligible =>confidence high, 100% observer coverage, compliance to regulations
Addition of non-biological material	Debris	1	4	3	Population Size	Patagonian toothfish *Dissostichus eleginoides*	1.1	1	1	2	Disposal of debris may occur accidentally on a few occasions each year. The limited number of vessels in the fishery coupled with MARPOL regulations restricting the deliberate disposal of debris and the installation of signs/notices in the accommodation to remind/educate the crew as to their legal obligations for disposal of debris. =>All are seen to reduce the intensity for debris disposal, therefore scored as negligible. =>The consequences of accidental disposal are seen as negligible. =>Confidence high, 100% observer coverage and compliance to regulations.
	Chemical pollution	1	4	2	Population size	Mackerel icefish *Champsocephalus gunnari*	1.1	2	2	2	Chemical pollution, generally accidental, may only occur rarely. The limited number of vessels in the fishery coupled with MARPOL regulations restricting the deliberate disposal of chemical pollutants and the installation of signs/notices in the accommodation to remind/educate the crew as to their legal obligations for disposal of chemical pollutants. =>All are seen to reduce the intensity for chemical pollutants disposal, therefore scored as minor =>Provided deliberate disposal of chemicals does not occur, the consequences of accidental disposal to mackerel icefish minor =>Confidence is high as the regulations limit chemicals being deliberately dumped at sea. Accidental loss of chemicals overboard is seen as minor and not sufficient to affect the fishery.

Direct impact of fishing	Fishing activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
	Exhaust	1	4	6	Population size	Mackerel icefish *Champsocephalus gunnari*	1.1	1	1	2	Exhaust emissions occur daily during the season. =>intensity and consequence are both scored as negligible. The limited number of vessels in the fishery coupled with the depth at which target species are found makes it highly unlikely that exhaust gas emissions will have an affect on the target species. Further weather conditions in the region are frequently extreme, rapidly dispersing exhaust emissions. =>Confidence is high due to depth of water column separating target species from emissions.
	Gear loss	1	4	3	Population size	Mackerel icefish *Champsocephalus gunnari*	1.1	2	2	2	Annual gear loss or HIMI small =>The limited number of vessels in the fishery coupled with the type of gear in use indicates a minor intensity value =>Consequence is also minor =>Confidence was recorded as high due to gear loss information from observer and SARAG reports.
	Navigation/ steaming	1	4	6	Behaviour/movement	Mackerel icefish *Champsocephalus gunnari*	6.1	1	1	1	Mackerel icefish chosen as mid-water/pelagic species more likely to be affected by noise or echo sounders than a demersal species =>Intensity negligible due to the limited number of vessels in the fishery. =>Consequence is also seen as negligible, as only a small area is affected and target species mobility and depth locations seen as mitigating factors. =>Confidence was recorded as low due to lack of data from the HIMI fishery regarding steaming/navigation.
	Activity/ presence on water	1	4	6	Behaviour/movement	Mackerel icefish *Champsocephalus gunnari*	6.1	1	1	1	Mackerel icefish chosen as mid-water/pelagic species more likely to be affected by presence of vessel than a demersal species. =>Intensity negligible due to the limited number of vessels in the fishery. =>Consequence is also seen as negligible as only a small area is affected and target species mobility and depth locations seen as mitigating factors. =>Confidence was recorded as low due to lack of data from the HIMI fishery regarding effects of presence/activity.
Disturb	Bait collection	0									

Direct impact of fishing	Fishing activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
physical processes	Fishing	1	4	6	Behaviour/movement	Patagonian toothfish *Dissostichus eleginoides*	6.1	3	2	1	Patagonian toothfish chosen as demersal species most likely affected by disturbance of the habitat by the trawl =>Intensity moderate as localised grounds are repeatedly targeted. =>Consequence is minor, only a small area is affected, research to assess benthic impacts has been planned indicating concern over benthic changes but MPAs were declared to preserve habitats. These changes could affect distribution of target stocks. =>Confidence recorded as low due to lack of data from the HIMI fishery regarding effects of benthos disturbance.
	Boat launching	0									
	Anchoring/ mooring	0									
	Navigation/ steaming	1	4	5	Behaviour/movement	Mackerel icefish *Champsocephalus gunnari*	6.1	2	1	1	Fishing occurs between 200-300 days, therefore navigation/steaming occurs daily during season. Mackerel icefish chosen as mid-water/pelagic species more likely to be affected than a demersal species. =>Intensity minor due to the limited number of vessels in the fishery. =>Consequence is seen as negligible, wake mixing would be undetectable against natural variation and unlikely to impact icefish =>Confidence was recorded as low due to lack of data from the HIMI fishery regarding effects of navigation/steaming.
External Impacts (specify the particular example within each activity area)	Other fisheries: HIMI midwater trawl; HIMI Autolongline; IUU fishing	1	6	5	Population size	Patagonian toothfish *Dissostichus eleginoides;* Mackerel icefish *Champsocephalus gunnari*	1.1	4	4	2	Domestic longline fishery for toothfish and midwater fishery for Mackerel icefish occur in region of fishery and might affect toothfish population. Foreign legal longlining and IUU fishing for toothfish is viewed as continual and widespread =>Intensity major =>Consequence is seen as major with the potential to close the HIMI fishery (Patagonian toothfish stocks reduced below biological reference levels). IUU fishing in adjacent regions may affect HIMI stocks as population thought to straddle/migrate between these areas. Continued IUU

Direct impact of fishing	Fishing activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
											fishing could then cause stock extinctions in the HIMI region =>Confidence was recorded as high; data from the HIMI fishery indicates continued intensive IUU fishing efforts in and around the HIMI area.
	Aquaculture	0									
	Coastal development	0									
	Other extractive activities	0									
	Other non extractive activities	0									
	Other anthropogenic activities	1	4	4	Behaviour/movement	Mackerel icefish *Champsocephalus gunnari*	6.1	1	1	2	Research and tourism and the passage of research/tourist vessels. Mackerel icefish chosen as mid-water/pelagic species more likely to be affected than a demersal species =>Intensity negligible due to the limited number of vessels/visits/groups per year =>Consequence is seen as negligible, as only a small area is affected and target species mobility and depth locations seen as mitigating factors. =>Confidence was recorded as high due to data regarding numbers and activities indicates species not at risk.

L1.2 - Byproduct and Bycatch Component

Direct impact of fishing	Fishing activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
Capture	Bait collection	0	0	0							
	Fishing	1	4	5	Population size	Skates and rays	1.1	3	3	2	Fishing occurs widely across the Heard Plateau-a minimum of 123 nm and a maximum of 240 nm separate the three fishing grounds A, B and C. Fishing occurs between 200-300 days. Population size most likely to be affected before other sub-components. =>Intensity moderate catches of skates and rays appear to be increasing. =>Consequence moderate bycatch levels being monitored and annually reviewed to set bycatch species TAC =>Confidence high due data collection by observers and research conducted in the fishery to date.
	Incidental behaviour	0	0	0							
Direct impact without capture	Bait collection	0	0	0							
	Fishing	1	4	5	Population size	Skates and rays	1.1	3	2	2	Fishing occurs between 200-300 days (weather permitting). Population size most likely to be affected before other sub-components. =>Intensity moderate as catches of skates and rays appear to be increasing =>Consequence rated as minor as bycatch levels being monitored and annually reviewed. =>Confidence high due to data collection by observers and research conducted in the fishery to date.
	Incidental behaviour	0	0	0							
	Gear loss	1	4	3	Population size	Skates and rays	1.1	2	2	2	Gear loss small =>The limited number of vessels in the fishery coupled with the type of gear in use indicates a minor intensity value. =>Consequence is seen as minor. =>Confidence was recorded as high
	Anchoring/ mooring	0	0	0							

Direct impact of fishing	Fishing activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
	Navigation/ steaming	1	4	5	Population size	Skates and rays	1.1	1	1	2	Population size affected by collision with vessel =>Intensity negligible as thought unlikely for deepwater demersal species to collide. =>Consequence negligible =>Confidence high, logical constraints would suggest impact is minimal.
Addition/ movement of biological material	Translocation of species	1	6	5	Population size	Skates and rays	1.1	1	2	1	Translocation of species via ballast, hull fouling could occur daily. Population size most likely to be affected before major changes in geographic range or genetic structure. =>Intensity negligible the likelihood of temperate water species surviving and establishing as a threat to skates and rays in sub-Antarctic waters is considered negligible =>However consequence scored as minor due to the potential for the spread of fish borne disease. =>Confidence low due to absence of data on susceptibility of skates and rays to fish borne diseases.
	On board processing	0	0	0							
	Discarding catch	0	0	0							
	Stock enhancement	0	0	0							
	Provisioning	0	0	0							
	Organic waste disposal	1	4	6	Behaviour/movement	Skates and rays	6.1	1	1	2	Vessels do not dispose of any plastic rubbish, or poultry products and comply strictly with MARPOL regulations therefore organic waste discharge could only be accidental. The ban on disposal of bycatch waste/fish meal also viewed as mitigating factor. =>Intensity negligible =>Consequence was also considered negligible =>Confidence in the consequence score was high because general fishing waste disposal was considered unlikely to impact on the population size.
Addition of non-biological material	Debris	1	4	3	Population Size	Skates and rays	1.1	1	1	2	Disposal of debris might occur accidentally on a few occasions each year. =>Intensity scored as negligible. The limited number of vessels in the fishery coupled with MARPOL regulations restricting the deliberate disposal of debris, the installation of signs/notices in the accommodation to remind/educate the crew as to their legal obligations for disposal of debris are all seen to reduce the intensity for debris disposal. =>The consequences of

Direct impact of fishing	Fishing activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
											accidental disposal are seen as negligible. =>Confidence high, 100% observer coverage
	Chemical pollution	1	4	2	Population size	Skates and rays	1.1	1	2	2	Chemical pollution, generally accidental, may only occur rarely =>Intensity scored as negligible. The limited number of vessels in the fishery coupled with MARPOL regulations prohibiting the deliberate disposal of chemical pollutants, the installation of signs/notices in the accommodation to remind/educate the crew as to their legal obligations for disposal of chemicals are all seen to reduce the intensity for chemical pollution. =>consequence minor due potential consequences of a single spill following grounding/loss of a vessel affecting demersal species. =>Confidence is high as the regulations limit chemicals being deliberately dumped at sea. Accidental loss of chemicals overboard is seen as minor and not sufficient to affect the fishery.
	Exhaust	1	4	6	Population size	Skates and rays	1.1	1	1	2	Exhaust emissions occur 200-300 days. =>intensity and consequence both scored as negligible. The limited number of vessels in the fishery coupled with the depth at which target species are found makes it highly unlikely that exhaust gas emissions will have an affect on the target species. Weather conditions in the region are frequently extreme, rapidly dispersing exhaust emissions. =>Confidence is high due to depth of water column separating species from emissions.

Direct impact of fishing	Fishing activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
	Gear loss	1	4	3	Population size	Skates and rays	1.1	2	2	2	Gear loss small =>The limited number of vessels in the fishery coupled with the type of gear in use indicates a minor intensity value. =>Consequence is seen as minor, as losses (e.g. floats, codends, bobbins) recorded from the demersal trawl fishery at HIMI were found =>Confidence was recorded as high due to information from observers and SARAG reports regarding gear loss at HIMI.
	Navigation/ steaming	1	4	6	Behaviour/movement	Skates and rays	6.1	1	1	2	Noise, echo sounding from navigation/steaming could affect behaviour of skates =>Intensity negligible due to the limited number of vessels in the fishery. =>Consequence is seen as negligible, as only a small area is affected and species mobility and depth locations seen as mitigating factors. =>Confidence high, logic
	Activity/ presence on water	1	4	6	Behaviour/movement	Skates and rays	6.1	1	1	2	Vessels present and active daily (200-300 days). Behaviour of skates and rays could be affected by attraction to vessel =>Intensity negligible due to the limited number of vessels in the fishery. =>Consequence is seen as negligible, as only a small area is affected and species mobility and depth locations seen as mitigating factors. =>Confidence high, logic
Disturb physical processes	Bait collection	0	0	0							
	Fishing	1	4	6	Behaviour/movement	Skates and rays	6.1	3	2	1	Skates and rays most likely to be affected by habitat disturbance from fishing =>Intensity rated as moderate based on possible severe but localised effects of disturbing benthos on trawl grounds =>Consequence is minor, only a small area is affected and creation of MPAs has preserved habitat in the area. However these changes could affect distribution of target and bycatch stocks. =>Confidence recorded as low due to lack of data from the HIMI fishery regarding effects of benthos disturbance.
	Boat launching	0	0	0							
	Anchoring/ mooring	0	0	0							

Direct impact of fishing	Fishing activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
	Navigation/ steaming	1	4	5	Behaviour/movement	Skates and rays	6.1	1	1	1	Skates and rays chosen as productivity of these species considered much lower than target species. =>Intensity rated as negligible due low numbers of vessels in fishery. =>Consequence is seen as negligible, as only a small area is affected and species mobility and depth locations seen as mitigating factors. =>Confidence was recorded as low due to lack of data from the HIMI fishery regarding effects of navigation/steaming.
External Impacts (specify the particular example within each activity area)	Other fisheries: HIMI midwater trawl; HIMI Autolongline; IUU fishing	1	6	5	Population size	Skates and rays	1.1	4	3	2	Domestic longline fishery for toothfish and midwater fishery for Mackerel icefish occur in region of fishery and might affect population sizes of bycatch species. Foreign legal longlining and IUU fishing for toothfish is viewed as continual and widespread but may not affect bycatch species =>Intensity major =>Consequence moderate =>Confidence was recorded as high; data from the HIMI fishery indicates continued intensive IUU fishing efforts in and around the HIMI area.
	Aquaculture	0	0	0							
	Coastal development	0	0	0							
	Other extractive activities	0	0	0							
	Other non extractive activities	0	0	0							
	Other anthropogenic activities	1	4	4	Behaviour/movement	Skates and rays	6.1	1	1	2	Research and tourism and the passage of research/tourist vessels visit the area several times a year. Skates and rays chosen as productivity of this species considered much lower than target species. =>Intensity negligible due to the limited number of vessels/visits/groups per year. =>Consequence negligible, as only a small area is affected and species mobility and depth locations seen as mitigating factors. =>Confidence was recorded as high due to data regarding numbers and activities.

L1.3 - TEP Species Component

Direct impact of fishing	Fishing activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
Capture	Bait collection	0	0	0							
	Fishing	1	4	5	Population size	Black browed albatross *Thalassarche melanophrys*	1.1	2	2	2	Fishing occurs widely across the Heard Plateau-a minimum of 123 nm and a maximum of 240 nm separate the three fishing grounds A, B and C. Fishing occurs between 200-300 days. Population size most likely to be affected before other sub-components. =>Intensity minor as about one bird per year (all petrels) captured despite many observations of birds on the fishing grounds =>consequence minor =>Confidence high, 100% observer coverage, and research conducted in the fishery to date.
	Incidental behaviour	0	0	0							
Direct impact without capture	Bait collection	0	0	0							
	Fishing	1	4	5	Population size	Black browed albatross *Thalassarche melanophrys*	1.1	2	2	2	Population size most likely to be affected before other sub-components as albatross numbers are low =>Birds often seen interacting with the gear with no apparent injury therefore intensity minor =>consequence minor =>Confidence high 100% observer coverage and research conducted in the fishery to date.
	Incidental behaviour	0	0	0							
	Gear loss	1	4	3	Population size	Black browed albatross *Thalassarche melanophrys*	1.1	1	1	2	Gear loss occurs occasionally based on observer records. Lost gear might entangle birds =>Intensity negligible due to limited numbers of vessels in fishery, and management controls requiring attempt to retrieve lost gear =>Consequence negligible. The types of gear recorded as lost are either small or have a minimal risk of entangling birds =>Confidence high, as observers present on all trips and report all gear lost.
	Anchoring/ mooring	0	0	0							

Direct impact of fishing	Fishing activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
	Navigation/steaming	1	4	5	Population size	Black browed albatross *Thalassarche melanophrys*	1.1	1	2	2	Population size most likely to be affected before other sub-components as albatross numbers are low. =>intensity negligible; Seabirds have flown into vessels or fishing gear by accident however no albatross have been killed. =>consequence minor. Mitigating measures including reduced lighting, bans on net-sonde cables, removal of protruding wires =>Confidence high 100% observer coverage and research conducted in the fishery to date..
Addition/ movement of biological material	Translocation of species	1	6	5	Population size	Black browed albatross *Thalassarche melanophrys*	1.1	1	2	2	Translocation of species via ballast, hull fouling could occur daily. Population size most likely to be affected before major changes in geographic range or genetic structure. =>intensity negligible the likelihood of temperate water species surviving and establishing as a threat to birds in sub-Antarctic waters is considered negligible =>However consequence scored as minor due to the potential for the spread of disease. =>Confidence high 100% coverage and research conducted in the fishery to date.
	On board processing	0	0	0							
	Discarding catch	0	0	0							
	Stock enhancement	0	0	0							
	Provisioning	0	0	0							
	Organic waste disposal	1	4	6	Behaviour/movement	Black browed albatross *Thalassarche melanophrys*	6.1	1	1	2	Vessels do not dispose of any plastic rubbish, or poultry products and comply strictly with MARPOL regulations therefore organic waste discharge could only be accidental. The ban on disposal of bycatch waste/fish meal also viewed as mitigating factor. =>Intensity negligible =>Consequence was also considered negligible =>Confidence in the consequence score was high because general fishing waste disposal was considered unlikely to impact on the population size.

Direct impact of fishing	Fishing activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
Addition of non-biological material	Debris	1	4	3	Population Size	Black browed albatross *Thalassarche melanophrys*	1.1	1	1	2	The limited number of vessels in the fishery coupled with MARPOL regulations restricting the deliberate disposal of debris, the installation of signs/notices in the accommodation to remind/educate the crew as to their legal obligations for disposal of debris are all seen to reduce the intensity for debris disposal.=>intensity negligible =>Provided deliberate disposal of debris does not occur, the consequences of accidental disposal to birds are seen as negligible =>Confidence high 100% observer coverage and compliance with disposal regulations.
	Chemical pollution	1	4	2	Population Size	Black browed albatross *Thalassarche melanophrys*	1.1	2	2	2	Chemical pollution, generally accidental, only occurs rarely e.g. Nella Dan. =>Intensity rated as minor due to the limited number of vessels in the fishery coupled with MARPOL regulations and the installation of signs/notices in the accommodation to remind/educate the crew as to their legal obligations for disposal of chemicals were all viewed as mitigating factors. =>consequences minor except in case of an oil spill due to the breeding populations of some TEP species. =>Confidence is high as regulations limit chemicals being deliberately dumped at sea.
	Exhaust	1	4	6	Behaviour/movement	Black browed albatross *Thalassarche melanophrys*	6.1	1	1	2	Exhaust emissions occur daily during the season (200-300 days). =>Intensity and consequences rated as negligible. The limited number of vessels in the fishery coupled with the local weather conditions makes it highly unlikely that exhaust gas emissions will have an affect on TEP species. Weather conditions in the region are frequently extreme, rapidly dispersing exhaust emissions. =>Confidence high, logic

Direct impact of fishing	Fishing activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
	Gear loss	1	4	3	Behaviour/movement	Black browed albatross *Thalassarche melanophrys*	6.1	1	1	2	Gear loss occurs annually in limited numbers. However, the limited number of vessels in the fishery coupled with the type of gear in use unlikely to alter distribution of seabirds =>Intensity negligible =>Consequence is seen as negligible =>Confidence was recorded as high due to gear loss information from observer records and SARAG reports for the HIMI fishery.
	Navigation/ steaming	1	4	6	Behaviour/movement	Black browed albatross *Thalassarche melanophrys*	6.1	1	1	2	Behaviour/movement most likely to be affected before other sub-components as albatross numbers are critically low. =>Intensity negligible due to the limited number of vessels in the fishery. =>Consequence negligible, as alteration of behaviour of albatross from noise likely to be transient only =>Confidence was recorded as high based on data from the HIMI fishery on seabird interactions.
	Activity/ presence on water	1	4	6	Behaviour/movement	Black browed albatross *Thalassarche melanophrys*	6.1	1	1	2	Behaviour/movement most likely to be affected before other sub-components but likely to be transient. =>Intensity negligible due to the limited number of vessels in the fishery. =>Consequence negligible =>Confidence was recorded as high due to data from the HIMI fishery on seabird interactions.
Disturb physical processes	Bait collection	0	0	0							
	Fishing	1	4	6	Behaviour/movement	Elephant Seal *Mirounga leonina,*	6.1	2	2	1	Elephant seals chosen as species most susceptible to disturbance by demersal trawling =>Intensity minor due to small area affected and low numbers of vessels in fishery. =>Consequence minor as not habitat dependent =>Confidence low, due to lack of data.
	Boat launching	0	0	0							
	Anchoring/ mooring	0	0	0							

Direct impact of fishing	Fishing activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
	Navigation/steaming	1	4	5	Behaviour/movement	Minke whale *Balaenoptera acutorostrata*	6.1	1	1	2	Navigation/steaming occurs daily during season. Minke whales chosen as TEP species most susceptible to disturbance by wake mixing =>Both intensity and consequence rated as negligible, only one vessel involved and changes in whale distribution only temporary =>Confidence high , 100% observer coverage and data on whale interactions suggests impact minimal.
External Impacts (specify the particular example within each activity area)	Other fisheries: HIMI midwater trawl; HIMI Autolongline; IUU fishing	1	6	5	Population size	Black browed albatross *Thalassarche melanophrys*	1.1	4	3	2	Domestic longline fishery for toothfish and midwater fishery for Mackerel icefish occur in region of fishery has recorded few deaths of birds compared to 10 000 birds in adjacent French EEZ. Foreign legal longlining and IUU fishing for toothfish is viewed as continual and widespread =>Intensity major =>Consequence moderate as impact on breeding birds from HIMI could be severe =>Confidence was recorded as high; data from the HIMI fishery indicates continued intensive IUU fishing efforts in and around the HIMI area.
	Aquaculture	0	0	0							
	Coastal development	0	0	0							
	Other extractive activities	0	0	0							
	Other non-extractive activities	0	0	0							
	Other anthropogenic activities	1	4	4	Population size	Black browed albatross *Thalassarche melanophrys*	1.1	1	1	2	Research and tourism and the passage of research/tourist vessels visit the area several times a year. Birds may be impacted =>Intensity negligible due to the limited number of vessels/visits/groups per year. =>Consequence negligible. =>Confidence was recorded as high due to data regarding numbers and activities.

L1.5 - Community Component

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
Capture Direct impact without capture	Bait collection	0	0	0							
	Fishing	1	4	5	Species composition	South Eastern Trough 500-1000m; Outer Heard Plateau 100-500m	1.1	3	3	2	Fishing occurs widely across the Heard Plateau but focussed on southern edges of the plateau. A minimum of 123 nm and a maximum of 240 nm separate the three fishing grounds A, B and C. Fishing occurs between 200-300 days (weather permitting). 2-3 vessels in fishery target specific grounds and species composition of community likely to be affected. =>Intensity moderate at broader spatial scale but may be locally severe. =>Consequence moderate, assuming fishery managed within sustainable levels. =>Confidence high, as fishery is closely monitored and assessed annually, and TACs on bycatch species as well as target species.
	Incidental behaviour	0	0	0							
	Bait collection	0	0	0							

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
	Fishing	1	4	5	Species composition	South Eastern Trough 500-1000m; Outer Heard Plateau 100-500m	1.1	3	2	2	Fish escape through net meshes and species composition most likely to be affected if post-capture survival is low =>intensity moderate =>Consequence minor, tagging surveys of toothfish and skates and rays successful therefore assume good post-capture survival after escapement =>Confidence high, based on data collected by observers and research conducted in the fishery to date.
	Incidental behaviour	0	0	0							
	Gear loss	1	4	3	Species composition	South Eastern Trough 500-1000m; Outer Heard Plateau 100-500m	1.1	1	2	2	Gear loss occurs annually based on observer records. Gear loss has potential to alter species composition by direct interactions with species particularly benthic species =>Intensity rated as negligible due to limited numbers of vessels in fishery, and management controls designed to reduce/monitor interactions with these species. =>Consequence rated as minor. The types of gear recorded as lost are either small or have a minimal risk of entangling rare/endangered species. =>Confidence high, as observers present on all trips and report all gear lost.
	Anchoring/ mooring	0	0	0							

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
	Navigation/ steaming	1	4	5	Species composition	Heard Plateau 0-1000m pelagic	1.1	2	1	2	Navigation/steaming occurs between 200-300 days across the Heard Plateau. Navigation/steaming has potential to alter species composition by direct impact with rare/endangered species including birds. =>Intensity minor due to limited numbers of vessels in fishery, and management controls designed to reduce/monitor interactions with these species. =>Consequence negligible =>Confidence high as the data on population sizes and incidents is well documented.
Addition/ movement of biological material	Translocation of species	1	6	5	Species composition	South Eastern Trough 500-1000m; Outer Heard Plateau 100-500m	1.1	1	2	1	Translocation of species via ballast, hull fouling could occur daily. Species composition most likely to be affected before major changes in geographic range or genetic structure. =>Intensity negligible the likelihood of temperate water species surviving and establishing as a threat to sub-Antarctic communities is considered negligible =>However consequence scored as minor due to the potential for the spread of fish borne disease. =>Confidence low
	On board processing	0	0	0							
	Discarding catch	0	0	0							
	Stock enhancement	0	0	0							
	Provisioning	0	0	0							

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
	Organic waste disposal	1	4	6	Distribution of community	Heard Plateau 0-1000m pelagic	3.1	1	1	2	Vessels do not dispose of any plastic rubbish, or poultry products and comply strictly with MARPOL regulations therefore organic waste discharge could only be accidental =>Intensity negligible. =>Consequence negligible. =>Confidence high, 100% observer coverage and compliance with regulations
Addition of non-biological material	Debris	1	4	3	Distribution of community	South Eastern Trough 500-1000m; Outer Heard Plateau 100-500m	3.1	1	1	2	All vessels comply not only with MARPOL regulations restricting the deliberate disposal of debris but also has installed signs/notices in the accommodation to remind/educate the crew as to their legal obligations for disposal of debris. =>Intensity negligible. =>consequence negligible as even accidental loss unlikely to impact pelagic species. =>Confidence high, 100% observer coverage, as the regulations limit debris being deliberately thrown overboard.

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
	Chemical pollution	1	4	2	Functional group composition	Heard Plateau 0-1000m pelagic	2.1	1	2	2	Chemical (particularly oil) pollution is considered to have a potential frequency of once every few years e.g. Nella Dan => Chemical (particularly oil) pollution has the potential to alter functional group composition by impacting severely on animals that cross the air/water interface, particularly avian and mammalian predators/scavengers. =>Intensity negligible, as while spread over a large area, pollution events are infrequent and discontinuous. Bans on disposal of pollutants are also part of management plans. =>Consequence minor as these events are expected to be rare from these vessels. However the potential impact of a large oil spill would be severe and deserves further investigation. =>Confidence high. No spills have been reported to date and all vessels should be operating under MARPOL regulations including Oil Record books and surveys of oily water separator monitoring equipment.
	Exhaust	1	4	6	Distribution of community	Heard Plateau 0-1000m pelagic	3.1	1	1	2	Exhaust emissions occurs daily during the season. =>intensity and consequence both scored as negligible. Limited vessels in the fishery and birds most likely species to interact but their mobility renders them unlikely to be affected by exhaust gas emissions Weather conditions in the region are frequently extreme, rapidly dispersing exhaust emissions. =>Confidence is high , 100% observer coverage, logic.

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
	Gear loss	1	4	3	Species composition	South Eastern Trough	1.1	1	1	2	Annual gear loss small => Gear loss has potential to alter species composition by direct impact with rare/endangered species. =>Intensity rated as negligible due to limited numbers of vessels in fishery. =>Consequence negligible; The types of gear recorded as lost are either small or have a minimal risk of entangling species or altering habitat of habitat-dependent species =>Confidence was recorded as high due records of amount and type of gear lost.
	Navigation/ steaming	1	4	6	Distribution of community	Heard Plateau 0-1000m pelagic	3.1	1	1	2	Navigation/steaming has the potential to alter community distributions by attracting species to the vessels and alter foraging patterns. =>Intensity negligible, due to small number of vessels involved. =>Consequence negligible, due to the small number of vessels involved. =>Confidence high, due to observer data on interactions with vessels navigating/steaming in the fishery.
	Activity/ presence on water	1	4	6	Distribution of community	Heard Plateau 0-1000m pelagic	3.1	1	1	2	Activity/presence has the potential to alter community distributions by attracting species to the vessel and alter foraging patterns. =>Intensity negligible, due to small number of vessels involved. =>Consequence negligible, due to the small number of vessels involved. =>Confidence high, due to observer data on interactions with vessels steaming in the fishery.
Disturb physical	Bait collection	0	0	0							

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
processes	Fishing	1	4	6	Distribution of community	South Eastern Trough 500-1000m; Outer Heard Plateau 100-500m	3.1	3	2	1	Fishing has the potential to alter distribution of community by disturbing seafloor and benthos and thus affect habitat-dependent species =>Intensity moderate, as grounds are continuously targeted once identified as productive =>Consequence minor as area relatively small and likelihood of detection small =>Confidence low, due to insufficient data. Research into the benthic impacts of the fishery is recognised as a current priority.
	Boat launching	0	0	0							
	Anchoring/ mooring	0	0	0							
	Navigation/steaming	1	4	5	Distribution of community	Heard Plateau 0-1000m pelagic	3.1	1	1	2	Navigation/steaming has the potential to alter community distributions by wake mixing of the pelagic community. =>Intensity negligible, due to small number of vessels involved and known wind mixing depths exceeding wake mixing. =>Consequence negligible, due to the small number of vessels involved. =>Confidence high, due consideration of logical constraints
External Impacts (specify the particular example within each activity area)	Other fisheries e.g. HIMI midwater trawl; HIMI Autolongline; IUU fishing	1	6	5	Species composition	South Eastern Trough 500-1000m; Outer Heard Plateau 100-500m	1.1	4	3	2	Domestic longline fishery for toothfish and midwater fishery for Mackerel icefish occur in region of fishery and might affect population sizes of species. Foreign legal longlining and IUU fishing for toothfish is viewed as continual and widespread but may not affect bycatch species =>Intensity major =>Consequence moderate =>Confidence was recorded as high; data from the HIMI fishery indicates continued intensive IUU fishing efforts in

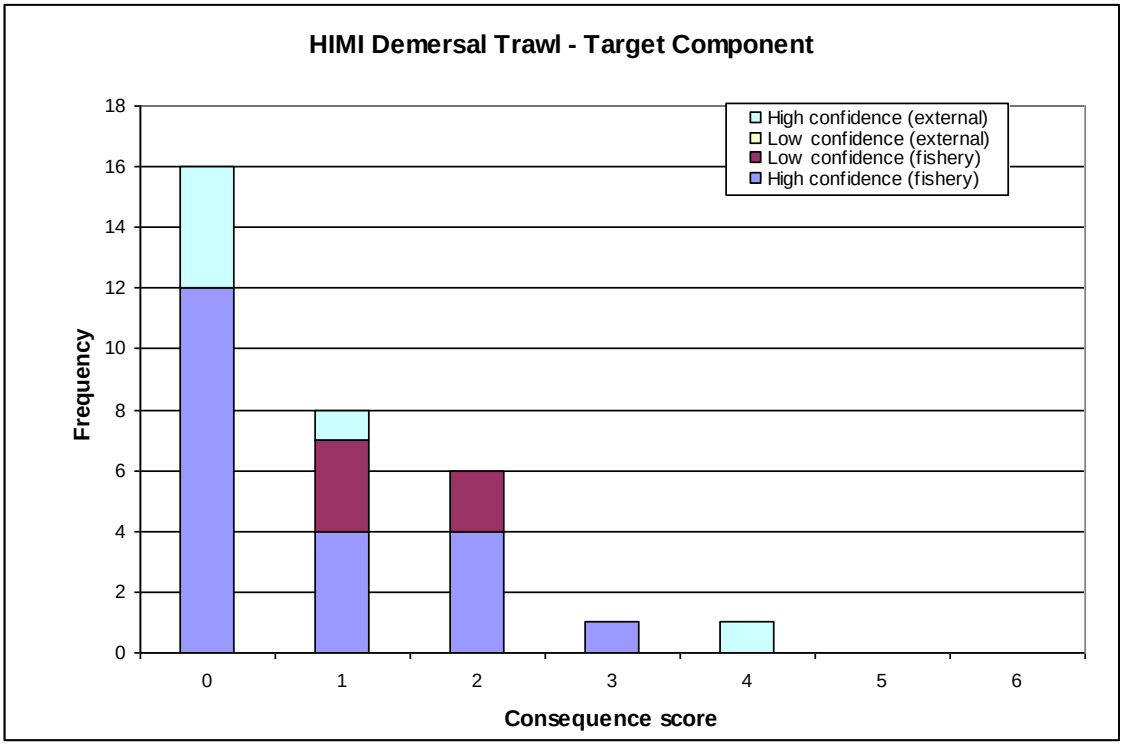
Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
											and around the HIMI area.
	Aquaculture	0	0	0							
	Coastal development	0	0	0							
	Other extractive activities	0	0	0							
	Other non extractive activities	0	0	0							
	Other anthropogenic activities	1	4	4	Distribution of community	South Eastern Trough 500-1000m; Outer Heard Plateau 100-500m	3.1	1	1	2	Research and tourism and the passage of research/tourist vessels visit the area several times a year. =>Intensity negligible due to the limited number of vessels/visits/groups per year. =>Consequence negligible, as only a small area is affected and species mobility and depth locations seen as mitigating factors. =>Confidence was recorded as high due to data regarding numbers and activities.

2.3.11 Summary of SICA results

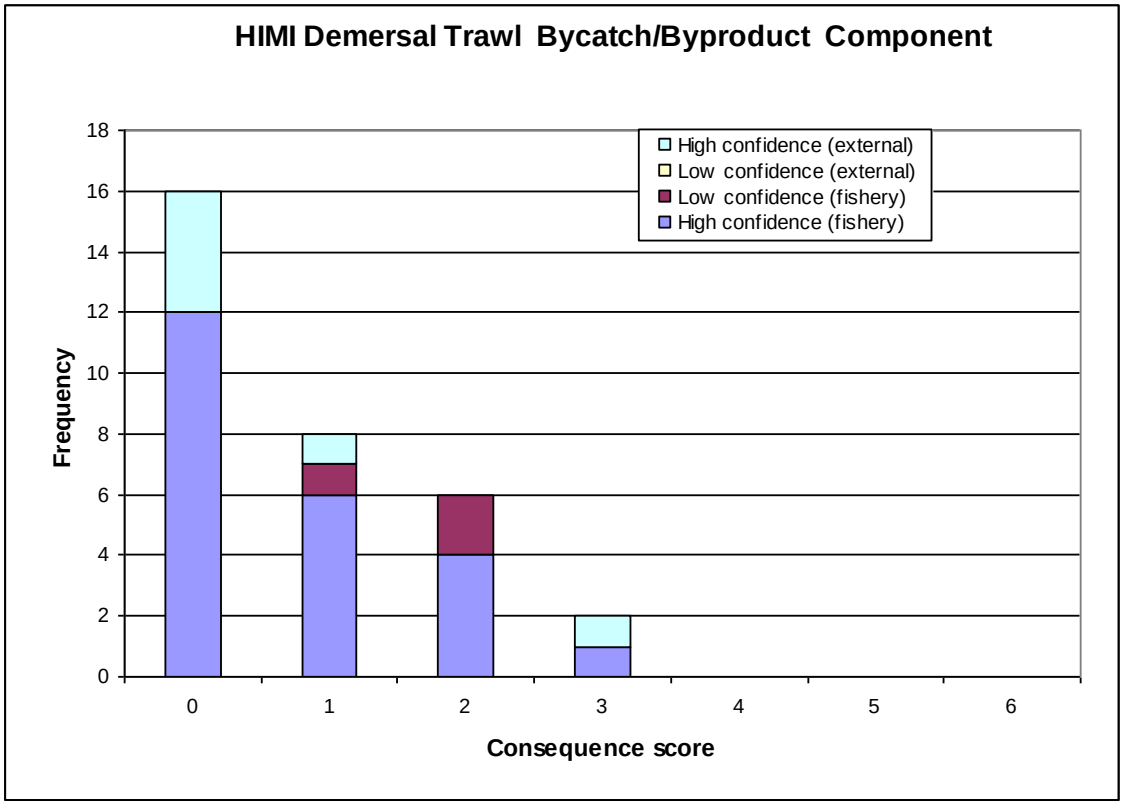
The report provides a summary table (**Level 1 (SICA) Document L1.6**) of consequence scores for all activity/component combinations and a table showing those that scored 3 or above for consequence, and differentiating those that did so with high confidence (in bold).

Level 1 (SICA) Document L1.6. Summary table of consequence scores for all activity/component combinations.

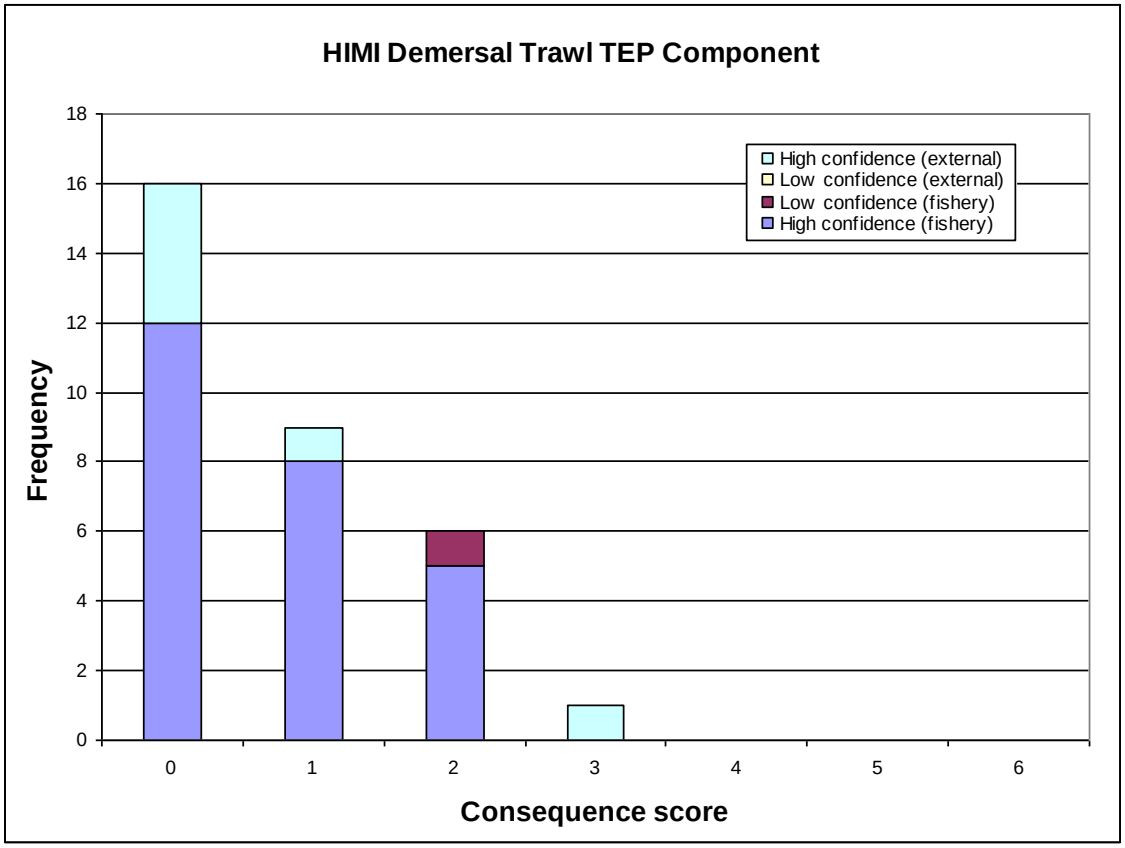
Direct impact of fishing	Fishing Activity	Target	Bycatch Byproduct	TEP	Communities
Capture	Bait collection	0	0	0	0
	Fishing	3	3	2	3
	Incidental behaviour	0	0	0	0
Direct impact without capture	Bait collection	0	0	0	0
	Fishing	2	2	2	2
	Incidental behaviour	0	0	0	0
	Gear loss	2	2	1	2
	Anchoring/ mooring	0	0	0	0
	Navigation/ steaming	1	1	2	1
Addition/ movement of biological material	Translocation of species	2	2	2	2
	On board processing	0	0	0	0
	Discarding catch	0	0	0	0
	Stock enhancement	0	0	0	0
	Provisioning	0	0	0	0
	Organic waste disposal	1	1	1	1
Addition of non-biological material	Debris	1	1	1	1
	Chemical pollution	2	2	2	2
	Exhaust	1	1	1	1
	Gear loss	2	2	1	1
	Navigation/ steaming	1	1	1	1
	Activity/ presence on water	1	1	1	1
Disturb physical processes	Bait collection	0	0	0	0
	Fishing	2	2	2	2
	Boat launching	0	0	0	0
	Anchoring/ mooring	0	0	0	0
	Navigation/steaming	1	1	1	1
External Impacts (specify the particular example within each activity area)	Other fisheries	4	3	3	3
	Aquaculture	0	0	0	0
	Coastal development	0	0	0	0
	Other extractive activities	0	0	0	0
	Other non-extractive activities	0	0	0	0
	Other anthropogenic activities	1	1	2	1



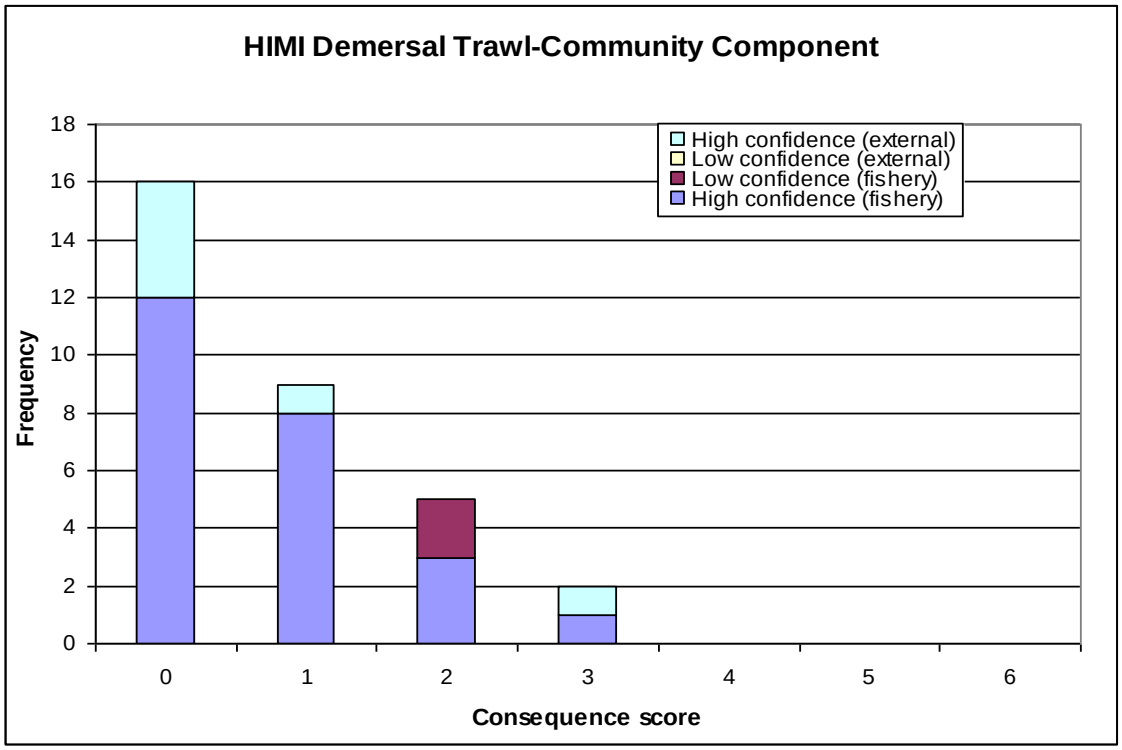
Target species: Frequency of consequence score differentiated between high and low confidence.



Byproduct and bycatch species: Frequency of consequence score differentiated between high and low confidence



TEP species: Frequency of consequence score differentiated between high and low confidence (SICA excel workbook)



Communities: Frequency of consequence score differentiated between high and low confidence (SICA excel workbook)

2.3.12 Evaluation/discussion of Level 1

One ecological component, TEP species, was eliminated at Level 1 (consequence (risk) score ≥3 for at least one activity).

Risk scores were between 1-5 across all 32 hazards (fishing activities) and four ecological components assessed. A number of hazards (fishing activities) were eliminated at Level 1 (risk scores 1 or 2). Those hazards included (risk scores of ≥3) were:

- Fishing (direct impacts on target, bycatch/byproduct and communities)

One risk, external hazard of fishing on target species, was rated as major (= 4). No risks rated as severe (= 5) or intolerable risks were scored (=6).

Risks from fishing was assessed to be moderate for the target species Patagonian toothfish, as targeting larger fish species may remove a significant proportion of the spawning stock. However, since the fishery operates with strict quotas catches are limited to sustainable levels. The confidence of this consequence score was high, since information is available using data collected from observers on board commercial fishing trips and other research activities to date.

The external hazard, "other fisheries in the region", was scored as a major risk (score=4) for target species and as moderate risks for the other ecological components assessed. In particular, IUU long-lining may impact Patagonian toothfish (target species component) skates and rays (bycatch/byproduct species component), wandering and black-browed albatross populations (TEP species component) and the Patagonian toothfish populations in the South-eastern Trough and outer Heard Plateau communities (community component). Also, mackerel icefish obtained from the HIMI mid-water trawl fishery could also impact icefish stocks in the HIMI demersal trawl fishery. All confidence scores were high, since data from HIMI fishery reports all legal fishing activity while IUU fishing in and around the HIMI area is reported to still occur although decreasing due to presence of the domestic fishery.

2.3.13 Components to be examined at Level 2

As a result of the preliminary SICA analysis, the components that are to be examined at Level 2 are those with any consequence scores of 3 or above. These components are:

- target
- bycatch/byproduct and
- communities.

2.4 Level 2 Productivity and Susceptibility Analysis (PSA)

When the risk of an activity at Level 1 (SICA) on a component is moderate or higher and no planned management interventions that would remove this risk are identified, an assessment is required at Level 2. The PSA approach is a method of assessment which allows all units within any of the ecological components to be effectively and comprehensively screened for risk. The units of analysis are the complete set of species habitats or communities identified at the scoping stage. The PSA results in sections 2.4.2 and 2.4.3 of this report measure risk from direct impacts of fishing only, which in all assessments to date has been the hazard with the greatest risks identified at Level 1. Future iterations of the methodology will include PSAs modified to measure the risk due to other activities, such as gear loss.

The PSA approach is based on the assumption that the risk to an ecological component will depend on two characteristics of the component units: (1) the extent of the impact due to the fishing activity, which will be determined by the susceptibility of the unit to the fishing activities (Susceptibility) and (2) the productivity of the unit (Productivity), which will determine the rate at which the unit can recover after potential depletion or damage by the fishing. It is important to note that the PSA analysis essentially measures potential for risk hereafter noted as 'risk'. A measure of absolute risk requires some direct measure of abundance or mortality rate for the unit in question, and this information is generally lacking at Level 2.

The PSA approach examines attributes of each unit that contribute to or reflect its productivity or susceptibility to provide a relative measure of risk to the unit. The following section describes how this approach is applied to the different components in the analysis. Full details of the methods are described in Hobday et al. (2007).

Species

The following Table outlines the seven attributes that are averaged to measure productivity, and the four aspects that are multiplied to measure susceptibility for all the species components.

	Attribute
Productivity	Average age at maturity
	Average size at maturity
	Average maximum age
	Average maximum size
	Fecundity
	Reproductive strategy
	Trophic level
Susceptibility	Availability considers overlap of fishing effort with a species distribution
	Encounterability considers the likelihood that a species will encounter fishing gear that is deployed within the geographic range of that species (based on two attributes: adult habitat and bathymetry)
	Selectivity considers the potential of the gear to capture or retain species
	Post capture mortality considers the condition and subsequent survival of a species that is captured and released (or discarded)

The productivity attributes for each species are based on data from the literature or from data sources such as FishBase. The four aspects of susceptibility are calculated in the following way:

Availability considers overlap of effort with species distribution. For species without distribution maps, availability is scored based on broad geographic distribution (global, southern hemisphere, Australian endemic). Where more detailed distribution maps are available (e.g. from BIOREG data or DEH protected species maps), availability is scored as the overlap between fishing effort and the portion of the species range that lies within the broader geographical spread of the fishery. Overrides can occur where direct data from independent observer programs are available.

Encounterability is the likelihood that a species will encounter fishing gear deployed within its range. Encounterability is scored using habitat information from FishBase, modified by bathymetric information. Higher risk corresponds to the gear being deployed at the core depth range of the species. Overrides are based on mitigation measures and fishery independent observer data.

For species that do encounter gear, **selectivity** is a measure of the likelihood that the species will be caught by the gear. Factors affecting selectivity will be gear and species dependent, but body size in relation to gear size is an important attribute for this aspect. Overrides can be based on body shape, swimming speed and independent observer data.

For species that are caught by the gear, **post capture mortality** measures the survival probability of the species. Obviously, for species that are retained, survival will be zero. Species that are discarded may or may not survive. This aspect is mainly scored using independent filed observations or expert knowledge.

Overall susceptibility scores for species are a product of the four aspects outlined above. This means that susceptibility scores will be substantially reduced if any one of the four aspects is considered to be low risk. However the default assumption in the absence of verifiable supporting data is that all aspects are high risk.

Habitats

Similar to species, PSA methods for habitats are based around a set of attributes that measure productivity and susceptibility. Productivity attributes include speed of regeneration of fauna, and likelihood of natural disturbance. The susceptibility attributes for habitats are described in the following Table.

Aspect	Attribute	Concept	Rationale
Susceptibility			
Availability	General depth range (Biome)	Spatial overlap of subfishery with habitat defined at biomic scale	Habitat occurs within the management area

Aspect	Attribute	Concept	Rationale
Encounterability	Depth zone and feature type	Habitat encountered at the depth and location at which fishing activity occurs	Fishing takes place where habitat occurs
	Ruggedness (fractal dimension of substratum and seabed slope)	Relief, rugosity, hardness and seabed slope influence accessibility to different sub-fisheries	Rugged substratum is less accessible to mobile gears. Steeply sloping seabed is less accessible to mobile gears
	Level of disturbance	Gear footprint and intensity of encounters	Degree of impact is determined by the frequency and intensity of encounters (inc. size, weight and mobility of individual gears)
Selectivity	Removability/ mortality of fauna/ flora	Removal/ mortality of structure forming epifauna/ flora (inc. bioturbating infauna)	Erect, large, rugose, inflexible, delicate epifauna and flora, and large or delicate and shallow burrowing infauna (at depths impacted by mobile gears) are preferentially removed or damaged.
	Areal extent	How much of each habitat is present	Effective degree of impact greater in rarer habitats: rarer habitats may maintain rarer species.
	Removability of substratum	Certain size classes can be removed	Intermediate sized clasts (~6 cm to 3 m) that form attachment sites for sessile fauna can be permanently removed
	Substratum hardness	Composition of substrata	Harder substratum is intrinsically more resistant
	Seabed slope	Mobility of substrata once dislodged; generally higher levels of structural fauna	Gravity or latent energy transfer assists movement of habitat structures, e.g. turbidity flows, larger clasts. Greater density of filter feeding animals found where currents move up and down slopes.
Productivity			
Productivity	Regeneration of fauna	Accumulation/ recovery of fauna	Fauna have different intrinsic growth and reproductive rates which are also variable in different conditions of temperature, nutrients, productivity.
	Natural disturbance	Level of natural disturbance affects intrinsic ability to recover	Frequently disturbed communities adapted to recover from disturbance

Communities

PSA methods for communities are still under development. Consequently, it has not yet been possible to undertake level 2 risk analyses for communities.

During the Level 2 assessment, each unit of analysis within each ecological component (species or habitat) is scored for risk based on attributes for productivity and susceptibility, and the results are plotted as shown in Figure 13.

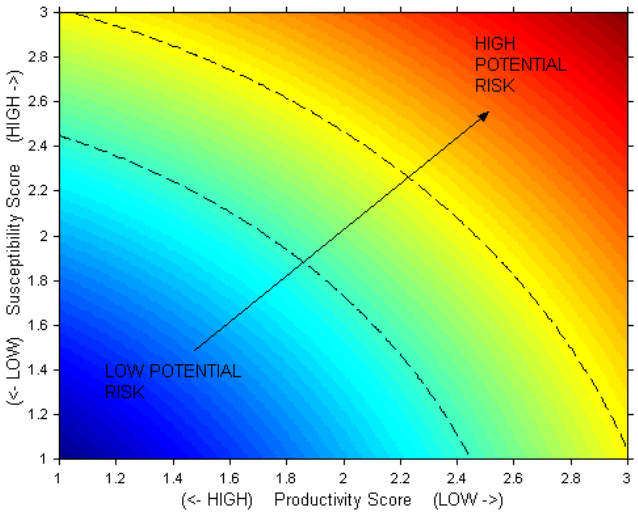


Figure 13. The axes on which risk to the ecological units is plotted. The x-axis includes attributes that influence the productivity of a unit, or its ability to recover after impact from fishing. The y-axis includes attributes that influence the susceptibility of the unit to impacts from fishing. The combination of susceptibility and productivity determines the relative risk to a unit, i.e. units with high susceptibility and low productivity are at highest risk, while units with low susceptibility and high productivity are at lowest risk. The contour lines divide regions of equal risk and group units of similar risk levels.

There are seven steps for the PSA undertaken for each component brought forward from Level 1 analysis.

Step 1	Identify the units excluded from analysis and document the reason for exclusion
Step 2	Score units for productivity
Step 3	Score units for susceptibility
Step 4	Plot individual units of analysis onto a PSA Plot
Step 5	Ranking of overall risk to each unit
Step 6	Evaluation of the PSA analysis
Step 7	Decision rules to move from Level 2 to Level 3

2.4.1 Units excluded from analysis and document the reason for exclusion (Step 1)

Species lists for PSA analysis are derived from recent observer data where possible or, for fisheries with no observer programs, from logbook and scientific data. In some logbook data, there may only be family level identifications. Where possible these are resolved to species level by cross-checking with alternative data sources and discussion with experts. In cases where this is not possible (mainly invertebrates) the analysis may be based on family average data.

Era species id	Taxa name	Scientific name	CAAB code	Family name	Common name	Role	Reason for removal
590	Chondrichthyan	Dalatias licha	37020002	Squalidae	Black shark	BP	Out of range. Potentially confused at data collation stage by the common name black shark which is used for a number of members of the family Squalidae
2770	Not Allocated	Bycatch					Insufficient taxonomic resolution
2774	Not Allocated	Jellyfish				DI	Insufficient taxonomic resolution
2778	Not Allocated	Bivalvia	22300000			DI	Insufficient taxonomic resolution
2786	Not Allocated	Echinodermata	26000000			DI	Insufficient taxonomic resolution
2791	Not Allocated	Otariidae, Phocidae				DI	Insufficient taxonomic resolution
2810	Not Allocated	Chionodraco myersi		Channichthyidae		BP	Shelf only, Antarctic continent only
2865	Not Allocated	Notothenia (Lepidonotothen) kempi		Nototheniidae		BP	Considered as Lepidonotothen squamifrons
2896	Not Allocated	Pseudoicichthys australis		Centrolophidae		BP	Out of range. Only juveniles of this species south of 50S
2913	Not Allocated	Unidentified	99800800	Unidentified			Insufficient taxonomic resolution
2923	Teleost	Himantolophus sp.		Himantolophidae		DI	Insufficient taxonomic resolution
2930	Not Allocated	Pycnogonid		Pycnogonidae		DI	Insufficient taxonomic resolution
2932	Teleost	Centrolophidae		Centrolophidae		BP	Insufficient taxonomic resolution
2943	Not Allocated	Scampi				BP	Insufficient taxonomic resolution
2949	Not Allocated	Ophiuroidea				DI	Insufficient taxonomic resolution
2959	Not Allocated	Durvilleaceae		Durvilleaceae		DI	Insufficient taxonomic resolution
2964	Not Allocated	Nomeidae		Nomeidae		BP	Insufficient taxonomic resolution

Era species id	Taxa name	Scientific name	CAAB code	Family name	Common name	Role	Reason for removal
2966	Not Allocated	Crinoids		Crinoidae		DI	Insufficient taxonomic resolution
2985	Not Allocated	Raja taaf		Rajidae		BP	Synonym of another species of skate
2989	Not Allocated	Nil Commercial Catch		None			Insufficient taxonomic resolution
2992	Not Allocated	Unlisted non-fish species					Insufficient taxonomic resolution
2993	Not Allocated	Unlisted fish species					Insufficient taxonomic resolution
3223	Not Allocated	Unknown (From AAD - HIMI, MIF)		Unknown	Unknown species		Insufficient taxonomic resolution
2782	Not Allocated	Moroteuthis ingens			Synonym for Onykia ingens	BP	Synonym; considered as Onykia ingens
42	Invertebrate	Gonatus antarcticus	23626001	Gonatidae	Gonate squid	DI	From scientific sampling only
2001	Invertebrate	Ommastrephidae - undifferentiated	23636000	Ommastrephidae	Flying squids	DI	Insufficient taxonomic resolution
41	Invertebrate	Onykia robsoni	23623006	Onychoteuthidae	Hooked squid	DI	From scientific sampling only
43	Invertebrate	Phsychroteuthis glacialis	23627001	Psychroteuthidae	Glacial squid	DI	From scientific sampling only
77	Invertebrate	Mesonychoteuthis hamiltoni	23643012	Cranchiidae	Squid	DI	From scientific sampling only
299	Invertebrate	Moroteuthis knipovitchi		Onychoteuthidae	Hooked squid	DI	From scientific sampling only
1282	Invertebrate	Lepidoteuthis grimaldii	23628001	Lepidoteuthidae	Scaled squid	DI	From scientific sampling only
1283	Invertebrate	Histioteuthis eltaninae	23630004	Histioteuthidae	Squid	DI	From scientific sampling only
47	Invertebrate	Galiteuthis glacialis	23643010	Cranchiidae	Squid	DI	From scientific sampling only
1281	Invertebrate	Kondakovia longimana	23623004	Onychoteuthidae	Hooked squid	DI	From scientific sampling only
1997	Not Allocated	Sepiolidae - undifferentiated	23609000	Sepiolidae	Dumpling squids	DI	Insufficient taxonomic resolution
2000	Invertebrate	Brachioteuthidae - undifferentiated	23634000	Brachioteuthidae	Armed squids	DI	Insufficient taxonomic resolution
267	Teleost	Stomias boa	37112002	Stomiidae	Scaly dragonfish	BP	Mis-identification of Stomias gracilis
271	Teleost	Gymnoscopelus piabilis	37122018	Myctophidae	Lanternfish	DI	From scientific sampling only
281	Teleost	Coryphaenoides serrulatus	37232015	Macrouridae	Whiptail	BP	Considered as Coryphaenoides sp.

Era species id	Taxa name	Scientific name	CAAB code	Family name	Common name	Role	Reason for removal
282	Teleost	Beryx splendens	37258002	Berycidae	Alfonsino	DI	Completely out of published distributional range, assumed to be a mis-identification
284	Teleost	Coryphaenoides subserrulatus	37232016	Macrouridae	Whiptail	BP	Considered as Coryphaenoides sp.
581	Teleost	Gobionotothen acuta synonym for original ID Notothenia		Nototheniidae	Triangular notothen	DI	Synonym: considered as Notothenia (Gobionotothen) acuta
582	Teleost	Lepidonotothen mizops synonym for original ID Notothenia		Nototheniidae	Icefish	DI	Synonym: considered as Nototheniops mizops
584	Teleost	Notothenia rossii synonym for original ID Notothenia		Nototheniidae	Marbled rockcod	BP	Synonym: considered as Notothenia (Notothenia) rossii rossii
643	Teleost	Chaenodraco wilsoni	37407790	Channichthyidae	Crocodile icefish	DI	From scientific sampling only
776	Teleost	Tubbia tasmanica	37445002	Centrolophidae	Rudderfish, Tasmanian rudderfish	BP	Out of range (RD), probably mis-id of Icicthys australis
779	Teleost	Neoachiropsetta milfordi	37460052	Achiropsettidae	Armless flounder	DI	Mis-identification of Archiropsetta or Mancopsetta
780	Teleost	Pleuragramma antarcticum	37404790	Nototheniidae	An icefish	DI	From scientific sampling only
781	Teleost	Trematomus eulepidotus	37404791	Nototheniidae	An icefish	DI	From scientific sampling only
800	Teleost	Lycodapus antarcticus		Zoarcidae	An eelpout	DI	From scientific sampling only
1365	Teleost	Scopelosaurus spp.	37125902	Notosudidae	Paperbones	DI	Insufficient taxonomic resolution
1366	Teleost	Ophidiidae	37228901	Ophidiidae	Cusk eel	BP	Insufficient taxonomic resolution
1371	Teleost	Ebinania sp. [Last]	37305003	Psychrolutidae	Blobfish	DI	Insufficient taxonomic resolution
1456	Teleost	Bathydraconidae indet		Bathydraconidae	An Antarctic dragonfish	DI	Insufficient taxonomic resolution
1470	Teleost	Unidentified Nototheniidae sp. A		Nototheniidae	An icefish	DI	Insufficient taxonomic resolution
1471	Teleost	Schedophilus sp.		Centrolophidae	Trevalla	BP	Insufficient taxonomic resolution

Era species id	Taxa name	Scientific name	CAAB code	Family name	Common name	Role	Reason for removal
1478	Teleost	Aethotaxis mitopteryx	37404794	Nototheniidae	[An icefish]	DI	From scientific sampling only
1485	Teleost	Paraliparis antarcticus	37307758	Liparidae	[A snailfish]	DI	From scientific sampling only
1486	Teleost	Dissostichus mawsoni	37404795	Nototheniidae	[An icefish]	BP	Very rare in the region (DW,AAD)
1503	Teleost	Gymnoscopelus braueri	37122751	Myctophidae	[A lanternfish]	BP	Too small for commercial gear, from scientific observational data only
1507	Teleost	Muraenolepis marmoratus	37223750	Muraenolepididae	[An eelcod]	BP	Only recorded once during the history of the fishery and assumed to be a mis-identification
1508	Teleost	Muraenolepis microps	37223751	Muraenolepididae	[An eelcod]	BP	Only recorded once during the history of the fishery and assumed to be a mis-identification
1534	Teleost	Unidentified Nototheniidae sp. C		Nototheniidae	An icefish	DI	Insufficient taxonomic resolution
2279	Teleost	Antennariidae, Tetrabrachiidae, Lophichthyidae	37200000		Anglerfish indet	DI	Insufficient taxonomic resolution
1483	Teleost	Notolepis coatsi	37126750	Paralepididae	[A barracudina]	DI	From scientific sampling only
1484	Teleost	Benthalbella elongata	37131750	Scopelarchidae	[A pearleye]	BP	Only recorded once during the history of the fishery and assumed to be a mis-identification
1487	Teleost	Paranotothenia magellanica	37404752	Nototheniidae	[An icefish]	DI	From scientific sampling only
1506	Teleost	Protomyctophum bolini	37122755	Myctophidae	[A lanternfish]	DI	Too small for commercial gear, from scientific observational data only
1982	Not Allocated	Class Hydrozoa - undifferentiated	11000000	Class Hydrozoa	Hydroids	DI	Insufficient taxonomic resolution
1984	Not Allocated	Order Alcyonacea - undifferentiated	11173000	Order Alcyonacea	Octocorals	DI	Insufficient taxonomic resolution
1985	Not Allocated	Order Pennatulacea -	11208000	Order	Seapens	DI	Insufficient taxonomic resolution

Era species id	Taxa name	Scientific name	CAAB code	Family name	Common name	Role	Reason for removal
		undifferentiated		Pennatulacea			
1986	Invertebrate	Actiniidae - undifferentiated	11232000	Actiniidae	Anemones	DI	Insufficient taxonomic resolution
1988	Invertebrate	Phylum Brachiopoda - undifferentiated	19100000		Brachiopods	DI	Insufficient taxonomic resolution
1989	Not Allocated	Class Polychaeta - undifferentiated	22000000	Class Polychaeta	Polychaete worms	DI	Insufficient taxonomic resolution
1990	Invertebrate	Aphroditidae - undifferentiated	22043000	Aphroditidae	Polychaete worms : sea mice	DI	Insufficient taxonomic resolution
1995	Not Allocated	Nautilidae - undifferentiated	23600000	Nautilidae	Nautiluses	DI	Insufficient taxonomic resolution
1999	Invertebrate	Loliginidae - undifferentiated	23617000	Loliginidae	Squids	DI	Insufficient taxonomic resolution
2002	Invertebrate	Chiroteuthidae - undifferentiated	23638000	Chiroteuthidae	Squids	DI	Insufficient taxonomic resolution
2003	Invertebrate	Order Octopoda - undifferentiated	23650000	Order Octopoda	Octopods	DI	Insufficient taxonomic resolution
2004	Invertebrate	Octopodidae - undifferentiated	23659000	Octopodidae	Octopuses	DI	Insufficient taxonomic resolution
2005	Invertebrate	Class Gastropoda - undifferentiated	24000000		Gastropods	DI	Insufficient taxonomic resolution
2010	Invertebrate	Class Asteroidea - undifferentiated	25102000	Class Asteroidea	Starfish	DI	Insufficient taxonomic resolution
2012	Not Allocated	Gorgonocephalidae - undifferentiated	25171000	Gorgonocephalida e	Basketstars	DI	Insufficient taxonomic resolution
2013	Not Allocated	Class Echinoidea - undifferentiated	25200000	Class Echinoidea	Sea urchins	DI	Insufficient taxonomic resolution
2014	Not Allocated	Holothuriidae - undifferentiated	25416000	Holothuriidae	Sea cucumbers	DI	Insufficient taxonomic resolution
2015	Not Allocated	Subphylum Crustacea - undifferentiated	27000000	Subphylum Crustacea	Crustaceans	DI	Insufficient taxonomic resolution
2017	Invertebrate	Euphausiidae -	28702000	Euphausiidae	Euphausiids	DI	Insufficient taxonomic resolution

Era species id	Taxa name	Scientific name	CAAB code	Family name	Common name	Role	Reason for removal
2018	Invertebrate	undifferentiated Penaeoidea & Caridea - undifferentiated	28710000	Penaeoidea & Caridea	Prawns	DI	Insufficient taxonomic resolution
2023	Invertebrate	Scyllaridae - undifferentiated	28821000	Scyllaridae	Shovel-nosed/slipper lobsters	DI	Insufficient taxonomic resolution
2025	Invertebrate	Lithodidae - undifferentiated	28836000	Lithodidae	King crabs	DI	Insufficient taxonomic resolution
2030	Invertebrate	Pycnogonidae	33000000		Pycnogonids	DI	Insufficient taxonomic resolution
2031	Invertebrate	Ascidiacea - undifferentiated	35000000	Class Ascidiacea	Ascidians	DI	Insufficient taxonomic resolution
2032	Not Allocated	Salpidae - undifferentiated	35103000	Salpidae	Salps	DI	Insufficient taxonomic resolution
2033	Teleost	Class Pisces - undifferentiated	37000000	class Pisces	Fishes	DI	Insufficient taxonomic resolution
2056	Teleost	Nemichthyidae - undifferentiated	37076000	Nemichthyidae	Snipe eels	DI	Insufficient taxonomic resolution
2059	Teleost	Bathylagidae - undifferentiated	37098000	Bathylagidae	Deepsea smelts	DI	Insufficient taxonomic resolution
2060	Teleost	Astronesthidae - undifferentiated	37108000	Astronesthidae	Snaggletooths	DI	Insufficient taxonomic resolution
2063	Teleost	Alepocephalidae - undifferentiated	37114000	Alepocephalidae	Slickheads	DI	Insufficient taxonomic resolution
2064	Teleost	Notosudidae - undifferentiated	37125000	Notosudidae	Waryfishes	DI	Insufficient taxonomic resolution
2065	Teleost	Paralepididae - undifferentiated	37126000	Paralepididae	Barracudinas	DI	Insufficient taxonomic resolution
2090	Teleost	Liparidae - undifferentiated	37307000	Liparidae	Snailfishes	DI	Insufficient taxonomic resolution
2093	Teleost	Apogonidae, Dinolestidae - undifferentiated	37327000	Apogonidae, Dinolestidae	Cardinalfishes & long-finned pikes	DI	Insufficient taxonomic resolution

Era species id	Taxa name	Scientific name	CAAB code	Family name	Common name	Role	Reason for removal
2112	Teleost	Channichthyidae - undifferentiated	37407000	Channichthyidae	Crocodile icefishes	DI	Insufficient taxonomic resolution
2120	Teleost	Centrolophidae - undifferentiated	37445000	Centrolophidae	Trevallas	DI	Insufficient taxonomic resolution
2121	Teleost	Nomeidae - undifferentiated	37446000	Nomeidae	Driftfishes	DI	Insufficient taxonomic resolution
2134	Algae	Phaeophyceae - undifferentiated	54000000	Class Phaeophyceae	Brown algae	DI	Insufficient taxonomic resolution
646	Teleost	Chionodraco hamatus		Channichthyidae	Crocodile icefish	DI	Antarctic continental shelf
1447	Invertebrate	Lithodes sp.		Lithodidae	King crab (undifferentiated)	DI	Insufficient taxonomic resolution
1449	Teleost	Unidentified Nototheniidae sp. B		Nototheniidae	An icefish	DI	Insufficient taxonomic resolution
1463	Teleost	Echiodon sp.		Carapidae	Pearlfishes (undifferentiated)	DI	Insufficient taxonomic resolution
1489	Teleost	Dacodraco hunteri	37407798	Channichthyidae	[A crocodile icefish]	DI	From scientific sampling only
1490	Teleost	Neopagetopsis ionah	37407799	Channichthyidae	[A crocodile icefish]	DI	From scientific sampling only
1491	Teleost	Pagetopsis macropterus	37407750	Channichthyidae	[A crocodile icefish]	DI	From scientific sampling only
1492	Teleost	Pagetopsis maculatus	37407751	Channichthyidae	[A crocodile icefish]	BP	Probably mis-identification
1493	Teleost	Mancopsetta maculata	37460076	Achiropsettidae	[A southern flounder]	BP	Considered as Mancopsetta sp.
1504	Teleost	Gymnoscopelus nicholsi	37122752	Myctophidae	[A lanternfish]	BP	Too small for commercial gear, from scientific observational data only
1505	Teleost	Krefftichthys anderssoni	37122754	Myctophidae	[A lanternfish]	DI	Too small for commercial gear, from scientific observational data only
1481	Chondrichthyan	Bathyraja maccaini	37031751	Rajidae	[A skate]	BP	Misidentification of B. eatonii
1482	Chondrichthyan	Raja georgiana	37031753	Rajidae	[A skate]	BP	Synonym of Bathyraja
1663	Chondrichthyan	Bathyraja sp. (false maccaini)		Rajidae	Skate	BP	Synonym of Bathyraja maccaini
2990	Not Allocated	Marine Pollution				DI	Not biological unit

Era species id	Taxa name	Scientific name	CAAB code	Family name	Common name	Role	Reason for removal
2991	Not Allocated	Rocks				DI	Not biological unit
2772	Algae	Algae				DI	Insufficient taxonomic resolution
2875	Teleost	Paralepididae larva indet	37126800	Paralepididae		BP	Larval fish are not captured by the commercial fishery. From scientific sampling only
2062	Teleost	Stomiidae - undifferentiated	37112000	Stomiidae	Scaly dragonfishes	BP	Insufficient taxonomic resolution
2918	Not Allocated	Elasmobranchii sp.				BP	Insufficient taxonomic resolution
2921	Not Allocated	Osteichthyes sp.				BP	Insufficient taxonomic resolution
2954	Not Allocated	Sunstar				BP	Insufficient taxonomic resolution
2135	Algae	Durvillaeaceae - undifferentiated	54095000	Durvillaeaceae	Brown algae ; Antarctic Bull Kelp	DI	Insufficient taxonomic resolution
2947	Invertebrate	Hydroids				DI	Insufficient taxonomic resolution
1454	Chondrichthyan	Rajiformes Egg		Rajidae	Skate		Insufficient taxonomic resolution
2280	Invertebrate	Invertebrata	910360000				Insufficient taxonomic resolution
1451	Chondrichthyan	Bathyraja spp.		Rajidae	Skate	BP	Insufficient taxonomic resolution
1063	Chondrichthyan	Dipturus sp. A	37031005	Rajidae	Long-nosed skate	TEP	Insufficient taxonomic resolution
1360	Chondrichthyan	Etmopterus sp.	37020097	Squalidae	Lantern shark	BP	Insufficient taxonomic resolution
1453	Chondrichthyan	Rajiformes		Rajidae	Skate	BP	Insufficient taxonomic resolution
2779	Invertebrate	Cephalopoda	22600000			BP	Insufficient taxonomic resolution
2776	Invertebrate	Lithodidae		Lithodidae		DI	Insufficient taxonomic resolution
2783	Invertebrate	Octopodidae	22630000	Octopodidae		BP	Insufficient taxonomic resolution
2788	Invertebrate	Echinoidea	26300000	Echinoidea		BP	Insufficient taxonomic resolution
2777	Invertebrate	Gastropoda	22200000			BP	Insufficient taxonomic resolution
2775	Invertebrate	Crustaceans	20000000			BP	Insufficient taxonomic resolution
2008	Invertebrate	Echinodermata - undifferentiated	25000000		Echinoderms	BP	Insufficient taxonomic resolution
2967	Invertebrate	Gorgonians				BP	Insufficient taxonomic resolution
2942	Invertebrate	Penaeoidea & Caridea - undifferentiated				BP	Insufficient taxonomic resolution

Era species id	Taxa name	Scientific name	CAAB code	Family name	Common name	Role	Reason for removal
3399	Invertebrate	Pycnogonidae - undifferentiated	33017000		Tardigrada, Pentastomida, Pycnogonida plus minor Arthropod groups - minor invertebrate phyla plus scorpions, spiders, sea spiders, horseshoe crabs	BP	Insufficient taxonomic resolution
2281	Invertebrate	Squid Indet	923600000		Squid	BP	Insufficient taxonomic resolution
2963	Invertebrate	Ascidiacea		Ascidiidae		BP	Insufficient taxonomic resolution
2790	Invertebrate	Thaliacea		Thaliacea		BP	Insufficient taxonomic resolution
2781	Invertebrate	Loligo sp.			Squid	BP	Insufficient taxonomic resolution
3398	Invertebrate	Axiidae - undifferentiated	28801000		Polychaete worm ; Slow prawns	BP	Insufficient taxonomic resolution
1991	Invertebrate	Phylum Mollusca - undifferentiated	23000000	Phylum Mollusca	Molluscs	DI	Insufficient taxonomic resolution
2787	Invertebrate	Asteroidea	26200000	Asteroidea	Starfish	BP	Insufficient taxonomic resolution
2922	Teleost	Alepocephalus spp.		Alepocephalidae		BP	Insufficient taxonomic resolution
1455	Teleost	Bathydraco sp.		Bathydraconidae	An Antarctic dragonfish	BP	
2122	Teleost	Bothidae, Achiropsettidae, Paralichthyidae - undifferentiated	37460000	Bothidae, Achiropsettidae, Paralichthyidae	Lefteye flounders	BP	Insufficient taxonomic resolution
2879	Teleost	Paraliparis sp.	37307800	Cyclopteridae	Bp	Undifferentiated taxa bigscales	Insufficient taxonomic resolution
2080	Teleost	Melamphaidae - undifferentiated	37251000	Melamphaidae			BP
1466	Teleost	Macrourus sp.		Macrouridae	Whiptail	BP	Insufficient taxonomic resolution

Era species id	Taxa name	Scientific name	CAAB code	Family name	Common name	Role	Reason for removal
2070	Teleost	Melanonidae, Moridae, Euclichthyidae - undifferentiated	37224000	Melanonidae, Moridae, Euclichthyidae	Pelagic cods, morid cods and eucla cods	BP	Insufficient taxonomic resolution
2061	Teleost	Melanostomiidae - undifferentiated	37109000	Melanostomiidae	Scaleless dragonfishes	BP	Insufficient taxonomic resolution
1459	Teleost	Myctophidae indet		Myctophidae	Lanternfish	BP	Insufficient taxonomic resolution
2862	Teleost	Notosudidae indet	37125800	Notosudidae		BP	Insufficient taxonomic resolution
2111	Teleost	Nototheniidae - undifferentiated	37404000	Nototheniidae	Icefishes	BP	Insufficient taxonomic resolution
2844	Teleost	Lycodapus sp.		Zoarcidae		BP	Insufficient taxonomic resolution
1464	Teleost	Melanostigma sp.		Zoarcidae	An eelpout (undifferentiated)	BP	Insufficient taxonomic resolution
1465	Teleost	Zoarcidae - undifferentiated	37231000	Zoarcidae	An eelpout (undifferentiated)	BP	Insufficient taxonomic resolution
1697	Marine mammal	Otariidae	41131000	Otariidae	Seal	TEP	Insufficient taxonomic resolution
1698	Marine mammal	Phocidae	41136000	Phocidae	Seal	TEP	Insufficient taxonomic resolution
1475	Marine bird	Tringa nebularia		Scolopacidae	Greenshank	TEP	Land bird (wader)
561	Teleost	Hoplostethus atlanticus	37255009	Trachichthyidae	Orange roughy	BP	Only been recorded once in observer data, probably an identification error

2.4.2 and 2.4.3 Level 2 PSA (steps 2 and 3)

Summary of Species PSA results

The results in the Tables below provide details of the PSA assessments for each species, separated by role in the fishery, and by taxa where appropriate. These assessments are limited to direct impacts from fishing, and the operational objective is to avoid over-exploitation due to fishing, either as over-fishing or becoming over-fished. The risk scores and categories (high, medium or low) reflect potential rather than actual risk using the Level 2 (PSA) method. No account is taken of the level of catch, the size of the population, or the likely exploitation rate for species assessed at Level 2. To assess actual risk for any species requires a Level 3 assessment which does account for these factors. However the spatial overlap of the fishery with a species range considers recent effort distributions at Level 2, whereas the entire jurisdictional range of the fishery is considered at Level 1.

The PSA analyses do not fully take account of management actions already in place in the fishery that may mitigate for high risk species. Some management actions or strategies, however, can be accounted for in the analysis where they exist. These include spatial management that limits the range of the fishery (affecting availability), gear limits that affect the size of animals that are captured (selectivity), and handling practices that may affect the survival of species after capture (post capture mortality). Management strategies that are not reflected in the PSA scores include limits to fishing effort, use of catch limits (such as TACs), and some other controls such as seasonal closures.

It should be noted that the PSA method is likely to generate more false positives for high risk (species assessed to be high risk when they are actually low risk) than false negatives (species assessed to be low risk when they are actually high risk). This is due to the precautionary approach to uncertainty adopted in the PSA method, whereby attributes are set at high risk levels in the absence of information. It also arises from the nature of the PSA method assessing potential rather than actual risk, as discussed above. Thus some species will be assessed at high risk because they have low productivity and are exposed to the fishery, even though they are rarely if ever caught and are relatively abundant.

In the PSA Tables below, the “Comments” column is used to provide information on one or more of the following aspects of the analysis for each species: use of overrides to alter susceptibility scores (for example based on use of observer data, or taking account of specific management measures or mitigation); data or information sources or limitations; and information that supports the overall scores. The use of over-rides is explained more fully in Hobday et al (2007).

The PSA Tables also report on “missing information” (the number of attributes with missing data that therefore score at the highest risk level by default). There are seven attributes used to score productivity and four aspects (availability, encounterability, selectivity and post capture mortality) used to score susceptibility (though encounterability is the average of two attributes). An attribute or aspect is scored as

missing if there are no data available to score it, and it has defaulted to high risk for this reason. For some species, attributes may be scored on information from related species or other supplementary information, and even though this information is indirect and less reliable than if species specific information was available, this is not scored as a missing attribute.

Observer data and observer expert knowledge are important sources of information in the PSA analyses, particularly for the bycatch and TEP components. The level of observer data for this fishery is regarded as high. There has been 100% observer coverage since the beginning of the fishery. Observer data are maintained by AAD and a copy held by AFMA (see Scoping Document S1 General Fishery Characteristics).

Level 2 PSA results. A summary of the species considered at Level 2 is presented below, and is sorted by role in the fishery, by taxa, and by the overall risk score (high(>3.18), medium(2.64-3.18), low(<2.64)), together with categorisation of risk (refer to section 2.4.8).

Target species *HIMI Demersal Trawl Fishery*

ERA species ID	Scientific Name	Common Name	Total catch (kg) 2001-05	Missing > 3 attributes (Y/N)	Number of missing productivity attributes (out of 7)	Number of missing susceptibility attributes (out of 5)	Productivity (additive) 1- low , 3 - high	Susceptibility (multiplicative) 1- low , 3 - high	Overall risk score 1.41- low , 4.24 - high	Susceptibility override used?	PSA risk category	High/Med risk category (Refer 2.4.8)	Comments
Teleost													
765	Dissostichus eleginoides	Patagonian toothfish	17,137,209	N	0	0	1.86	3.00	3.53	N	High	Spatial uncertainty	
1390	Champsocephalus gunnari	Mackerel icefish	8,087,411	N	0	0	1.43	2.33	2.74	N	Med	Spatial uncertainty	

Byproduct species *HIMI Demersal Trawl Fishery*

ERA species ID	Scientific Name	Common Name	Total catch (kg) 2001-05	Missing > 3 attributes (Y/N)	Number of missing productivity attributes (out of 7)	Number of missing susceptibility attributes (out of 5)	Productivity (additive) 1- low , 3 - high	Susceptibility (multiplicative) 1- low , 3 - high	Overall risk score 1.41- low , 4.24 - high	Susceptibility override used?	PSA risk category	High/Med risk category (Refer 2.4.8)	Comments
Chondrichthyan													
302	Bathyraja irrasa	skate	8,731	N	0	0	2.43	3.00	3.86	N	High	Spatial uncertainty	
1480	Bathyraja eatonii	skate	81,277	N	0	0	2.43	3.00	3.86	N	High	Spatial uncertainty	
304	Bathyraja murrayi	skate	3,712	N	0	0	2.29	3.00	3.77	N	High	Spatial uncertainty	
826	Etmopterus granulosus	southern lantern shark	104	N	0	0	2.43	2.33	3.37	N	High	Spatial uncertainty	
Invertebrate													
1981	Porifera - undifferentiated	sponges	6,403	Y	7	3	3.00	3.00	4.24	N	High	Missing data	
2773	Actinaria - undifferentiated	coral-soft	8,028	Y	7	3	3.00	3.00	4.24	N	High	Missing data	
3397	Arcoida - undifferentiated	molluscs-Bivalves	not available	Y	7	3	3.00	3.00	4.24	N	High	Missing data	
3396	Cirroteuthidae - undifferentiated	squid	not available	Y	7	3	3.00	3.00	4.24	N	High	Missing data	

ERA species ID	Scientific Name	Common Name	Total catch (kg) 2001-05	Missing > 3 attributes (Y/N)	Number of missing productivity attributes (out of 7)	Number of missing susceptibility attributes (out of 5)	Productivity (additive) 1- low , 3 - high	Susceptibility (multiplicative) 1- low , 3 - high	Overall risk score 1.41- low , 4.24 - high	Susceptibility override used?	PSA risk category	High/Med risk category (Refer 2.4.8)	Comments
2009	Crinoidea - undifferentiated	starfish-crinoids	not available	Y	7	3	3.00	3.00	4.24	N	High	Missing data	
2011	Ophiuroidea - undifferentiated	brittlestars	not available	Y	7	3	3.00	3.00	4.24	N	High	Missing data	
2020	Nephropidae - undifferentiated	scampi-lobsters	not available	Y	7	3	3.00	3.00	4.24	N	High	Missing data	
2956	Bugs	bug	not available	Y	7	3	3.00	3.00	4.24	N	High	Missing data	
2951	Gorgonocephalidae	coral	2,593	Y	7	3	3.00	3.00	4.24	N	High	Missing data	
2948	Pennatulacea	coral-soft	not available	Y	7	3	3.00	3.00	4.24	N	High	Missing data	
2784	Octopus (pelagic)	octopus	25	Y	7	3	3.00	3.00	4.24	N	High	Missing data	
2938	Holothurian	sea cucumber	2,589	Y	7	3	3.00	3.00	4.24	N	High	Missing data	
2962	Aphrodite sp.	worm	not available	Y	7	3	3.00	3.00	4.24	N	High	Missing data	
1321	Bathyteuthis abyssicola	squid	not available	Y	7	2	3.00	2.33	3.80	N	High	Missing data	
1328	Pasiphaea sp.	carid shrimp	not available	Y	7	2	3.00	2.33	3.80	N	High	Missing data	
40	Onykia ingens	squid	not	Y	6	1	2.86	2.33	3.69	N	High	Missing data	

ERA species ID	Scientific Name	Common Name	Total catch (kg) 2001-05	Missing > 3 attributes (Y/N)	Number of missing productivity attributes (out of 7)	Number of missing susceptibility attributes (out of 5)	Productivity (additive) 1- low , 3 - high	Susceptibility (multiplicative) 1- low , 3 - high	Overall risk score 1.41- low , 4.24 - high	Susceptibility override used?	PSA risk category	High/Med risk category (Refer 2.4.8)	Comments
			available										
1284	Martialia hyadesi	squid-flying squid	1	Y	6	2	2.86	2.33	3.69	N	High	Missing data	
46	Todarodes filippovae	squid-Southern Ocean arrow squid	not available	N	2	0	1.86	2.33	2.98	N	Med	Spatial uncertainty	
Teleost													
2805	Bathylagus sp.	0	1	Y	7	3	3.00	3.00	4.24	N	High	Missing data	
2902	Stomias sp.	scaly dragonfishes	not available	Y	7	3	3.00	3.00	4.24	N	High	Missing data	
2069	Himantolophidae - undifferentiated	footballfishes	not available	Y	7	3	3.00	3.00	4.24	N	High	Missing data	
2074	Carapidae - undifferentiated	pearlfishes	not available	Y	7	3	3.00	3.00	4.24	N	High	Missing data	
2933	Astronesthes sp.	0	not available	Y	7	3	3.00	3.00	4.24	N	High	Missing data	
2960	Liparidae - undifferentiated	0	not available	Y	7	3	3.00	3.00	4.24	N	High	Missing data	
2937	Anglerfish Indet	0	1	Y	7	3	3.00	3.00	4.24	N	High	Missing data	
2925	Paralaemonema sp.	0	not available	Y	7	3	3.00	3.00	4.24	N	High	Missing data	

ERA species ID	Scientific Name	Common Name	Total catch (kg) 2001-05	Missing > 3 attributes (Y/N)	Number of missing productivity attributes (out of 7)	Number of missing susceptibility attributes (out of 5)	Productivity (additive) 1- low , 3 - high	Susceptibility (multiplicative) 1- low , 3 - high	Overall risk score 1.41- low , 4.24 - high	Susceptibility override used?	PSA risk category	High/Med risk category (Refer 2.4.8)	Comments
2957	Nasolychnus sp.	0	1	Y	7	3	3.00	3.00	4.24	N	High	Missing data	
2977	Nemichthyidae	0	2	Y	7	3	3.00	3.00	4.24	N	High	Missing data	
2958	Scopelosaurus sp.	0	not available	Y	7	3	3.00	3.00	4.24	N	High	Missing data	
3400	Coryphaenoides sp.	Serrulate whiptail	not available	Y	7	3	3.00	3.00	4.24	N	High	Missing data	
1473	Mancopsetta sp.	Southern flounder	not available	Y	6	1	2.86	3.00	4.14	N	High	Missing data	
1472	Achiropsetta sp. (grey)	Southern flounder	1	Y	4	0	2.43	3.00	3.86	N	High	Missing data	
1457	Melanostomias sp.	scaleless dragonfish	not available	Y	4	0	2.43	3.00	3.86	N	High	Missing data	
273	Anotopterus pharao	daggerfish	not available	N	3	0	2.29	3.00	3.77	N	High	Spatial uncertainty	
1467	Macrouridae	whiptail	184	N	1	1	2.14	3.00	3.69	N	High	Spatial uncertainty	
638	Bathydraco antarcticus	an Antarctic dragonfish	not available	N	2	0	2.00	3.00	3.61	N	High	Spatial uncertainty	
1462	Lepidion sp.	morid cod	not available	N	2	0	1.71	3.00	3.46	N	High	Spatial uncertainty	

ERA species ID	Scientific Name	Common Name	Total catch (kg) 2001-05	Missing > 3 attributes (Y/N)	Number of missing productivity attributes (out of 7)	Number of missing susceptibility attributes (out of 5)	Productivity (additive) 1- low , 3 - high	Susceptibility (multiplicative) 1- low , 3 - high	Overall risk score 1.41- low , 4.24 - high	Susceptibility override used?	PSA risk category	High/Med risk category (Refer 2.4.8)	Comments
1461	Muraenolepis sp.	Moray cod (undifferentiated)	9	N	2	0	1.71	3.00	3.46	N	High	Spatial uncertainty	
770	Channichthys rhinoceratus	Unicorn icefish	77,244	N	0	1	1.43	3.00	3.32	N	High	Spatial uncertainty	
274	Ceratias tentaculatus	seadevil	not available	N	2	0	2.29	2.33	3.27	N	High	Spatial uncertainty	
1509	Notothenia coriiceps	[an icefish]	52	N	0	0	1.29	3.00	3.26	N	High	Spatial uncertainty	
574	Zanclorhynchus spinifer	Spiny horsefish	6	N	3	0	2.14	2.33	3.17	N	Med	Spatial uncertainty	
2845	Macrourus holotrachys	0	5,819	N	1	0	2.14	2.33	3.17	N	Med	Spatial uncertainty	
1479	Macrourus whitsoni	[a whiptail]	3,256	N	0	0	2.00	2.33	3.07	N	Med	Spatial uncertainty	
1013	Neocyttus rhomboidalis	Spiky Oreo	not available	N	0	0	2.00	2.33	3.07	N	Med	Spatial uncertainty	
336	Macrourus carinatus	whiptail ; Bigeye grenadier	5,720	N	0	0	1.86	2.33	2.98	N	Med	Spatial uncertainty	
536	Cynomacrurus piriei	rattail/whiptail/grenadier	358	N	0	0	1.86	2.33	2.98	N	Med	Spatial uncertainty	
277	Lepidion microcephalus	Ribaldo (market name - morid cod) : smallhead cod	4	N	2	0	1.71	2.33	2.90	N	Med	Spatial uncertainty	

ERA species ID	Scientific Name	Common Name	Total catch (kg) 2001-05	Missing > 3 attributes (Y/N)	Number of missing productivity attributes (out of 7)	Number of missing susceptibility attributes (out of 5)	Productivity (additive) 1- low , 3 - high	Susceptibility (multiplicative) 1- low , 3 - high	Overall risk score 1.41- low , 4.24 - high	Susceptibility override used?	PSA risk category	High/Med risk category (Refer 2.4.8)	Comments
2936	Pseudoachiropsetta milfordi	0	3	Y	2	2	1.71	2.33	2.90	N	Med	Missing data	
788	Magnisudis prionosa	barracudina	4	N	1	0	1.71	2.33	2.90	N	Med	Spatial uncertainty	
644	Lampris immaculatus	Southern moonfish	365	N	3	0	2.43	1.44	2.83	N	Med	Low attribute score	
576	Paraliparis gracilis	snailfish/lumpfish	not available	N	1	0	1.57	2.33	2.81	N	Med	Spatial uncertainty	
2867	Notothenia (notothenia) rossii rossii	Marbled rockcod	267	N	0	0	1.57	2.33	2.81	N	Med	Spatial uncertainty	
2868	Nototheniops mizops	icefish	60	N	0	0	1.57	2.33	2.81	N	Med	Spatial uncertainty	
278	Melanonus gracilis	melanonid	not available	N	3	0	2.00	1.89	2.75	N	Med	Spatial uncertainty	
768	Lepidonotothen squamifrons	Grey rockcod ; an icefish	not available	N	0	0	1.43	2.33	2.74	N	Med	Spatial uncertainty	
773	Paradiplospinus gracilis	snake mackerel/gemfish	3	N	0	0	1.43	2.33	2.74	N	Med	Spatial uncertainty	
2863	Notothenia (gobionotothen) acuta	Triangular notothen	593	N	0	0	1.43	2.33	2.74	N	Med	Spatial uncertainty	
372	Alepisaurus brevirostris	Short-nosed Lancet Fish	6	N	3	0	2.14	1.67	2.71	N	Med	Low attribute score	

ERA species ID	Scientific Name	Common Name	Total catch (kg) 2001-05	Missing > 3 attributes (Y/N)	Number of missing productivity attributes (out of 7)	Number of missing susceptibility attributes (out of 5)	Productivity (additive) 1- low , 3 - high	Susceptibility (multiplicative) 1- low , 3 - high	Overall risk score 1.41- low , 4.24 - high	Susceptibility override used?	PSA risk category	High/Med risk category (Refer 2.4.8)	Comments
35	Labichthys yanoi	snipe eel	not available	N	3	0	2.29	1.44	2.70	N	Med	Low attribute score	
36	Notacanthus chemnitzii	spiny eel	1	N	3	0	2.29	1.44	2.70	N	Med	Low attribute score	
557	Stomias gracilis	Scaly dragonfish	not available	N	2	0	1.86	1.89	2.65	N	Med	Spatial uncertainty	
631	Pseudocyttus maculatus	Smooth oreo	not available	N	0	0	1.86	1.67	2.50	N	Low		
37	Bathylagus antarcticus	deep sea smelt	34	N	3	0	2.00	1.44	2.47	N	Low		
280	Melanostigma gelatinosum	eelpout	not available	N	0	0	1.57	1.89	2.46	N	Low		
766	Harpagifer georgianus georgianus	spiny plunderfish	not available	N	3	0	2.14	1.15	2.43	N	Low		
275	Antimora rostrata	morid cod	122	N	1	0	1.71	1.67	2.39	N	Low		
276	Halargyreus johnsonii	Morid cod	8	N	2	0	1.71	1.67	2.39	N	Low		
537	Poromitra crassiceps	bigscale	not available	N	3	0	2.00	1.22	2.34	N	Low		
640	Icichthys australis	Smooth driftfish	not available	N	1	0	1.57	1.44	2.13	N	Low		
1458	Gymnoscopelus sp.	lanternfish	2	N	0	1	1.29	1.67	2.10	N	Low		

ERA species ID	Scientific Name	Common Name	Total catch (kg) 2001-05	Missing > 3 attributes (Y/N)	Number of missing productivity attributes (out of 7)	Number of missing susceptibility attributes (out of 5)	Productivity (additive) 1- low , 3 - high	Susceptibility (multiplicative) 1- low , 3 - high	Overall risk score 1.41- low , 4.24 - high	Susceptibility override used?	PSA risk category	High/Med risk category (Refer 2.4.8)	Comments
270	Electrona carlsbergi	lanternfish	not available	N	0	0	1.29	1.44	1.93	N	Low		
558	Gymnoscopelus bolini	lanternfish	1	N	0	1	1.29	1.44	1.93	N	Low		

Bycatch species *HIMI Demersal Trawl Fishery*

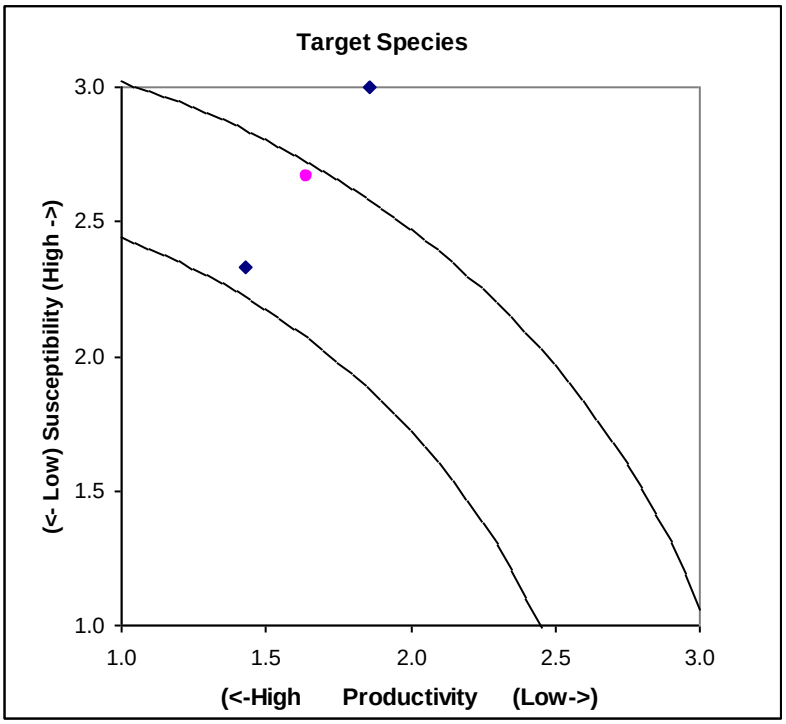
ERA species ID	Scientific Name	Common Name	Total catch (kg) 2001-05	Missing > 3 attributes (Y/N)	Number of missing productivity attributes (out of 7)	Number of missing susceptibility attributes (out of 5)	Productivity (additive) 1- low , 3 - high	Susceptibility (multiplicative) 1- low , 3 - high	Overall risk score 1.41- low , 4.24 - high	Susceptibility override used?	PSA risk category	High/Med risk category (Refer 2.4.8)	Comments
Chondrichthyan													
257	Somniosus antarcticus	Sleeper shark; Southern Sleeper Shark	39,555	N	0	0	2.57	3.00	3.95	Y	High	Spatial uncertainty	Expert override: override applied to availability - increased from 1 to 3 because restricted to Southern Hemisphere (Scott 1976;Yano, Stevens and Compagno 2004).

ERA species ID	Scientific Name	Common Name	Total catch (kg) 2001-05	Missing > 3 attributes (Y/N)	Number of missing productivity attributes (out of 7)	Number of missing susceptibility attributes (out of 5)	Productivity (additive) 1- low , 3 - high	Susceptibility (multiplicative) 1- low , 3 - high	Overall risk score 1.41- low , 4.24 - high	Susceptibility override used?	PSA risk category	High/Med risk category (Refer 2.4.8)	Comments
972	Lamna nasus	Porbeagle shark	6,766	N	0	0	2.71	1.22	2.98	N	Med	Low attribute score	
Invertebrate													
2709	Coral	0	686	Y	7	3	3.00	3.00	4.24	N	High	Missing data	
1445	Medusae	jellyfish	614	Y	7	3	3.00	3.00	4.24	N	High	Missing data	
2789	Salpidae	salp	54	Y	7	3	3.00	3.00	4.24	N	High	Missing data	
80	Lithodes murrayi	crab-Subantarctic king crab	not available	Y	6	1	2.71	3.00	4.05	N	High	Missing data	
1446	Paralomis sp.	crab-King crab (undifferentiated)	not available	Y	7	2	3.00	1.67	3.43	N	High	Missing data	
298	Periphylla periphylla	jellyfish	957	Y	6	2	2.86	1.67	3.31	N	High	Missing data	

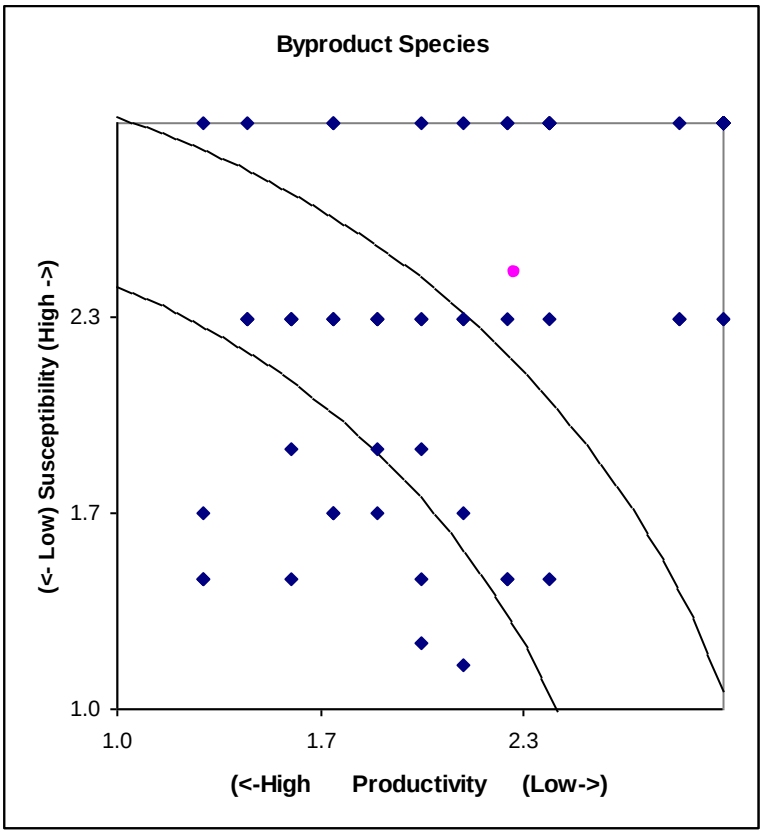
2.4.4 PSA Plot for individual units of analysis (Step 4)

The average productivity and susceptibility scores for each unit of analysis (e.g. for each species) are then used to place the individual units of analysis on 2D plots (as below). The relative position of the units on the plot will determine relative risk at the unit level as per PSA plot below. The overall risk value for a unit is the Euclidean distance from the origin of the graph. Units that fall in the upper third of the PSA plots are deemed to be at high risk. Units with a PSA score in the middle are at medium risk, while units in the lower third are at low risk with regard to the productivity and susceptibility attributes. The divisions between these risk categories are based on dividing the area of the PSA plots into equal thirds. If all productivity and susceptibility scores (scale 1-3) are assumed to be equally likely, then 1/3rd of the Euclidean overall risk values will be greater than 3.18 (high risk), 1/3rd will be between 3.18 and 2.64 (medium risk), and 1/3rd will be lower than 2.64 (low risk).

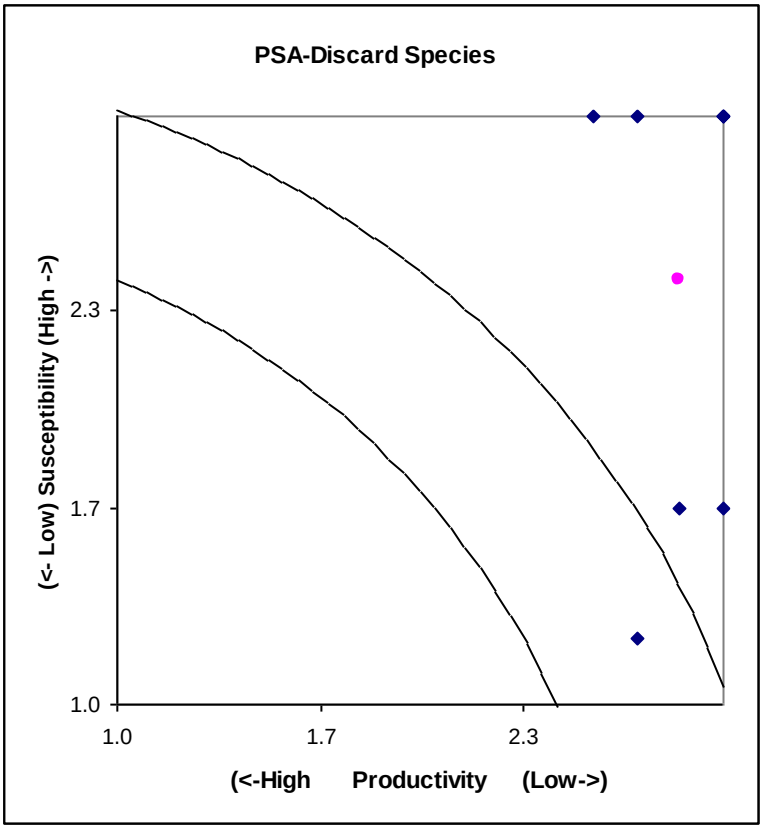
Results of the PSA plot from PSA workbook ranking worksheet



PSA plot for target species



PSA plot for byproduct species



PSA plot for bycatch species

The overall risk value for each unit is the Euclidean distance from the origin to the location of the species on the PSA plot. The units are then divided into three risk categories, high, medium and low, according to the risk values (**Figure 17)**. The cut-offs for each category are thirds of the total distribution of all possible risk values (**Figure 17)**.

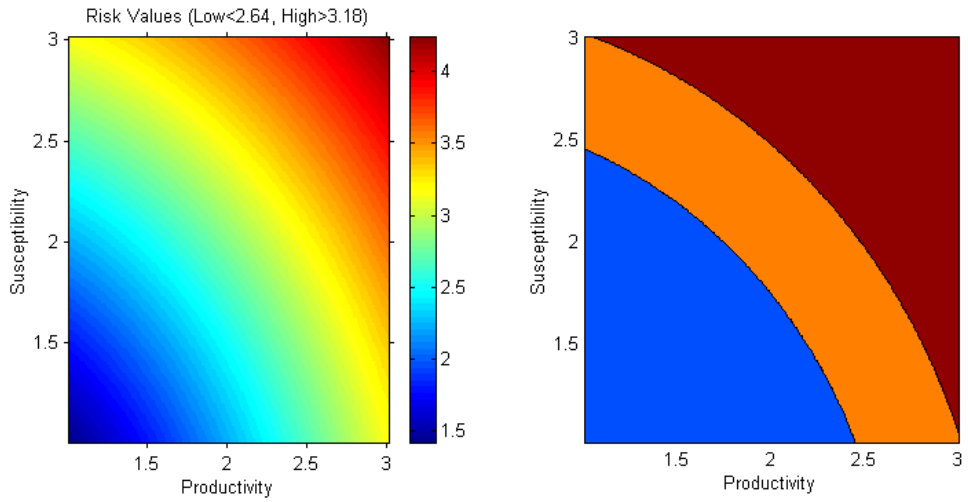


Figure 17. Overall risk values in the PSA plot. Left panel. Colour map of the distribution of the Euclidean overall risk values. Right panel. The PSA plot contoured to show the low risk (blue), medium risk (orange) and high risk (red) value.

The PSA output allows identification and prioritization (via ranking the overall risk scores) of the units (e.g. species, habitat types, communities) at greatest risk to fishing activities. This prioritization means units with the lowest inherent productivity or highest susceptibility, which can only sustain the lowest level of impact, can be examined in detail. The overall risk to an individual unit will depend on the level of impact as well its productivity and susceptibility.

2.4.5 Uncertainty analysis ranking of overall risk (Step 5)

The final PSA result for a species is obtained by ranking overall risk value resulting from scoring the productivity and susceptibility attributes. Uncertainty in the PSA results can arise when there is imprecise, incorrect or missing data, where an average for a higher taxonomic unit was used (e.g. average genera value for species units), or because an inappropriate attribute was included. The number of missing attributes, and hence conservative scores, is tallied for each unit of analysis. Units with missing scores will have a more conservative overall risk value than those species with fewer missing attributes, as the highest score for the attribute is used in the absence of data. Gathering the information to allow the attribute to be scored may reduce the overall risk value. Identification of high-risk units with missing attribute information should translate into prioritisation of additional research (an alternative strategy).

A second measure of uncertainty is due to the selection of the attributes. The influence of particular attributes on the final result for a unit of analysis (e.g. a habitat unit) can be quantified with an uncertainty analysis, using a Monte Carlo resampling technique. A set of productivity and susceptibility scores for each unit is calculated by removing one

of the productivity or susceptibility attributes at a time, until all attribute combinations have been used. The variation (standard deviation) in the productivity and susceptibility scores is a measure of the uncertainty in the overall PSA score. If the uncertainty analysis shows that the unit would be treated differently with regard to risk, it should be the subject of more study.

The validity of the ranking can also be examined by comparing the results with those from other data sources or modelling approaches that have already been undertaken in specific fisheries. For example, the PSA results of the individual species (target, byproduct and bycatch and TEP) can be compared against catch rates for any species or against completed stock assessments. These comparisons will show whether the PSA ranking agrees with these other sources of information or more rigorous approaches.

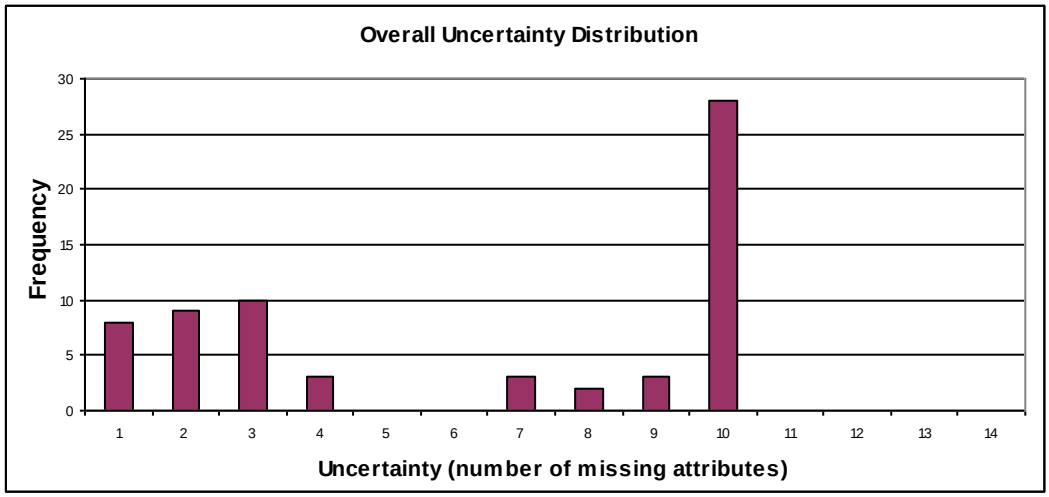
Availability of information

The ability to score each species based on information on each attribute varied between the attributes (as per summary below). With regard to the productivity attributes, maximum age was missing in 64% of species, and so the most conservative score was used, while information on size at maturity could be found or calculated for 59% of species. For the susceptibility attributes, bathymetry was missing in 48% of species, and so the most conservative score was used, while information on size at maturity was missing for 41% of species. The current method of scoring the availability and post-capture mortality susceptibility attributes provides a value for each attribute for each species – some of these are based on good information, whereas others are merely sensible default values.

Summary of the success of obtaining information on the set of productivity and susceptibility attributes for the species. Where information on an attribute was missing the highest score was used in the PSA.

Productivity Attributes	**Average age at maturity**	**Average max age**	**Fecundity**	**Average max size**	**Average size at Maturity**	**Repro-ductive strategy**	**Trophic level (FishBase)**
Total species scores for attribute	37	31	31	50	51	49	51
n species scores with attribute unknown, (conservative score used)	50	56	56	37	36	38	36
% unknown information	57	64	64	43	41	44	41
Susceptibility Attributes	**Availability**	**Encounterability**		**Selectivity**	**PCM**		
		Bathymetry overlap	**Habitat**				
Total species scores for attribute	87	87	87	87	87		
n species scores with attribute unknown, (conservative score used)	0	0	0	0	0		
% unknown information	0	0	0	0	0		

The species considered in the analysis had information for an average of 3.45 (49%) productivity attributes and 3.80 (76%) susceptibility attributes. This meant that, on average, conservative scores were used for less than 42% of the attributes for a single species. Species had missing information for between 0 and 10 of the combined 12 productivity and susceptibility attributes.



Species: Overall uncertainty distribution - frequency of missing information for the combined productivity and susceptibility attributes

Correlation between attributes

Species component:

The attributes selected for productivity were often strongly correlated (as per correlation matrix below for productivity). The strongest productivity attribute correlation was between maximum size and size at maturity. This is why the attributes for productivity are averaged, as they are all in turn correlated with the intrinsic rate of increase (see *ERAEF: Methodology* document for more details). In contrast the susceptibility attributes were less correlated, which is to be expected as they measure independent aspects of this dimension, and are multiplied to obtain the overall susceptibility score. The susceptibility correlation could not be calculated between the post-capture mortality score and any other aspect, because there was no variation in the post-capture mortality score.

Correlation matrix for the species productivity attributes. The correlation (r) is based on the scores within each attribute pair. Results from PSA workbook ranking graphs worksheet.

	Age at maturity	Max age	Fecun-dity	Max size	Min size at maturity	Repro-ductive strategy	Trophic level
Age at maturity	X						
Max age	0.71	X					
Fecundity	0.47	0.34	X				
Max size	0.59	0.44	0.45	X			
Min size at maturity	0.62	0.45	0.54	0.89	X		
Reproductive strategy	0.47	0.33	0.38	0.67	0.66	X	
Trophic level	0.55	0.38	0.48	0.67	0.74	0.59	X

Correlation matrix for the four species susceptibility attributes. The correlation (r) is based on the scores within each attribute pair. Results from PSA workbook ranking graphs worksheet.

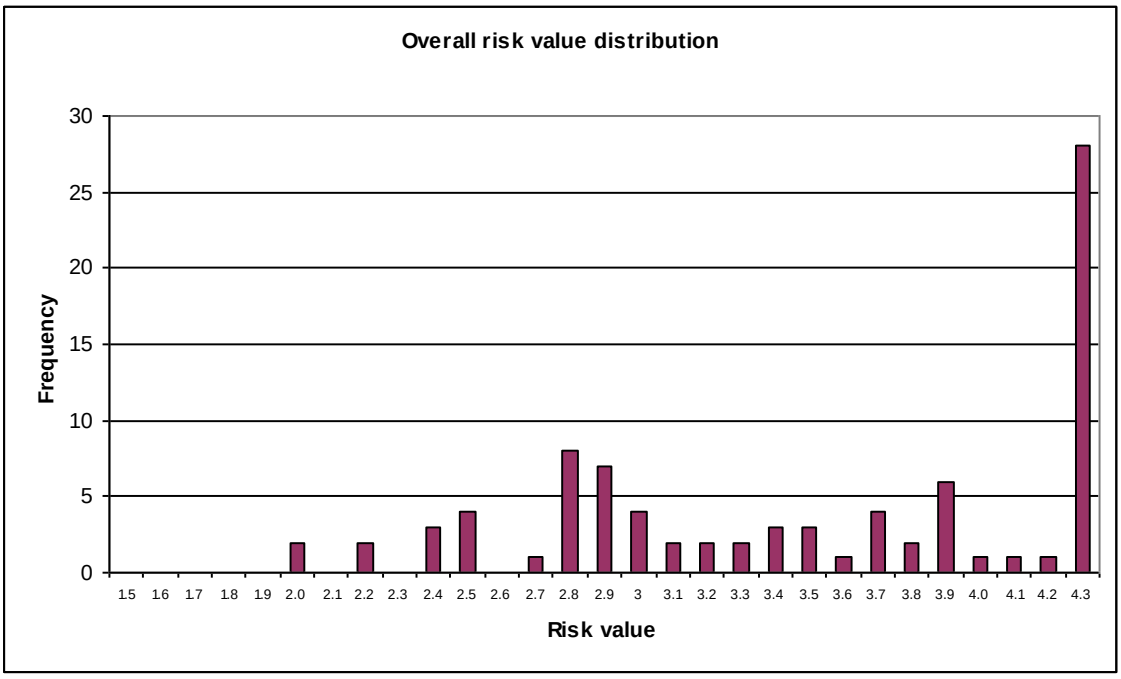
	Availability	Encounterability	Selectivity	Post-capture mortality
Availability	X			
Encounterability	0.29	X		
Selectivity	0.13	0.06	X	
Post-capture mortality	-	-	-	X

Productivity and susceptibility values for species

The average productivity score for all species was 2.35 ± 0.08 (mean ± SD of scores calculated using n-1 attributes) and the mean susceptibility score was 2.49 (as per summary of average productivity and susceptibility scores as below). Individual scores are shown above in *Summary of PSA results*. The small variation in the average of the boot-strapped values (using n-1 attributes), indicates the productivity and susceptibility scores are robust to elimination of a single attribute. Information for a single attribute does not have a disproportionately large effect on the productivity and susceptibility scores. Information was missing for an average of 4 attributes out of 12 possible for each species unit.

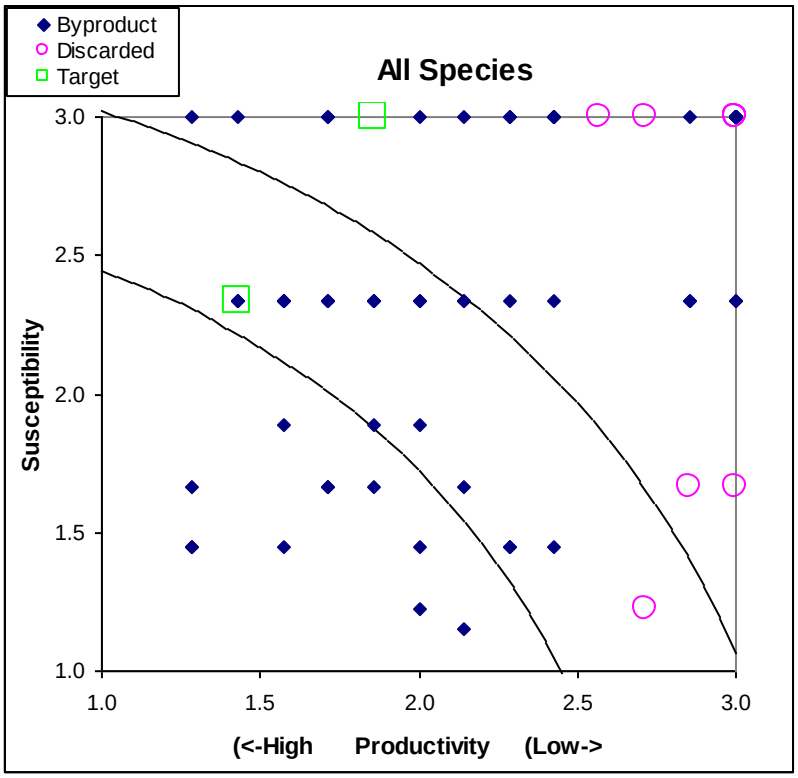
Overall Risk Values for Species

The overall risk values (Euclidean distance on the PSA plot) could fall between 1.41 and 4.24 (scores of 1&1 and 3&3 for both productivity and susceptibility respectively). The mean observed overall risk score was 3.45, with a range of 1.93 – 4.24**.** The actual values for each species are shown in *Summary of PSA results* (above). A total of 52 species (60%) were classed as high risk, 24 (27%) were in the medium risk category, and 11 (13%) were classed as low risk**.**



Frequency distribution of the overall risk values generated for the 87 species in the HIMI demersal trawl fishery PSA.

The distribution of the overall risk values of all species is shown on the PSA plot below. The species are distributed in all parts of the plot, indicating that both high and low risk units are potentially impacted in the HIMI demersal trawl fishery.



PSA plot for all species in the HIMI demersal trawl fishery. Species in the upper right of the plot are at highest risk.

The number of attributes with missing information is of particular interest, because the conservative scoring means these units may be scored at higher risk than if all the information was known. This relationship between the overall risk score and the number of missing attributes shows that an increase in the number of missing attributes (and hence conservative scores used) results in a skew to higher risk values. This suggests that as information becomes available on those attributes, the risk values may decline for some units.

2.4.6 Evaluation of the PSA results (Step 6)

Species Components:

Overall

A total of 261 species were considered. Of these, 174 species, more than half, were eliminated from the species list because they were synonyms or had insufficient taxonomic resolutions. The TEP species component was eliminated at Level 1. A total

of 87 species were subsequently considered at level 2, of which expert over rides were used on one species. Of the 51 species assessed to be at high risk, 37 had more than 3 missing attributes.

The average number of missing attributes was high for byproduct and discard species: 4.65 and 6.75 out of a possible 12 respectively. This largely reflects the remoteness of the Antarctic region, where there have been fewer studies of the bio-geography, taxonomy and biology of demersal fishes and invertebrates, compared to the Australian continental EEZ.

Summary of average productivity, susceptibility and overall risk scores.

Component	Measure	
All species	Number of species	87
	Average of productivity total	1.64
	Average of susceptibility total	2.49
	Average of overall risk value (2D)	3.45
	Average number of missing attributes	4.74
Target species	Number of species	2
	Average of productivity total	1.64
	Average of susceptibility total	2.67
	Average of overall risk value (2D)	3.13
	Average number of missing attributes	0
Byproduct species	Number of species	77
	Average of productivity total	2.32
	Average of susceptibility total	2.49
	Average of overall risk value (2D)	3.43
	Average number of missing attributes	4.65
Bycatch species	Number of species	8
	Average of productivity total	2.86
	Average of susceptibility total	2.44
	Average of overall risk value (2D)	3.81
	Average number of missing attributes	6.75

PSA risk categories for each species component.

Risk Category	High	Medium	Low	Total
Target species	1	1	0	2
Byproduct species	44	21	11	77
Bycatch species	7	1	0	8
Total	52	24	11	87

PSA risk categories for each taxon.

Risk Category	High	Medium	Low	Total
Chondrichthyan	5	1	0	6
Invertebrate	23	1	0	24
Teleost	24	22	11	57
Total	52	24	11	87

Target species
The toothfish was classified as high risk without effective management intervention. The mackerel icefish was medium risk.

Byproduct species
Of the 77 byproduct species, 52 are classified as high risk, 24 as medium risk and 11 as low risk.

The large number of high risk scores was influenced by missing information. The average number of missing attributes was high. However some species need further consideration. These species include skates, whiptails and benthic invertebrates.
Skates are considered among the most threatened marine vertebrates worldwide (Dulvy et al. 2000). Observer data suggests about 94 tonnes of skate have been caught by trawling in the HIMI trawl fishery over the last five years (2000/1-2004/5 inclusive). Tagging studies suggest post capture mortality is high and that migration rates are low.

Skates	**Weight recorded 2001-4 (kg)**
Bathyraja irrasa	8,731
Bathyraja murrayi	3,712
Bathyraja eatonii	81,277
Total	93,720

Several species of whiptails have been caught in significant quantities (almost 10 t) over the last five years but the volume caught is much lower than the HIMI auto-longline fishery. Of the whiptails caught, *M. holotrachys* has been caught in the greatest quantities – 5 t over the last five years. This species is restricted to the Southern Ocean. It is a relatively long-lived species, living to 52 years but matures early (12 years) and has high fecundity (15,000).

Almost 20 t of benthic invertebrates have been reported in observer data over the last five years, with 75 t of rocks.

Invertebrate species	**Weight recorded 2001-4 (kg)**
Sponges	6,403
Soft corals	8,028
Hard corals	2,593
Sea cucumbers	2,589
Total	19,613

Bycatch species
The bycatch includes sleeper sharks, porbeagle sharks and invertebrates. The two shark species are normally released at the surface. Studies of other deepwater dogfishes as well as blue sharks and white sharks suggest about half of these survive. Other species of deepwater dogfish have annual fecundity of less than 1. There are no yield estimates for sleeper sharks.

Observer data indicates some crabs and around 1.5 t of jelly fish were discarded over the last five years. Presumably these discards are not attractive to birds.

Habitat Component:
Habitats are currently under assessment by AAD.

2.4.7 Decision rules to move from Level 2 to Level 3 (Step 7)

For the PSA overall risk values, units that fall in the upper third (risk value > 3.18) and middle third (2.64 < risk value < 3.18) of the PSA plots are deemed to be at high and medium risk respectively. These need to be the focus of further work, either through implementing a management response to address the risk to the vulnerable species or by further examination for risk within the particular ecological component at Level 3. Units at low risk, in the lower third (risk value <2.64), will be deemed not at risk from the sub-fishery and the assessment is concluded for these units.

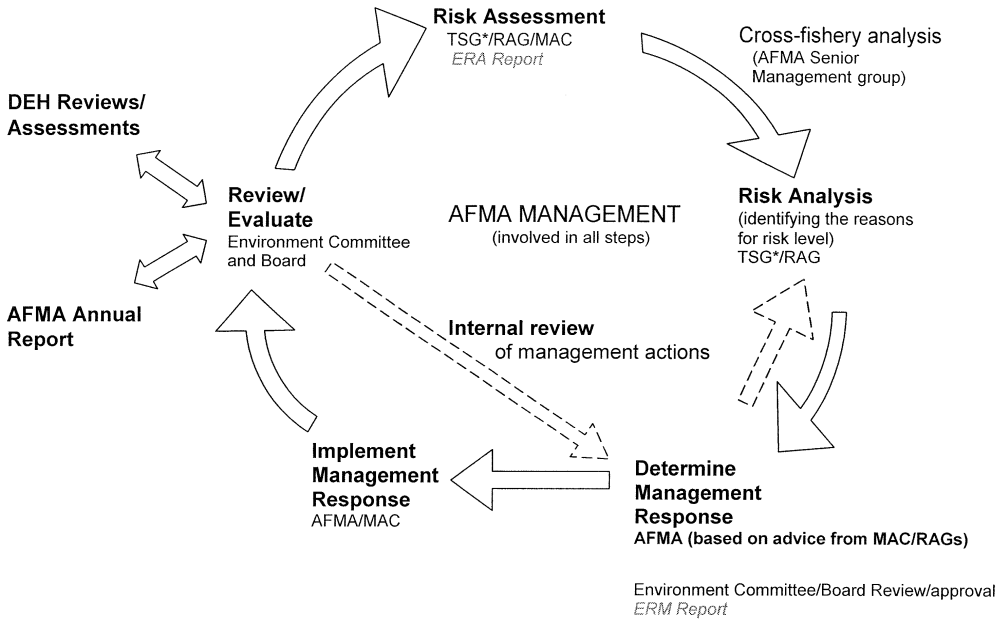
For example, if in a Level 2 analysis of habitat types, two of seven habitat types were determined to have risk from the sub-fishery, only those two habitat types would be considered at Level 3.

The output from the Level 2 analysis will result in four options:

- The risk of fishing on a unit of analysis within a component (e.g. single species or habitat type) is not high, the rationale is documented, and the impact of the fishing activity on this unit need not be assessed at a higher level unless management or the fishery changes.
- The risk of fishing on a unit is high but management strategies are introduced rapidly that will reduce this risk, this unit need not be assessed further unless the management or the fishery changes.
- The risk of fishing on a unit is high but there is additional information that can be used to determine if Level 3, or even a new management action is required. This information should be sought before action is taken
- The risk of fishing on a unit is high and there are no planned management interventions that would remove this risk, therefore the reasons are documented and the assessment moves to Level 3.

At level 2 analysis, a fishery can decide to further investigate the risk of fishing to the species via a level 3 assessment or implement a management response to mitigate the risk. To ensure all fisheries follow a consistent process in responding to the results of the risk assessment, AFMA has developed an ecological risk management framework. The framework (see Figure x below) makes use of the existing AFMA management structures to enable the ERAs to become a part of normal fisheries management, including the involvement of fisheries consultative committees. A separate document, the ERM report, will be developed that outlines the reasons why species are at high risk and what actions the fishery will implement to respond to the risks.

Figure x: Ecological Risk Management Framework



*TSG – Technical Support Group - currently provided by CSIRO.

2.4.8 High/Medium risk categorisation (Step 8)

Following the Level 2 PSA scoring of target, bycatch and byproduct, and TEP species, the high and medium risk species have been divided into five categories that highlight potential reasons for the higher risk scores. These categories should also help identify areas of uncertainty and assist decisions regarding possible management responses for these species. The categories are independent and species are allocated to each category in the order the categories are presented below. Thus, while in principle a species could qualify for both Category 1 and 2, it will only appear in Category 1 because that was scored first. The five categories are programmed into the PSA excel spreadsheets for each fishery according to the following algorithms:

- **Category 1: Missing data** (*>3 missing attributes in either Productivity or Susceptibility estimation)*. Rationale: A total of more than 3 missing attributes (out of 12 possible) could lead to a change in risk score if the information became known. This is because where information is missing for an attribute, that attribute is automatically scored as high risk. The choice of 3 attributes was identified using sensitivity analysis.
- **Category 2**: **Spatial overlap**
    - **2A. Widely distributed** *(More than 80% of the full range of a species is outside the jurisdictional boundary of the fishery)*. Rationale: These species may have refuge outside the fishery.
    - **2B. Low overlap** *(<20% overlap between effort and the species distribution inside the fishery).* Refers to the preferred Availability attribute used to calculate Susceptibility. Rationale: This cutoff (20%) has no strong rationale,

other than being a low percentage overlap. Additional work to determine what threshold might be applicable is required. However, the categories are to be used as a guide for management, and additional effort to decide on cutoffs may be misplaced if the categories are just used as a guide. A similar analysis could be undertaken for the encounterability and selectivity attributes, but there is more information available for availability (overlap) for most species and overlap may be more informative about risk. A subtle change in fishing practice could modify encounterability or selectivity, while to change availability requires a major change in fleet location, which will be easier to detect.

- **Category 3**: **Low (susceptibility) attribute score** (*One of the susceptibility attribute scores = 1).* Rationale: These species may be scored high risk based on productivity risk alone, even if their susceptibility is very low.
- **Category 4**: **Spatial uncertainty** (*No detailed distributional dat*a *available*) Availability was calculated using less reliable mapping data or distributional categories: Global/Southern Hemisphere/Australia, with stock likelihood overrides where necessary. Rationale: the absence of fine scale catch and species distribution data (e.g. TEP species) means that the substitute attribute (precautionary) was used. Spatial data should be sought.
- **Category 5 Other**: *risk score not affected by 1-4 considered above*

Categorisation results - High risk species

Detailed species by species results of the categorisation are presented for medium and high risk species in the Tables in section 2.4.2 of this report. The following is a brief summary of the results for species classified as high risk from the PSA analyses.
In this fishery of the 52 species classified as high risk, 38 had missing information (Category 1) and the remaining 14 had uncertain spatial distribution information.

Note: Table below from PSA spreadsheet.

High risk Category	Description	Total
Category 1	High risk - Missing data for more that 3 attributes	38
Category 2A	High risk - Widely distributed outside fishery	0
Category 2B	High risk - Low overlap inside fishery	0
Category 3	High risk - One susceptibility attribute scored low	0
Category 4	High risk - Spatial uncertainty	14
Other	High risk -other	0
	Total High	52

It is important to stress that this categorization does not imply a down-grading of risk. It is intended as a tool to focus subsequent discussions on risk treatment and identify needs for further data. Sensitivity analysis to the particular cutoffs has not been undertaken in a formal sense, and may not be required, as these categories are intended

as guides to focus further consideration of the high risk species. These categories may also indicate the presence of false positives in the high risk species category, but only further analysis or data can determine this.

2.5 Level 3

Elements of Level 3 assessment have already occurred for the high risk target species. Annual stock assessments are carried out for both target species, as well as ongoing monitoring of bycatch/byproduct species. The results of these assessments confirm the result obtained in the ERAEF approach, this species is at high risk without effective management intervention.

3. General discussion and research implications

The HIMI demersal trawl fishery operates on the Heard Island Plateau. Demersal trawl nets are used to target Patagonian Toothfish in water 450 – 700 m deep.

TEP species were eliminated at the end of level one because there have been very few bird interactions.

Proportionally there were more high risk scores for byproduct/bycatch teleosts and invertebrates in the HIMI demersal trawl fishery than in other trawl fisheries evaluated by ERAEF. These high risk scores largely reflect uncertainty – missing attributes. This uncertainty reflects our limited knowledge of the biogeography and fish fauna of this remote region. However one shark species and a number of skate species are at genuine risk without effective management intervention and these species need further consideration.

Benthic invertebrate species have been captured in significant amounts, indicating assessment of habitats should be a priority.

3.1 Level 1

The main hazards identified at level 1 with consequence scores of moderate or above were capture fishing and external impacts from foreign-legal and IUU fishing.

Capture fishing is likely to have moderate impacts on the target species but these are under comprehensive management plans. Capture fishing is likely to have moderate impacts on the byproduct/discard component, particularly on sharks and rays.

One ecological component was eliminated at Level 1: TEP. It is important to note that the worst case scenario considered for TEP species was the impact of capture fishing on black-browed albatross. This bird species has the smallest population size for any in the region – around 1,200. However, it is almost certain that an annual catch of 1% (12 birds per year) would not prevent this fishery from meeting its main objective for TEP species - ensure TEP species do not further approach extinction or become extinct. The fishery currently has measures in place which would result in closure of the sub-fishery before ten birds were caught in a year. There are some records of birds being caught by trawling in the HIMI sub-fishery, but few of these are by demersal trawling.

Habitats for this fishery were not assessed using most recent ERAEF methodology. Although a significant amount of relevant data is held by the AAD, it was not made available to CSIRO. Instead AAD are currently undertaking more detailed (Level 3) studies of benthic habitats and additional work is proposed for this region by the AAD in the future.

Communities were considered at moderate risk from capture fishing largely as a result of the risk imposed on species components. While effort is low it is unlikely that significant impact on functional groups would occur and consideration of spatial overlap

of the fishery with the community at a higher level assessment could probably reduce the risk.

The hazard presented by translocation of species was assessed as minor but with high uncertainty. The apparent absences present the classical problem for risk assessment – a low probability event combined with a potentially high impact consequence. For this sub-fishery, translocation risks are most likely due to hull and net fouling, and bilge. However, the risk of temperate water species found in the other areas where the vessels operate establishing in the much colder and more extreme environments of the Polar Front would logically seem remote.

External fisheries are considered a major risk to the target species.

3.2 Level 2

The Level 1 analysis suggested target and byproduct/bycatch species components were at high risk from capture fishing. These risks were further analysed at Level 2. The level 2 analyses indicated 51 species were at high risk, 24 at medium risk and 12 at low risk. The high risk species included one target species, the remainder byproduct/bycatch species.

3.2.1 Species at risk

One of the target species Patagonian toothfish was considered at high potential risk without effective management but this species has detailed (Level 3) assessments and is managed on a precautionary basis (see CCAMLR WG-FSA October, 2006).

Overall, of the 52 species rated as high risk from the PSA analyses, the authors consider that 8 non-target species need further evaluation or management response. This expert judgment is based on taxonomy/identification, distribution, stock structure, and movements, and overlap with the longline fishery.

Species	*Risk Category*
• *Bathyraja irrasa*	Spatial uncertainty
• *B. eatonii*	Spatial uncertainty
• *B. murrayi*	Spatial uncertainty
• *Macrourus holotrachys*(medium risk)	Missing data
• *M. whitsoni*(medium risk)	Spatial uncertainty
• *M. carinatus* (medium risk)	Spatial uncertainty
• *Channichthys rhinoceratus*	Spatial uncertainty
• *Somniosus antarcticus*	Spatial uncertainty

A large number of byproduct species were scored high risk but nearly three-quarters of these scores reflect missing information. More detailed review of the productivity attributes in the ERAEF database and the volumes caught in observer data suggested

that skates and sleeper sharks are genuine high risk species. Skates are considered among the most threatened marine vertebrates worldwide (Dulvy et al. 2000). Porbeagle sharks are also captured but this species occur mainly higher in the water column than demersal trawl gear.

The large quantities of *Channichthys rhinoceratus*, *Macrourus holotrachys (*medium risk), *M. whitsoni* and *M. carinatus (*medium risk) caught in the fishery might also be cause for concern requiring further information to clarify some of the missing data particularly finer resolution of spatial information, however, it should be noted that all these species are managed by a TAC.

Observer data indicates about 20 t of benthic invertebrates and have become tangled in the gear and removed over the last five years including sponges, hard and soft corals and sea cucumbers. This suggests that risks to habitats should be examined.

Residual risk

As discussed elsewhere in this report (Section 1), the ERAEF methods are both hierarchically structured and precautionary. The Level 1 (SICA) analyses are used to identify potential hazards associated with fishing and which broad components of the ecological system they apply to. The Level 2 (PSA) analyses consider the direct impacts of fishing on individual species and habitats (rather than whole components), but the large numbers of species that need to be assessed and the nature of the information available for most species in the PSA analyses limits these analyses in several important respects. These include that some existing management measures are not directly accounted for, and that no direct account is taken of the level of mortality associated with fishing. Both these factors are taken into account in the ERAEF framework at Level 3, but the analyses reported here stop at Level 2. This means that the risk levels for species must be regarded as identifying potential rather than actual risk, and due to the precautionary assumptions made in the PSA analyses, there will be a tendency to overestimate absolute levels of risk from fishing.

In moving from ERA to ERM, AFMA will focus scarce resources on the highest priority species and habitats (those likely to be most at risk from fishing). To that end, and because Level 3 analyses are not yet available for most species, AFMA (with input from CSIRO and other stakeholders) has developed guidelines to assess “residual risk” for those species identified as being at high potential risk based on the PSA analyses. The residual risk guidelines will be applied on a species by species basis, and include consideration of existing management measures not currently accounted for in the PSA analyses, as well as additional information about the levels of direct mortality. These guidelines will also provide a transparent process for including more precise or missing information into the PSA analysis as it becomes available.

CSIRO and AFMA will continue to work together to include the broad set of management arrangements in Level 2 analyses, and these methods will be incorporated in future developments of the ERAEF framework. CSIRO has also undertaken some preliminary Level 3 analyses for bycatch species for several fisheries, and these or similar methods will also form part of the overall ERAEF framework into the future.

3.2.2 Habitats at risk

Not examined however invertebrates were included in the species analyses above.

3.2.3 Community assemblages at risk

The community component was not assessed at Level 2 for this sub-fishery, but should be considered in future assessments when the methods to do this are fully developed

3.4. Key Uncertainties / Recommendations for Research and Monitoring

Specific recommendations arising from this assessment include:

- Maintain existing mitigation measures for seabirds and maintain the current high level of observer coverage to ensure compliance
- Examine the impacts of trawling on benthic habitats
- Develop a strategy for skates and sleeper sharks in conjunction with the AAD and the demersal longline sub-fishery in the HIMI area.

References

Ecological Risk Assessment References (specific for each Sub fishery)

AFMA (2002). AFMA Annual Report 2001-2002. (Commonwealth of Australia, Canberra.) 216pp.

AFMA (2003). Bycatch Action Plan – Antarctic Fisheries. (Australian Fisheries Management Authority, Canberra.)

AFMA (2005). New and Exploratory Fisheries in the CCAMLR Region. Assessment Report. (Australian Fisheries Management Authority, Canberra.)

AFMA (2005). Heard Island and McDonald Islands Fishery Conditions on Statutory Fishing Rights (SFRS) for the 2004/5 season.

AAD (2005).Background to the Threat Abatement Plan for the incidental catch (or by-catch) of seabirds during oceanic longline fishing operations.

CCAMLR (2005). Schedule of Conservation Measures in Force 2005/6.

CCAMLR (2006). *Statistical Bulletin*, Vol. **18** (Electronic Version). www.ccamlr.org

Dulvy, N. K., Metcalfe, J. D., Glanville, J., Pawson, M., Reynolds, J. D. (2000). Fishery Stability, Local Extinctions, and Shifts in Community Structure in Skates Conservation Biology 14 (1), 283–293.

Environment Australia (2002). Assessment of the Heard Island and McDonald Islands Fishery for the purposes of Part 10, Part 13 and Part 13A of the *Environment Protection and Biodiversity Conservation Act 1999.* (Environment Australia, Marine and Water Division, April 2002.)

Meyer, L., Constable, A, and Williams, R. (2000) *Conservation of marine habitats in the region of Heard and McDonald Islands*. (Australian Antarctic Division, Hobart.)

Moore, J., Robertson, G. and Wienecke, B. (1998) Food requirements of breeding king penguins at Heard Island and potential overlap with commercial fisheries. *Polar Biology* **20**: 293-302.

Tuck, G.N., de la Mare, W.K., Hearn, W.S., Williams, R., Smith, A.D.M., He, X. and Constable, A. (2003) An exact time of release and recapture stock assessment model with an application to Macquarie Island Patagonian toothfish (*Dissostichus eleginoides*). *Fisheries Research* **1521**: 1-13.

Scott, E. O. G. (1976). Observations on some Tasmanian fishes: Part 22. *Pap. Proc. R. Soc. Tasmania* **110**: 157-217.

van Wijk, E. and Williams, R.(2003). Fish and Invertebrate by-catch from Australian fisheries for *D. eleginoides* and *C. gunnari* in Division 58.5.2. CCAMLR WG-FSA-03/73.

Wienecke, B., Robertson, G., (2002) Seabird and seal – fisheries interaction in the Australian Patagonian toothfish *Dissostichus eleginoides* trawl fishery. *Fisheries Research* **54**: 253-265.

Williams, R., van Wijk, E., Constable, A. and Lamb, T. (2003). The fishery for *Champsocephalus gunnari* and its biology at Heard Island (Division 58.5.2). CCAMLR WG-FSA-03/73.

Williams, R., Tuck, G.N., Constable, A.J. and Lamb, T. (2002) Movement, growth and available abundance to the fishery of *Dissostichus eleginoides* Smitt, 1898 at Heard Island, derived from tagging experiments. *CCAMLR Science* **9**: 33-48.

Yano, K., Stevens, J. D., Compagno, L. J. V. (2004). A review of the systematics of the sleeper shark genus *Somniosus* with redescriptions of *Somniosus* (*Somniosus*) *antarcticus* and *Somniosus* (*Rhinoscymnus*) *longus* (Squaliformes: Somniosidae). *Ichthyological Research* **51**: 360-373.

General Methodology References

Fletcher, W. J. (2005) The application of qualitative risk assessment methodology to prioritize issues for fisheries management. *ICES Journal of Marine Science* **62**:1576-1587.

Fletcher, W. J., Chesson, J., Fisher, M., Sainsbury, K. J., Hundloe, T., Smith, A.D.M. and Whitworth, B. 2002. National ESD reporting framework for Australian Fisheries: The how to guide for wild capture fisheries. FRDC Report 2000/145, Canberra, Australia.

Hobday, A. J., A. Smith and I. Stobutzki (2004). Ecological risk Assessment for Australian Commonwealth Fisheries. Final Report Stage 1. Hazard identification and preliminary risk assessment. Report Number R01/0934. (CSIRO Marine Research, Hobart.)

Stobutzki, I., Miller, M., Brewer, D., 2001. Sustainability of fishery bycatch: a process for assessing highly diverse and numerous bycatch. *Environmental Conservation* **28**, 167-181.

Walker, T. (2004). Elasmobranch fisheries management techniques. Chapter 13. Management measures. *Technical manual for the management of elasmobranchs.* J. A. Musick and R. Bonfil, Asia Pacific Economic Cooperation**:** (in press).

Species Methodology References

Bax, N. J. and Knuckey, I. 1996. Evaluation of selectivity in the South-East fishery to determine its sustainable yield. Final Report to the Fisheries Development Corporation. Project 1996/40.

Daley, R. K., last, P. R., Yearsley, G. K. and Ward, R. D. 1997. South East Fishery Quota Species – an Identification Guide. (CSIRO Division of Marine Research, Hobart.) 91 pp.

Gomon, M. F., Glover, J. C. M. and Kuiter, R. H. (Eds.) 1994. The Fishes of Australia's South Coast. (State Print, Adelaide.) 992 pp.

Last, P., V. Lyne, G. Yearsley, D. Gledhill, M. Gomon, T. Rees and W. White. (2005). Validation of national demersal fish datasets for the regionalisation of the Australian continental slope and outer shelf (>40 m depth). Final Report to the National Oceans Office. (National Oceans Office, Hobart.) 99pp.

Milton, D. A. 2000. Assessing the susceptibility to fishing of rare trawl bycatch: sea snakes caught by Australia's Northern Prawn Fishery. *Biological Conservation.* **101**: 281 – 290.

Walker, T. I., Hudson, R. J. and Gason, A. S. 2005. Catch evaluation of target, byproduct and bycatch species taken by gillnets and longlines in the shark fishery of south-eastern Australia. *Journal of Northwest Atlantic Fisheries Science* **35**: 505 – 530.

Yearsley, G. K., Last, P. R. and Ward, R. D. 1999. Australian Seafood Handbook – Domestic species. (CSIRO Marine Research, Hobart.) 461 pp.

Habitat Methodology References

Althaus F.A. and Barker B. 2005. Lab Guide to Habitat scoring (unpublished).

Bax N., Kloser R., Williams A., Gowlett-Holmes K., Ryan T. 1999. Seafloor habitat definition for spatial management in fisheries: a case study on the continental shelf of southeast Australia. *Oceanologica Acta* **22**: 705-719.

Bax N. and Williams A. 2001. Seabed habitat on the south-eastern Australian continental shelf: context, vulnerability and monitoring. *Marine and Freshwater Research* **52**: 491-512.

Bulman C., Sporcic M., Dambacher J. 2005 (in prep). Ecological Risk Assessment for Communities Methodology Report.

Commonwealth of Australia 2005. National Marine Bioregionalisation of Australia. Summary. (Department of Environment and Heritage, Canberra, Australia.)

Greene H.G., Yoklavich M.M., Starr R.M., O'Connell V.E., Wakefield W.W., Sullivan D.E., McRea J.E. Jr., Cailliet G.M. 1999. A classification scheme for deep seafloor habitats. *Oceanologica Acta* **22**: 663-678.

Heap A.D., Harris P.T., Last P., Lyne V., Hinde A., Woods M. 2005. Draft Benthic Marine Bioregionalisation of Australia's Exclusive Economic Zone. Geoscience Australia Report to the National Oceans Office. (Geoscience Australia, Canberra.)

Harris P., Heap A.D., Passlow V., Sbaffi L., Fellows M., Porter-Smith R., Buchanan C., Daniell J (2003). Geomorphic Features of the Continental Margin of Australia. (Geoscience Australia, Canberra.)

Kloser R., Williams A., Butler A. 2000. Assessment of Acoustic Mapping of Seabed Habitats: Phase 1 Surveys April-June 2000, Progress Report 1. Marine Biological and Resource Surveys South-East Region.

Kostylev V.E., Todd B.J., Fader G.B.J., Courtney R.C., Cameron G.D.M., Pickrill R.A. 2001. Benthic habitat mapping on the Scotian Shelf based on multibeam bathymetry, surficial geology and sea floor photographs. *Marine Ecology Progress Series* **219**: 121-137.

Roff J.C., and Taylor M.E. 2000. National Frameworks for marine conservation – a hierarchical geophysical approach. *Aquatic Conservation: Marine and Freshwater Ecosystems* **10**: 209- 223

Community Methodology References

Condie, S., Ridgway, K., Griffiths, B., Rintoul, S. and Dunn, J. (2003). National Oceanographic Description and Information Review for National Bioregionalisation. Report for National Oceans Office.(CSIRO Marine Research: Hobart, Tasmania, Australia.)

Interim Marine and Coastal Regionalisation for Australia Technical Group (1998). Interim Marine and Coastal Regionalisation for Australia: an ecosystem-based classification for marine and coastal environments. Version 3.3 (Environment Australia, Commonwealth Department of the Environment: Canberra, Australia.)

Last, P., Lyne, V., Yearsley, G., Gledhill, D., Gomon, M., Rees, T., and White, W. (2005). Validation of national demersal fish datasets for the regionalisation of the Australian continental slope and outer shelf (>40m depth). (National Oceans Office, Department of Environment and Heritage and CSIRO Marine Research, Australia.)

Lyne, V. and Hayes, D. (2004). Pelagic Regionalisation. National Marine Bioregionalisation Integration Project. 137 pp. (CSIRO Marine Research and NOO: Hobart, Australia.)

Meyer, L., Constable, A. and Williams, R. (2000). Conservation of marine habitats in the region of Heard Island and McDonald Islands. Final Report to Environment Australia. (Australian Antarctic Division, Kingston, Tasmania.)

Rees, A.J.J., Yearsley, G.K., and Gowlett-Holmes, K. (2005). Codes for Australian Aquatic Biota (on-line version). CSIRO Marine Research, World Wide Web electronic publication, 1999 onwards. Available at: http://www.marine.csiro.au/caab/.

Glossary of Terms

Assemblage	A subset of the species in the community that can be easily recognized and studied. For example, the set of sharks and rays in a community is the Chondrichthyan assemblage.
Attribute	A general term for a set of properties relating to the productivity or susceptibility of a particular unit of analysis.
Bycatch species	A non-target species captured in the fishing gear but not brought on board. In other fisheries, bycatch species include discarded fish species. How ever in Australia's sub-Antarctic fisheries this type of discarding is not permitted (see Byproduct) and bycatch species include only those released alive at the surface, such as skates, and some invertebrates such as coral.
Byproduct species	A non-target species captured in a fishery, and brought on board. In other fisheries this group includes species have value to the fisher and be retained for sale. In Australia's sub-Antarctic fisheries it mainly includes a number of low value species that are converted to fish meal on board which may be sold.
Community	A complete set of interacting species.
Component	A major area of relevance to fisheries with regard to ecological risk assessment (e.g. target species, bycatch and byproduct species, threatened and endangered species, habitats, and communities).
Component model	A conceptual description of the impacts of fishing activities (hazards) on components and sub-components, linked through the processes and resources that determine the level of a component.
Consequence	The effect of an activity on achieving the operational objective for a sub-component.
Core objective	The overall aim of management for a component.
End point	A term used in risk assessment to denote the object of the assessment; equivalent to component or sub-component in ERAEF
Ecosystem	The spatially explicit association of abiotic and biotic elements within which there is a flow of resources, such as nutrients, biomass or energy (Crooks, 2002).
External factor	Factors other than fishing that affect achievement of operational objectives for components and sub-components.
Fishery method	A technique or set of equipment used to harvest fish in a fishery (e.g. long-lining, purse-seining, trawling).
Fishery	A related set of fish harvesting activities regulated by an authority (e.g. South-East Trawl Fishery).

Habitat	The place where fauna or flora complete all or a portion of their life cycle.
Hazard identification	The identification of activities (hazards) that may impact the components of interest.
Indicator	Used to monitor the effect of an activity on a sub-component. An indicator is something that can be measured, such as biomass or abundance.
Likelihood	The chance that a sub-component will be affected by an activity.
Operational objective	A measurable objective for a component or sub-component (typically expressed as "the level of X does not fall outside acceptable bounds")
Precautionary approach	The approach whereby, if there is uncertainty about the outcome of an action, the benefit of the doubt should be given to the biological entity (such as species, habitat or community).
PSA	Productivity-Susceptibility Analysis. Used at Level 2 in the ERAEF methodology.
Scoping	A general step in an ERA or the first step in the ERAEF involving the identification of the fishery history, management, methods, scope and activities.
SICA	Scale, Impact, Consequence Analysis. Used at Level 1 in the ERAEF methodology.
Sub-component	A more detailed aspect of a component. For example, within the target species component, the sub-components include the population size, geographic range, and the age/size/sex structure.
Sub-fishery	A subdivision of the fishery on the basis of the gear or areal extent of the fishery. Ecological risk is assessed separately for each sub-fishery within a fishery.
Sustainability	Ability to be maintained indefinitely
Target species	A species or group of species whose capture is the goal of a fishery, sub-fishery, or fishing operation.
Trophic position	Location of an individual organism or species within a food web.
Unit of analysis	The entities for which attributes are scored in the Level 2 analysis. For example, the units of analysis for the Target Species component are individual "species", while for Habitats, they are "biotypes", and for Communities the units are "assemblages".

Appendix A: General summary of stakeholder feedback

Date	Format received	Comment from stakeholder	Action/explanation
		No comments made	

Appendix B: PSA results summary of stakeholder discussions

Level 2 (PSA) Document L2.1. Summary table of stakeholder discussion regarding PSA results. No species were discussed at Level 2 (PSA) at the Sub Antarctic Fisheries meeting on 27 June 2006 at AFMA, Canberra.

Taxa name	Scientific name	Common name	Role in fishery	PSA risk ranking (H/M/L)	Comments from meeting, and follow-up	Action	Outcome	Possible management response
					e.g. Distribution queried- core depth is mostly shallower than fishery	*Changed depth dsn*	*Reduced risk from high to medium*	
					e.g. extra size information provided by fishers	*Max size added*	*Reduced risk from high to medium*	
					e.g. Confusion re species identification	*none*	*none*	*Improve species identification*
					e.g. more common on outer shelf. Does occur in range of fishery according to literature.	*none*	*none*	*Check depths at which caught in adjacent fishery*

Appendix C: SICA consequence scores for ecological components

Table C1. Target Species. Description of consequences for each component and each sub-component. Use table as a guide for scoring the level of consequence for target species (Modified from Fletcher et al. 2002).

Sub-component	Score/level					
	1 Negligible	**2 Minor**	**3 Moderate**	**4 Major**	**5 Severe**	**6 Intolerable**
Population size	**1. Population size** Insignificant change to population size/growth rate (r). Unlikely to be detectable against background variability for this population.	**1. Population size** Possible detectable change in size/growth rate (r) but minimal impact on population size and none on dynamics.	**1. Population size** Full exploitation rate but long-term recruitment dynamics not adversely damaged.	**1. Population size** Affecting recruitment state of stocks and/or their capacity to increase	**1. Population size** Likely to cause local extinctions if continued in longer term	**1. Population size** Local extinctions are imminent/immediate
Geographic range	**2. Geographic range** No detectable change in geographic range. Unlikely to be detectable against background variability for this population.	**2. Geographic range** Possible detectable change in geographic range but minimal impact on population range and none on dynamics, change in geographic range up to 5 % of original.	**2. Geographic range** Change in geographic range up to 10 % of original.	**2. Geographic range** Change in geographic range up to 25 % of original.	**2. Geographic range** Change in geographic range up to 50 % of original.	**2. Geographic range** Change in geographic range > 50 % of original.
Genetic structure	**3. Genetic structure** No detectable change in genetic structure. Unlikely to be detectable against background variability for this population.	**3. Genetic structure** Possible detectable change in genetic structure. Any change in frequency of genotypes, effective population size or number of spawning units up to	**3. Genetic structure** Change in frequency of genotypes, effective population size or number of spawning units up to 10%.	**3. Genetic structure** Change in frequency of genotypes, effective population size or number of spawning units up to 25%.	**3. Genetic structure** Change in frequency of genotypes, effective population size or number of spawning units, change up to 50%.	**3. Genetic structure** Change in frequency of genotypes, effective population size or number of spawning units > 50%.

Sub-component	Score/level					
	1 Negligible	2 Minor	3 Moderate	4 Major	5 Severe	6 Intolerable
		5%.				
Age/size/sex structure	**4. Age/size/sex structure** No detectable change in age/size/sex structure. Unlikely to be detectable against background variability for this population.	**4. Age/size/sex structure** Possible detectable change in age/size/sex structure but minimal impact on population dynamics.	**4. Age/size/sex structure** Impact on population dynamics at maximum sustainable level, long-term recruitment dynamics not adversely affected.	**4. Age/size/sex structure** Long-term recruitment dynamics adversely affected. Time to recover to original structure up to 5 generations free from impact.	**4. Age/size/sex structure** Long-term recruitment dynamics adversely affected. Time to recover to original structure up to 10 generations free from impact.	**4. Age/size/sex structure** Long-term recruitment dynamics adversely affected. Time to recover to original structure > 100 generations free from impact.
Reproductive capacity	**5. Reproductive capacity** No detectable change in reproductive capacity. Unlikely to be detectable against background variability for this population.	**5. Reproductive capacity** Possible detectable change in reproductive capacity but minimal impact on population dynamics.	**5. Reproductive capacity** Impact on population dynamics at maximum sustainable level, long-term recruitment dynamics not adversely affected.	**5. Reproductive capacity** Change in reproductive capacity adversely affecting long-term recruitment dynamics. Time to recovery up to 5 generations free from impact.	**5. Reproductive capacity** Change in reproductive capacity adversely affecting long-term recruitment dynamics. Time to recovery up to 10 generations free from impact.	**5. Reproductive capacity** Change in reproductive capacity adversely affecting long-term recruitment dynamics. Time to recovery > 100 generations free from impact.
Behaviour/movement	**6. Behaviour/ movement** No detectable change in behaviour/ movement. Unlikely to be detectable against background variability for this population. Time taken to recover to pre-disturbed state on	**6. Behaviour/ movement** Possible detectable change in behaviour/ movement but minimal impact on population dynamics. Time to return to original behaviour/ movement on the scale of days to	**6. Behaviour/ movement** Detectable change in behaviour/ movement with the potential for some impact on population dynamics. Time to return to original behaviour/ movement on the scale of weeks to	**6. Behaviour/ movement** Change in behaviour/ movement with impacts on population dynamics. Time to return to original behaviour/ movement on the scale of months to years.	**6. Behaviour/ movement** Change in behaviour/ movement with impacts on population dynamics. Time to return to original behaviour/ movement on the scale of years to decades.	**6. Behaviour/ movement** Change to behaviour/ movement. Population does not return to original behaviour/ movement.

Sub-component	Score/level					
	1 Negligible	2 Minor	3 Moderate	4 Major	5 Severe	6 Intolerable
	the scale of hours.	weeks.	months.			

Table C2. Bycatch and Byproduct species. Description of consequences for each component and each sub-component. Use table as a guide for scoring the level of consequence for bycatch/byproduct species (Modified from Fletcher et al. 2002).

Sub-component	Score/level					
	1 Negligible	**2 Minor**	**3 Moderate**	**4 Major**	**5 Severe**	**6 Intolerable**
Population size	**1. Population size** Insignificant change to population size/growth rate (r). Unlikely to be detectable against background variability for this population.	**1. Population size** Possible detectable change in size/growth rate (r) but minimal impact on population size and none on dynamics.	**1. Population size** No information is available on the relative area or susceptibility to capture/ impact or on the risk of life history traits of this type of species Susceptibility to capture is suspected to be less than 50% and species do not have vulnerable life history traits. For species with vulnerable life history traits to stay in this category susceptibility to capture must be less than 25%.	**1. Population size** Relative state of capture/susceptibility suspected/known to be greater than 50% and species should be examined explicitly.	**1. Population size** Likely to cause local extinctions if continued in longer term	**1. Population size** Local extinctions are imminent/immediate
Geographic range	**2. Geographic range** No detectable change in geographic range. Unlikely to be detectable against background	**2. Geographic range** Possible detectable change in geographic range but minimal impact on population range and none on dynamics,	**2. Geographic range** Change in geographic range up to 10 % of original.	**2. Geographic range** Change in geographic range up to 25 % of original.	**2. Geographic range** Change in geographic range up to 50 % of original.	**2. Geographic range** Change in geographic range > 50 % of original.

Sub-component	Score/level					
	1 Negligible	2 Minor	3 Moderate	4 Major	5 Severe	6 Intolerable
	variability for this population.	change in geographic range up to 5 % of original.				
Genetic structure	**3. Genetic structure** No detectable change in genetic structure. Unlikely to be detectable against background variability for this population.	**3. Genetic structure** Possible detectable change in genetic structure. Any change in frequency of genotypes, effective population size or number of spawning units up to 5%.	**3. Genetic structure** Detectable change in genetic structure. Change in frequency of genotypes, effective population size or number of spawning units up to 10%.	**3. Genetic structure** Change in frequency of genotypes, effective population size or number of spawning units up to 25%.	**3. Genetic structure** Change in frequency of genotypes, effective population size or number of spawning units up to 50%.	**3. Genetic structure** Change in frequency of genotypes, effective population size or number of spawning units > 50%.
Age/size/sex structure	**4. Age/size/sex structure** No detectable change in age/size/sex structure. Unlikely to be detectable against background variability for this population.	**4. Age/size/sex structure** Possible detectable change in age/size/sex structure but minimal impact on population dynamics.	**4. Age/size/sex structure** Detectable change in age/size/sex structure. Impact on population dynamics at maximum sustainable level, long-term recruitment dynamics not adversely damaged.	**4. Age/size/sex structure** Long-term recruitment dynamics adversely affected. Time to recover to original structure up to 5 generations free from impact.	**4. Age/size/sex structure** Long-term recruitment dynamics adversely affected. Time to recover to original structure up to 10 generations free from impact.	**4. Age/size/sex structure** Long-term recruitment dynamics adversely affected. Time to recover to original structure > 100 generations free from impact.
Reproductive capacity	**5. Reproductive capacity** No detectable change in reproductive capacity. Unlikely to be detectable against background	**5. Reproductive capacity** Possible detectable change in reproductive capacity but minimal impact on population dynamics.	**5. Reproductive capacity** Detectable change in reproductive capacity, impact on population dynamics at maximum	**5. Reproductive capacity** Change in reproductive capacity adversely affecting long-term recruitment dynamics. Time to	**5. Reproductive capacity** Change in reproductive capacity adversely affecting long-term recruitment	**5. Reproductive capacity** Change in reproductive capacity adversely affecting long-term recruitment dynamics. Time to recovery > 100

Sub-component	Score/level					
	1 Negligible	**2 Minor**	**3 Moderate**	**4 Major**	**5 Severe**	**6 Intolerable**
	variability for this population.		sustainable level, long-term recruitment dynamics not adversely damaged.	recovery up to 5 generations free from impact.	dynamics. Time to recovery up to 10 generations free from impact.	generations free from impact.
Behaviour/movement	**6. Behaviour/ movement** No detectable change in behaviour/ movement. Unlikely to be detectable against background variability for this population. Time taken to recover to pre-disturbed state on the scale of hours.	**6. Behaviour/ movement** Possible detectable change in behaviour/ movement but minimal impact on population dynamics. Time to return to original behaviour/ movement on the scale of days to weeks.	**6. Behaviour/ movement** Detectable change in behaviour/ movement with the potential for some impact on population dynamics. Time to return to original behaviour/ movement on the scale of weeks to months.	**6. Behaviour/ movement** Change in behaviour/ movement with impacts on population dynamics. Time to return to original behaviour/ movement on the scale of months to years	**6. Behaviour/ movement** Change in behaviour/ movement with impacts on population dynamics. Time to return to original behaviour/ movement on the scale of years to decades.	**6. Behaviour/ movement** Change to behaviour/ movement. Population does not return to original behaviour/ movement.

Table C3. TEP species. Description of consequences for each component and each sub-component. Use table as a guide for scoring the level of consequence for TEP species (Modified from Fletcher et al. 2002).

Sub-component	Score/level					
	1 Negligible	**2 Minor**	**3 Moderate**	**4 Major**	**5 Severe**	**6 Intolerable**
Population size	**1. Population size** Almost none are killed.	**1. Population size** Insignificant change to population size/growth rate (r). Unlikely to be detectable against background variability for this population.	**1. Population size**. State of reduction on the rate of increase are at the maximum acceptable level. Possible detectable change in size/ growth rate (r) but minimal impact on population size and none on dynamics of TEP species.	**1. Population size** Affecting recruitment state of stocks or their capacity to increase.	**1. Population size** Local extinctions are imminent/immediate	**1. Population size** Global extinctions are imminent/immediate
Geographic range	**2. Geographic range** No interactions leading to impact on geographic range.	**2. Geographic range** No detectable change in geographic range. Unlikely to be detectable against background variability for this population.	**2. Geographic range** Possible detectable change in geographic range but minimal impact on population range and none on dynamics. Change in geographic range up to 5 % of original.	**2. Geographic range** Change in geographic range up to 10% of original.	**2. Geographic range** Change in geographic range up to 25% of original.	**2. Geographic range** Change in geographic range up to 25% of original.
Genetic structure	**3. Genetic structure** No interactions leading to impact on genetic structure.	**3. Genetic structure** No detectable change in genetic structure. Unlikely to be detectable against background variability for this population.	**3. Genetic structure** Possible detectable change in genetic structure but minimal impact at population level. Any change in frequency of genotypes, effective	**3. Genetic structure** Moderate change in genetic structure. Change in frequency of genotypes, effective population size or number of spawning units up to	**3. Genetic structure** Change in frequency of genotypes, effective population size or number of spawning units up to 25%.	**3. Genetic structure** Change in frequency of genotypes, effective population size or number of spawning units up to 25%.

Sub-component	Score/level					
	1 Negligible	**2 Minor**	**3 Moderate**	**4 Major**	**5 Severe**	**6 Intolerable**
			population size or number of spawning units up to 5%.	10%.		
Age/size/sex structure	**4. Age/size/sex structure** No interactions leading to change in age/size/sex structure.	**4. Age/size/sex structure** No detectable change in age/size/sex structure. Unlikely to be detectable against background variability for this population.	**4. Age/size/sex structure** Possible detectable change in age/size/sex structure but minimal impact on population dynamics.	**4. Age/size/sex structure** Detectable change in age/size/sex structure. Impact on population dynamics at maximum sustainable level, long-term recruitment dynamics not adversely damaged.	**4. Age/size/sex structure** Severe change in age/size/sex structure. Impact adversely affecting population dynamics. Time to recover to original structure up to 5 generations free from impact	**4. Age/size/sex structure** Impact adversely affecting population dynamics. Time to recover to original structure > 10 generations free from impact
Reproductive capacity	**5. Reproductive capacity** No interactions resulting in change to reproductive capacity.	**5. Reproductive capacity** No detectable change in reproductive capacity. Unlikely to be detectable against background variability for this population.	**5. Reproductive capacity** Possible detectable change in reproductive capacity but minimal impact on population dynamics.	**5. Reproductive capacity** Detectable change in reproductive capacity, impact on population dynamics at maximum sustainable level, long-term recruitment dynamics not adversely damaged.	**5. Reproductive capacity** Change in reproductive capacity, impact adversely affecting recruitment dynamics. Time to recover to original structure up to 5 generations free from impact	**5. Reproductive capacity** Change in reproductive capacity, impact adversely affecting recruitment dynamics. Time to recover to original structure > 10 generations free from impact
Behaviour/movement	**6. Behaviour/ movement** No interactions resulting in change to behaviour/	**6. Behaviour/ movement** No detectable change in behaviour/ movement. Time to	**6. Behaviour/ movement** Possible detectable change in behaviour/ movement but	**6. Behaviour/ movement** Detectable change in behaviour/ movement with the	**6. Behaviour/ movement** Change in behaviour/ movement, impact adversely affecting	**6. Behaviour/ movement** Change in behaviour/ movement. Impact adversely affecting

Sub-component	Score/level					
	1 Negligible	**2 Minor**	**3 Moderate**	**4 Major**	**5 Severe**	**6 Intolerable**
	movement.	return to original behaviour/ movement on the scale of hours.	minimal impact on population dynamics. Time to return to original behaviour/ movement on the scale of days to weeks	potential for some impact on population dynamics. Time to return to original behaviour/ movement on the scale of weeks to months	population dynamics. Time to return to original behaviour/ movement on the scale of months to years.	population dynamics. Time to return to original behaviour/ movement on the scale of years to decades.
Interaction with fishery	**7. Interactions with fishery** No interactions with fishery.	**7. Interactions with fishery** Few interactions and involving up to 5% of population.	**7. Interactions with fishery** Moderate level of interactions with fishery involving up to10 % of population.	**7. Interactions with fishery** Major interactions with fishery, interactions and involving up to 25% of population.	**7. Interactions with fishery** Frequent interactions involving ~ 50% of population.	**7. Interactions with fishery** Frequent interactions involving the entire known population negatively affecting the viability of the population.

Table C4. Habitats. Description of consequences for each component and each sub-component. Use table as a guide for scoring the level of consequence for habitats. Note that for sub-components Habitat types and Habitat structure and function, time to recover from impact scales differ from substrate, water and air. Rationale: structural elements operate on greater timeframes to return to pre-disturbance states (Modified from Fletcher et al. 2002).

Sub-component	Score/level					
	1 Negligible	**2 Minor**	**3 Moderate**	**4 Major**	**5 Severe**	**6 Intolerable**
Substrate quality	**1. Substrate quality** Reduction in the productivity (similar to the intrinsic rate of increase for species) on the substrate from the activity is unlikely to be detectable. Time taken to recover to pre-disturbed state on the scale of hours.	**1. Substrate quality** Detectable impact on substrate quality. At small spatial scale time taken to recover to pre-disturbed state on the scale of days to weeks, at larger spatial scales recovery time of hours to days.	**1. Substrate quality** More widespread effects on the dynamics of substrate quality but the state are still considered acceptable given the percent area affected, the types of impact occurring and the recovery capacity of the substrate. For impacts on non-fragile substrates this may be for up to 50% of habitat affected, but for more fragile habitats, e.g. reef substrate, to stay in this category the % area affected needs to be smaller up to 25%.	**1. Substrate quality** The level of reduction of internal dynamics of habitats may be larger than is sensible to ensure that the habitat will not be able to recover adequately, or it will cause strong downstream effects from loss of function. Time to recover from local impact on the scale of months to years, at larger spatial scales recovery time of weeks to months.	**1. Substrate quality** Severe impact on substrate quality with 50 - 90% of the habitat affected or removed by the activity which may seriously endanger its long-term survival and result in changes to ecosystem function. Recovery period measured in years to decades.	**1. Substrate quality** The dynamics of the entire habitat is in danger of being changed in a major way, or > 90% of habitat destroyed.
Water quality	**2. Water quality** No direct impact on water quality. Impact unlikely to be	**2. Water quality** Detectable impact on water quality. Time to recover from local	**2. Water quality** Moderate impact on water quality. Time to recover from local	**2. Water quality** Time to recover from local impact on the scale of months to	**2. Water quality** Impact on water quality with 50 - 90% of the habitat	**2. Water quality** The dynamics of the entire habitat is in danger of being

Sub-component	Score/level					
	1 Negligible	2 Minor	3 Moderate	4 Major	5 Severe	6 Intolerable
	detectable. Time taken to recover to pre-disturbed state on the scale of hours.	impact on the scale of days to weeks, at larger spatial scales recovery time of hours to days.	impact on the scale of weeks to months, at larger spatial scales recovery time of days to weeks.	years, at larger spatial scales recovery time of weeks to months.	affected or removed by the activity which may seriously endanger its long-term survival and result in changes to ecosystem function. Recovery period measured in years to decades.	changed in a major way, or > 90% of habitat destroyed.
Air quality	**3. Air quality** No direct impact on air quality. Impact unlikely to be detectable. Time taken to recover to pre-disturbed state on the scale of hours.	**3. Air quality** Detectable impact on air quality. Time to recover from local impact on the scale of days to weeks, at larger spatial scales recovery time of hours to days.	**3. Air quality** Detectable impact on air quality. Time to recover from local impact on the scale of weeks to months, at larger spatial scales recovery time of days to weeks.	**3. Air quality** Time to recover from local impact on the scale of months to years, at larger spatial scales recovery time of weeks to months.	**3. Air quality** Impact on air quality with 50 - 90% of the habitat affected or removed by the activity .which may seriously endanger its long-term survival and result in changes to ecosystem function. Recovery period measured in years to decades.	**3. Air quality** The dynamics of the entire habitat is in danger of being changed in a major way, or > 90% of habitat destroyed.
Habitat types	**4. Habitat types** No direct impact on habitat types. Impact unlikely to be detectable. Time taken to recover to pre-disturbed state on the scale of hours to days.	**4. Habitat types** Detectable impact on distribution of habitat types. Time to recover from local impact on the scale of days to weeks, at larger spatial scales recovery time of days	**4. Habitat types** Impact reduces distribution of habitat types. Time to recover from local impact on the scale of weeks to months, at larger spatial scales recovery time	**4. Habitat types** The reduction of habitat type areal extent may threaten ability to recover adequately, or cause strong downstream effects in habitat distribution and	**4. Habitat types** Impact on relative abundance of habitat types resulting in severe changes to ecosystem function. Recovery period likely to be > decadal	**4. Habitat types** The dynamics of the entire habitat is in danger of being changed in a catastrophic way. The distribution of habitat types has been shifted away

Sub-component	Score/level					
	1 Negligible	**2 Minor**	**3 Moderate**	**4 Major**	**5 Severe**	**6 Intolerable**
		to months.	of months to < one year.	extent. Time to recover from impact on the scale of > one year to < decadal timeframes.		from original spatial pattern. If reversible, will require a long-term recovery period, on the scale of decades to centuries.
Habitat structure and function	**5. Habitat structure and function** No detectable change to the internal dynamics of habitat or populations of species making up the habitat. Time taken to recover to pre-disturbed state on the scale of hours to days.	**5. Habitat structure and function** Detectable impact on habitat structure and function. Time to recover from impact on the scale of days to months, regardless of spatial scale	**5. Habitat structure and function** Impact reduces habitat structure and function. For impacts on non-fragile habitat structure this may be for up to 50% of habitat affected, but for more fragile habitats, to stay in this category the % area affected needs to be smaller up to 20%. Time to recover from local impact on the scale of months to < one year, at larger spatial scales recovery time of months to < one year.	**5. Habitat structure and function** The level of reduction of internal dynamics of habitat may threaten ability to recover adequately, or it will cause strong downstream effects from loss of function. For impacts on non-fragile habitats this may be for up to 50% of habitat affected, but for more fragile habitats, to stay in this category the % area affected up to 25%. Time to recover from impact on the scale of > one year to < decadal timeframes.	**5. Habitat structure and function** Impact on habitat function resulting from severe changes to internal dynamics of habitats. Time to recover from impact likely to be > decadal.	**5. Habitat structure and function** The dynamics of the entire habitat is in danger of being changed in a catastrophic way which may not be reversible. Habitat losses occur. Some elements may remain but will require a long-term recovery period, on the scale of decades to centuries.

TableC5. Communities. Description of consequences for each component and each sub-component. Use table as a guide for scoring the level of consequence for communities (Modified from Fletcher et al. 2002).

Sub-component	Score/level					
	1 Negligible	**2 Minor**	**3 Moderate**	**4 Major**	**5 Severe**	**6 Intolerable**
Species composition	1. Species composition Interactions may be occurring which affect the internal dynamics of communities leading to change in species composition not detectable against natural variation.	1. Species composition Impacted species do not play a keystone role – only minor changes in relative abundance of other constituents. Changes of species composition up to 5%.	1. Species composition Detectable changes to the community species composition without a major change in function (no loss of function). Changes to species composition up to 10%.	1. Species composition Major changes to the community species composition (~25%) (involving keystone species) with major change in function. 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 period measured in years.	1. Species composition Change to ecosystem structure and function. Ecosystem dynamics currently shifting as different species appear in fishery. Recovery period measured in years to decades.	1. Species composition Total collapse of ecosystem processes. Long-term recovery period required, on the scale of decades to centuries
Functional group composition	2. Functional group composition Interactions which affect the internal dynamics of communities leading to change in functional group composition not detectable against natural variation.	2. Functional group composition Minor changes in relative abundance of community constituents up to 5%.	2. Functional group composition Changes in relative abundance of community constituents, up to 10% chance of flipping to an alternate state/ trophic cascade.	2. Functional group composition Ecosystem function altered measurably and some functional groups are locally missing/declining/increasing outside of historical range and/or allowed/facilitated new species to appear. Recovery period measured in months to years.	2. Functional group composition Ecosystem dynamics currently shifting, some functional groups are missing and new species/groups are now appearing in the fishery. Recovery period measured in years to decades.	2. Functional group composition Ecosystem function catastrophically altered with total collapse of ecosystem processes. Recovery period measured in decades to centuries.
Distribution of the	3. Distribution of	3. Distribution of	3. Distribution of	3. Distribution of the	3. Distribution of	3. Distribution of the

Sub-component	Score/level					
	1 Negligible	**2 Minor**	**3 Moderate**	**4 Major**	**5 Severe**	**6 Intolerable**
community	the community Interactions which affect the distribution of communities unlikely to be detectable against natural variation.	the community Possible detectable change in geographic range of communities but minimal impact on community dynamics change in geographic range up to 5 % of original.	the community Detectable change in geographic range of communities with some impact on community dynamics Change in geographic range up to 10 % of original.	community Geographic range of communities, ecosystem function altered measurably and some functional groups are locally missing/declining/increasing outside of historical range. Change in geographic range for up to 25 % of the species. Recovery period measured in months to years.	the community Change in geographic range of communities, ecosystem function altered and some functional groups are currently missing and new groups are present. Change in geographic range for up to 50 % of species including keystone species. Recovery period measured in years to decades.	community Change in geographic range of communities, ecosystem function collapsed. Change in geographic range for >90% of species including keystone species. Recovery period measured in decades to centuries.
Trophic/size structure	4. Trophic/size structure Interactions which affect the internal dynamics unlikely to be detectable against natural variation.	4. Trophic/size structure Change in mean trophic level, biomass/ number in each size class up to 5%.	4. Trophic/size structure Changes in mean trophic level, biomass/ number in each size class up to 10%.	4. Trophic/size structure Changes in mean trophic level. 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 period measured in years to decades.	4. Trophic/size structure Changes in mean trophic level. Ecosystem function severely altered and some function or components are missing and new groups present. Recovery period measured in years to decades.	4. Trophic/size structure Ecosystem function catastrophically altered as a result of changes in mean trophic level, total collapse of ecosystem processes. Recovery period measured in decades to centuries.
Bio-geochemical	5. Bio- and	5. Bio- and	5. Bio- and	5. Bio- and geochemical	5. Bio- and	5. Bio- and

Sub-component	Score/level					
	1 Negligible	**2 Minor**	**3 Moderate**	**4 Major**	**5 Severe**	**6 Intolerable**
cycles	geochemical cycles Interactions which affect bio- & geochemical cycling unlikely to be detectable against natural variation.	geochemical cycles Only minor changes in relative abundance of other constituents leading to minimal changes to bio- & geochemical cycling up to 5%.	geochemical cycles Changes in relative abundance of other constituents leading to minimal changes to bio- & geochemical cycling, up to 10%.	cycles Changes in relative abundance of constituents leading to major changes to bio- & geochemical cycling, up to 25%.	geochemical cycles Changes in relative abundance of constituents leading to Severe changes to bio- & geochemical cycling. Recovery period measured in years to decades.	geochemical cycles Ecosystem function catastrophically altered as a result of community changes affecting bio- and geo- chemical cycles, total collapse of ecosystem processes. Recovery period measured in decades to centuries.