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Australian Government
Australian Fisheries Management Authority

Ecological Risk Assessment (ERA) for Effects of Fishing

REPORT FOR THE MIDWATER TRAWL SUB-FISHERY OF THE SMALL PELAGIC FISHERY

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Daley, R., Dowdney, J., Bulman, C, Sporcic, M., Fuller, M., Ling, S. and Hobday, A (2007). Ecological Risk Assessment for the Effects of Fishing. Report for the midwater trawl sub-fishery of the Small Pelagic Fishery. Report for the Australian Fisheries Management Authority. Canberra, Australia.

<u>Notes to this document:</u>
This fishery ERA report document 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. (2007) 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 document 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., A. Hobday, 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 Small Pelagic Fishery - Midwater Trawl sub-fishery was undertaken using the ERAEF method version 9.2. ERAEF stands for "Ecological Risk Assessment for Effect of Fishing", and was developed in a research program sponsored 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 SPF midwater trawl sub-fishery includes the following:

- Scoping
- Level 1 results for all components
- Level 2 results for the three species components, and for habitats

Fishery Description

Gear:	Midwater otter trawl
Area:	Queensland border south around Tasmania, to 31S along the west coast of Western Australia, from 3-200 nm, and including waters inside 3 nm around Tasmania. Divided into 4 zones.
Depth range:	35 to ~ 357 m of bottom depth
Fleet size:	Two active permits, one in Zone A, one in Zone B.
Effort:	Search time of vessels: 1372 hours in 2005
Landings:	5000 to 12,000 tones from 2001-2005
Discard rate:	very low, bycatch less than 1%
Main target species:	redbait (Emmelichthys nitidus)
Management:	No management plan, limited entry by permit
Observer program:	Dedicated program over the 5-year history of this sub-fishery – Equal to best practice for sub-fishery assessed under ERAEF.

Ecological Units Assessed

Target species:	1
By-product and bycatch species:	16 and 2
TEP species:	218
Habitats:	24 benthic habitats in region of fishery 2 pelagic in area of current effort
Communities:	8 benthic habitats in region of fishery 2 pelagic in area of current effort

Level 1 Results

One ecological component was eliminated at Level 1 (Habitats); there was at least one risk score of 3 – moderate – or above for the other four components. All but one hazard (fishing activities) was eliminated at Level 1 (risk scores 1 or 2). The remaining hazard was:

- Fishing (direct impacts on four ecological components)

Significant external hazards included other fisheries in the region and coastal development.

Impacts from fishing on all species components were assessed in more detail at Level 2. Community impacts should also be examined in future iterations; time was insufficient to complete this analysis following development of the ERAEF Level 2 community analysis.

Level 2 Results

<u>Species</u>
Of the 237 species assessed at Level 2 using the PSA analysis, expert/observer over-rides were used on 95 species. A total of 26 species were found to be at high risk. Of these, 1 species had more than 3 missing attributes.

The, 26 species assessed to be at high risk, included 0 target species, 0 by-product species, 0 by-catch species, and 26 TEP species. By taxa, the high risk species comprised 3 marine birds, and 23 marine mammals.

Of the 26 TEP species assessed to be at high risk, 2 of the bird species that are at high risk are common in the area fished and, although there are no records of mortalities in this fishery, there are records of warp strike mortality for these species in other domestic trawl fisheries and interactions with midwater trawl fisheries. The other bird species had missing information and is potentially a false positive. The 23 marine mammals of high risk are difficult to exclude because they are most often underwater and the way they interact with the gear fishing gear is difficult to document. Captures of at least two mammal species has resulted in mortality in this fishery (Browne *et al*, 2005, Observer Reports).

<u>Habitats</u>

Habitats were eliminated at the end of Level 1

<u>Communities</u>

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

Only one issue emerges from the ERAEF analysis of the SPF midwater trawl fishery. This is the direct impact of fishing on two groups of TEP species; birds and marine mammals. There have been recent observations of mortality of seals and dolphins in this sub-fishery, and mitigating this risk remains a challenge for the fishery. While the populations of these marine mammals may not be at risk from this mortality, under Australian legislation, these interactions require intervention and have in some case resulted in the temporary closure of the fishery.

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.

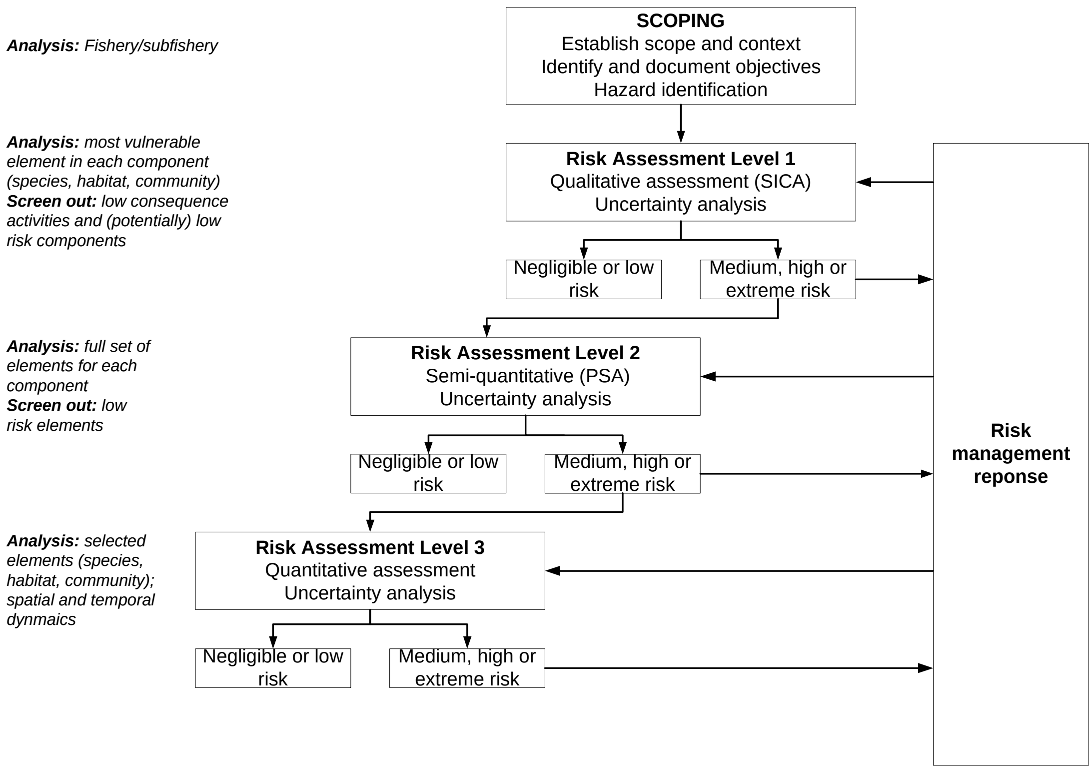

Figure 1. Overview of ERAEF showing focus of analysis for each level at the left in italics.

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.

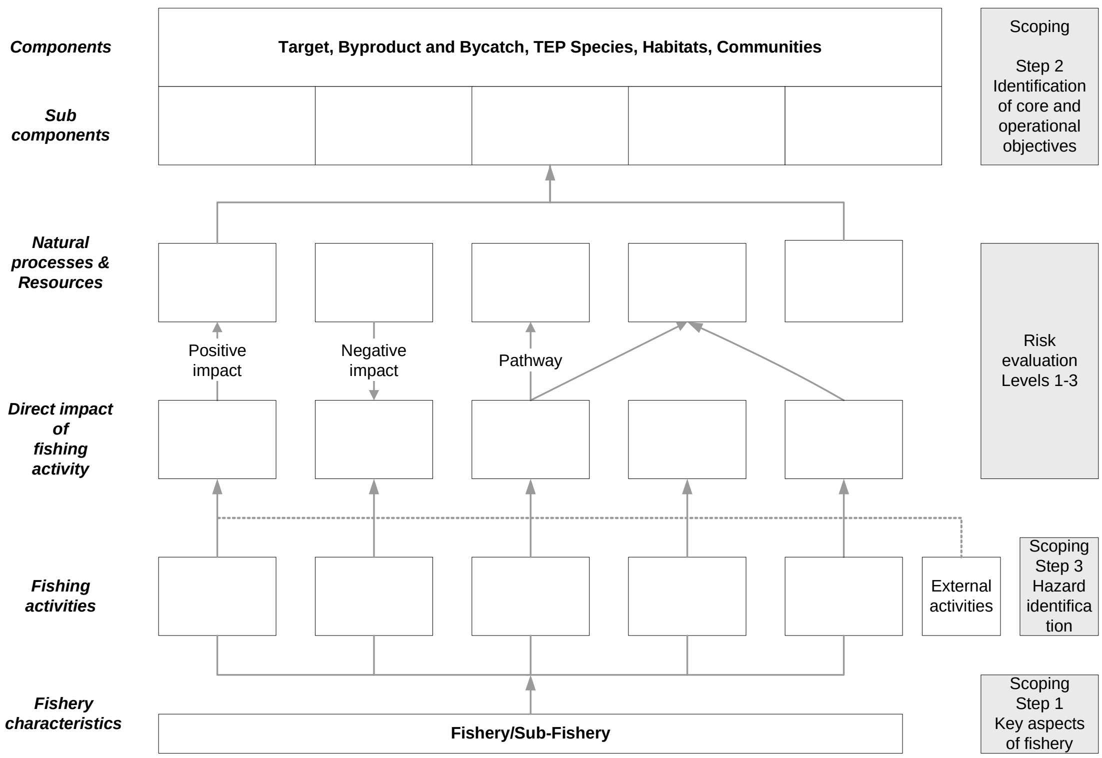

Figure 2. Generic conceptual model used in ERAEF.

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* 2007). 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 Document 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 cutoff 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.

The results presented below are for Small Pelagic Fishery – Midwater Trawl

2.1 Stakeholder engagement

2.1 Summary Document SD1. Summary of stakeholder involvement for fishery

SMALL PELAGIC FISHERY – MIDWATER TRAWL

Fishery ERA report stage	Type of stakeholder interaction	Date of stakeholder interaction	Composition of stakeholder group (names or roles)	Summary of outcome
Scoping	Workshop	Feb 27, 2004, Canberra	SPRAT. See minutes for this meeting	New Strategic Assessment document made available to ERA team. Hazards agreed on. Species list comments to be included.
	Phone call and email comments on draft materials sent to meeting	March 23, 2004	Denis Brown	Comments to be incorporated.
Level 1 (SICA)	Workshop	Feb 27, 2004, Canberra	SPRAT. See minutes for this meeting	Presented the scenarios as an overview of the preliminary outcomes. Agreed to distribute out of session once modified with some of the feedback
Level 2 (PSA)	Workshop	February 27, 2004. Canberra	SPRAT. See minutes for this meeting	Draft Level 2 presented. Additional sources for biological attributes identified. Papers sent through by Jeremy Lyle with additional species data.
Level 2 (PSA)	Meeting at TAFI	September 2005	Ross Daley, Jeremy Lyle, Dirk Welsford	Comments mainly on TEP species and need to improve mapping/availability of these species. Feedback incorporated prior to workshop[
Level 2 (PSA)	Workshop	September 2005	AFMA, fishers, and Scientists (TAFI, SARDI),	Review of updated methodology and level 2. Problems with lack of PS observer data highlighted. AFMA staff undertake to obtain observer data from state PS Fisheries
Level 2 (PSA)	E-Mails	April 2006	AFMA/CMAR	AFMA indicate they are unable to provide any additional observer

Fishery ERA report stage	Type of stakeholder interaction	Date of stakeholder interaction	Composition of stakeholder group (names or roles)	Summary of outcome
				data. The consequence of this data gap (namely higher scores for TEP species) were made clear in an e-mail from Ross Daley to AFMA.
Scoping updates	E-mails	25 May 2005	TAFI/CMAR	Check with Jeremy Lyle if jurisdictional arrangements have been resolved for zone A. Not resolved yet. Noted in scoping
Scoping updates	E-mails	26 May 2006	TAFI/AFMA	Clarification on updated management arrangements. Specific questions answered, Waiting for general comments on General Fishery Characteristics re-draft.

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

<u>Fishery Name</u>: Small Pelagic Fishery – Midwater Trawl
<u>Date of assessment</u>: 28 May 2006
<u>Assessor</u>: Ross Daley

General Fishery Characteristics	
Fishery Name	Small Pelagics Fishery
Sub-fisheries	*Identify sub-fisheries on the basis of fishing method/area* Permits in the Fishery allow two methods of fishing: purse seine and mid water trawl. This report covers the midwater trawl sub-fishery.
Sub-fisheries assessed	*The sub-fisheries to be assessed on the basis of fishing method/area in this report.* This report deals only with midwater trawl sub-fishery. A separate ERAEF report covers the purse-seine sub-fishery
Start date/history	*Provide an indication of the length of time the fishery has been operating.* The SPF has had a long history, beginning in 1936 when CSIRO surveys located large schools of small pelagics along the wester edge of the GAB and off eastern Tasmania. In the 1940’s and 1950’s purse seining was trialled off NSW and eastern Tasmania. The fist catch comprised 4 t of Jack mackerel taken near Hobart and from then until to 2002, the SPF was dominated by the purse seine sub-fishery targeting surface schools of jack mackerel off eastern Tasmania (Zone A) In 1979, Australia declared the 200 mile Australian Fishing Zone. This gave the States responsibility for management of fisheries resources out to 3 nm and the Commonwealth responsibility for resources from 3 – 200 miles. For resources that occurred both inside 3 m as well as offshore in Commonwealth waters - licensing, management and enforcement

	became complicated. In 1983, the *Offshore Constitutional Settlement* came into effect. This arrangement between the state and the Commonwealth allows for the exchange of powers for controlling resources that cross jurisdictional boundaries (the '3-mile line'). This process is still not finalised for Zone A (off Tasmania) but the fishery has been co-managed by the State and Federal Governments since 1984, The Midwater Trawl sub-fishery of the SPF commenced in 2001/2002 when the first significant catches of redbait were taken in zone A. In 2002, two midwater trawling licences were granted and by 2003 and 2004 midwater trawling took the vast majority (>90%) of the SPF total annual catch. Most of the catch has been redbait (*Emmelichthys nitidus*), sold whole (not mealed) to feed farmed Tuna in Port Lincoln. With most of the market for the fishery in Port Lincoln, there was a clear potential for the fishery to expand into other areas, particularly the GAB and areas closer to the market than Tasmania. In 2001, the AFMA board pre-emptively began developed a Management Policy for remaining areas within the jurisdictional boundaries (Zones B, C, D). Under the new management policy framework, AFMA announced, plans to restructure management of most zones of the fishery in 2004. An investment warning and a freeze on permits followed. A discussion paper on management of zones B, C, D was developed. An Independent Allocation Advisory Panel (IAAP) was established to investigate how TAC management could be developed for the fishery. In December 2005, The AFMA Board accepted most of the advice from the Independent Allocation Advisory Panel and finalised the allocation formula to be used in allocating statutory fishing rights under the management plan for the fishery. The Board lifted the freeze on boat nominations and expects to finalise management policy into a detailed Management Plan for the fishery in 2006. Looking forward, the fishery is likely to face a number of challenges for managing the target species. Output controls are to be the preferred method for managing Commonwealth Fisheries but his may be problematic. Output controls are normally set against some reference point based on the initial biomass of the stock. Setting reference points for the SPF will be a challenge for the future because the initial biomass is not known. The fishery is also responding to challenges in managing TEP species. A number of dolphins have been captured in the sub-fishery. As a response, the fishery has established a Cetacean Mitigation Working Group. Cetacean catches are carefully monitored by observer programs using innovative techniques. Catch levels recorded to date appear to have been at sustainable levels.
Geographic extent of fishery	*The geographic extent of the managed area of the fishery. Maps of the managed area and distribution of fishing effort should be included in the detailed description below, or appended to the end of this table.* The jurisdictional boundary of the fishery extends from waters south of the Queensland border on the east coast, across southern Australia to 31° S on the west coast, north of Perth. It includes waters from 3 – 200 miles and waters inside 3 nautical miles around Tasmania.

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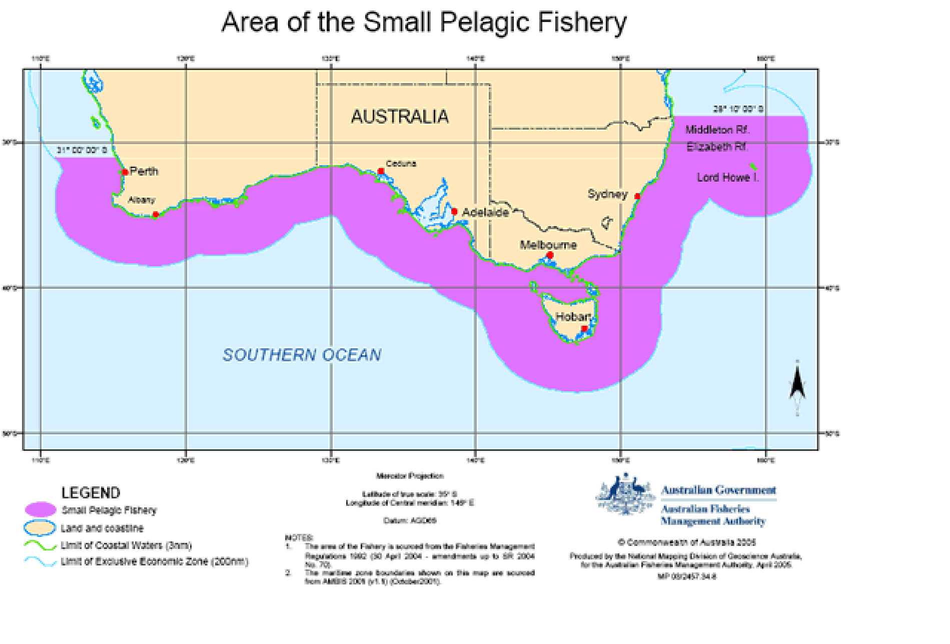
<tr><td></td><td>
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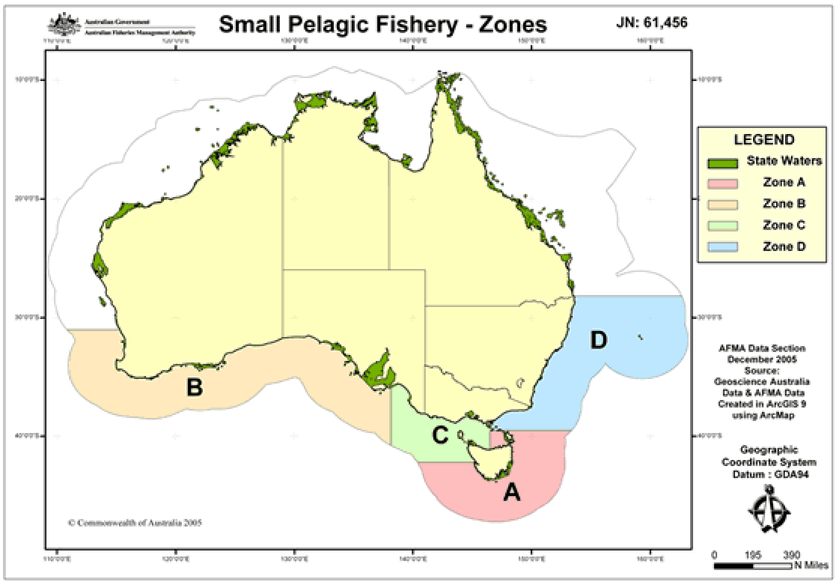
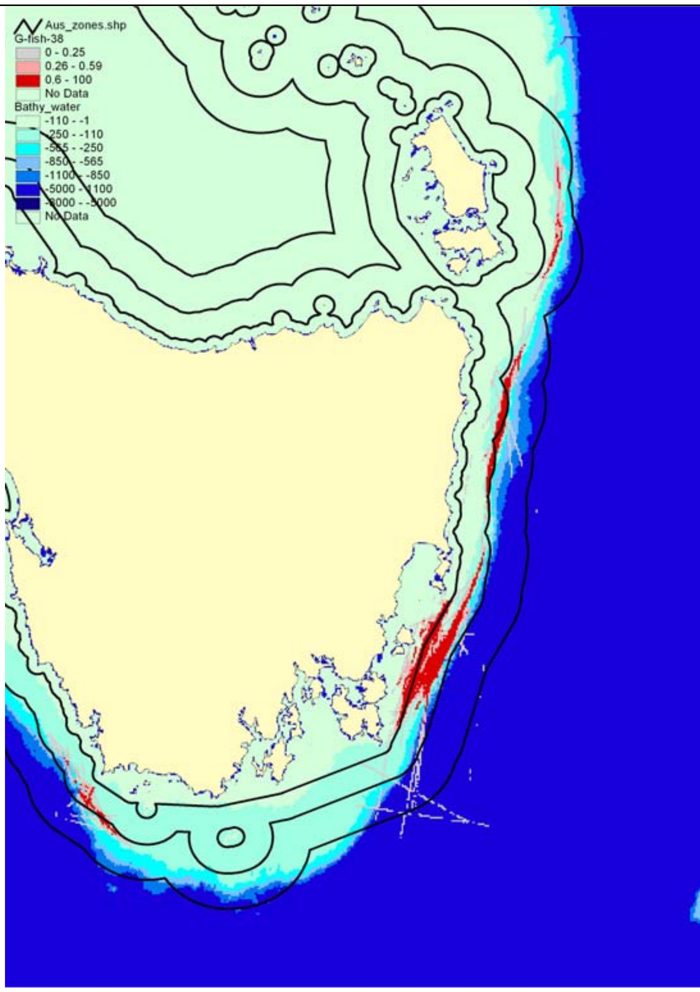
<tr><td>Regions or Zones within the fishery</td><td>Any regions or zones used within the fishery for management purposes and the reason for these zones if known.

The fishery is divided into four zones.

From 2001 – 2004 almost all midwater trawl effort in the SPF was off eastern Tasmania in both Commonwealth and state waters of zone A. The 2005 and 2006 logbook data sets have not been analysed to date, but there are anecdotal reports of some targeting of redbait in the Great Australian Bight during 2006.



Map of the Small Pelagic Fishery including Zones, © Commonwealth of Australia 2005</td></tr>
</table>

	 Distribution of Midwater trawl effort in the SPF based on 2001-2004 logbook data mapped in 1 km squares
Fishing season	*Species targeted and where known, stock status.* Fishing occurs throughout most of the year with most catches in the warmer months and a peak in April-May
Target species and stock status	*Species targeted and where known, stock status.* The main species targeted with midwater trawl is redbait: (*Emmelichthys nitidus*). However this species may form mixed schools with four other species which are effectively targeted: Jack mackerel (*Trachurus declivis)* Peruvian mackerel (*Trachurus murphyi)* Yellowtail scad (*Trachurus novaezelandiae)* Blue mackerel (*Scomber australasicus)* The stock status of the four target species is uncertain; potentially underfished in zone B (Caton 2001). Jack mackerel is discussed in related documents for the purse seine sub-fishery.
Bait Collection and usage	*Identify bait species and source of bait used in the sub-fishery. Describe methods of setting bait and trends in bait usage.* Not applicable because the fishery only uses nets to capture the target species and there is no chum.

Current entitlements	*The number of current entitlements in the fishery. Note latent entitlements. Licences/ permits/ boats and number active* There are 37 concession authorising fishing for SPF species using midwater trawl. Some are restricted to particular zones. Currently only two permits are active, one in zone A, and one in zone B
Current and recent TACs, quota trends by method	*The most recent catch quota levels in the fishery by fishing method (sub-fishery). Summary of the most recent catch quota levels in the fishery by fishing method (sub-fishery) in table form.* There are currently no Commonwealth TACs in the SPF but AFMA is committed to introducing SFRs (Statutory Fishing Rights), in the form of Individual Transferable Quota's into the fishery and expects to grant Statutory Fishing Rights under the proposed management plan in 2006. In the interim, Trigger Catch Limits (TCL) are in place for zones B, C, and D. If catches reach these triggers then a management response is required. TCLs have been set on a species specific basis for blue mackerel, yellowtail scad and redbait. A combined species TAC/TCL will be set for the various jack mackerel species (*Trachurus spp*). TACs or TCLs are reviewed annually by the Small Pelagics Research and Assessment Team (SPRAT),

	Zone B	Zone C	Zone D
Blue mackerel	5,000	3,500	3,500
Jack mackerel group	4,000	2,500	2,500
Redbait	1,000	1,000	1,000
Yellowtail Scad	100	100	100

There is no OCS arrangement for SPF species in Tasmanian State waters. There was agreement to form a formal Joint Authority to manage Zone A but this agreement was not gazetted and therefore did not take effect. Presently Zone A is managed cooperatively, with Tasmania having responsibility for setting annual TACs. The current TAC for all species and gears is 34 000t.

Current and recent fishery effort trends by method	*The most recent estimate of effort levels in the fishery by fishing method (sub-fishery).* There has been significant effort in the fishery from 2002 – 2005. Effort in 2001 was exploratory. There was no midwater trawling in the SPF prior to 2001.

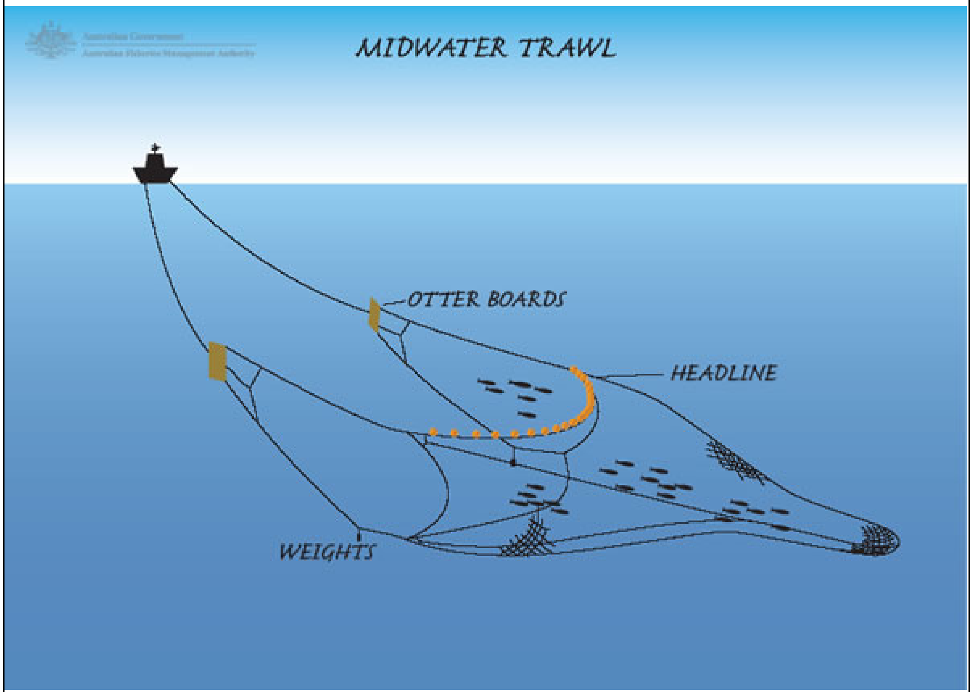
Year	Search time (hours) for midwater trawl vessels in SPF (Logbook data)
2000	0
2001	77
2002	777
2003	1,724
2004	2,446
2005	1,372

Current and recent fishery catch trends by method	*Summary of the most recent estimate of catch levels in the fishery by fishing method (sub-fishery). In table form* The first significant catches were taken in 2001. From 2001 – 2005 annual catches have been 5,000 t – 12 000 t, putting the SPF among the highest volume fisheries in Australia Total catches for the purse seine method in the SPF Based on logbook data

Year	Total catch (t)
2000	0
2001	723
2002	4,862

	2003 10,320 2004 11,621 2005 6,430
Current and recent value of fishery ($)	*Summary of the most recent value of the fishery (sub-fishery).* There is no overall economic data available for this new sub-fishery but the first point of sale value of the fishery is estimated as follows: 10,000,000 kg at $1 per kg = $10 million
Relationship with other fisheries	*Commercial and recreational, state, national and international fisheries. List other fisheries operating in the same region any interactions* State fisheries The States of New South Wales, Victoria, Tasmania and South Australia Control small pelagic resources within 3 nm. Western Australia manages waters inside 3 nm east of 125° E. The commonwealth has jurisdiction to the high water mark west of this point. Victoria, South Australia and Western Australia do not allow state licensed commercial operators to target small pelagic species. (Draft Assessment Report 2003). Commonwealth fisheries The fishery has strong economic links with the SBT farming in Port Lincoln, which uses redbait for feed. Small amounts of Jack mackerel and redbait are also caught as bycatch by demersal trawl in the SESS demersal trawl sectors. The 2003 SESSF management plan prohibits targeting of small pelagic species. However, a vessel with both SPF and SESS permits could potentially target small pelagic stocks using midwater trawl. Shared fisheries With most of the current redbait taken in the co-managed zone A, the current jurisdictional boundaries are not problematic, but this may change if shared stocks are located in other zones.
Gear	
Fishing gear and methods	*Example of Fishing gear* Trawl type: mid water otter trawl Trawl Name: Motueka Pelagic Trawl headrope length: 136m ground rope length: 136m ground rope type: leaded rope or chain Horizontal opening: 48m Vertical Opening: 32m main mesh size: 18m No meshes Round: 36 codend Mesh size: 4cm codend # meshes around: 360 codend mesh orientation: Diamond max wing mesh size: 18m door to wing length: 100m door type: Super vee - High aspect ratio Door Name: Thyboron Pelagic Type 10 Door Weight: 1200kgs Door Area: 10sqm Net sonde: Cable Link Comments: Steel SED in place of mesh SED *Fishing method* Midwater trawls fish in the water column and are used to catch a variety of pelagic fish species. Some fisheries may use paired trawls, where two boats pull one net. Midwater trawl nets may incorporate acoustic technology to tell the skipper the position of the net

in the water column, the opening/spread of the net and the volume of fish entering the net. Additional instruments on the net can record the speed at which the net is traveling. Both demersal and midwater trawls use otterboards to keep the mouth of the net open.



Fishing gear restrictions	*Any restrictions on gear* Minimum mesh size is 40mm. Some permits allow the use of a 20mm codend mesh liner.
Selectivity of gear and fishing methods	*Description of the selectivity of the sub-fishery methods* Midwater trawls target midwater fish aggregations identified from using echo sounders. The catch is almost entirely redbait with only small traces of other species such as flathead and a few other teleosts.
Spatial gear zone set	*Description where gear set i.e. continental shelf, shelf break, continental slope (range nautical miles from shore)* The gear is generally set in areas of high productivity over the shelf and along the edge of the shelf.
Depth range gear set	*Depth range gear set at in meters* The gear is set in waters where the bottom is 35 – 357 m from the surface
How gear set	*Description how set, pelagic in water column, benthic set (weighted) on seabed* The gear is set in the middle third of the water column. Potentially the gear can come into contact with the bottom but this does not occur frequently
Area of gear impact per set or shot	*Description of area impacted by gear per set (square meters)* Horizontal opening: 48 m Vertical Opening: 32 m Area of opening = 48 x 32 m=1,538 m The area does not normally come into contact with the bottom
Capacity of gear	*Description number hooks per set, net size weight per trawl shot* The largest shots recorded in observer records are around 65 t. The vessels can carry up to 800 t

Effort per annum all boats	*Description effort per annum of all boats in fishery by shots or sets and hooks, for all boats* See Current and recent fishery effort trends by method (above)
Lost gear and ghost fishing	*Description of how gear is lost, whether lost gear is retrieved, and what happens to gear that is not retrieved, and impacts of ghost fishing.* The gear is designed to fly midwater and not prone to snagging. Potentially the gear could be snagged when trialling new or unfamiliar gear. The gear is expensive and economics and career prospects for skippers provide powerful incentives to prevent gear loss and recover any lost gear.
Issues	
Target species issues	*List any issues, including biological information such as spawning season and spawning location, major uncertainties about biology or management, interactions etc* There are no estimates of original biomass for the target species. In line with the Ministerial Direction of 2005, a harvest strategy is being developed for the fishery. The harvest strategy will be used to determine appropriate TACs. James Findlay from BRS is preparing draft harvest strategy for SPFRAG and SPFMAC to consider later this year. Much of the fisheries biology of redbait is poorly defined. Key research needs include spatio-temporal patterns in population structure, reproductive biology and early life history, validation of ageing studies, further analysis of trophic interactions (see Community Issues, below), early life history and biomass estimates (Welsford and Lyle 2003). Redbait (*Emmelichthys nitidus*, Emmelichthyidae) are distributed from New South Wales to South Australia, including Tasmania. The also occur in Southern Africa and New Zealand Waters. The form surface or midwater schools over the continental shelf. Spawning in redbait takes place between October and January in Tasmanian waters (Kailola *et al* 1993, Welsford and Lyle2003.). Little is know about early life history stages (Welsford and Lyle 2003). The juveniles of closely related ruby fish are associated with drift algae off northeastern New Zealand (Kingsford 1992). Redbait are thought to mature at 2 – 3 years and grow to a maximum age of 8.5 years. However, uncertainties in age estimates include variability in how spawning date affects growth, seasonal and inter0-annual variability in growth, low precision in ageing estimates and variation in size at age (Welsford and Lyle 2003). Worldwide there have been few assessments of species of the family Emmelichthyidae. In New Zealand, an assessment of rubyfish (Plagiogeneion rubiginosum, Emmelichthyidae) was undertaken in 1997 and then updated in 1999 and 2002 (Paul 1997, Annala *et al.* 2002). In Australia, there is large-scale variation in catches of target species and this makes assessment of Target Catch Limits difficult. These catches are likely to be influenced by seasonal and inter-annual variability in physical oceanography of water masses of the east coast of Tasmania (Harris *et al*. 1987, Harris *et al* 1988).
Byproduct and bycatch issues and interactions	*List any issues, as for the target species above* The fishery is highly targeted and the volume of bycatch less than 1% of the total catch in a shot. Bycatch rates in midwater trawl are much lower than in demersal trawls (up to 50%). Midwater trawling targets highly aggregated schools of the target species The volume of bycatch is so small relative to the overall catch in a shot that it can be difficult to measure or even detect. A 30 t shot of redbait may contain 300 kg of barracouta and spotted warehou. (Observer data)
TEP issues and	*List any issues. This section should consider all TEP species groups: marine mammals, chondrichthyans (sharks, rays etc.), marine reptiles, seabirds, teleosts (bony fishes),*

interactions	*include any key spawning/breeding/aggregation locations that might overlap with the fishery/sub-fishery.* SPF species play an important ecological role as food for many marine birds and mammals (see community issues below). It is important the harvest strategies contain reference points for the target species that allow a viably functioning ecosystem that can support birds and mammals higher in the food chain. There have been a small number of dolphins captured in the fishery. These catches are reported in detail and reports are evaluated by The Cetacean Mitigation Working Group.
Habitat issues and interactions	*List any issues for any of the habitat units identified in **Scoping Document S1.2**. This should include reference to any protected, threatened or listed habitats* None identified. The gear is designed to fly just above the bottom and, although the gear does come into contact with the bottom occasionally, the impact on benthic habitats is likely to be minimal compared to demersal trawling.
Community issues and interactions	*List any issues for any of the community units identified in **Scoping Document S1.2**.* Off south-eastern Australia, redbait prey on pelagic crustaceans and invertebrates (Bulman *et al*. 2001). Off south Africa, they prey on pelagic invertebrates as well as fish and squid which migrate vertically in the food chain (Meyer and Smale 1991). Redbait in turn are preyed on by marine birds, such as the Australasian Gannet, Shy albatrosses and mammals such as the Australian fur seal (Brothers *et. al.* 1993, Gales and Pemberton 1994, Hedd and Gales 2001). The fishery has removed 34 k t of redbait from the food chain which will affect the production and/or structure of the food chain to an unknown extent. There are likely to be indirect impacts on predatory species such as dolphins, beaked whales and tunas. Any indirect effects of fishing may be difficult to evaluate and distinguish from natural variability. Production and structure of the food chain is also linked to seasonal and inter-annual variability in the physical processes in the water masses of f Tasmania. (Harris *et al.* 1991). The shared nature of this migratory resource, its ecological importance within the broader marine environment, and its trophic importance in supporting other more valuable fisheries, make the species of the SPF a valuable component of Australia's marine ecosystem that need further examination
Discarding	*Summary of discarding practices by sub-fishery, including bycatch, juveniles of target species, high-grading, processing at sea.* There is no discarding of the target species. The largest recorded discard volume from a single shot was 1 t of barracouta.
Management: planned and those implemented	
Management Objectives	*The management objectives from the most recent management plan* The management objectives from AFMA’s SPF management policy are: • Ensuring management arrangements facilitate the Ecologically Sustainable Development of the SPF, and promote the productivity and efficient conduct of the commercial, recreational, and ecological components of the fishery; • Adopting a strategic approach to management of the SPF, developing and maintaining fisheries management best practice, including recognising and embracing the need for ecosystem based management; • Managing the SPF resource on behalf of the Australian community, and in doing so ensuring that management arrangements are consistent with the requirements of key stakeholders, including other management jurisdictions; and, • Within the life of this policy, developing a set of performance criteria by which the effectiveness of SPF management arrangements can be measured.

	(Management Policy for the Commonwealth Small Pelagics Fishery; AFMA webpage, 10-Feb-04)
Fishery management plan	*Is there a fisheries management plan is it in the planning stage or implemented what are the key features* Currently there is no management plan in place for the fishery but a management policy has been in place since 2002. A harvest strategy framework is being developed by SPFRAG and SPFMAC in 2006. The Harvest Strategy Plan will be reviewed by experts and AFMA will report on the HSP to the Minister by 30 June 2006.
Input controls	*Summary of any input controls in the fishery, e.g. limited entry, area restrictions (zoning), vessel size restrictions and gear restrictions. Primarily focused on target species as other species are addressed below.* Limited entry will apply on a zone by zone basis under the new management plan (see current entitlements above) Under the proposed management arrangements, operators may be required to hold Commonwealth trawl entitlements when midwater trawling for small pelagics in the area of other Commonwealth trawl fisheries.
Output controls	*Summary of any output controls in the fishery, e.g. quotas. Effort days at sea. Primarily focused on target species as other species are addressed below.* See TAC trends (above)
Technical measures	*Summary of any technical measures in the fishery, e.g. size limits, bans on females, closed areas or seasons. Gear mesh size, mitigation measures such as TEDs. Primarily focused on target species as other species are addressed below.* None identified. There are currently no spatial closures in the fishery and none have been proposed or considered to date. However, SPFRAG and SPFMAC may consider the role of spatial management in future.
Regulations	*Regulations regarding species (bycatch and byproduct, TEP), habitat, and communities; MARPOL and pollution; rules regarding activities at sea such as discarding offal and/ or processing at sea.* Under the new management plan, all interactions with TEP species need to be recorded on the monthly catch returns.
Initiatives and strategies	*BAPs; TEDs; Industry codes of conduct* In December 2005 the AFMA board approved a new Bycatch Action plan for the Fishery
Enabling processes	*Monitoring, logbooks, observer data, scientific surveys); assessment stock assessments); performance indicators (decision rules, processes, compliance; education; consultation process.* An Independent Allocation Advisory Panel (IAAP), established by the AFMA board, provides advice on the allocation of Statutory Fishing Rights in the fishery The Small Pelagic Fishery Cetacean Mitigation Working Group was established to minimise cetacean interactions. Its first meeting was held in April 2005 SPFRAG - Assesses research for the fishery SPFMAC - Provides advice to the AFMA Board on management of the fishery
Other initiatives or agreements	*State, national or international conventions or agreements that impact on the management of the fishery/sub-fishery being evaluated.* Electronic monitoring using vessel mounted cameras is being developed to reduce costs and improve data quality
Data	
Logbook data	*Verified logbook data; data summaries describe program*

	Catch and effort data are recorded on a shot by shot basis in logbooks. Data has been compiled into a centralised database by AFMA and been made available to CMAR for the ERAEF assessment
Observer data	Purpose: There is no stated objective for the observer program in the midwater trawl sub-fishery. Objectives may vary between observer trips but recently the priorities have been 1. Monitor interactions with marine mammals giving priority to dolphins 2. Maintain shot logs and catch compositions for all components and collect biological data on the retained components of the catch. 3. Monitor interactions with seabirds Data collection: Experimental design: to date there has been no statistical design of data collection. Scope: In line with the Ministerial direction, the fishery is expected to review it observer coverage. Objectives for a revised program are still under consideration under the developing Harvest Strategy Framework but are likely to include: *Measuring discards and bycatch* *Validating logbooks* *Identifying TEP interactions* *Collecting scientific data* *Monitoring and compliance* Coverage: Observer data has been collected off Tasmania but not in the GAB. Experience and Education: Observers have included Mick Baron who has one of the longest and broadest backgrounds in fishery observer work in Australia. Dirk Welsford (Previously TAFI) has collected biological data first hand and undertaken detailed analysis and reporting. Dirk has recently joined the AAD and is unlikely to be available to undertake future observer work in the SPF. Training & Resources: AFMA is likely to recruit additional observers to its expanding program. It is not clear what resources and training will be provided Data collation: Observer data has been collated in AFMA's centralised database Data communication: The data has been made available outside AFMA in the form of observer trip reports and as raw data. There is no annual data summary Data checking: The data has been analysed and reviewed by CMAR.
Other data	TAFI collects detailed biological data on the target species.

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]

The number of units of analysis examined in this report is shown by component in the following Table.

Target	By-product	By-catch	TEP	Habitats	Communities
1	16	2	218	26	10

Scoping Document S2A Species list for the Target (TA), Byproduct and Bycatch (BP, DI) and TEP components.

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

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.

ERAEF species ID	Role in fishery (Component)	Taxa	Family name	Scientific name	Common Name	CAAB code	Source
155	TA	Teleost	Emmelichthyidae	Emmelichthys nitidus	Redbait	37345001	Don Bromhead

Byproduct species

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.

ERAEF species ID	Role in fishery (Component)	Taxa	Family name	Scientific name	Common Name	CAAB code	Reference
11	BP	Invertebrate	Ommastrephidae	Nototodarus gouldi	Arrow Squid	23636004	Don Bromhead
982	BP	Teleost	Merluciidae	Macruronus novaezelandiae	Blue Grenadier	37227001	Don Bromhead
69	BP	Teleost	Berycidae	Centroberyx lineatus	swallowtail	37258005	Don Bromhead
214	BP	Teleost	Zeidae	Cyttus australis	Silver dory	37264002	Don Bromhead
1097	BP	Teleost	Zeidae	Zenopsis nebulosus	Mirror Dory	37264003	Don Bromhead
1037	BP	Teleost	Platycephalidae	Neoplatycephalus richardsoni	Flathead	37296001	Don Bromhead
1088	BP	Teleost	Carangidae	Trachurus declivis	Jack Mackerel	37337002	Don Bromhead
150	BP	Teleost	Carangidae	Pseudocaranx dentex	Silver Trevally	37337062	Don Bromhead
1087	BP	Teleost	Gempylidae	Thyrsites atun	Barracouta	37439001	Don Bromhead
210	BP	Teleost	Scombridae	Scomber australasicus	Blue Mackerel	37441001	Don Bromhead
958	BP	Teleost	Centrolophidae	Hyperoglyphe antarctica	Blue Eye Trevalla	37445001	Don Bromhead
215	BP	Teleost	Centrolophidae	Centrolophus niger	Rudderfish	37445004	Don Bromhead
1068	BP	Teleost	Centrolophidae	Seriolella brama	Blue Warehou	37445005	Don Bromhead
1069	BP	Teleost	Centrolophidae	Seriolella punctata	Spotted Warehou	37445006	Don Bromhead
233	BP	Teleost	Monacanthidae	Nelusetta ayraudi	Chinaman-Leatherjacket	37465006	Don Bromhead
252	BP	Teleost	Molidae	Mola mola	ocean sunfish	37470002	Don Bromhead

Discard species

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

However, in the ERAEF method, the part of the target or byproduct catch that is discarded is included in the assessment of the target or byproduct species. The list of bycatch species is obtained by reviewing all available fishery literature, including logbooks, observer reports and discussions with stakeholders.

ERAEF species ID	Role in fishery (Component)	Taxa	Family name	Scientific name	Common Name	CAAB code	Reference
106	DI	Teleost	Triglidae	Lepidotrigla vanessa	butterfly gurnard	37288003	Don Bromhead
208	DI	Teleost	Trichiuridae	Lepidopus caudatus	Southern Frostfish	37440002	Don Bromhead

<u>TEP species</u>
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.

ERAEF species ID	Role in fishery (Component)	Taxa	Family name	Scientific name	Common Name	CAAB code	Reference
313	TEP	Chondrichthyan	Odontaspididae	Carcharias taurus	grey nurse shark	37008001	DEH
315	TEP	Chondrichthyan	Lamnidae	Carcharodon carcharias	white shark	37010003	DEH
1067	TEP	Chondrichthyan	Rhincodontidae	Rhincodon typus	whale shark	37014001	DEH
898	TEP	Marine bird	Spheniscidae	Eudyptula minor	Little Penguin	40001008	DEH
1032	TEP	Marine bird	Diomedeidae	Thalassarche bulleri	Buller's Albatross	40040001	DEH
1033	TEP	Marine bird	Diomedeidae	Thalassarche cauta	Shy Albatross	40040002	DEH
1034	TEP	Marine bird	Diomedeidae	Thalassarche chlororhynchos	Yellow-nosed Albatross, Atlantic Yellow-	40040003	DEH
1035	TEP	Marine bird	Diomedeidae	Thalassarche chrysostoma	Grey-headed Albatross	40040004	DEH
753	TEP	Marine bird	Diomedeidae	Diomedea epomophora	Southern Royal Albatross	40040005	DEH
451	TEP	Marine bird	Diomedeidae	Diomedea exulans	Wandering Albatross	40040006	DEH
1085	TEP	Marine bird	Diomedeidae	Thalassarche melanophrys	Black-browed Albatross	40040007	DEH
1008	TEP	Marine bird	Diomedeidae	Phoebetria fusca	Sooty Albatross	40040008	DEH
1009	TEP	Marine bird	Diomedeidae	Phoebetria palpebrata	Light-mantled Albatross	40040009	DEH
755	TEP	Marine bird	Diomedeidae	Diomedea gibsoni	Gibson's Albatross	40040010	DEH
628	TEP	Marine bird	Diomedeidae	Diomedea antipodensis	Antipodean Albatross	40040011	DEH
799	TEP	Marine bird	Diomedeidae	Diomedea sanfordi	Northern Royal Albatross	40040012	DEH

ERAEF species ID	Role in fishery (Component)	Taxa	Family name	Scientific name	Common Name	CAAB code	Reference
1084	TEP	Marine bird	Diomedeidae	Thalassarche impavida	Campbell Albatross	40040013	DEH
1031	TEP	Marine bird	Diomedeidae	Thalassarche carteri	Indian Yellow-nosed Albatross	40040014	DEH
894	TEP	Marine bird	Diomedeidae	Thalassarche salvini	Salvin's albatross	40040016	DEH
889	TEP	Marine bird	Diomedeidae	Thalassarche eremita	Chatham albatross	40040017	DEH
1428	TEP	Marine bird	Diomedeidae	Diomedea amsterdamensis	Amsterdam Albatross	40040018	DEH
1429	TEP	Marine bird	Diomedeidae	Diomedea dabbenena	Tristan Albatross	40040019	DEH
1580	TEP	Marine bird	Procellariidae	Calonectris leucomelas	streaked shearwater	40041002	DEH
595	TEP	Marine bird	Procellariidae	Daption capense	Cape Petrel	40041003	DEH
314	TEP	Marine bird	Procellariidae	Fulmarus glacialoides	Southern fulmar	40041004	DEH
939	TEP	Marine bird	Procellariidae	Halobaena caerulea	Blue Petrel	40041005	DEH
1052	TEP	Marine bird	Procellariidae	Lugensa brevirostris	Kerguelen Petrel	40041006	DEH
73	TEP	Marine bird	Procellariidae	Macronectes giganteus	Southern Giant-Petrel	40041007	DEH
981	TEP	Marine bird	Procellariidae	Macronectes halli	Northern Giant-Petrel	40041008	DEH
1003	TEP	Marine bird	Procellariidae	Pachyptila turtur	Fairy Prion	40041013	DEH
1006	TEP	Marine bird	Procellariidae	Pelecanoides urinatrix	Common Diving-Petrel	40041017	DEH
1041	TEP	Marine bird	Procellariidae	Procellaria aequinoctialis	White-chinned Petrel	40041018	DEH
494	TEP	Marine bird	Procellariidae	Procellaria cinerea	Grey petrel	40041019	DEH
1042	TEP	Marine bird	Procellariidae	Procellaria parkinsoni	Black Petrel; Parkinsons Petrel	40041020	DEH
1043	TEP	Marine bird	Procellariidae	Procellaria westlandica	Westland Petrel	40041021	DEH
1691	TEP	Marine bird	Procellariidae	Pseudobulweria rostrata	Tahiti Petrel	40041022	DEH
1045	TEP	Marine bird	Procellariidae	Pterodroma cervicalis	White-necked Petrel	40041025	DEH
504	TEP	Marine bird	Procellariidae	Pterodroma lessoni	White-headed petrel	40041029	DEH
1046	TEP	Marine bird	Procellariidae	Pterodroma leucoptera	Gould's Petrel	40041030	DEH
1047	TEP	Marine bird	Procellariidae	Pterodroma macroptera	Great-winged Petrel	40041031	DEH
1048	TEP	Marine bird	Procellariidae	Pterodroma mollis	Soft-plumaged Petrel	40041032	DEH
1049	TEP	Marine bird	Procellariidae	Pterodroma neglecta	Kermadec Petrel (western)	40041033	DEH
1050	TEP	Marine bird	Procellariidae	Pterodroma nigripennis	Black-winged Petrel	40041034	DEH
1051	TEP	Marine bird	Procellariidae	Pterodroma solandri	Providence Petrel	40041035	DEH
1053	TEP	Marine bird	Procellariidae	Puffinus assimilis	Little Shearwater (Tasman Sea)	40041036	DEH
1054	TEP	Marine bird	Procellariidae	Puffinus bulleri	Buller's Shearwater	40041037	DEH

ERAEF species ID	Role in fishery (Component)	Taxa	Family name	Scientific name	Common Name	CAAB code	Reference
1055	TEP	Marine bird	Procellariidae	Puffinus carneipes	Flesh-footed Shearwater	40041038	DEH
1056	TEP	Marine bird	Procellariidae	Puffinus gavia	Fluttering Shearwater	40041040	DEH
1057	TEP	Marine bird	Procellariidae	Puffinus griseus	Sooty Shearwater	40041042	DEH
1058	TEP	Marine bird	Procellariidae	Puffinus huttoni	Hutton's Shearwater	40041043	DEH
1059	TEP	Marine bird	Procellariidae	Puffinus pacificus	Wedge-tailed Shearwater	40041045	DEH
1060	TEP	Marine bird	Procellariidae	Puffinus tenuirostris	Short-tailed Shearwater	40041047	DEH
918	TEP	Marine bird	Hydrobatidae	Fregetta grallaria	White-bellied Storm-Petrel (Tasman Sea),	40042001	DEH
917	TEP	Marine bird	Hydrobatidae	Fregetta tropica	Black-bellied Storm-Petrel	40042002	DEH
555	TEP	Marine bird	Hydrobatidae	Garrodia nereis	Grey-backed storm petrel	40042003	DEH
556	TEP	Marine bird	Hydrobatidae	Oceanites oceanicus	Wilson's storm petrel (subantarctic)	40042004	DEH
1004	TEP	Marine bird	Hydrobatidae	Pelagodroma marina	White-faced Storm-Petrel	40042007	DEH
1432	TEP	Marine bird	Phaethontidae	Phaethon rubricauda	Red-tailed Tropicbird	40045002	DEH
1549	TEP	Marine bird	Sulidae	Morus capensis	Cape gannet	40047001	DEH
998	TEP	Marine bird	Sulidae	Morus serrator	Australasian Gannet	40047002	DEH
1433	TEP	Marine bird	Sulidae	Sula dactylatra	Masked Booby	40047004	DEH
912	TEP	Marine bird	Phalacrocoracidae	Phalacrocorax fuscescens	Black faced cormorant	40048003	DEH
1438	TEP	Marine bird	Laridae	Anous minutus	Black Noddy	40128001	DEH
203	TEP	Marine bird	Laridae	Anous stolidus	Common noddy	40128002	DEH
67	TEP	Marine bird	Laridae	Anous tenuirostris	Lesser noddy	40128003	DEH
325	TEP	Marine bird	Laridae	Catharacta skua	Great Skua	40128005	DEH
973	TEP	Marine bird	Laridae	Larus dominicanus	Kelp Gull	40128012	DEH
974	TEP	Marine bird	Laridae	Larus novaehollandiae	Silver Gull	40128013	DEH
975	TEP	Marine bird	Laridae	Larus pacificus	Pacific Gull	40128014	DEH
1582	TEP	Marine bird	Laridae	Procelsterna cerulea	grey ternlet	40128018	DEH
1014	TEP	Marine bird	Laridae	Sterna albifrons	Little tern	40128022	DEH
1015	TEP	Marine bird	Laridae	Sterna anaethetus	Bridled Tern	40128023	DEH
1017	TEP	Marine bird	Laridae	Sterna bergii	Crested Tern	40128025	DEH
1018	TEP	Marine bird	Laridae	Sterna caspia	Caspian Tern	40128026	DEH
1020	TEP	Marine bird	Laridae	Sterna fuscata	Sooty tern	40128028	DEH

ERAEF species ID	Role in fishery (Component)	Taxa	Family name	Scientific name	Common Name	CAAB code	Reference
1021	TEP	Marine bird	Laridae	Sterna hirundo	Common tern	40128029	DEH
1023	TEP	Marine bird	Laridae	Sterna paradisaea	Arctic tern	40128032	DEH
1024	TEP	Marine bird	Laridae	Sterna striata	White-fronted Tern	40128033	DEH
1025	TEP	Marine bird	Laridae	Sterna sumatrana	Black-naped tern	40128034	DEH
1086	TEP	Marine bird	Diomedeidae	Thalassarche steadi	White-capped Albatross	0	DEH
1673	TEP	Marine bird	Thalassarche	Thalassarche nov. sp.	Pacific Albatross	0	DEH
896	TEP	Marine mammal	Balaenidae	Eubalaena australis	Southern Right Whale	41110001	DEH
289	TEP	Marine mammal	Balaenidae	Caperea marginata	Pygmy Right Whale	41110002	DEH
256	TEP	Marine mammal	Balaenopteridae	Balaenoptera acutorostrata	Minke Whale	41112001	DEH
261	TEP	Marine mammal	Balaenopteridae	Balaenoptera borealis	Sei Whale	41112002	DEH
262	TEP	Marine mammal	Balaenopteridae	Balaenoptera edeni	Bryde's Whale	41112003	DEH
265	TEP	Marine mammal	Balaenopteridae	Balaenoptera musculus	Blue Whale	41112004	DEH
268	TEP	Marine mammal	Balaenopteridae	Balaenoptera physalus	Fin Whale	41112005	DEH
984	TEP	Marine mammal	Balaenopteridae	Megaptera novaeangliae	Humpback Whale	41112006	DEH
1439	TEP	Marine mammal	Balaenidae	Balaenoptera bonaerensis	Antarctic Minke Whale	41112007	DEH
612	TEP	Marine mammal	Delphinidae	Delphinus delphis	Common Dolphin	41116001	DEH
902	TEP	Marine mammal	Delphinidae	Feresa attenuata	Pygmy Killer Whale	41116002	DEH
934	TEP	Marine mammal	Delphinidae	Globicephala macrorhynchus	Short-finned Pilot Whale	41116003	DEH
935	TEP	Marine mammal	Delphinidae	Globicephala melas	Long-finned Pilot Whale	41116004	DEH
937	TEP	Marine mammal	Delphinidae	Grampus griseus	Risso's Dolphin	41116005	DEH
970	TEP	Marine mammal	Delphinidae	Lagenodelphis hosei	Fraser's Dolphin	41116006	DEH
832	TEP	Marine mammal	Delphinidae	Lagenorhynchus cruciger	Hourglass dolphin	41116007	DEH
971	TEP	Marine mammal	Delphinidae	Lagenorhynchus obscurus	Dusky Dolphin	41116008	DEH
61	TEP	Marine mammal	Delphinidae	Lissodelphis peronii	Southern Right Whale Dolphin	41116009	DEH
1002	TEP	Marine mammal	Delphinidae	Orcinus orca	Killer Whale	41116011	DEH
1007	TEP	Marine mammal	Delphinidae	Peponocephala electra	Melon-headed Whale	41116012	DEH
1044	TEP	Marine mammal	Delphinidae	Pseudorca crassidens	False Killer Whale	41116013	DEH
1076	TEP	Marine mammal	Delphinidae	Sousa chinensis	Indo-Pacific Humpback Dolphin	41116014	DEH
1080	TEP	Marine mammal	Delphinidae	Stenella attenuata	Spotted Dolphin	41116015	DEH
1081	TEP	Marine mammal	Delphinidae	Stenella coeruleoalba	Striped Dolphin	41116016	DEH

ERAEF species ID	Role in fishery (Component)	Taxa	Family name	Scientific name	Common Name	CAAB code	Reference
1082	TEP	Marine mammal	Delphinidae	Stenella longirostris	Long-snouted Spinner Dolphin	41116017	DEH
1083	TEP	Marine mammal	Delphinidae	Steno bredanensis	Rough-toothed Dolphin	41116018	DEH
1091	TEP	Marine mammal	Delphinidae	Tursiops truncatus	Bottlenose Dolphin	41116019	DEH
1494	TEP	Marine mammal	Delphinidae	Tursiops aduncus	Indian Ocean bottlenose dolphin	41116020	DEH
968	TEP	Marine mammal	Physeteridae	Kogia breviceps	Pygmy Sperm Whale	41119001	DEH
969	TEP	Marine mammal	Physeteridae	Kogia simus	Dwarf Sperm Whale	41119002	DEH
1036	TEP	Marine mammal	Physeteridae	Physeter catodon	Sperm Whale	41119003	DEH
269	TEP	Marine mammal	Ziphiidae	Berardius arnuxii	Arnoux's Beaked Whale	41120001	DEH
959	TEP	Marine mammal	Ziphiidae	Hyperoodon planifrons	Southern Bottlenose Whale	41120002	DEH
985	TEP	Marine mammal	Ziphiidae	Mesoplodon bowdoini	Andrew's Beaked Whale	41120004	DEH
986	TEP	Marine mammal	Ziphiidae	Mesoplodon densirostris	Blainville's Beaked Whale	41120005	DEH
987	TEP	Marine mammal	Ziphiidae	Mesoplodon gingkodens	Gingko Beaked Whale	41120006	DEH
988	TEP	Marine mammal	Ziphiidae	Mesoplodon grayi	Gray's Beaked Whale	41120007	DEH
989	TEP	Marine mammal	Ziphiidae	Mesoplodon hectori	Hector's Beaked Whale	41120008	DEH
990	TEP	Marine mammal	Ziphiidae	Mesoplodon layardii	Strap-toothed Beaked Whale	41120009	DEH
991	TEP	Marine mammal	Ziphiidae	Mesoplodon mirus	True's Beaked Whale	41120010	DEH
1030	TEP	Marine mammal	Ziphiidae	Tasmacetus shepherdi	Tasman Beaked Whale	41120011	DEH
1098	TEP	Marine mammal	Ziphiidae	Ziphius cavirostris	Cuvier's Beaked Whale	41120012	DEH
216	TEP	Marine mammal	Otariidae	Arctocephalus forsteri	New Zealand Fur-seal	41131001	DEH
253	TEP	Marine mammal	Otariidae	Arctocephalus pusillus doriferus	Australian Fur Seal	41131003	DEH
263	TEP	Marine mammal	Otariidae	Arctocephalus tropicalis	Subantarctic fur seal	41131004	DEH
1000	TEP	Marine mammal	Otariidae	Neophoca cinerea	Australian Sea-lion	41131005	DEH
295	TEP	Marine mammal	Phocidae	Hydrurga leptonyx	Leopard seal	41136001	DEH
993	TEP	Marine mammal	Phocidae	Mirounga leonina	Elephant seal	41136004	DEH
813	TEP	Marine mammal	Dugongidae	Dugong dugon	Dugong	41206001	DEH
324	TEP	Marine reptile	Cheloniidae	Caretta caretta	Loggerhead	39020001	DEH
541	TEP	Marine reptile	Cheloniidae	Chelonia mydas	Green turtle	39020002	DEH
822	TEP	Marine reptile	Cheloniidae	Eretmochelys imbricata	Hawksbill turtle	39020003	DEH
613	TEP	Marine reptile	Dermochelyidae	Dermochelys coriacea	Leathery turtle	39021001	DEH

ERAEF species ID	Role in fishery (Component)	Taxa	Family name	Scientific name	Common Name	CAAB code	Reference
1408	TEP	Marine reptile	Hydrophiidae	Acalyptophis peronii	Horned Seasnake	39125001	DEH
254	TEP	Marine reptile	Hydrophiidae	Astrotia stokesii	Stokes' seasnake	39125009	DEH
1530	TEP	Marine reptile	Hydrophiidae	Disteira kingii	spectacled seasnake	39125010	DEH
957	TEP	Marine reptile	Hydrophiidae	Hydrophis elegans	Elegant seasnake	39125021	DEH
1423	TEP	Marine reptile	Hydrophiidae	Hydrophis ornatus	seasnake	39125028	DEH
1005	TEP	Marine reptile	Hydrophiidae	Pelamis platurus	yellow-bellied seasnake	39125033	DEH
1074	TEP	Teleost	Solenostomidae	Solenostomus cyanopterus	Blue-finned Ghost Pipefish, Robust Ghost	37281001	DEH
1075	TEP	Teleost	Solenostomidae	Solenostomus paradoxus	Harlequin Ghost Pipefish, Ornate Ghost Pipefish	37281002	DEH
1010	TEP	Teleost	Syngnathidae	Phycodurus eques	Leafy Seadragon	37282001	DEH
1011	TEP	Teleost	Syngnathidae	Phyllopteryx taeniolatus	Weedy Seadragon, Common Seadragon	37282002	DEH
320	TEP	Teleost	Syngnathidae	Solegnathus guentheri	Indonesian Pipefish, Gunther's Pipehorse	37282003	DEH
1072	TEP	Teleost	Syngnathidae	Solegnathus robustus	Robust Spiny Pipehorse, Robust Pipehorse	37282004	DEH
549	TEP	Teleost	Syngnathidae	Hippocampus angustus	Western Spiny Seahorse	37282005	DEH
1089	TEP	Teleost	Syngnathidae	Trachyrhamphus bicoarctatus	Bend Stick Pipefish, Short-tailed Pipefish	37282006	DEH
1092	TEP	Teleost	Syngnathidae	Urocampus carinirostris	Hairy Pipefish	37282008	DEH
980	TEP	Teleost	Syngnathidae	Lissocampus runa	Javelin Pipefish	37282009	DEH
946	TEP	Teleost	Syngnathidae	Hippocampus bleekeri	pot bellied seahorse	37282010	DEH
953	TEP	Teleost	Syngnathidae	Histiogamphelus briggsii	Briggs' Crested Pipefish, Briggs' Pipefish	37282011	DEH
961	TEP	Teleost	Syngnathidae	Hypselognathus rostratus	Knife-snouted Pipefish	37282012	DEH
978	TEP	Teleost	Syngnathidae	Leptoichthys fistularius	Brushtail Pipefish	37282013	DEH
966	TEP	Teleost	Syngnathidae	Kaupus costatus	Deep-bodied Pipefish	37282014	DEH
995	TEP	Teleost	Syngnathidae	Mitotichthys semistriatus	Half-banded Pipefish	37282015	DEH
979	TEP	Teleost	Syngnathidae	Lissocampus caudalis	Australian Smooth Pipefish, Smooth Pipefish	37282016	DEH
1026	TEP	Teleost	Syngnathidae	Stigmatopora argus	Spotted Pipefish	37282017	DEH
1027	TEP	Teleost	Syngnathidae	Stigmatopora nigra	Wide-bodied Pipefish, Black Pipefish	37282018	DEH
1028	TEP	Teleost	Syngnathidae	Stipecampus cristatus	Ring-backed Pipefish	37282019	DEH

ERAEF species ID	Role in fishery (Component)	Taxa	Family name	Scientific name	Common Name	CAAB code	Reference
1061	TEP	Teleost	Syngnathidae	Pugnaso curtirostris	Pug-nosed Pipefish	37282021	DEH
994	TEP	Teleost	Syngnathidae	Mitotichthys mollisoni	Mollison's Pipefish	37282022	DEH
1094	TEP	Teleost	Syngnathidae	Vanacampus phillipi	Port Phillip Pipefish	37282023	DEH
1095	TEP	Teleost	Syngnathidae	Vanacampus poecilolaemus	Australian Long-snout Pipefish, Long-snouted Pipefish	37282024	DEH
996	TEP	Teleost	Syngnathidae	Mitotichthys tuckeri	Tucker's Pipefish	37282025	DEH
947	TEP	Teleost	Syngnathidae	Hippocampus breviceps	Short-head Seahorse, Short-snouted Seaho	37282026	DEH
952	TEP	Teleost	Syngnathidae	Hippocampus whitei	white's seahorse	37282027	DEH
1073	TEP	Teleost	Syngnathidae	Solegnathus spinosissimus	spiny pipehorse	37282029	DEH
938	TEP	Teleost	Syngnathidae	Halicampus grayi	Mud Pipefish, Gray's Pipefish	37282030	DEH
949	TEP	Teleost	Syngnathidae	Hippocampus taeniopterus	Spotted Seahorse, Yellow Seahorse	37282033	DEH
105	TEP	Teleost	Syngnathidae	Acentronura australe	Southern Pygmy Pipehorse	37282034	DEH
114	TEP	Teleost	Syngnathidae	Acentronura breviperula	Hairy Pygmy Pipehorse	37282035	DEH
287	TEP	Teleost	Syngnathidae	Campichthys galei	Gale's Pipefish	37282039	DEH
288	TEP	Teleost	Syngnathidae	Campichthys tryoni	Tryon's Pipefish	37282041	DEH
389	TEP	Teleost	Syngnathidae	Choeroichthys suillus	Pig-snouted Pipefish	37282046	DEH
563	TEP	Teleost	Syngnathidae	Corythoichthys amplexus	Fijian Banded Pipefish, Brown-banded Pipefish	37282047	DEH
578	TEP	Teleost	Syngnathidae	Corythoichthys ocellatus	Orange-spotted Pipefish, Ocellated Pipefish	37282050	DEH
401	TEP	Teleost	Syngnathidae	Cosmocampus banneri	Roughridge Pipefish	37282053	DEH
580	TEP	Teleost	Syngnathidae	Cosmocampus howensis	Lord Howe Pipefish	37282055	DEH
569	TEP	Teleost	Syngnathidae	Doryrhamphus melanopleura	Bluestripe Pipefish	37282058	DEH
904	TEP	Teleost	Syngnathidae	Festucalex cinctus	Girdled Pipefish	37282061	DEH
321	TEP	Teleost	Syngnathidae	Festucalex scalaris	Ladder Pipefish	37282063	DEH
914	TEP	Teleost	Syngnathidae	Filicampus tigris	Tiger Pipefish	37282064	DEH
54	TEP	Teleost	Syngnathidae	Halicampus brocki	Brock's Pipefish	37282065	DEH
1592	TEP	Teleost	Syngnathidae	Halicampus macrorhynchus	[a pipefish]	37282067	DEH
942	TEP	Teleost	Syngnathidae	Heraldia nocturna	Upside-down Pipefish	37282071	DEH
943	TEP	Teleost	Syngnathidae	Hippichthys cyanospilos	Blue-speckled Pipefish, Blue-spotted Pipefish	37282072	DEH

ERAEF species ID	Role in fishery (Component)	Taxa	Family name	Scientific name	Common Name	CAAB code	Reference
944	TEP	Teleost	Syngnathidae	Hippichthys heptagonus	Madura Pipefish	37282073	DEH
945	TEP	Teleost	Syngnathidae	Hippichthys penicillus	Beady Pipefish, Steep-nosed Pipefish	37282075	DEH
951	TEP	Teleost	Syngnathidae	Hippocampus planifrons	Flat-face Seahorse	37282078	DEH
954	TEP	Teleost	Syngnathidae	Histiogamphelus cristatus	Rhino Pipefish, Macleay's Crested Pipefish	37282081	DEH
960	TEP	Teleost	Syngnathidae	Hypselognathus horridus	Shaggy Pipefish, Prickly Pipefish	37282082	DEH
967	TEP	Teleost	Syngnathidae	Kimblaeus bassensis	Trawl Pipefish, Kimbla Pipefish	37282083	DEH
390	TEP	Teleost	Syngnathidae	Lissocampus fatiloquus	Prophet's Pipefish	37282084	DEH
983	TEP	Teleost	Syngnathidae	Maroubra perserrata	Sawtooth Pipefish	37282085	DEH
992	TEP	Teleost	Syngnathidae	Micrognathus andersonii	Anderson's Pipefish, Shortnose Pipefish	37282086	DEH
1604	TEP	Teleost	Syngnathidae	Micrognathus pygmaeus	[a pipefish]	37282087	DEH
798	TEP	Teleost	Syngnathidae	Microphis manadensis	Manado River Pipefish, Manado Pipefish	37282091	DEH
1243	TEP	Teleost	Syngnathidae	Mitotichthys meraculus	Western Crested Pipefish	37282092	DEH
1242	TEP	Teleost	Syngnathidae	Nannocampus subosseus	Bony-headed Pipefish	37282094	DEH
1001	TEP	Teleost	Syngnathidae	Notiocampus ruber	Red Pipefish	37282095	DEH
1070	TEP	Teleost	Syngnathidae	Solegnathus dunckeri	Duncker's Pipehorse	37282098	DEH
1071	TEP	Teleost	Syngnathidae	Solegnathus sp. 1 [in Kuiter, 2000]	Pipehorse	37282099	DEH
1029	TEP	Teleost	Syngnathidae	Syngnathoides biaculeatus	Double-ended Pipehorse, Alligator Pipefish	37282100	DEH
1093	TEP	Teleost	Syngnathidae	Vanacampus margaritifer	Mother-of-pearl Pipefish	37282102	DEH
1096	TEP	Teleost	Syngnathidae	Vanacampus vercoi	Verco's Pipefish	37282103	DEH
950	TEP	Teleost	Syngnathidae	Hippocampus minotaur	Bullneck Seahorse	37282105	DEH
1591	TEP	Teleost	Syngnathidae	Halicampus boothae	[a pipefish]	37282107	DEH
948	TEP	Teleost	Syngnathidae	Hippocampus queenslandicus	Kellogg's Seahorse	37282110	DEH
1602	TEP	Teleost	Syngnathidae	Hippocampus tristis	[a pipefish]	37282117	DEH
1664	TEP	Teleost	Syngnathidae	Hippocampus abdominalis	Big-bellied / southern potbellied seahorse	37282120	DEH
548	TEP	Teleost	Syngnathidae	Hippocampus subelongatus	West Australian Seahorse	37282123	DEH
1548	TEP	Teleost	Syngnathidae	Heraldia sp. 1 [in Kuiter, 2000]	Western upsidedown pipefish	37282130	DEH

ERAEF species ID	Role in fishery (Component)	Taxa	Family name	Scientific name	Common Name	CAAB code	Reference
308	TEP	Teleost	Clinidae	Heteroclinus perspicillatus	Common weedfish	37416013	DEH
1666	TEP	Teleost	Syngnathidae	Hippocampus kelloggi	Kellogg's Seahorse	NA	DEH
1667	TEP	Teleost	Syngnathidae	Hippocampus kuda	Spotted Seahorse, Yellow Seahorse	NA	DEH
1668	TEP	Teleost	Syngnathidae	Hippocampus subelongatus	West Australian Seahorse	NA	DEH
1699	TEP	Teleost	Syngnathidae	Idiotropiscis australe	Southern Pygmy Pipehorse	NA	DEH

Scoping Document S2B1. Benthic Habitats

Risk assessment for benthic habitats considers both the seafloor structure and its attached invertebrate fauna. Because data on the types and distributions of benthic habitat in Australia's Commonwealth fisheries are generally sparse, and because there is no universally accepted benthic classification scheme, the ERAEF methodology has used the most widely available type of data – seabed imagery – classified in a similar manner to that used in bioregionalisation and deep seabed mapping in Australian Commonwealth waters. Using this imagery, benthic habitats are classified based on an SGF score, using sediment, geomorphology, and fauna. Where seabed imagery is not available, a second method (Method 2) is used to develop an inferred list of potential habitat types for the fishery. For details of both methods, see Hobday *et al* (2007).

A list of the benthic habitats for the Small Pelagic Fishery: Midwater Trawl sub-fishery. All habitats occur within the jurisdictional boundary of the sub-fishery; however, effort is pelagic with only occasional benthic contact from Midwater Trawl nets.

ERAEF record No.	ERAEF Habitat Number	Sub-biome	Feature	Habitat type	SGF Score	Depth (m)	Image available	Reference image location
0011	001	inner-shelf	shelf	gravel, current rippled, mixed faunal community	313	25- 100	Y	SE Image Collection
0023	002	inner-shelf	shelf	Sedimentary rock, outcrop, large sponges	691	25- 100	Y	SE Image Collection
0035	003	inner-shelf	shelf	Sedimentary rock, outcrop, mixed faunal community	693	25- 100	Y	SE Image Collection
0047	004	inner-shelf	shelf	Sedimentary rock, outcrop, large sponges	671	25- 100	Y	SE Image Collection
0059	005	inner-shelf	shelf	cobble, debris flow, large sponges	441	25- 100	Y	SE Image Collection
0071	006	inner-shelf	shelf	coarse sediments, subcrop, large sponges	251	25- 100	Y	SE Image Collection
0083	007	inner-shelf	shelf	gravel, debris flow, mixed faunal community	343	25- 100	Y	SE Image Collection
0095	009	inner-shelf	shelf	coarse sediments, wave rippled, sedentary	227	25- 100	Y	SE Image Collection
0994	010	Inner shelf	shelf	Coarse sediments, directed scour, No fauna	210	25- 100	Y	GAB image collection
0120	011	inner-shelf	shelf	coarse sediments, wave rippled, large sponges	221	25- 100	Y	SE Image Collection
0132	012	inner-shelf	shelf	fine sediments, unrippled, large sponges	101	25- 100	Y	SE Image Collection
0144	013	inner-shelf	shelf	coarse sediments, unrippled, large sponges	201	25- 100	Y	SE Image Collection
0156	014	inner-shelf	shelf	fine sediments, wave rippled, large sponges	111	25- 100	Y	SE Image Collection
0168	016	inner-shelf	shelf	fine sediments, unrippled, mixed faunal community	103	25- 100	Y	SE Image Collection
2137	089	inner shelf	Shelf	Coarse sediments, irregular, bryozoan turf	236	25-100	Y	WA Image Collection

ERAEF record No.	ERAEF Habitat Number	Sub-biome	Feature	Habitat type	SGF Score	Depth (m)	Image available	Reference image location
0868	090	inner-shelf	shelf	coarse sediments, current rippled, bioturbators	219	25- 100	N	SE Image Collection
0880	091	inner-shelf	shelf	fine sediments, irregular, large sponges	131	25- 100	N	SE Image Collection
0892	092	inner-shelf	shelf	fine sediments, irregular, small sponges	132	25- 100	N	SE Image Collection
0904	093	inner-shelf	shelf	fine sediments, unrippled, bioturbators	109	25- 100	N	SE Image Collection
0916	094	inner-shelf	shelf	fine sediments, unrippled, small sponges	102	25- 100	N	SE Image Collection
2133	095	inner shelf	Shelf	Fine sediments, Wave rippled, No fauna	120	25-100	Y	WA Image Collection
0941	096	inner-shelf	shelf	fine sediments, wave rippled, small sponges	122	25- 100	N	SE Image Collection
0953	097	inner-shelf	shelf	gravel, wave rippled, bioturbators	329	25- 100	Y	SE Image Collection
0965	098	inner-shelf	shelf	gravel, wave rippled, no fauna	320	25- 100	Y	SE Image Collection

Scoping Document S2B2. Pelagic Habitats

A list of the pelagic habitats for the Small Pelagic Fishery: Midwater Trawl. Shading denotes habitats occurring within the jurisdictional boundary of the sub-fishery that are not subject to effort from Midwater Trawling.

ERAEF Habitat Number	Pelagic Habitat type	Depth (m)	Comments	Reference
P1	Eastern Pelagic Province - Coastal	0 – 200		dow167A1, A2, A4
P2	Eastern Pelagic Province - Oceanic	0 – > 600	this is a compilation of the range covered by Oceanic Community (1) and (2)	dow167A1, A2, A4
P7	Southern Pelagic Province - Coastal	0 – 200	this is a compilation of the range covered by Coastal pelagic Tas and GAB	dow167A1, A2, A4
P8	Southern Pelagic Province - Oceanic	0 – > 600	this is a compilation of the range covered by Oceanic Communities (1), (2), and (3)	dow167A1, A2, A4
P9	Southern Pelagic Province - Seamount Oceanic	0 – > 600	this is a compilation of the range covered by Seamount Oceanic Communities (1), (2), and (3)	dow167A1, A2, A4
P12	Eastern Pelagic Province - Seamount Oceanic	0 – > 600	this is a compilation of the range covered by Seamount Oceanic Communities (1) and (2)	dow167A1, A2, A4

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.

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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,]								x		x									
Upper Slope 250 – 565m [3]								x		x									
Mid–Upper Slope 565 – 820m [3]								x		x									
Mid Slope 820 – 1100m [3]								x		x									
Lower slope/ Abyssal > 1100m [6]																			
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																			

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
Plateau 0 – 110m																			
Plateau 110- 250m[4]																			
Plateau 250 – 565m[4]																			
Plateau 565 – 820m[5]																			
Plateau 820 – 1100m[5]																			

Demersal communities which underlie the pelagic communities in the Small Pelagic midwater trawl sub-fishery (x). Shaded cells indicate all communities within the province. [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, 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 in which fishing activity occurs in Small Pelagic midwater trawl sub-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]			x					
Oceanic (1) 0 – 600m								
Oceanic (2) >600m								
Seamount oceanic (1) 0 – 600m								
Seamount oceanic (2) 600-3000m								
Oceanic (1) 0 – 200m			x					
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]								
Oceanic (1) 0-1000m								
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.

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

Table (Note: Operational objectives that are eliminated should be shaded out and a rationale provided as for the retained operational objectives)

Component	Core Objective	Sub-component	Example Operational Objectives	Example Indicators	Rationale
	"What is the general goal?"		*"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
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 EMO – Catch levels set to ensure a high probability the population is maintained. 1.2 EMO - set Total Allowable Catch (TAC) for target species. Trigger catch limits of target species is being used to manage fishing effort in each zone. 1.3 EMO – Current catch levels set to ensure it should not fall below 50% of TAC
		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 Fishery managed in four zones and there are trigger catch limits for target species in each zone.
		3- Genetic structure	- 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 in this fishery, difficult and expected to respond at a slower rate than some of the other indicators.
		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 Maintain population size and age structure. Fishery catches can be dominated by few age classes. Need to ensure this does not adversely impact on the entire population

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) Recruitment to the population does not change outside acceptable bounds	Egg production of population Abundance of recruits	5.1 TACs and Trigger catch limits are set conservatively in the knowledge that the target species have large natural fluctuations in numbers. A change in fecundity might result in lower recruitment to the fishery
		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 bate, lights)	6.1 Populations of target species move widely in response to currents. Trigger TACs set to minimize impacts on spatially or temporally more vulnerable schools
Byproduct and Bycatch species	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 EMO - Fishing is conducted in a manner that does not threaten stocks of by-product / by-catch species (AFMA 2002). 1.2 Byproduct/bycatch trigger levels set to ensure catch remains a small proportion of total catch. 1.3 Total catch set to ensure biomass or target and byproduct/bycatch remain at sustainable levels. 1.4 Not desirable to maintain by-catch/by-product at specified level for the SBT Fishery – want to minimise by-catch/by-product
		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 by-catch/by-product species.
		3. Genetic structure	- Genetic diversity does not change outside acceptable bounds	Frequency of genotypes in the population, effective population size (N_e), number of spawning units	Not currently monitored. No reference levels established. No specific management objective based on the genetic structure of by-catch species.

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 Not currently monitored. No reference levels established. No specific management objective for the age/size structure of byproduct/bycatch species
		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. Not currently monitored in the fishery. No specific management measures identified to assess changes in reproductive capacity of byproduct/bycatch species
		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 Not currently monitored in the fishery. No specific management measures identified to assess changes in reproductive capacity of byproduct/bycatch species
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 - No trend in biomass - Maintain biomass above a specified level - 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 (AFMA 2002). - A positive trend in biomass is desirable for TEP species. - Maintenance of TEP biomass above specified level not currently a fishery operational objective.
		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 GAB	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.

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 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.
		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) 5.2 Recruitment to the population does not change outside acceptable bounds	Egg production of population Abundance of recruits	5.1 & 5.2 The reproductive capacity of TEP species is of concern to the Small Pelagics Fishery because potential fishery induced changes in reproductive ability (e.g. reduction in bait fish reduction in seabird brooding success) may have immediate impact on the population size of TEP species.
		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 Purse seine capture methods may attract TEP species and alter behaviour and movement patterns, resulting in the attraction of offshore species to inshore areas e.g. great white shark. The overall effect may be to further fragment the population. Fishing operations may also influence the behaviour of calving whales by visual/sound stimuli.

Component	Core Objective	Sub-component	Example Operational Objectives	Example Indicators	Rationale
		7. Interactions with fishery	7.1 Interactions between TEP and the fishery are minimised. 7.2 Survival after interactions is maximised 7.3 Interactions do not affect the viability of the population or its ability to recover	Number of interactions Survival rate of species after interactions Number of interactions, biomass or numbers in population	7.1, 7.2, 7.3 EMO - The fishery is conducted in a manner that avoids mortality of, or injuries to, endangered, threatened or protected species (AFMA 2002).
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 Few water quality issues because of the dispersed nature of the fishery and low levels in fishing effort.
		- Air quality	- Air quality does not change outside acceptable bounds	Air chemistry, noise levels, visual pollution, pollutant concentrations, light pollution from artificial light	- Not currently perceived as an important habitat sub-component, purse seine operations not believed to strongly influence air quality.
		- Substrate quality	- Sediment quality does not change outside acceptable bounds	Sediment chemistry, stability, particle size, debris, pollutant concentrations	- Purse-seining and midwater trawling do not impact on the substrate so there is not perceived effects from this fishery.
		- Habitat types	- Relative abundance of habitat types does not vary outside acceptable bounds	Extent and area of habitat types, % cover, spatial pattern, landscape scale	- Purse seine operations not perceived to result in change of habitat frequency.
		2. Habitat structure and function	2.1 Size, shape and condition of habitat types does not vary outside acceptable bounds	Size structure, species composition and morphology of biotic habitats	2.1 Purse seining and midwater trawling activities may result in local disruption to pelagic 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 ecological communities (AFMA 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 There may be changes to the geographic extent of pelagic community components due to associated fishing activities.
		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 Extraction of Small Pelagics may reduce the prey of the higher level predator functional group in the Zone 4 potentially resulting in migratory or behavioural shifts in predator species like SBT and seals.
		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 Purse seine and midwater trawl operations not perceived to have a measurable 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

Fishery Name: Small Pelagics Fishery
Sub-fishery Name: Midwater trawl sub-fishery
Date: 29 May 2006

Direct impact of Fishing	Fishing Activity	Score (0/1)	Documentation of Rationale
Capture	Bait collection	0	Bait not required by fishery.
	Fishing	1	Actual fishing, i.e. capture of small pelagic species resulting from deployment and retrieval of midwater trawl net including target, bycatch, byproduct and TEP species caught but not landed.
	Incidental behaviour	0	
Direct impact without capture	Bait collection	0	Not required by fishery.
	Fishing	1	Disorientation/injury/mortality as a result of momentary entanglement in net but animal may free itself, e.g. dolphin, escaping target species. Birds may strike trawl warps.
	Incidental behaviour	0	
	Gear loss	1	Minor components: occasionally lost. Potential lost items could entangle animals includes netting, ropes, buoys, etc. – Observer data needed. Major component gear loss: Midwater trawl nets are extremely expensive and simple commercial considerations predicate cautious deployment. Major gear loss is likely to be infrequent.
	Anchoring/ mooring	0	Fishery only operates in deep water; boats do not anchor at night, when not fishing.
	Navigation/steaming	1	Steaming/navigation to find aggregations of fish may result in collisions (e.g. seabirds or whales vessel interactions), seabird collisions with night-time lights/navigation lights.
Addition/ movement of biological material	Translocation of species (boat launching, reballasting)	0	No bait used. Vessels do not launch or travel inter-state to fish
	On board processing	0	
	Discarding catch	1	Discarding is limited, but may attract predators.
	Stock enhancement	0	
	Provisioning	0	
	Organic waste disposal	1	Disposal of organic wastes (food scraps, sewage) occurs as a result of general fishing vessel operations, may affect behaviour/ movement of animals.
Addition of non-biological material	Debris	1	Debris generated during general fishing vessel operations, debris may entangle animals causing damage or mortality or may disrupt behaviour, volume of debris generated by SP fishery unknown requires monitoring.

Direct impact of Fishing	Fishing Activity	Score (0/1)	Documentation of Rationale
	Chemical pollution	1	Exhaust from diesel engines occurs during fishing activities and steaming.
	Exhaust	1	Occurs
	Gear loss	1	See comments under above entry for gear loss. Potential lost items includes netting, ropes, buoys etc.
	Navigation/ steaming	1	Purse seine operations involve vessels navigating to and from fishing grounds.
	Activity/ presence on water	1	Purse seine operations involve the presence of several vessels on the fishing grounds –introducing noise and visual stimuli into the environment.
Disturb physical processes	Bait collection	0	Bait not required by fishery.
	Fishing	1	Purse seine fishing activities may disturb/disrupt local physical water flow patterns, e.g. vertical mixing. Interaction with benthic habitat occurs but does not cause significant alteration of benthic habitats.
	Boat launching	0	Not applicable. Vessels in fishery come from designated ports.
	Anchoring/ mooring	0	Does not occur on fishing grounds.
	Navigation/ steaming	1	Purse seine operations involve vessels navigating to and from fishing grounds.
External Hazards (specify the particular example within each activity area)	Other capture fishery methods	1	Target Species may be captured by purse-seine methods. Byproduct species in the SPF are targeted in other fisheries (e.g. blue eye).
	Aquaculture	0	Fishery offshore.
	Coastal development	1	Unlikely to have significant impact with current distribution of effort which is mainly offshore.
	Other extractive activities	1	Offshore fishery but offshore petroleum exploration occurs in Bass Strait.
	Other non-extractive activities	1	Use by military, munitions testing, disposal, cable laying not suggested. Coastal shipping may disrupt feeding schools.
	Other anthropogenic activities	1	Whale watching and charter fishing occurs.

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 uses 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,	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
	reballasting)	
	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.

Direct Impact of Fishing	Fishing Activity	Examples of Activities Include
	Fishing	Fishing activities may disturb physical processes if the gear contacts seafloor-disturbing sediment, or if the gear disrupts water flow patterns.
	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. Five out of 6 external activities were identified. Thus, a total of 19 activity-component scenarios will be considered at Level 1. This results in 95 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 subcomponent
- 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 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 C).

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

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 (from S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence score (1-2)	Rationale
Capture	Bait collection	0									
	Fishing	1	4	6	Population size	Redbait	1.2	2	3	1	Fishing effort is almost entirely restricted to waters along the edge of the continental shelf off the east coast of Tasmania. Fishing occurs daily. Trigger limits on catch size. Intense fishing effort off E. Tasmania. Sustainable exploitation rate off Tas. Confidence was considered low because there is no formal stock assessment.
	Incidental behaviour	0									
Direct impact without capture	Bait collection	0									
	Fishing	1	4	6	Behaviour/ movement	Redbait	6.1	2	2	1	Fishing effort is almost entirely restricted to waters along the edge of the continental shelf off the east coast of Tasmania. Fishing occurs daily Fishing known to disrupt target species schools and hence is expected to have highest potential risk for the Behaviour/ movement sub-component . Consequence considered minor as ‘school’ impacts would be localised and change not detectable at the scale of the fishery. Confidence low because no data exists on non-capture fishing impacts on small pelagics.
	Incidental behaviour	0									
	Gear loss	1	4	4	Population size	Redbait	1.2	2	1	2	Fishing effort is almost entirely restricted to waters along the edge of the continental shelf off the east coast of Tasmania. Fishing occurs daily. Gear loss may occur quarterly. Lost gear resulting in damage/ mortality most likely to effect population size of small pelagic species. Intensity was scored as Minor because lost gear – small pelagic species interactions (if they occur) are considered to be rare Consequence considered Negligible - unlikely to be detectable at the scale of the small pelagic stocks Confidence was scored as low because of a lack of data on interactions between small pelagic species and lost purse seine fishing gear.
	Anchoring/ mooring	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 (from S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence score (1-2)	Rationale
	Navigation/ steaming	1	4	6	Behaviour/ movement	Redbait	6.1	2	1	2	Fishing effort is almost entirely restricted to waters along the edge of the continental shelf off the east coast of Tasmania. Fishing occurs daily. Direct impact without capture due to Navigation/steaming was considered most likely to affect behaviour/ movement of small pelagic species. Most fishing effort, hence Navigation/ steaming, is concentrated off eastern Tasmania in Zone A and so the intensity of the activity is local (Minor). Consequence was considered Negligible – any impact unlikely to result in detectable change to behaviour and movement, time taken to recover to pre-disturbed state on the scale of hours. Confidence was scored as high because it was considered (within logical constraints) unlikely for there to be strong negative interactions between Navigation/steaming and small pelagic species.
Addition/ movement of biological material	Translocation of species	0									
	On board processing	0									
	Discarding catch	1	4	6	Behaviour/ movement	Redbait	6.1	2	2	1	Fishing effort is almost entirely restricted to waters along the edge of the continental shelf off the east coast of Tasmania. Discarding occurs daily. Addition of biological material due to onboard processing was considered most likely to affect Behaviour/ movement of small pelagic species => Discarding catch could cause local Behavioural/ movement impacts indirectly via attraction of predators. Intensity: Minor – very small proportion of catch Consequence Minor – possible detectable change, time to return to original behaviour/ movement on the scale of days to weeks. Confidence low because there is no observational data on impacts of discarding on behaviour
	Stock enhancement	0									
	Provisioning	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 (from S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence score (1-2)	Rationale
	Organic waste disposal	1	4	6	Behaviour/ movement	Redbait	6.1	1	1	2	Fishing effort is almost entirely restricted to waters along the edge of the continental shelf off east coast Tasmania. Discarding occurs daily. Disposal of organic waste is expected to pose greatest potential risk for the Behaviour/movement of target species resulting in either attraction e.g. food scraps or repulsion e.g. raw sewage Intensity was scored as negligible because although the hazard was considered over a large range/scale, each disposal event was considered to only effect a small < 1 nm area and because small pelagic species are highly mobile strong avoidance ability was expected at the scale of 1 nm Consequence was also considered negligible i.e. any consequence on the small pelagic species in the four fishing zones are unlikely to be measurable Confidence in the consequence score was high because general fishing waste disposal was considered unlikely to impact on behaviour/movement of the mobile Small Pelagic species..
Addition of non-biological material	Debris	1	4	6	Behaviour/ movement	Redbait	6.1	2	1	2	Fishing effort is almost entirely restricted to waters along the edge of the continental shelf off the east coast of Tasmania. Discarding occurs daily. Floating marine debris may attract small pelagic species to shelter beneath it affecting behaviour and movement. considered Minor – occurs rarely or in few isolated incidences. Consequence scored negligible – unlikely to be measurable against background variability for population. Confidence high – no dumping
	Chemical pollution	1	4	6	Population size	Redbait	1.2	2	2	2	Fishing effort is almost entirely restricted to waters along the edge of the continental shelf off the east coast of Tasmania. Discarding occurs daily. Possible detectable change in behaviour/ movement but minimal impact on population, time to return to behaviour on the scale of days to weeks Intensity Minor - Chemical pollution occurs infrequently and on local scale . Chemical pollution likely to have measurable consequences if large-scale event occurs in a sensitive area, the scale of an event will be limited by the amount of chemicals carried by the fishing vessels). Consequence considered Minor – Possible detectable change in behaviour/ movement but minimal impact on population, time to return to behaviour on the scale of days to weeks.

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 (from S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence score (1-2)	Rationale
	Exhaust	1	4	6	Behaviour/ movement	Redbait	6.1	1	1	2	Fishing effort is almost entirely restricted to waters along the edge of the continental shelf off the east coast of Tasmania. Discarding occurs daily. Exhaust emission was considered to pose greatest risk for the Behaviour/movement of small pelagic species resulting in repulsion. Intensity was scored as negligible because although the hazard was considered over a large range/scale, exhaust considered to only impact a small < 1 nm area and because pelagic species are highly mobile strong avoidance ability was expected at the scale of 1 nm Consequence was also considered negligible i.e. any consequence on small pelagics unlikely to be detectable . Confidence in the consequence score was considered high because localised exhaust unlikely to impact on behaviour/movement of highly mobile small pelagics.
	Gear loss	1	6	5	Behaviour/ movement	Redbait	6.1	2	2	1	Fishing effort is almost entirely restricted to waters along the edge of the continental shelf off the east coast of Tasmania. Minor gear loss may occur weekly. Lost gear not resulting in damage/ mortality most likely to effect behaviour /movement of small pelagic species. Intensity: Minor because lost gear – small pelagic species interactions (if they occur) are considered to be rare. Consequence considered minor on small pelagic species stock - any consequence on small pelagics unlikely to be detectable, time taken to recover on scale of days –weeks. Confidence was scored as low because of a lack of data on interactions between small pelagic species and lost purse seine fishing gear.
	Navigation/ steaming	1	4	6	Behaviour/ movement	Redbait	6.1	1	1	2	Fishing effort is almost entirely restricted to waters along the edge of the continental shelf off the east coast of Tasmania... Fishing occurs daily. Navigation/ steaming most likely to affect Behaviour/ movement of small pelagic species. Intensity: unlikely to have a measurable impact Consequence: Negligible unlikely to be detectable - any consequence on small pelagic species unlikely to be detectable, time taken to recover on scale of days - weeks. Confidence: high because it is considered unlikely for there to be strong interactions between Navigation/ steaming and small pelagic species Behaviour/ movement.

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 (from S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence score (1-2)	Rationale
	Activity/ presence on water	1	4	6	Behaviour/ movement	Redbait	6.1	1	1	2	Fishing effort is almost entirely restricted to waters along the edge of the continental shelf off the east coast of Tasmania. Minor gear loss may occur weekly. Activity/presence on water of fishing vessels was expected to pose greatest potential risk for the Behaviour/movement of small pelagic species resulting in disruption to feeding and/or movement. Intensity was scored as negligible because although the hazard was considered over a large range/scale, vessel presence considered to only impact a small < 1 nm area and because small pelagic species are highly mobile strong avoidance ability was expected at the scale of 1 nm. Consequence was also considered negligible with any consequence of vessel presence impacts unlikely to be detectable for small pelagic species. Confidence in the consequence score was high because localised vessel presence/activity considered unlikely to impact and have consequences for the behaviour/movement of highly mobile small pelagic species.
Disturb physical processes	Bait collection	0									
	Fishing	1	4	6	Behaviour/ movement	Redbait	6.1	1	1	2	Fishing effort is almost entirely restricted to waters along the edge of the continental shelf off the east coast of Tasmania. Fishing occurs daily. Disturbance of physical processes via fishing was expected to pose greatest potential risk for the Behaviour/ movement of small pelagic species resulting in momentary disruption to feeding and/or movement Intensity: negligible - although the hazard was considered over a large range/scale, fishing considered to only impact physical processes over a small < 1 nm area. Consequence was also considered negligible with any consequence of water column disturbance unlikely to be detectable for small pelagic species. Confidence in consequence score was considered high because localised disruption of water column unlikely to impact and have consequences for the behaviour/movement of highly mobile pelagic species.
	Boat launching	0									
	Anchoring/ mooring	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 (from S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence score (1-2)	Rationale
	Navigation/ steaming	1	4	6	Behaviour/ movement	Redbait	6.1	1	1	2	Fishing effort is almost entirely restricted to waters along the edge of the continental shelf off the east coast of Tasmania. Minor gear loss may occur weekly. Disturbance to pelagic physical processes due to Navigation/steaming of fishing vessels was expected to pose greatest potential risk for the Behaviour/movement of small pelagic species resulting in disruption to feeding and/or migration. Intensity was scored as negligible because although the hazard was considered over a large range/scale, Navigation/ steaming considered to only impact a small < 1 nm area and because small pelagic species are highly mobile strong avoidance ability was expected at the scale of 1 nm => Consequence was also considered negligible with any impact of Navigation/ steaming unlikely to be detectable for small pelagic species. Confidence in the consequence score was considered high because Navigation/ steaming unlikely to impact and have consequences for the behaviour/movement of highly mobile pelagic species.
External Impacts (specify the particular example within each activity area)	Other fisheries	1	6	6	Population size	Redbait	1.2	2	3	1	Target species are captured daily in external fisheries including in commonwealth fisheries. Intensity considered Moderate because target species in this fishery are also the target or bycatch of other commonwealth and state fisheries => Consequence considered minor – volumes of redbait caught using other fishing methods are much lower than Midwater trawl. Consequence may be widespread relative to the species distribution in Australian waters. Confidence considered low because of a lack of formal stock assessment and the existence of unreported catch of unknown size.
	Aquaculture	0									
	Coastal development	1	6	5	Behaviour/ Movement	Redbait	6.1	2	2	1	Coastal development occurs daily around the range of the fishery, beyond the areas where effort is currently focused. Does not affect the fishery because some of the fishing is well offshore Runoff may affect primary productivity. Considered to pose greatest risk by influencing behaviour/ movement of small pelagics. Intensity considered Minor compared to large natural inter-annual variations in primary productivity Consequence considered Minor – possible detectable change in Behaviour/

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 (from S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence score (1-2)	Rationale
											movement, time to return to original behaviour/ movement on the scale of days to weeks. Confidence low because of a lack of data.
	Other extractive activities	1	5	6	Behaviour /movement	Redbait	6.1	2	2	1	Oil exploration occurs daily, beyond the main effort in the fishery across a wide geographic range, particularly in Bass Strait. Target species would avoid any spills. Intensity: spills are rare Consequence: minor, unlikely to affect a population Confidence low. No data
	Other non extractive activities	1	6	6	Behaviour/ movement	Redbait	6.1	1	1	2	Shipping activity occurs daily across the full range of the fishery, and outside areas of current effort. Greatest potential risks are to the Behaviour/movement of small pelagic species resulting in disruption to feeding and/ or migration Intensity: negligible because although the hazard was considered over a large range/scale, the shipping track is narrow - impact a < 1 nm wide and because small pelagic species are highly mobile strong avoidance ability was expected at the scale of 1 nm. Consequence: negligible with any consequence of shipping impacts unlikely to be detectable for small pelagic species Confidence: high shipping unlikely to impact and have consequences for the behaviour/movement of highly mobile small pelagic species.

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 (from S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence score (1-2)	Rationale
	Other anthropogenic activities	1	4	5	Behaviour/moveme nt	Redbait	6.1	1	1	2	Tourism occurs daily across the full range of the fishery, and outside areas of current effort. Unlikely to affect the fishery daily because much of the effort occurs offshore, away from tourism Greatest potential risks are to the Behaviour/movement of small pelagic species resulting in disruption to feeding and/ or migration. Intensity: negligible because although the hazard is dispersed over a large range, its occurrence is patchy- around population centres, and because small pelagic species are highly mobile strong avoidance ability was expected. Consequence: negligible with any consequence of tourism impacts unlikely to be detectable for small pelagic species. Confidence: high- tourism unlikely to impact and have consequences for the behaviour/movement of highly mobile small pelagic species.

2.3.1 Level 1 (SICA) Documents 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 (from S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence score (1-2)	Rationale
Capture	Bait collection	0									
	Fishing	1	4	6	Population size	Blue eye Trevalla	1.3	3	3	1	Fishing effort is almost entirely restricted to waters along the edge of the continental shelf off the east coast of Tasmania. Fishing occurs daily. Byproduct species include benthopelagic SEF quota species which have comprehensive management plans and detailed assessments e.g. blue eye Intense fishing effort of E. Tasmania. Stock fully exploited off Tas. Consequence: moderate, need to consider impacts on other fisheries Confidence: low – hard to determine the impact on SEF quota species because the volume of SEF species is difficult to evaluate during the pumping out of the target species.
	Incidental behaviour	0									
Direct impact without capture	Bait collection	0									
	Fishing	1	4	6	Behaviour/ movement	Blue eye Trevalla	6.1	2	2	1	Fishing effort is almost entirely restricted to waters along the edge of the continental shelf off the east coast of Tasmania. Fishing occurs daily. ➔Fishing known to disrupt target species schools and hence is expected to have highest potential risk for the Behaviour/ movement sub-component. ➔Consequence considered minor as 'school' impacts would be localised and change not detectable at the scale of the fishery. ➔Confidence: low - no data on non-capture fishing is sparse.
	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 (from S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence score (1-2)	Rationale
	Gear loss	1	4	4	Population size	Blue eye Trevalla	1.3	2	1	2	Lost gear resulting in damage/ mortality most likely to effect population size of demersal teleosts – may occur quarterly.➔Intensity was scored as Minor because lost gear – demersal teleost interactions (if they occur) are considered to be rare . ➔Consequence considered Negligible - unlikely to be a detectable impact on stocks. ➔Confidence was scored as low because of a lack of data on interactions between demersal teleosts and lost fishing gear.
	Anchoring/ mooring	0									
	Navigation/ steaming	1	4	6	Behaviour/ movement	Spotted warehou	6.1	1	1	2	Fishing effort is almost entirely restricted to waters along the edge of the continental shelf off the east coast of Tasmania. Fishing occurs daily. ➔Direct impact without capture due to Navigation/steaming was considered most likely to affect behaviour/ movement of spotted warehou which move up into the water column➔Most fishing effort, hence Navigation/ steaming, is concentrated off eastern Tasmania in Zone A and so the intensity of the activity is local (Minor) . ➔Consequence was considered Negligible – any impact unlikely to result in detectable change to behaviour and movement, time taken to recover to pre-disturbed state on the scale of hours ➔Confidence was scored as high because it was considered (within logical constraints) unlikely for there to be strong negative interactions between Navigation/steaming and demersal teleost species.
Addition/ movement of biological material	Translocation of species	0									
	On board processing	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 (from S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence score (1-2)	Rationale
	Discarding catch	1	4	6	Behaviour/ movement	Blue eye Trevalla	6.1	2	2	1	Fishing effort is almost entirely restricted to waters along the edge of the continental shelf off the east coast of Tasmania. Fishing occurs daily. ➔Addition of biological material due to onboard processing was considered most likely to effect Behaviour/ movement of Byproduct/ bycatch species => Discarding catch could cause local Behavioural/ movement impacts indirectly via attraction of predators➔Intensity considered Minor as discard volume is low➔Consequence Minor – possible detectable change, time to return to original behaviour/ movement on the scale of days to weeks. ➔Confidence low – no data on behavioural impacts of discarding on bycatch.
	Stock enhancement	0									
	Provisioning	0									
	Organic waste disposal	1	4	6	Behaviour/ movement	spotted warehou	6.1	1	1	2	Fishing effort is almost entirely restricted to waters along the edge of the continental shelf off the east coast of Tasmania. Fishing occurs daily. ➔Disposal of organic waste is expected to pose greatest potential risk for the Behaviour/movement of spotted warehou which move up into the water column resulting in either attraction e.g. food scraps or repulsion e.g. raw sewage. ➔Intensity was scored as negligible because although the hazard was considered over a large range/scale, each disposal event was considered to only effect a small < 1 nm area and because the byproduct and bycatch are all mobile and so strong avoidance ability was expected at the scale of 1 nm => ➔Consequence was also considered negligible i.e. any consequence on the byproduct and bycatch species in the four fishing zones are unlikely to be measurable. ➔Confidence in consequence score was high as waste disposal from general fishing activities was considered unlikely to impact on behaviour/movement of these species.

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 (from S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence score (1-2)	Rationale
Addition of non-biological material	Debris	1	4	6	Behaviour/ movement	spotted warehou	6.1	1	1	2	Fishing effort is almost entirely restricted to waters along the edge of the continental shelf off the east coast of Tasmania. Fishing occurs daily. ➔Floating marine debris may affect spotted warehou which move up into the water column to shelter beneath it affecting behaviour and movement ➔ Intensity considered Minor – occurs rarely or in few isolated incidences ➔Consequence scored negligible – unlikely to be measurable against background variability for population. ➔Confidence high – no dumping
	Chemical pollution	1	4	3	Behaviour/ movement	spotted warehou	6.1	2	1	2	Fishing effort is almost entirely restricted to waters along the edge of the continental shelf off the east coast of Tasmania. Fishing occurs daily but significant spills are unlikely to occur more than once per year. . ➔Chemical pollution most likely to affect behaviour of spotted warehou which move up into the water column. - repulsion➔Possible detectable change in behaviour/ movement but minimal impact on population, time to return to behaviour on the scale of days to weeks. ➔Intensity Minor - Chemical pollution occurs infrequently and on local scale ➔Chemical pollution likely to have measurable consequences if large-scale event occurs in a sensitive area, the scale of an event will be limited by the amount of chemicals carried by the fishing vessels). ➔Consequence considered Minor – Possible detectable change in behaviour/ movement but minimal impact on population, time to return to behaviour on the scale of hours➔ Confidence high because chemical spill considered to quickly disperse in the pelagic environment (note the likelihood of large event, e.g. sinking and oil slick, considered very rare).

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 (from S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence score (1-2)	Rationale
	Exhaust	1	4	6	Behaviour/ movement	spotted warehou	6.1	1	1	2	Fishing effort is almost entirely restricted to waters along the edge of the continental shelf off the east coast of Tasmania. Fishing occurs daily. ➔Exhaust emission was considered to pose greatest risk for the Behaviour/movement of spotted warehou which move up into the water column. - repulsion ➔Intensity was scored as negligible because although the hazard was considered over a large range/scale, exhaust considered to only impact a small < 1 nm area and because benthopelagic teleosts are highly mobile strong avoidance ability was expected at the scale of 1 nm . ➔Consequence was also considered negligible i.e. any consequence unlikely to be detectable. ➔Confidence in the consequence score was considered high because localised exhaust unlikely to impact on behaviour/movement.
	Gear loss	1	4	5	Behaviour/ movement	blue eye	6.1	1	1	2	Fishing effort is almost entirely restricted to waters along the edge of the continental shelf off east coast of Tasmania. Fishing occurs daily. Gear is expensive and major gear loss more than four times per year would not be commercially viable but minor gear loss may occur more often. ➔ Lost gear not resulting in damage/mortality most likely to effect behaviour /movement of benthopelagic teleosts e.g. blue eye➔ Intensity scored as Minor as lost gear – benthopelagic teleost interactions (if they occur) are considered to be rare ➔ Consequence considered minor on stocks - any consequence unlikely to be detectable, time taken to recover on scale of days -weeks ➔Confidence: low – no data.
	Navigation/ steaming	1	4	6	Behaviour/ movement	spotted warehou	6.1	1	1	2	Fishing effort is almost entirely restricted to waters along the edge of the continental shelf off the east coast of Tasmania.. Fishing occurs daily. ➔ Navigation/ steaming most likely to effect Behaviour/ movement of spotted warehou which move up into the water column. ➔Intensity: unlikely to have a measurable impact➔Consequence: Negligible unlikely to be detectable - any consequence unlikely to be detectable , time taken to recover on scale of days - weeks ➔Confidence: high because it is considered unlikely for there to be strong interactions between Navigation/ steaming and demersal teleost Behaviour/ movement.

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 (from S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence score (1-2)	Rationale
	Activity/ presence on water	1	4	6	Behaviour/ movement	spotted warehou	6.1	1	1	2	Fishing effort is almost entirely restricted to waters along the edge of the continental shelf off the east coast of Tasmania.. Fishing occurs daily. Activity/presence on water of fishing vessels was expected to pose greatest potential risk for the Behaviour/movement of spotted warehou which move up into the water column Intensity was scored as negligible because although the hazard was considered over a large range/scale, vessel presence considered to only impact a small < 1 nm. area and because benthopelagic teleosts are highly mobile strong avoidance ability was expected at the scale of 1 nm => Consequence was also considered negligible with any consequence of vessel presence impacts unlikely to be detectable benthopelagic teleosts Confidence in the consequence score was high because localised vessel presence/activity considered unlikely to impact and have consequences for the behaviour/movement of highly mobile benthopelagic teleosts .
Disturb physical processes	Bait collection	0									
	Fishing	1	4	6	Behaviour/ movement	spotted warehou	6.1	2	1	2	Fishing effort is almost entirely restricted to waters along the edge of the continental shelf off the east coast of Tasmania. Fishing occurs daily. ➔Disturbance of physical processes via was expected to pose greatest potential risk for the Behaviour/movement of spotted warehou which move up into the water column resulting in momentary disruption to feeding and/or movement . ➔Intensity was scored as negligible because although the hazard was considered over a large range/scale, fishing considered to only impact physical processes over a small < 1 nm area . ➔Consequence was also considered negligible with any consequence of water column disturbance unlikely to be detectable for benthopelagic teleosts. ➔Confidence in consequence score was considered high as localised disruption of water column unlikely to impact and have consequences for the behaviour/movement of benthopelagic teleosts.
	Boat launching	0									
	Anchoring/	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 (from S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence score (1-2)	Rationale
	mooring										
	Navigation/steaming	1	4	6	Behaviour/ movement	spotted warehou	6.1	1	1	2	Fishing effort is almost entirely restricted to waters along the edge of the continental shelf off the east coast of Tasmania.. Fishing occurs daily. ➔Disturbance to physical processes due to Navigation/steaming of fishing vessels was expected to pose greatest potential risk for the Behaviour/movement of spotted warehou which move up into the water column resulting in disruption to feeding and/or migration . ➔Intensity was scored as negligible because although the hazard was considered over a large range/scale, Navigation/ steaming considered to only impact a small < 1 nm area and because benthopelagic teleosts are highly mobile strong avoidance ability was expected at the scale of 1 nm => ➔Consequence was also considered negligible with any impact of Navigation/ steaming unlikely to be detectable for benthopelagic teleosts. ➔ Confidence in the consequence score was considered high because Navigation/ steaming unlikely to impact and have consequences for the behaviour/movement of highly mobile benthopelagic teleosts
External Impacts (specify the particular example within each activity area)	Other fisheries	1	6	6	Population size	Blue eye	1.3	3	3	2	Byproduct species are targeted daily in external fisheries e.g. blue eye targeted in GHATF. ➔ Intensity considered Moderate because byproduct species in this fishery are also the target or bycatch of other commonwealth and state fisheries. ➔Consequence considered Moderate (full exploitation rate but long term recruitment dynamics not adversely damaged) because byproduct species are already fully exploited in other fisheries e.g. blue eye. ➔Confidence: high – SEF quota species have detailed stock assessments.
	Aquaculture	0									
	Other extractive activities	1	5	6	Behaviour/ movement	Spotted warehou	6.1	2	2	1	Oil exploration occurs daily, beyond the main effort in the fishery across a wide geographic range, particularly in Bass Strait. ➔Demersal byproduct species would avoid any spills – most likely to affect spotted warehou which move up into the water column. ➔Intensity: spills are rare➔Consequence: minor, unlikely to affect a population➔Confidence low. No data

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 (from S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence score (1-2)	Rationale
	Other non extractive activities	1	6	6	Behaviour/ movement	Byproduct and bycatch	6.1	1	1	1	Shipping activity occurs daily across the full range of the fishery, and outside areas of current effort. ➔Greatest potential risks are to the Behaviour/movement of benthopelagic teleost species resulting in disruption to feeding and/ or migration➔ Intensity: negligible because although the hazard was considered over a large range/scale, the shipping track is narrow - impact a < 1 nm wide and because benthopelagic teleosts are highly mobile strong avoidance ability was expected at the scale of 1 nm. ➔Consequence: negligible with any consequence of shipping impacts unlikely to be detectable for benthopelagic teleosts➔Confidence: high shipping unlikely to impact and have consequences for the behaviour/movement of highly mobile small pelagic species.
	Other anthropogenic activities	1	4	5	Behaviour/ movement	Byproduct and bycatch	6.1	1	1	2	Tourism occurs across the full range of the fishery, and outside areas of current effort. Impacts are unlikely to occur daily because much of the effort is offshore. ➔Greatest potential risks are to the Behaviour/movement of affect spotted warehou which move up into the water column resulting in disruption to feeding and/ or migration. ➔Intensity: negligible because although the hazard is dispersed over a large range, its occurrence is patchy- around population centres, and because small pelagic species are highly mobile strong avoidance ability was expected. ➔Consequence: negligible with any consequence of tourism impacts unlikely to be detectable for benthopelagic teleosts. ➔Confidence: high- tourism unlikely to impact and have consequences for the behaviour/movement.

2.3.1 Level 1 (SICA) Documents 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 (from S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence score (1-2)	Rationale
Capture	Bait collection	0									
	Fishing	1	4	6	Population size	Bottle-nose dolphins	1	2	3	1	Fishing effort is almost entirely restricted to waters along the edge of the continental shelf off the east coast of Tasmania. Fishing occurs daily➔Intesity moderate: Species is protected. Catches have been reported in this fishery. ➔Consequence: moderate. Any significant catches would be publicly unacceptable.
	Incidental behaviour	0									
Direct impact without capture	Bait collection	0									
	Fishing	1	4	6	Behaviour / movement	Bottle-nose dolphins	6	2	2	2	Fishing effort is almost entirely restricted to waters along the edge of the continental shelf off the east coast of Tasmania. Fishing occurs daily =>Direct impact of fishing without capture would be expected to impact dolphins by modifying their behaviour and attracting them to regions they would not normally occur in high abundances, could lead to dependency and possible flow-on population effects if fishing patterns change => At current levels of fishing the intensity was considered Minor - activity occurs in a few restricted locations over the scale of the total area of the fishery. ➔ Consequence considered Minor - no detectable change in behaviour/ movement, time to return to original behaviour/ movement on the scale of hours => The number of dolphins-fishing interactions in the purse-seine sub-fishery has not been monitored so confidence score is high.
	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 (from S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence score (1-2)	Rationale
	Gear loss	1	4	4	Behaviour / movement	Bottle-nose dolphins,	6	2	2	1	Fishing effort is almost entirely restricted to waters along the edge of the continental shelf off the east coast of Tasmania. Fishing occurs daily. Gear loss sufficient to affect behaviour considered to occur quarterly. ➔Gear loss may modify dolphin behaviour by attracting them to specific places. ➔ The frequency of gear loss events is low and so the Intensity of this activity is Minor - activity occurs in a few restricted locations over the scale of the total area of the fishery. ➔ Consequence considered Minor - no detectable change in behaviour/ movement, time to return to original behaviour/ movement on the scale of hours. ➔This assessment was made with low confidence as the frequency of dolphin interactions in the purse-seine sub-fishery has not been verified.
	Anchoring/ mooring	0									
	Navigation/ steaming	1	4	6	Behaviour / movement	Bottle-nose dolphins	6	3	2	2	Fishing effort is almost entirely restricted to waters along the edge of the continental shelf off the east coast of Tasmania. Fishing occurs daily Fish Navigation / steaming modify dolphin behaviour as they learn to ride bow waves and associate vessels with food may disrupt natural feeding patterns and/or migration => ➔Intensity considered Moderate - severe but local or moderate at broader spatial scale => ➔Consequence was considered Minor - time to return to original behaviour/ movement on the scale of hours =>➔Confidence: low – lack of data
Addition/ movement of biological material	Translocation of species	0									
	On board processing	0									
	Discarding catch	1	4	6	Behaviour / movement	Bottle-nose dolphins	6	2	2	1	Fishing effort is almost entirely restricted to waters along the edge of the continental shelf off the east coast of Tasmania. Fishing occurs daily➔At current levels of fishing, the Intensity was scored Minor. Discards <1% of catch - activity few restricted over the scale of the total area of the fishery. ➔ Given the Minor intensity of the activity the consequence was also considered Minor - time to return to original behaviour/ movement on the scale of hours. ➔The confidence score is low because of no data

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 (from S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence score (1-2)	Rationale
	Stock enhancement	0									
	Provisioning	0									
	Organic waste disposal	1	4	6	Behaviour / movement	Bottle-nose dolphins	6	2	2	2	Fishing effort is almost entirely restricted to waters along the edge of the continental shelf off the east coast of Tasmania.. Fishing occurs daily➔Organic waste disposal will initially impact on seabird behaviour by attracting them to the offal for food =>➔At current levels of fishing, the Intensity was scored Minor - activity occurs in a few restricted locations over the scale of the total area of the fishery =>➔ Given the Minor intensity of the activity the consequence was also considered Minor - time to return to original behaviour/ movement on the scale of hours => ➔The confidence score is high because the attraction toward this food is conceivably less than other sources e.g. discards/ onboard processing.
Addition of non-biological material	Debris	1	4	6	Behaviour / movement	Species – Seabirds, mainly smaller species of terns	6	2	2	1	Fishing effort is almost entirely restricted to waters along the edge of the continental shelf off the east coast of Tasmania.. Fishing occurs daily➔Floating debris will initially impact on seabird behaviour by attracting them to the debris for food because Debris generates new habitat for surface-schooling fish that seabirds would be attracted to for food => ➔Intensity considered Minor because Debris considered to occur rarely => Given the Minor intensity of the activity the Consequence was also considered Minor - time to return to original behaviour/ movement considered to occur on the scale of hours => ➔Low confidence – no data
	Chemical pollution	1	4	3	Population size	Species – Seabirds, in particular little penguins	1	2	2	1	Fishing effort is almost entirely restricted to waters along the edge of the continental shelf off the east coast of Tasmania. Fishing occurs daily but chemical pollution sufficient to impact on the population size of birds is unlikely to occur more than annually➔The direct impact of chemical pollution considered to lead to highest consequence was impact on seabirds in particular little penguins that would be immersed in the spill, ➔Population size was selected as the sub-component =>➔Intensity Minor - Chemical pollution occurs infrequently and on local scale =>➔ Consequence also scored Minor - insignificant change to population growth rate, unlikely to be detectable against

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 (from S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence score (1-2)	Rationale
											background variability for this population => ➔The confidence score is low because there is a lack of data on the extent that chemical pollution occurs in the fishery.
	Exhaust	1	4	6	Behaviour/ movement	Species – Seabirds	6	1	2	2	Fishing effort is almost entirely restricted to waters along the edge of the continental shelf off the east coast of Tasmania.. Fishing occurs daily➔Exhaust emission was considered to pose greatest risk for the Behaviour/movement of Seabirds resulting in repulsion =>➔ Intensity was scored as negligible because although the hazard was considered over a large range/scale, exhaust considered to only impact a small < 1 nm area and because Seabird species are mobile hence strong avoidance ability was expected at the scale of 1 nm => ➔Consequence considered Minor i.e. any consequence on seabirds unlikely to be detectable. ➔ Confidence in the consequence score was considered high because localised exhaust unlikely to impact on behaviour/movement of mobile seabirds.
	Gear loss	1	6	4	Behaviour / Movement	Bottle nosed dolphins	6	2	2	1	Fishing effort is almost entirely restricted to waters along the edge of the continental shelf off the east coast of Tasmania.. Fishing occurs daily➔Gear loss is likely to attract dolphins to the food, hence lost gear not resulting in damage/mortality most likely to effect behaviour . ➔ Intensity was scored as Minor because lost gear – dolphin entangelement in lost gear, if it occurs, is infrequent. ➔Consequence considered Minor on dolphin behaviour/ movement - any consequence on turtles unlikely to be detectable, time taken to recover on scale of days - weeks => ➔Confidence was scored as low because of a lack of data on interactions between dolphins and fishing gear.

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 (from S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence score (1-2)	Rationale
	Navigation/ steaming	1	4	6	Behaviour / Movement	Species - Seabirds	6	1	2	2	Fishing effort is almost entirely restricted to waters along the edge of the continental shelf off the east coast of Tasmania.. Fishing occurs daily➔Navigation and steaming would have the greatest effect on seabird behaviour by encouraging the birds to follow the ships in the expectation of obtaining food. ➔Navigation/steaming is a large component of the small pelagic species fishing operations, however there is remote likelihood of impact on Seabirds over the spatial scale of the fishery . ➔ Consequence Minor - no detectable change in behaviour/ movement. Time to return to original behaviour/ movement on the scale of hours. ➔ Confidence was recorded as high because it is considered unlikely for there to be strong interactions between Navigation/ steaming and Seabird Behaviour/ movement.
	Activity/ presence on water	1	4	6	Behaviour / Movement	Species - Seabirds	6	1	1	2	Fishing effort is almost entirely restricted to waters along the edge of the continental shelf off the east coast of Tasmania.. Fishing occurs daily➔The presence of vessels on the water would have the greatest effect on seabird behaviour by attracting birds to the vessel in the expectation of obtaining food=> ➔Intensity was scored as Negligible because although the hazard was considered over a large range/scale, vessel presence considered to only impact a small < 1 nm area => ➔Consequence was considered Minor with any impacts of vessel presence unlikely to be detectable for highly mobile Seabirds, expected to return to normal Behaviour/ movement on the scale of hours . ➔Confidence in the consequence score was high because localised vessel presence/activity considered unlikely to have measurable impact on populations.
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 (from S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence score (1-2)	Rationale
physical processes	Fishing	1	4	6	Behaviour/ movement	Seabirds	6	1	1	2	Fishing effort is almost entirely restricted to waters along the edge of the continental shelf off the east coast of Tasmania.. Fishing occurs daily➔Disturbance of physical processes via fishing was expected to pose greatest potential risk for the Behaviour/movement of Seabirds resulting in momentary disruption to feeding and/or movement => ➔Intensity was scored as negligible because although the hazard was considered over a large range/scale, fishing considered to only impact physical processes over a small < 1 nm area => ➔Consequence was also considered Negligible with any consequence of water column disturbance unlikely to have detectable effects on Seabird foraging behaviour => ➔Confidence in the consequence score was considered high because localised disruption of water column unlikely to impact and have consequences for the behaviour/movement of highly mobile Seabirds (can be evaluated without data).
	Boat launching	0									
	Anchoring/ mooring	0									
	Navigation/steaming	1	4	6	Behaviour / Movement	Species - Seabirds	6	1	1	2	Fishing effort is almost entirely restricted to waters along the edge of the continental shelf off the east coast of Tasmania.. Fishing occurs daily➔Disturbance of physical processes via navigation and steaming was expected to pose greatest potential risk for the Behaviour/movement of Seabirds resulting in momentary disruption to feeding and/or movement =>➔ Intensity was scored as negligible because although the hazard was considered over a large range/scale, the activity was considered to only impact physical processes over a small < 1 nm area => ➔Consequence was also considered Negligible with any consequence of water column disturbance unlikely to have detectable effects on Seabird foraging behaviour => ➔Confidence in the consequence score was considered high because localised disruption of water column unlikely to impact and have consequences for the behaviour/movement of highly mobile Seabirds (can be evaluated without data).

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 (from S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence score (1-2)	Rationale
External Impacts (specify the particular example within each activity area)	Other fisheries	1	6	6	Population size	Species – Albatross species	1	4	4	2	Commercial fisheries impacting on albatross extend across southern Australian waters and beyond, fishing occurs daily. ➔Other capture fishery methods were considered to pose greatest risk to the population size sub-component for TEP species, several albatross species are known to interact with long-line tuna fisheries and strike warps in demersal trawl fisheries. ➔ Long-line impact on albatrosses was considered a Major impact on population size that occurs reasonably often at broad spatial scale => ➔Consequence was scored as Major because serious consequences are believed to be now occurring => Confidence was recorded as high because of extensive observational data on albatross long-line fishery interactions.
	Aquaculture	0									
	Coastal development	1	6	5	Behaviour / Movement	Species - Seabirds	6	1	1	1	Coastal development occurs daily around the range of the fishery, beyond the areas where effort is currently focused. Impacts on the SPF do not occur daily because much of the effort is offshore. ➔Intensity considered Negligible – occurs rarely at small spatial scale ➔Coastal development was not considered to change behaviour and movement so the consequence scored negligible => ➔Confidence low – no data
	Other extractive activities	1	5	6	Behaviour/ Movement	Bottle nose dolphins	6	2	2	1	Oil exploration occurs daily, beyond the main effort in the fishery across a wide geographic range, particularly in Bass Strait. ➔Dolphins species would avoid any spills other than a large oil slick caused by a sinking or stranding. ➔Intensity: spills are rare➔Consequence: minor, unlikely to affect a population➔Confidence low. Little data
	Other non extractive activities	1	6	6	Behaviour / Movement	Species - Seabirds	6	1	1	2	Shipping activity occurs daily across the full range of the fishery, and outside areas of current effort. ➔Greatest potential risks are to the Behaviour/movement of seabird species resulting in disruption to feeding and/ or migration. Seabirds may be attracted to ships expecting food➔ Intensity: negligible because although the hazard was considered over a large range/scale, the shipping track is narrow - impact a < 1 nm wide. ➔Consequence: negligible with any consequence of shipping impacts unlikely to be detectable for seabirds➔Confidence: high - shipping unlikely to impact and have

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 (from S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence score (1-2)	Rationale
											significant negative consequences for the behaviour/movement of seabirds (can be evaluated without data).
	Other anthropogenic activities	1	6	6	Behaviour/ movement	Bottle nose dolphins	6	2	2	1	Tourism occurs daily across the full range of the fishery, and outside areas of current effort. ➔Greatest potential risks are to the Behaviour/movement of dolphin species resulting in disruption to feeding and/ or migration. ➔Intensity: minor because although the hazard is dispersed over a large range, its occurrence is patchy- around population centres. ➔Consequence: minor with any consequence of tourism impacts likely to be detectable for dolphins. ➔Confidence: low – no data

2.3.1 Level 1 (SICA) Documents L1.4 - Habitat 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 (from S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence score (1-2)	Rationale
Capture	Bait collection	0									
	Fishing	1	4	6	Habitat structure and Function	Southern coastal pelagic Province	5.1	3	1	1	Most fishing activity occurs along on the east coast of Tasmania over a range of 200 n miles, in AFMA management Zone A. Mid water trawling for small pelagic species is mainly likely to affect pelagic habitat structure and function transiently as the shot passes through the water. Intensity: moderate, relatively localised. Consequence: Negligible, as water column expected to resume state rapidly. Confidence: low because of insufficient knowledge of pelagic habitat processes.
	Incidental behaviour	0									
Direct impact without capture	Bait collection	0									
	Fishing	1	4	6	Habitat structure and Function	fine sediments, subcrop, large sponges, outer-shelf	5.1	2	2	1	Most fishing activity occurs along on the east coast of Tasmania over a range of 200 n miles, in AFMA management Zone A. Mid water trawl shots occasionally contact the benthos during deployment. Where nets contact the bottom, direct impact will be sustained by habitat (substratum and faunal communities) within the vicinity of the contact. Subsequent degree of disturbance, damage or mortality of substratum and associated faunal assemblages, will depend on size of net (footprint), contact force, extent of area dragged before net lifted. Recovery capacity of habitat is species and depth related (deeper =slower). Intensity: minor, the impact of non-capture damage or mortality was considered to occur infrequently. Consequence: negligible if shelf waters <60m, however one event likely to cause severe localised effect in fragile shelf break habitats (e.g. bryozoan, octocorals), however over the entire scale of the effort is likely to be minor, unless frequency increases. Confidence: low due to unvalidated record of frequency of this occurrence.
	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 (from S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence score (1-2)	Rationale
	Gear loss	1	4	4	Habitat structure and Function	sedimentary rock, outcrop, mixed faunal community, Inner shelf	5.1	2	1	2	Gear loss possible over entire range of the sub-fishery, but more likely to occur in the area of greatest fishing effort. Gear loss considered to occur a few times a year during the calendar fishing year, perhaps quarterly. Lost gear may be irretrievable in deeper waters, may impact benthos in process of balling up and retrieval, or snag on higher relief reefs, potentially damaging habitat in the vicinity, eventually becoming habitat. Intensity: minor, considered a rare event. Consequence: negligible, habitat modification likely to be undetectable. Confidence: high, though effects not visually documented for this fishery, and there is a lack of verified data on rates and types of gear loss.
	Anchoring/ mooring	0									
	Navigation/steaming	1	4	6	Habitat structure and Function	Southern coastal pelagic Province	5.1	1	1	2	Navigation/ steaming may occur daily during fishing season. The pelagic water quality of the Southern Coastal Pelagic habitat may change with increased turbulence and changes in water mixing that could occur from movement of vessels through water. Intensity and Consequence: negligible due to remote likelihood of detection at any spatial or temporal scale, and interactions that may be occurring are not detectable against natural variation. Confidence scored high because of logical constraints.
Addition/ movement of biological material	Translocation of species	0									
	On board processing	1									
	Discarding catch	1	4	6	Substrate quality	fine sediments, subcrop, large sponges, outer-shelf	5.1	2	2	1	Discarding byproduct species known to occur during fishing trips. Most discards will be opportunistically taken up by the increased relative abundance of predators attracted by this process i.e. sharks and TEP species. Some discards may reach the benthos, where they could be expected to be taken up rapidly by demersal species, depending on volume. Localized accumulation unlikely, but if occurs leads to anoxic bottom sediments, particularly if fine, which alters substratum biogeochemistry for burrowing infauna. Large, erect habitat could be damaged however, Intensity considered minor, as

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 (from S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence score (1-2)	Rationale
											thought to occur rarely. Consequence: minor because only short term changes in benthos structure, function and quality likely to occur. Confidence low: because of a lack of insufficient knowledge on trophic dynamics.
	Stock enhancement	0									
	Provisioning	0									
	Organic waste disposal	1	4	6	Water Quality	Pelagic: Southern coastal pelagic Province	1.1	1	1	2	Organic waste disposal possible over the entire scale of fishing effort. Boats subject to MARPOL. Water quality of pelagic habitats is considered to experience greatest impact of organic waste disposal. Overall volume of waste likely to be too small to reach benthos, or accumulate even if it does. Intensity: moderate. Consequence: Minor, addition of high nutrient material is realistically expected to cause short term peaks in productivity or scavenging species interactions, with minimal detectability within minutes to hours. Confidence: high logical constraints.
Addition of non-biological material	Debris	1	4	6	Habitat structure and Function	Southern coastal pelagic province	5.1	2	2	1	Fishing activity occurs over a small spatial scale, generation of debris possible over this scale, and may occur on a daily basis during fishing season. Greatest effort within the Southern Coastal Pelagic province habitat, therefore considered the most likely habitat to accumulate floating plastics, and inadvertent losses from fishing operations. All boats subject to MARPOL rules, which means losses should be unintentional, and retrieved if possible. Debris considered to reduce water quality, and alter habitat structure with the addition of ingestible materials putting susceptible species at risk e.g. seabirds, dolphins or seals. Intensity: minor if adherence to MARPOL regulations. Consequence: minor to habitat as dispersal and small volumes. Consequence: low

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 (from S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence score (1-2)	Rationale
											because the volume of debris generated and species susceptibility are unknown.
	Chemical pollution	1	4	6	Water quality	Southern coastal pelagic province.	1.1	2	2	1	Fishing activity occurs along on the edge of the continental shelf, off the East coast of Bass Strait and Tasmania, hence chemical spill during fishing activities possible over this scale. Chemical spill considered annual but is possible every time fishing occurs. The Southern Coastal Pelagic habitat would be most at risk from chemical pollution. Residence time of small volume of contaminants likely to be short term in the offshore environment as weather and oceanographics disperse substances quickly. Intensity: minor because the activity (chemical spill) is thought to occur rarely, particularly if boats follow MARPOL rules. Consequence: minor, possible detectable change in water quality, but time to return to prior state on the scale of hours to days (note that chemical pollution likely to have measurable consequences if large-scale event occurs in a sensitive area, the scale of an event will be limited by the amount of chemicals carried by the fishing vessels). Confidence: low with out data on the volume of pollution.
	Exhaust	1	4	6	Air quality	Southern coastal pelagic province.	2.1	1	1	2	Exhaust from running engines may impact the air quality of the species within Southern Coastal Pelagic habitat (e.g. birds). Intensity: negligible. Consequence: negligible due to rapid dispersal of pollutants in winds, and likely to be physically undetectable over very short time frames. Confidence in assessment: high because effect of exhaust was considered to be very localised, and logical consideration.

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 (from S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence score (1-2)	Rationale
	Gear loss	1	6	5	Habitat structure and Function	Pelagic: Southern coastal pelagic Province, Benthic: sedimentary rock, outcrop, mixed faunal community, outer-shelf	5.1	2	1	2	Lost gear known to ball up if not retrieved, or snag on higher relief reefs, potentially damaging habitat in the vicinity, eventually becoming habitat. Intensity: minor, considered an uncommon event. Consequence: negligible, habitat modification likely to be undetectable. Confidence: high, though effects not visually documented for this fishery, and there is a lack of verified data on rates and types of gear loss.
	Navigation/ steaming	1	4	6	Water quality	Southern coastal pelagic Province	1.1	1	1	2	Navigation/ steaming may occur daily during fishing season. Addition of non-biological material will occur during the normal course of steaming throughout the fishing operations. Changes to the pelagic air and water quality, and habitat function of the Southern Coastal Pelagic habitat are likely to be undetectable over these scales due to rapid dispersal of presence in air and water. Intensity and Consequence: negligible due to remote likelihood of detection at any spatial or temporal scale, and interactions that may be occurring are not detectable against natural variation. Confidence scored high because of logical constraints.
	Activity/ presence on water	1	4	6	Water quality	Southern coastal pelagic Province	1.1	1	1	2	Activity/presence on water occurs over a small spatial scale, daily during fishing season. Activity/presence on water of purse seine fishing vessels was expected to pose greatest potential risk for the Eastern coastal pelagic habitat. Intensity and Consequence: negligible, remote likelihood of impact at any spatial or temporal scale. Confidence in consequence score: high because it was considered highly unlikely that vessel presence/activity would lead to community level changes in its own right (logical constraints).
Disturb physical processes	Bait collection	0									
	Fishing	1	4	6	Substrate quality	fine sediments, unrippled, mixed faunal community, outer shelf	3.1	2	2	1	Fishing activity concentrates along on the narrow band of the outer continental shelf edge and upper slope, of SE Bass Strait and Eastern Tasmania. This zone is characterised by gently sloping plains of muddy and sandy sediments grading into narrow mud terraces and escarpments. Soft ground is interspersed with hard patches (± a veneer of fine sediments) which provide attachment points for mixed faunal communities. Suspension and filter feeding animals dominate

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 (from S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence score (1-2)	Rationale
											these communities. Disturbance of physical processes via midwater trawling will occur if nets contact benthos. Sediments will be resuspended, potentially smothering filter feeding animals. Shallow infaunal bioturbators will be dislodged, settling elsewhere. Recovery capacity of sessile species removed by the net is unknown for many groups. Intensity: minor because net contact with bottom not a usual part of deployment. Consequence: minor with current level of effort, however this would need review if effort increases. Disturbance of water column unlikely to be detectable for pelagic communities. Confidence: low for benthos, inadequate documentation of frequency of this occurrence.
	Boat launching	0									
	Anchoring/ mooring	0									
	Navigation/ steaming	1	4	6	Habitat structure and function	Southern coastal pelagic Province	5.1	1	1	2	Navigation/ steaming may occur daily during fishing season. Disturbance of physical processes will occur during the normal course of steaming throughout the fishing zone. Turbulence and disturbance of pelagic water quality is unlikely to affect normal water column processes for long. Any disruption to these processes can therefore be expected to alter habitat function only briefly for macroscopic fauna. Intensity and Consequence: negligible due to remote likelihood of detection at any spatial or temporal scale, and interactions that may be occurring are not detectable against natural variation. Confidence scored high because of logical constraints.

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 (from S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence score (1-2)	Rationale
External Impacts (specify the particular example within each activity area)	Other fisheries	1	6	6	Habitat structure and function	Southern coastal pelagic Province	5.1	3	4	1	Fishery covers a small spatial area in which other fisheries occur, using different targeting methods and gears. Fishing activity of these fisheries occurs over a large spatial range, over which there can be daily fishing activity. Other fisheries most likely to effect benthic habitats include those using bottom gears i.e. SET Danish seine, and otter trawl, GHAT gillnet, autolongline, (and to a lesser degree) demersal longlines, dropline, trap. Intensity: moderate, the impact was considered to be potentially severe at local scales but moderate at broader spatial scale. Consequence: major to severe, because the cumulative effects of fishing are likely to have measurable changes to structure, function, extent, quality and regeneration capacity of vulnerable habitats. Loss of habitat results in short and long term loss of species, as habitats play a keystone role in ecosystem stability. Confidence: low because of insufficient knowledge of habitat dynamics, and ecosystem connectivity
	Aquaculture	0									
	Coastal development	1	6	5	Habitat structure and function	fine sediments, unrippled, mixed faunal community, outer shelf	5.1	3	3	1	Coastal development occurs within an area on the scale of 10 nm Frequent, local impacts at small spatial scales are likely to have most obvious impact on the habitat composition, structure and function, including for pelagic types, water quality and for benthic types, substratum state. Intensity: moderate at broader spatial scale, or severe but localized within the areas affected. Consequence: moderate, greatest impacts likely to be inshore including waters less than 25m, extending in some cases further out onto the inner shelf Southern Coastal Pelagic and benthic habitats. Confidence: low because of a lack of data.
	Other extractive activities	1	5	6	Habitat structure and function	Southern coastal pelagic Province	5.1	2	2	1	Oil and gas industry occur in the broad area (e.g. Bass Strait). There may be pollution from the petrochemical industry in both shallow and deep water and associated stimuli. Intensity: minor as direct and indirect impact(s) on community likely to be low, but linkages need to be better understood. Consequence: Cumulative impacts may exist, but considered minor as commercial fishing restricted within these zones.

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 (from S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence score (1-2)	Rationale
											Confidence: low, due to limited information available.
	Other non extractive activities	1	6	6	Habitat structure and function	Southern coastal pelagic Province	5.1	2	1	1	Shipping may occur in the area of fishing effort (predominantly AFMA management Zone A) and may occur daily. Most shipping considered to occur in the Southern Coastal Pelagic environment and impact bio- and geo-chemical cycles of pelagic waters by disturbing mixed depth layer, and addition of non biological materials. Intensity: minor because natural levels of mixing and re-mixing considered high in Eastern Coastal Pelagic and benthic impacts localised over scale of fishery area. Consequence: negligible - Interactions which affect bio- & geochemical cycling unlikely to be detectable against natural variation. Benthic detection decreases with time and object forms basis of reef structure which will be colonized over time (more rapidly in waters < 200m. Confidence: low because of a lack of information on shipping-animal interactions plus insufficient knowledge on effects of ships on bio- and geo-chemical cycling
	Other anthropogenic activities	1	4	5	Habitat structure and function	Southern coastal pelagic Province	5.1	2	2	1	Habitats may be disturbed by charter boats associated with general recreational activities, and tourism (e.g. whale watching, fishing tours, anchoring, recreational diving etc). Intensity: Assumed to have minor direct and indirect impacts on pelagic habitat, and un measured on benthos. Consequence: Until there is better information, difficult to score therefore low confidence.

2.3.1 Level 1 (SICA) Documents 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 (from S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence score (1-2)	Rationale
Capture	Bait collection	0									
	Fishing	1	4	6	Functional group composition	Southern coastal pelagic	2	3	3	1	Most of the current fishing effort in the sub-fishery is restricted to the east coast of Tasmania in AFMA management Zone A over a range of approximately 200 nm. Fishing occurs daily over the fishing season. Mid water trawling for small pelagic species most likely to effect functional group composition, i.e. removal of the small pelagic species functional group from the Southern Coastal Pelagic community. Intensity: moderate 6–i.e. the impact was considered to be potentially severe at local scales but moderate at broader spatial scale => Consequence: moderate, i.e. it was considered that fishing would have measurable changes to the ecosystem without a major change in function => Confidence: low because of insufficient knowledge of trophic interactions.
	Incidental behaviour	0									
Direct impact without capture	Bait collection	0									
	Fishing	1	4	6	Functional group composition	Southern coastal pelagic	2	2	1	1	Most of the current fishing effort in the sub-fishery is restricted to the east coast of Tasmania in AFMA management Zone A over a range of approximately 200 nm. Mid water trawling (not resulting in capture) most likely to effect functional group composition => damage or mortality to the small pelagic functional group from the Southern Coastal Pelagic community. Intensity: minor – i.e. the impact of non-capture damage or mortality was considered to occur rarely because mechanics of purse seine fishing unlikely to strongly impact fish not captured. Consequence: negligible because it was considered that damage or mortality to non-caught small pelagic species is unlikely to have strong impacts on the small pelagic functional group in its own right => Confidence: low because of insufficient knowledge on effects of mid water trawling on non-captured individuals.
	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 (from S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence score (1-2)	Rationale
	Gear loss	1	4	4	Functional group composition	Tasmanian outer shelf	2	1	1	1	Gear is most likely to be lost off eastern Tasmania. It is unlikely that even minor gear loss occurs daily. Gear loss was considered to have greatest community level impact by effecting predators such as tunas and large sharks => Impact: negligible –i.e. the likelihood of impact was considered remote. Consequence: negligible for the tuna/ shark predatory functional group => Confidence in the consequence score: low because of a lack of verified data on rates and types of gear loss and insufficient knowledge of trophic interactions.
	Anchoring/ mooring	0									
	Navigation/ steaming	1	4	6	Species composition	Southern coastal pelagic	1	1	1	2	Navigation/ steaming occurs daily during fishing season, mainly off eastern Tasmania. The species composition of the autotrophs of the Southern Coastal Pelagic community may change with increased turbulence and changes in water mixing that could occur from high levels of fishing activity => Intensity: negligible - remote likelihood of detection at any spatial or temporal scale => Consequence: negligible as interactions may be occurring which affect the internal dynamics of communities leading to change in species composition but not detectable against natural variation => Confidence scored high because of logical constraints.
Addition/ movement of biological material	Translocation of species	0									Redbait sold as aquaculture but potential impact of potential pathogens would not occur in this fishery
	On board processing	0									
	Discarding catch	1	4	6	Species composition	Southern coastal pelagic	1	2	2	1	Discarding is most likely to occur off eastern Tasmania, daily during the fishing season. Discard species include southern frostfish (*Lapidopus caudatus)* and butterfly gurnard (*Lepidotrigla vanessa*). The Southern Coastal Pelagic community is most at risk to discarded catch because discarded catch is considered to have greatest community level impact on species composition by increasing relative abundance of large, rare top order predators i.e. sharks and TEP species. Intensity: minor – i.e. thought to occur rarely. Consequence: minor because only minor changes in relative abundance of constituents perceived to occur => Confidence

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 (from S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence score (1-2)	Rationale
											in consequence score: low because of a lack of insufficient knowledge on trophic dynamics.
	Stock enhancement	0									
	Provisioning	0									
	Organic waste disposal	1	4	6	Species composition	Southern coastal pelagic	1	1	1	1	Organic waste disposal is most likely to occur of eastern Tasmania, daily during the fishing season. Boats subject to MARPOL. The pelagic community is where organic waste was considered to have greatest community level impact. This impact would be on species composition by increasing relative abundance of scavenging species e.g. large, rare top order predators or seabirds. Impact: negligible – i.e. thought to occur rarely => Consequence: negligible as only negligible changes in relative abundance of constituents perceived to occur => Confidence in consequence score: low because of a lack of insufficient knowledge on trophic dynamics.
Addition of non-biological material	Debris	1	4	6	Species composition	Southern coastal pelagic	1	2	2	1	Fishing activity occurs mainly off eastern Tasmania. [2]Debris generated daily during fishing season => The Southern Coastal Pelagic community considered most likely to accumulate debris (e.g. floating plastics), debris was considered to have greatest community level impact on species composition by decreasing relative abundance of susceptible species e.g. seabirds, dolphins or seals => Intensity: minor – i.e. thought to occur rarely, if MARPOL rules followed. Consequence: minor because considered only a minor change to relative abundance of seabird species – unlikely to change outside natural variation => Confidence in the consequence score: low because the volume of debris generated and species susceptibility are unknown.

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 (from S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence score (1-2)	Rationale
	Chemical pollution	1	4	3	Distribution of the community	Southern coastal pelagic	3	2	2	1	Highest potential for pollution off eastern Tasmania. Possible chemical spill. The Southern Coastal Pelagic community would be most at risk from chemical pollution from fishing vessels, the most obvious effect would be to force species to move either offshore or along shore to avoid contaminants. Intensity: minor because the activity (chemical spill) is thought to occur rarely. Consequence: minor - possible detectable change in community distribution but minimal impact on communities, time to return to prior distribution on the scale of days to weeks (note that chemical pollution likely to have measurable consequences if large-scale event occurs in a sensitive area, the scale of an event will be limited by the amount of chemicals carried by the fishing vessels). Confidence: low with out data on the volume of pollution.
	Exhaust	1	4	6	Distribution of the community	Southern coastal pelagic	3	1	1	2	Most exhaust fumes released off eastern Tasmania. Exhaust occurs daily and may impact the distribution of the Southern coastal pelagic community. Intensity: negligible. Consequence: negligible because considered low impact on communities. Confidence: high because effect of exhaust was considered to be very local, and disperse rapidly and therefore unlikely to impact community.
	Gear loss	1	4	5	Functional group composition	Tasmanian outer shelf	2	1	1	1	Gear loss most likely to occur off eastern Tasmania. It is unlikely that even minor gear loss occurs on a daily basis. The Tasmanian outer shelf community was considered most likely to interact with lost gear, gear loss was considered to have greatest community level impact by creating new benthic habitat or potential risk of entanglement. Intensity: negligible – i.e. the likelihood of impact was considered remote. Consequence: negligible. Confidence in the consequence score: low because of a lack of verified data on rates and types of gear loss and insufficient knowledge of trophic interactions.

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 (from S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence score (1-2)	Rationale
	Navigation/ steaming	1	4	6	Species composition	Southern coastal pelagic	1	1	1	2	Most Navigation and steaming in the purse-seine sub-fishery occur off eastern Tasmania, daily during the fishing season. The species composition of the Southern Coastal Pelagic community is likely to be affected by changes in turbulence and water movement due to navigation/ steaming, some species will not be able to survive in these environments. Intensity: negligible - Navigation/steaming is a large component of small pelagic species purse seine operations, however there is remote likelihood of impact on small pelagic species over the spatial scale of the fishery. Consequence: negligible since unlikely to be detectable - any consequence on small pelagics unlikely to be detectable, time taken to recover on scale of days – weeks. Confidence: high as direct impacts are unlikely to be detectable (i.e. logical constraints).
	Activity/ presence on water	1	4	6	Distribution of community	Southern coastal pelagic	3.1	1	1	2	Activity/presence on water concentrates along on the edge of the continental shelf and covers an area of over 4700 km^2. Activity/presence on water of mid water trawling vessels was expected to impact the Distribution of the Southern Coastal pelagic community. Intensity: negligible – i.e. remote likelihood of impact at any spatial or temporal scale. Consequence: negligible. Confidence in consequence score: high because it was considered highly unlikely that vessel presence/activity would lead to community level changes in its own right (logical constraints).
Disturb physical processes	Bait collection	0									
	Fishing	1	4	6	Distribution of community	Southern coastal pelagic	3	1	1	2	Most fishing occurs along the east coast of Tasmania, daily during the fishing season. Disturbance of physical processes via midwater trawling was expected to impact the Distribution of the Southern Coastal Pelagic community. Intensity: negligible. Consequence: negligible with any consequence of water column disturbance unlikely to be detectable for pelagic communities. Confidence in the consequence score: high because localized disruption of water column unlikely to impact and have consequences for the distribution of highly mobile pelagic communities.

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 (from S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence score (1-2)	Rationale
	Boat launching	0									
	Anchoring/ mooring	0									
	Navigation/steaming	1	4	6	Species composition	Southern coastal pelagic	1	1	1	2	Navigation /steaming concentrates along the east coast of Tasmania, daily during the fishing season. The species composition of the Southern Coastal Pelagic community is likely to be affected by changes in turbulence and water movement due to navigation/steaming. Some species will not be able to survive in these environments. Intensity: negligible - navigation/steaming is a large component of the small pelagic species mid water trawling operations, however there is remote likelihood of impact on small pelagic species over the spatial scale of the fishery. Consequence: negligible as unlikely to be detectable - any consequence unlikely to be detectable. Confidence: high because direct impacts are unlikely to be detectable (i.e. logical constraints).
External Impacts (specify the particular example within each activity area)	Other fisheries e.g. South East Fishery – otter trawl; GHAT – auto-longline	1	6	6	Functional group composition	Southern coastal pelagic	2	3	3	1	Other fisheries capture the target and byproduct species across the full area of the fishery, beyond the range of current effort in the SPF. Other fisheries most likely to effect functional group composition. Intensity: moderate – i.e. the impact was considered to be potentially severe at local scales but moderate at broader spatial scale. Consequence: moderate, i.e. it was considered that fishing would have measurable changes to the ecosystem without a major change in function. Confidence: low because of insufficient knowledge of trophic dynamics.
	Aquaculture	0									
	Coastal development	1	6	5	Species composition	Southern coastal pelagic	1	3	2	1	Coastal development occurs across the range of the fishery, beyond the boundaries of current effort but not in all areas (e.g. central Bass Strait) => Frequent, local impacts at small spatial scales should have most obvious impact on the species composition of the areas affected, the impacts should be local and their consequences only minor to the entire Southern Coastal Pelagic community. Intensity: moderate - moderate at broader spatial scale, or severe but local. Consequence: minor - impacted species do not play a keystone role – only

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 (from S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence score (1-2)	Rationale
											minor changes in relative abundance of other constituents. Confidence: low because of a lack of data.
	Other extractive activities	1	5	6	Distribution of community	Eastern coastal pelagic	3	2	2	1	Oil and gas industry occur in the broad area (e.g. Bass Strait). There may be pollution from the petrochemical industry in both shallow and deep water and associated stimuli. Intensity: minor as direct and indirect impact(s) on community likely to be low, but linkages need to be better understood. Consequence: Cumulative impacts may exist, but considered minor. Confidence: low, due to limited information available.
	Other non extractive activities	1	6	6	Bio- and geo-chemical cycles	Southern coastal pelagic	5	2	1	1	Shipping may occur in the area of fishing effort (predominantly AFMA management Zone A) and may occur daily. Most shipping considered to occur in the Southern Coastal Pelagic community and impact bio- and geo-chemical cycles of pelagic waters by disturbing mixed depth layer. Intensity: minor because natural levels of mixing and re-mixing considered high in Southern Coastal Pelagic and community level impact considered rarely detectable. Consequence: negligible - Interactions which affect bio- & geochemical cycling unlikely to be detectable against natural variation. Confidence in consequence score: low because of a lack of information on shipping-animal interactions plus insufficient knowledge on effects of ships on bio- and geo-chemical cycling.
	Other anthropogenic activities	1	4	5	Distribution of community	Eastern coastal pelagic	3	2	2	1	Community may be disturbed by tourism (e.g. whale watching) due to charter boats. Intensity: Assumed to have minor direct and indirect impacts on community. Consequence: Until there is better information, difficult to score therefore low confidence.

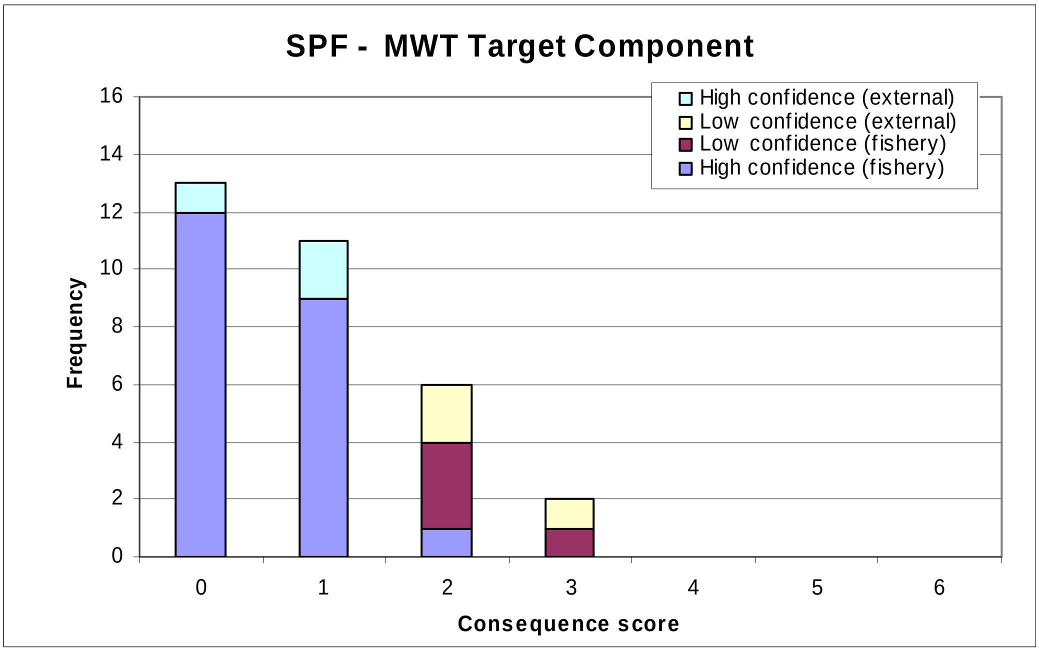
2.3.11 Summary of SICA results

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).

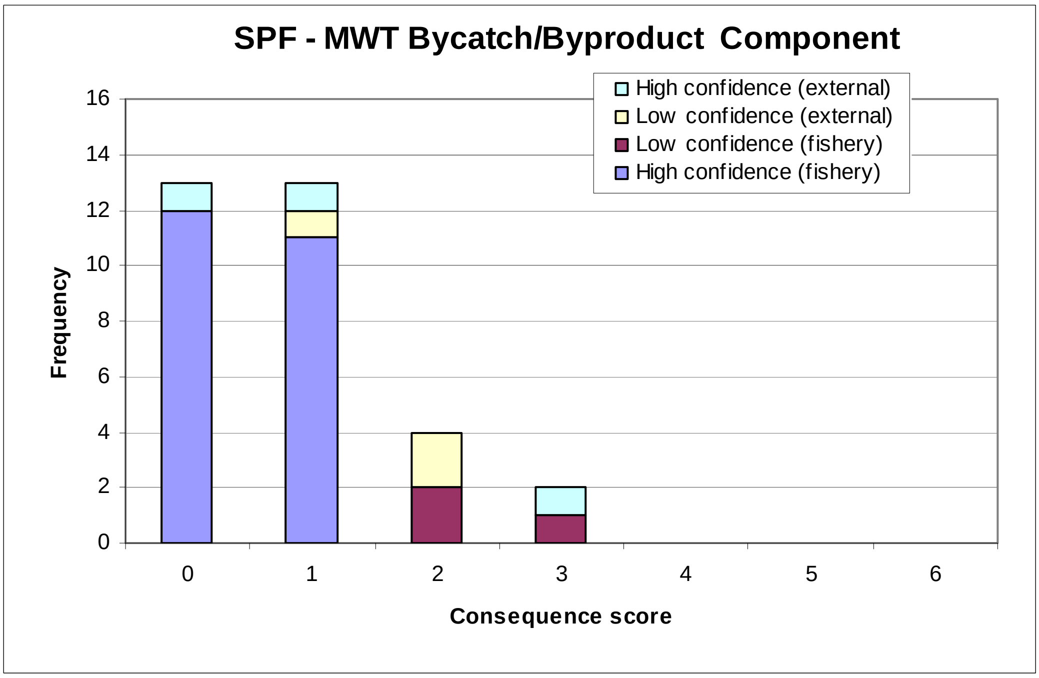
Level 1 (SICA) Document L1.6. Summary table of consequence scores for all activity/component combinations.

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

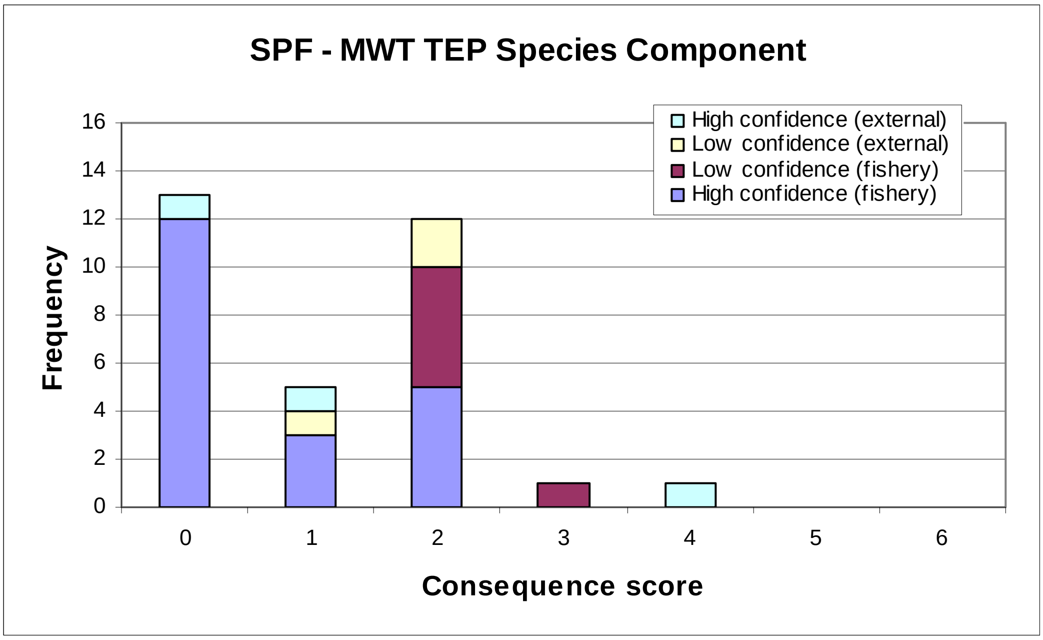
Target species: Frequency of consequence score differentiated between high and low confidence.



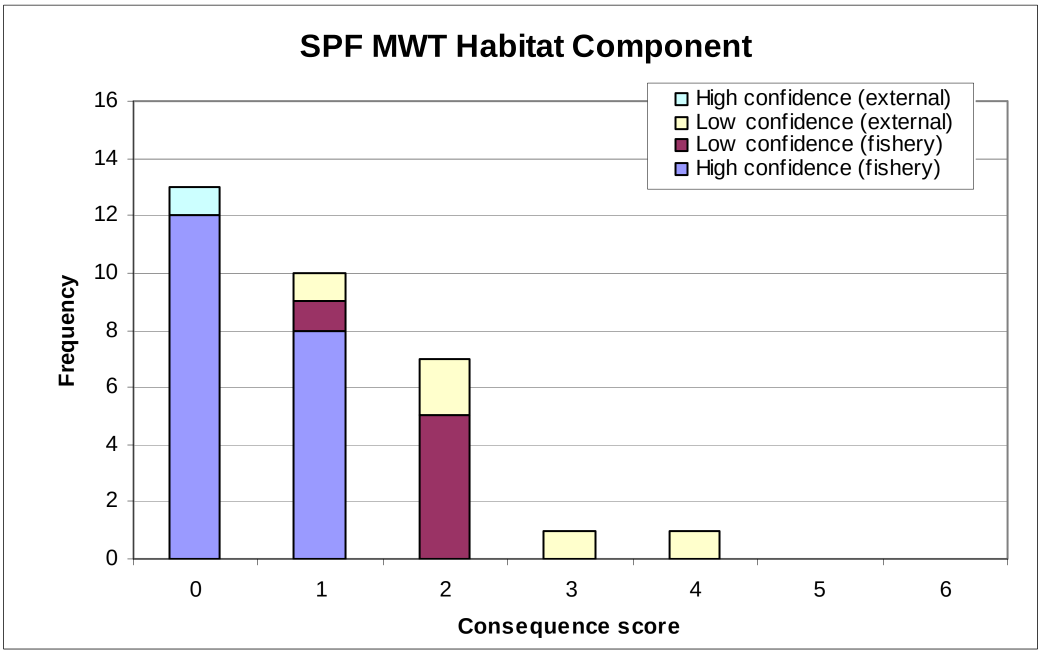
Byproduct and bycatch species: Frequency of consequence score differentiated between high and low confidence



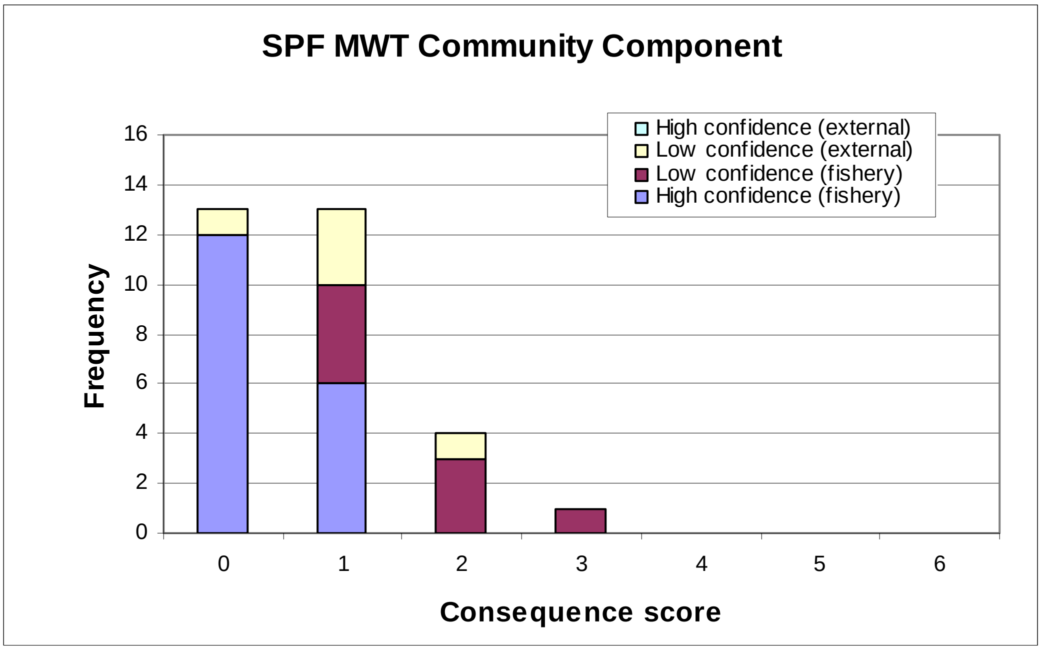
TEP species: Frequency of consequence score differentiated between high and low confidence (SICA excel workbook)



Habitats: Frequency of consequence score differentiated between high and low confidence



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



2.3.12 Evaluation/discussion of Level 1

This section provides a brief discussion of the results of the Level 1 analysis. Full details and rationale for the scores are provided in the SICA tables earlier in this section.

There were 19 of the 32 possible activity scenarios identified as leading to some form of impact in the SPF midwater trawl sub-fishery (i.e., activities occurred in the sub-fishery). Of the 19 ‘impact causing activities’ across five components (95 scenarios), only four scenarios (plus five out of 30 external to the fishery) were identified as having an impact of moderate or above (see **Level 1 (SICA) Document L1.6**). These four internal scenarios occurred across four components (one each); target species, bycatch and byproduct species, TEP species and communities. The only impact-causing activity involved was

- Fishing (direct impacts)

The significant external hazards to the components relevant to the SPF midwater trawl sub-fishery were external fishing (all five components) and coastal development (habitats)

This analysis did not yield any surprises; the low level of fishing currently occurring means that the impact of just about all activities was minor. The apparently large capture volume of the target species, together with some identified issues about direct capture and mortality of TEP species, as well as indirect impacts caused by the removal of the an important prey species for the ecological community. Potential capture of a heavily fished (in other fisheries) byproduct species (Blue eye trevalla) is a concern that should be considered in more detail. Evaluation of these components at Level 2 allows the risks to be considered in more detail, and they may subsequently be eliminated with greater analysis effort.

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 species*
- *Bycatch and byproduct species*
- *TEP species*
- *Communities*

The SICA has removed some components from further analysis, as these are judged to be impacted with low consequence by the set of activities considered. Those components excluded are

- Habitats

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. In all assessments to date, this 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.

<u>Habitats</u>

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
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.

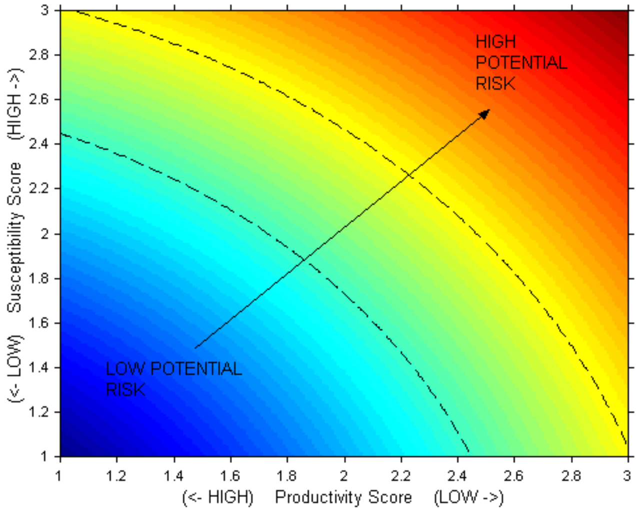


Figure 13. The axes on which risk to the ecological units is plotted. The *x*-axis includes attributes that influence the productivity of a unit, or its ability to recover after impact from fishing. The *y*-axis includes attributes that influence the susceptibility of the unit to impacts from fishing. 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.

No species were eliminated from the Level 2 analyses; however, two taxa that are identified in the logbooks at a high taxonomic level were removed as the species within these taxa are already present in the assessment.

ERA_SPECIES_ID	ERA_SUB_FISHERY_ID	TAXA_NAME	SCIENTIFIC_NAME	CAAB_CODE	FAMILY_NAME	COMMON_NAME	Explanation for why taxa excluded
2136	38	Teleost	Emmelichthys spp	37345901	Emmelichthyidae	redbait	Duplicate of redbait
1998	38	Invertebrate	Order Teuthoidea - undifferentiated	23615000	Order Teuthoidea	squid	Duplicate of arrow squid
		Invertebrate	Scyllaridae - undifferentiated		Scyllaridae	Slipper lobster	Erroneus data

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. For species assessed at Level 2, no account is taken of the level of catch, the size of the population, or the likely exploitation rate. To assess actual risk for any species requires a Level 3 assessment which does account for these factors. However, recent fishing effort distributions are considered when calculating the availability attribute for the Level 2 analysis, 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.

There are differences between analyses for TEP species and the other species components. In particular, target, by-product and by-catch species are included on the basis that they are known to be caught by the fishery (in some cases only very rarely). However TEP species are included in the analysis on the basis that they occur in the area of the fishery, whether or not there has ever been an interaction with the fishery recorded. For this reason there may be a higher proportion of false positives for high vulnerability for TEP species, unless there is a robust observer program that can verify that species do not interact with the gear.

Observer data and observer expert knowledge are important sources of information in the PSA analyses, particularly for the bycatch and TEP components. Observer data has been collected by the agencies that co-manage the fishery. There are no stated objectives of the program and objectives have varied between trips. Objectives for a revised program are still under consideration under the developing Harvest Strategy Framework. Additional information is given in the scoping section.

A summary of the species considered at Level 2 is presented below, sorted by component, by taxa within components, and then 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 *Small Pelagic Fishery*

ERA species ID	Scientific name	Common name	Average logbook catch (kg) (2001-04)	Missing > 3 attributes (Y/N)	Number of missing productivity attributes (out of	Missing susceptibility attributes (out of 5)	Productivity (additive) 1- low risk, 3 - high risk	Susceptibility (mult) 1- low risk, 3 - high risk	2D risk value (P&S) 1.41- low risk, 4.24 - high risk	Susceptibility override used?	2D P&S risk category	High/Med risk category (Refer 2.4.8)	Comments
Teleost													
155	Emmelichthys nitidus	redbait	0	N	1	0	1.57	1.67	2.29	N	Low		

Byproduct species *Small Pelagic Fishery*

ERA species ID	Scientific name	Common name	Average logbook catch (kg) (2001-04)	Missing > 3 attributes (Y/N)	Number of missing productivity attributes (out of 7)	Missing susceptibility attributes (out of 5)	Productivity (additive) 1- low risk, 3 - high risk	Susceptibility (mult) 1- low risk, 3 - high risk	2D risk value (P&S) 1.41- low risk, 4.24 - high risk	Susceptibility override used?	2D P&S risk category	High/Med risk category (Refer 2.4.8)	Comments
Invertebrate													
11	Nototodarus gouldi	Arrow Squid	0	N	0	0	1.43	1.67	2.20	N	Low		
Teleost													
252	Mola mola	ocean sunfish	0	N	1	0	2.29	1.67	2.83	N	Med	Low attribute score	
958	Hyperoglyphe antarctica	Blue Eye Trevalla	0	N	0	0	2.00	1.44	2.47	N	Low		
982	Macruronus novaezelandiae	Blue Grenadier	50	N	0	0	1.71	1.67	2.39	N	Low		
1087	Thyrsites atun	Barracouta	52,150	N	0	0	1.57	1.67	2.29	N	Low		
215	Centrolophus niger	Rudderfish	0	N	0	0	1.57	1.67	2.29	N	Low		
69	Centroberyx lineatus	swallowtail	10	N	1	0	1.71	1.44	2.24	N	Low		
150	Pseudocaranx dentex	Silver Trevally	855	N	0	0	1.57	1.44	2.13	N	Low		
233	Nelusetta ayraudi	Chinaman-Leatherjacket	6	N	0	0	1.29	1.67	2.10	N	Low		
1097	Zenopsis nebulosus	Mirror Dory	0	N	0	0	1.43	1.44	2.03	N	Low		
1069	Seriolella punctata	Spotted Warehou	8,825	N	0	0	1.43	1.44	2.03	N	Low		
214	Cyttus australis	Silver dory	0	N	0	0	1.29	1.44	1.93	N	Low		
1088	Trachurus declivis	Jack Mackerel	1,834,225	N	0	0	1.29	1.44	1.93	N	Low		
210	Scomber australasicus	Blue Mackerel	121,138	N	0	0	1.29	1.44	1.93	N	Low		
1068	Seriolella brama	Blue Warehou	250	N	0	0	1.29	1.44	1.93	N	Low		
1037	Neoplatycephalus richardsoni	Flathead	0	N	0	0	1.29	1.22	1.77	N	Low		

Bycatch species *Small Pelagic Fishery*

ERA species ID	Scientific name	Common name	Average logbook catch (kg) (2001-04)	Missing > 3 attributes (Y/N)	Number of missing productivity attributes (out of 7)	Missing susceptibility attributes (out of 5)	Productivity (additive) 1- low risk, 3 - high risk	Susceptibility (mult) 1- low risk, 3 - high risk	2D risk value (P&S) 1.41- low risk, 4.24 - high risk	Susceptibility override used?	2D P&S risk category	High/Med risk category (Refer 2.4.8)	Comments
Teleost													
106	Lepidotrigla vanessa	butterfly gurnard	0	N	0	0	1.29	1.22	1.77	N	Low		
208	Lepidopus caudatus	Southern Frostfish	0	N	1	0	1.71	1.67	2.39	N	Low		

TEP species *Small Pelagic Fishery*

ERA species ID	Scientific name	Common name	Average logbook catch (kg) (2001-04)	Missing > 3 attributes (Y/N)	Number of missing productivity attributes (out of 7)	Missing susceptibility attributes (out of 5)	Productivity (additive) 1- low risk, 3 - high risk	Susceptibility (mult) 1- low risk, 3 - high risk	2D risk value (P&S) 1.41- low risk, 4.24 - high risk	Susceptibility override used?	2D P&S risk category	High/Med risk category (Refer 2.4.8)	Comments
Chondrichthyan													
315	Carcharodon carcharias	white shark	0	N	0	0	2.86	1.22	3.11	Y	Med	Low overlap	Observer over-ride, Encounterability reduced from, 3 to 1, Not captured in any mid-water fisheries (observer workshop August 2005)
1067	Rhincodon typus	whale shark	0	N	0	0	2.71	1.44	3.07	N	Med	Widely distributed	Observer over-ride,:Availability reduced from, 3 to 1. No detailed mapping analysis available for pelagic species. Mainly tropical, migratory, and unlikely to form a separate stock around Tasmania where effort was focussed from 01-04 (Expert comment from John Stevens, Logbook data, stock structure proxy table from Methodology document)

313	Carcharias taurus	grey nurse shark	0	N	0	0	2.71	1.22	2.98	Y	Med	Widely distributed	Observer over-ride, Encounterability reduced from, 3 to 1, Not captured in any mid-water fisheries (observer workshop August 2005)
Marine bird													
1033	Thalassarche cauta	Shy Albatross	0	N	1	0	2.43	2.33	3.37	Y	High	Spatial uncertainty	Observer over-ride: Encounterability reduced from 3 to 2. Birds are not caugh in the nets but albatross with large wing-span can strike trawl warps which has resulted in bird mortality in other Australian trawl fisheries (Observer workshop August 2005).
1085	Thalassarche melanophrys	Black-browed Albatross	0	N	1	0	2.43	2.33	3.37	Y	High	Spatial uncertainty	see shy albatross
889	Thalassarche eremita	Chatham albatross	0	Y	3	1	2.86	1.44	3.20	Y	High	Missing data	see shy albatross
1673	Thalassarche nov. sp.	Pacific Albatross	0	N	1	1	2.71	1.22	2.98	Y	Med	Low attribute score	see shy albatross
753	Diomedea epomophora	Southern Royal Albatross	0	N	1	0	2.57	1.44	2.95	Y	Med	Low attribute score	see Pacific albatross
451	Diomedea exulans	Wandering Albatross	0	N	1	0	2.57	1.44	2.95	Y	Med	Low attribute score	see Pacific albatross
755	Diomedea gibsoni	Gibson's Albatross	0	N	1	0	2.57	1.44	2.95	Y	Med	Low attribute score	see Pacific albatross
628	Diomedea antipodensis	Antipodean Albatross	0	N	1	0	2.57	1.44	2.95	Y	Med	Low attribute score	see Pacific albatross
799	Diomedea sanfordi	Northern Royal Albatross	0	N	1	0	2.57	1.44	2.95	Y	Med	Low attribute score	see Pacific albatross
1084	Thalassarche impavida	Campbell Albatross	0	N	1	0	2.57	1.44	2.95	Y	Med	Low attribute score	see Pacific albatross
1031	Thalassarche carteri	Indian Yellow-nosed Albatross	0	N	1	0	2.57	1.44	2.95	Y	Med	Low attribute score	see Pacific albatross
894	Thalassarche salvini	Salvin's albatross	0	N	3	0	2.57	1.44	2.95	Y	Med	Low attribute score	see Pacific albatross
1428	Diomedea amsterdamensis	Amsterdam Albatross	0	N	1	0	2.57	1.44	2.95	Y	Med	Low attribute score	see Pacific albatross
1429	Diomedea dabbenena	Tristan Albatross	0	N	1	0	2.57	1.44	2.95	Y	Med	Low attribute score	see Pacific albatross

1580	Calonectris leucomelas	streaked shearwater	0	N	3	0	2.57	1.44	2.95	Y	Med	Low attribute score	Observer over-ride, Availability reduced from, 3 to 1, rare or not present on grounds, Encounterability reduced from, 3 to1, not captured in this fishery (AFMA observer data)
1003	Pachyptila turtur	Fairy Prion	0	N	3	0	2.43	1.67	2.95	Y	Med	Low attribute score	see streaked shearwater
1060	Puffinus tenuirostris	Short-tailed Shearwater	0	N	1	0	2.43	1.67	2.95	Y	Med	Low attribute score	Observer over-ride: Encounterability reduced from, 3 to 1, not captured in this fishery (AFMA observer data)
1045	Pterodroma cervicalis	White-necked Petrel	0	N	3	0	2.57	1.22	2.85	Y	Med	Low attribute score	see streaked shearwater
1051	Pterodroma solandri	Providence Petrel	0	N	3	0	2.57	1.22	2.85	Y	Med	Low attribute score	see streaked shearwater
1054	Puffinus bulleri	Buller's Shearwater	0	N	3	0	2.57	1.22	2.85	Y	Med	Low attribute score	see streaked shearwater
912	Phalacrocorax fuscescens	Black faced cormorant	0	N	1	0	2.57	1.22	2.85	Y	Med	Low attribute score	see streaked shearwater
1086	Thalassarche steadi	White-capped Albatross	0	N	2	0	2.57	1.22	2.85	Y	Med	Low attribute score	see streaked shearwater
1041	Procellaria aequinoctialis	White-chinned Petrel	0	N	1	0	2.29	1.67	2.83	Y	Med	Low attribute score	See short-tailed shearwater
1032	Thalassarche bulleri	Buller's Albatross	0	N	1	0	2.43	1.44	2.83	Y	Med	Low attribute score	see pacific albatross
1035	Thalassarche chrysostoma	Grey-headed Albatross	0	N	1	0	2.43	1.44	2.83	Y	Med	Low attribute score	see pacific albatross
1009	Phoebetria palpebrata	Light-mantled Albatross	0	N	1	0	2.43	1.44	2.83	Y	Med	Low attribute score	see Pacific albatross
314	Fulmarus glacialoides	Southern fulmar	0	N	1	0	2.43	1.44	2.83	Y	Med	Low attribute score	see streaked shearwater
939	Halobaena caerulea	Blue Petrel	0	N	3	0	2.43	1.44	2.83	Y	Med	Low attribute score	see streaked shearwater
1052	Lugensa brevirostris	Kerguelen Petrel	0	N	3	0	2.43	1.44	2.83	Y	Med	Low attribute score	see streaked shearwater
1042	Procellaria parkinsoni	Black Petrel; Parkinsons Petrel	0	N	2	0	2.43	1.22	2.72	Y	Med	Low attribute score	see streaked shearwater
1043	Procellaria westlandica	Westland Petrel	0	N	2	0	2.43	1.22	2.72	Y	Med	Low attribute score	see streaked shearwater
1046	Pterodroma leucoptera	Gould's Petrel	0	Y	4	0	2.43	1.22	2.72	Y	Med	Missing data	see streaked shearwater

1047	Pterodroma macroptera	Great-winged Petrel	0	N	2	0	2.43	1.22	2.72	Y	Med	Low attribute score	see streaked shearwater
1048	Pterodroma mollis	Soft-plumaged Petrel	0	N	3	0	2.43	1.22	2.72	Y	Med	Low attribute score	see streaked shearwater
1050	Pterodroma nigripennis	Black-winged Petrel	0	N	3	0	2.43	1.22	2.72	Y	Med	Low attribute score	see streaked shearwater
1053	Puffinus assimilis	Little Shearwater (Tasman Sea)	0	N	3	0	2.43	1.22	2.72	Y	Med	Low attribute score	see streaked shearwater
1055	Puffinus carneipes	Flesh-footed Shearwater	0	N	1	0	2.43	1.22	2.72	Y	Med	Low attribute score	see streaked shearwater
1059	Puffinus pacificus	Wedge-tailed Shearwater	0	N	1	0	2.43	1.22	2.72	Y	Med	Low attribute score	see streaked shearwater
918	Fregetta grallaria	White-bellied Storm-Petrel (Tasman Sea),	0	N	3	0	2.43	1.22	2.72	Y	Med	Low attribute score	see streaked shearwater
917	Fregetta tropica	Black-bellied Storm-Petrel	0	N	3	0	2.43	1.22	2.72	Y	Med	Low attribute score	see streaked shearwater
555	Garrodia nereis	Grey-backed storm petrel	0	N	3	0	2.43	1.22	2.72	Y	Med	Low attribute score	see streaked shearwater
325	Catharacta skua	Great Skua	0	N	1	0	2.43	1.22	2.72	Y	Med	Low attribute score	see streaked shearwater
1034	Thalassarche chlororhynchos	Yellow-nosed Albatross, Atlantic Yellow-	0	N	1	0	2.29	1.44	2.70	Y	Med	Low attribute score	see Pacific albatross
1008	Phoebetria fusca	Sooty Albatross	0	N	1	0	2.29	1.44	2.70	Y	Med	Low attribute score	see Pacific albatross
595	Daption capense	Cape Petrel	0	N	1	0	2.29	1.44	2.70	Y	Med	Low attribute score	see streaked shearwater
73	Macronectes giganteus	Southern Giant-Petrel	0	N	1	0	2.29	1.22	2.59	Y	Low		see streaked shearwater
981	Macronectes halli	Northern Giant-Petrel	0	N	1	0	2.29	1.22	2.59	Y	Low		see streaked shearwater
494	Procellaria cinerea	Grey petrel	0	N	1	0	2.29	1.22	2.59	Y	Low		see streaked shearwater
1691	Pseudobulweria rostrata	Tahiti Petrel	0	N	1	1	2.29	1.22	2.59	Y	Low		see streaked shearwater
504	Pterodroma lessoni	White-headed petrel	0	N	1	0	2.29	1.22	2.59	Y	Low		see streaked shearwater
1049	Pterodroma neglecta	Kermadec Petrel (western)	0	N	2	0	2.29	1.22	2.59	Y	Low		see streaked shearwater
1057	Puffinus griseus	Sooty Shearwater	0	N	1	0	2.29	1.22	2.59	Y	Low		see streaked shearwater
1432	Phaethon rubricauda	Red-tailed Tropicbird	0	N	1	0	2.29	1.22	2.59	Y	Low		see streaked shearwater
1549	Morus capensis	Cape gannet	0	N	1	0	2.29	1.22	2.59	Y	Low		see streaked shearwater
998	Morus serrator	Australasian Gannet	0	N	1	0	2.29	1.22	2.59	Y	Low		see streaked shearwater
1433	Sula dactylatra	Masked Booby	0	N	1	0	2.29	1.22	2.59	Y	Low		see streaked shearwater
203	Anous stolidus	Common noddy	0	N	1	0	2.29	1.22	2.59	Y	Low		see streaked shearwater
975	Larus pacificus	Pacific Gull	0	N	1	0	2.29	1.22	2.59	Y	Low		see streaked shearwater

1017	Sterna bergii	Crested Tern	0	N	1	0	2.29	1.22	2.59	Y	Low		see streaked shearwater
1018	Sterna caspia	Caspian Tern	0	N	1	0	2.29	1.22	2.59	Y	Low		see streaked shearwater
898	Eudyptula minor	Little Penguin	0	N	1	0	2.14	1.22	2.47	Y	Low		see streaked shearwater
1056	Puffinus gavia	Fluttering Shearwater	0	N	2	0	2.14	1.22	2.47	Y	Low		see streaked shearwater
1058	Puffinus huttoni	Hutton's Shearwater	0	N	2	0	2.14	1.22	2.47	Y	Low		see streaked shearwater
1438	Anous minutus	Black Noddy	0	N	1	0	2.14	1.22	2.47	Y	Low		see streaked shearwater
67	Anous tenuirostris	Lesser noddy	0	N	2	0	2.14	1.22	2.47	Y	Low		see streaked shearwater
973	Larus dominicanus	Kelp Gull	0	N	1	0	2.14	1.22	2.47	Y	Low		see streaked shearwater
974	Larus novaehollandiae	Silver Gull	0	N	3	0	2.14	1.22	2.47	Y	Low		see streaked shearwater
1582	Procelsterna cerulea	grey ternlet	0	N	1	0	2.14	1.22	2.47	Y	Low		see streaked shearwater
1020	Sterna fuscata	Sooty tern	0	N	1	0	2.14	1.22	2.47	Y	Low		see streaked shearwater
1021	Sterna hirundo	Common tern	0	N	1	0	2.14	1.22	2.47	Y	Low		see streaked shearwater
1023	Sterna paradisaea	Arctic tern	0	N	1	0	2.14	1.22	2.47	Y	Low		see streaked shearwater
1025	Sterna sumatrana	Black-naped tern	0	N	2	0	2.14	1.22	2.47	Y	Low		see streaked shearwater
556	Oceanites oceanicus	Wilson's storm petrel (subantarctic)	0	N	1	0	2.00	1.22	2.34	Y	Low		see streaked shearwater
1004	Pelagodroma marina	White-faced Storm-Petrel	0	N	1	0	2.00	1.22	2.34	Y	Low		see streaked shearwater
1014	Sterna albifrons	Little tern	0	N	1	0	2.00	1.22	2.34	Y	Low		see streaked shearwater
1015	Sterna anaethetus	Bridled Tern	0	N	1	0	2.00	1.22	2.34	Y	Low		see streaked shearwater
1024	Sterna striata	White-fronted Tern	0	N	1	0	2.00	1.22	2.34	Y	Low		see streaked shearwater
1006	Pelecanoides urinatrix	Common Diving-Petrel	0	N	1	0	1.86	1.22	2.22	Y	Low		see streaked shearwater
Marine mammal													
253	Arctocephalus pusillus doriferus	Australian Fur Seal	0	N	0	0	2.29	3.00	3.77	N	High	Spatial uncertainty	
902	Feresa attenuata	Pygmy Killer Whale	0	N	0	0	2.86	1.67	3.31	N	High	Low attribute score	
934	Globicephala macrorhynchus	Short-finned Pilot Whale	0	N	0	0	2.86	1.67	3.31	N	High	Low attribute score	
935	Globicephala melas	Long-finned Pilot Whale	0	N	0	0	2.86	1.67	3.31	N	High	Low attribute score	
937	Grampus griseus	Risso's Dolphin	0	N	0	0	2.86	1.67	3.31	N	High	Low attribute score	
1044	Pseudorca crassidens	False Killer Whale	0	N	1	0	2.86	1.67	3.31	N	High	Low attribute score	
1091	Tursiops truncatus	Bottlenose Dolphin	0	N	0	0	2.86	1.67	3.31	N	High	Low attribute score	
1494	Tursiops aduncus	Indian Ocean bottlenose dolphin	0	N	1	0	2.86	1.67	3.31	N	High	Low attribute score	

985	Mesoplodon bowdoini	Andrew's Beaked Whale	0	N	1	0	2.86	1.67	3.31	N	High	Low attribute score	
986	Mesoplodon densirostris	Blainville's Beaked Whale	0	N	0	0	2.86	1.67	3.31	N	High	Low attribute score	
987	Mesoplodon gingkodens	Gingko Beaked Whale	0	N	1	0	2.86	1.67	3.31	N	High	Low attribute score	
989	Mesoplodon hectori	Hector's Beaked Whale	0	N	0	0	2.86	1.67	3.31	N	High	Low attribute score	
991	Mesoplodon mirus	True's Beaked Whale	0	N	0	0	2.86	1.67	3.31	N	High	Low attribute score	
959	Hyperoodon planifrons	Southern Bottlenose Whale	0	N	1	0	2.86	1.44	3.20	N	High	Low attribute score	
988	Mesoplodon grayi	Gray's Beaked Whale	0	N	1	0	2.86	1.44	3.20	N	High	Low attribute score	
990	Mesoplodon layardii	Strap-toothed Beaked Whale	0	N	1	0	2.86	1.44	3.20	N	High	Low attribute score	
1098	Ziphius cavirostris	Cuvier's Beaked Whale	0	N	0	0	2.86	1.44	3.20	N	High	Low attribute score	
970	Lagenodelphis hosei	Fraser's Dolphin	0	N	1	0	2.71	1.67	3.19	N	High	Low attribute score	
832	Lagenorhynchus cruciger	Hourglass dolphin	0	N	1	1	2.71	1.67	3.19	N	High	Low attribute score	
61	Lissodelphis peronii	Southern Right Whale Dolphin	0	N	1	0	2.71	1.67	3.19	N	High	Low attribute score	
1081	Stenella coeruleoalba	Striped Dolphin	0	N	0	0	2.71	1.67	3.19	N	High	Low attribute score	
295	Hydrurga leptonyx	Leopard seal	0	N	0	0	2.71	1.67	3.19	N	High	Low attribute score	
993	Mirounga leonina	Elephant seal	0	N	0	0	2.71	1.67	3.19	N	High	Low attribute score	
1002	Orcinus orca	Killer Whale	0	N	0	0	2.86	1.22	3.11	Y	Med	Low attribute score	Observer over-ride, Encounterability reduced from, 3 to 1, does not feed on small pelagics (Observer workshop August 2005)
269	Berardius arnuxii	Arnoux's Beaked Whale	0	N	0	0	2.86	1.22	3.11	N	Med	Low attribute score	
1030	Tasmacetus shepherdi	Tasman Beaked Whale	0	N	1	0	2.86	1.22	3.11	N	Med	Low attribute score	

256	Balaenoptera acutorostrata	Minke Whale	0	N	0	0	2.86	1.15	3.08	Y	Med	Low attribute score	Observer over-ride, Encounterability reduced from, 3 to 1, a plankton feeder not attracted to schooling redbait pelagics (Observer workshop August 2005)
1007	Peponocephala electra	Melon-headed Whale	0	N	1	0	2.57	1.67	3.06	N	Med	Low attribute score	
1080	Stenella attenuata	Spotted Dolphin	0	N	1	0	2.57	1.67	3.06	N	Med	Low attribute score	
261	Balaenoptera borealis	Sei Whale	0	N	0	0	2.86	1.07	3.05	Y	Med	Low attribute score	see minke whale
262	Balaenoptera edeni	Bryde's Whale	0	N	0	0	2.86	1.07	3.05	Y	Med	Low attribute score	see minke whale
268	Balaenoptera physalus	Fin Whale	0	N	0	0	2.86	1.07	3.05	Y	Med	Low attribute score	see minke whale
1439	Balaenoptera bonaerensis	Antarctic Minke Whale	0	N	1	0	2.86	1.07	3.05	Y	Med	Low attribute score	see minke whale
968	Kogia breviceps	Pygmy Sperm Whale	0	N	0	0	2.86	1.07	3.05	Y	Med	Low attribute score	Observer over-ride, Encounterability reduced from, 3 to 1, feeds deep, not atracted to schooling fish (Observer workshop August 2005)
1036	Physeter catodon	Sperm Whale	0	N	0	0	2.86	1.07	3.05	Y	Med	Low attribute score	see pygmy sperm whale
984	Megaptera novaeangliae	Humpback Whale	0	N	0	0	2.71	1.22	2.98	Y	Med	Low attribute score	see minke whale
1076	Sousa chinensis	Indo-Pacific Humpback Dolphin	0	N	0	0	2.71	1.22	2.98	N	Med	Low attribute score	
1083	Steno bredanensis	Rough-toothed Dolphin	0	N	0	0	2.71	1.22	2.98	N	Med	Low attribute score	
969	Kogia simus	Dwarf Sperm Whale	0	N	0	0	2.71	1.22	2.98	Y	Med	Low attribute score	see pygmy sperm whale
813	Dugong dugon	Dugong	0	N	1	0	2.71	1.22	2.98	N	Med	Low attribute score	
289	Caperea marginata	Pygmy Right Whale	0	N	1	0	2.71	1.15	2.95	Y	Med	Low attribute score	see minke whale
1082	Stenella longirostris	Long-snouted Spinner Dolphin	0	N	0	0	2.43	1.67	2.95	N	Med	Low attribute score	
216	Arctocephalus forsteri	New Zealand Fur-seal	0	N	0	0	2.43	1.67	2.95	N	Med	Low attribute score	

1000	Neophoca cinerea	Australian Sea-lion	0	N	0	0	2.43	1.67	2.95	N	Med	Low attribute score	
896	Eubalaena australis	Southern Right Whale	0	N	0	0	2.71	1.07	2.92	Y	Med	Low attribute score	see minke whale
612	Delphinus delphis	Common Dolphin	0	N	0	0	2.29	1.67	2.83	N	Med	Low attribute score	
263	Arctocephalus tropicalis	Subantarctic fur seal	0	N	0	0	2.29	1.67	2.83	N	Med	Low attribute score	
265	Balaenoptera musculus	Blue Whale	0	N	0	0	2.57	1.07	2.79	Y	Med	Low attribute score	see minke whale
971	Lagenorhynchus obscurus	Dusky Dolphin	0	N	0	0	2.29	1.22	2.59	N	Low		
Marine reptile													
1530	Disteira kingii	spectacled seasnake	0	Y	3	1	2.71	1.44	3.07	Y	Med	Missing data	Expert over-rided: Encounterability reduced from 3 to 2. Breathes on the surface and feed on the bottom. Not encountered mid-water (Wassenberg *et al*. 1994).
613	Dermochelys coriacea	Leathery turtle	0	N	1	0	2.57	1.67	3.06	N	Med	Low attribute score	
1408	Acalyptophis peronii	Horned Seasnake	0	N	3	0	2.71	1.22	2.98	N	Med	Low attribute score	
254	Astrotia stokesii	Stokes' seasnake	0	N	3	0	2.71	1.22	2.98	N	Med	Low attribute score	
1423	Hydrophis ornatus	seasnake	0	N	3	0	2.71	1.22	2.98	N	Med	Low attribute score	
1005	Pelamis platurus	yellow-bellied seasnake	0	N	3	0	2.71	1.22	2.98	N	Med	Low attribute score	
324	Caretta caretta	Loggerhead	0	N	1	0	2.43	1.67	2.95	N	Med	Low attribute score	
541	Chelonia mydas	Green turtle	0	N	1	0	2.43	1.67	2.95	N	Med	Low attribute score	
822	Eretmochelys imbricata	Hawksbill turtle	0	N	1	0	2.43	1.67	2.95	N	Med	Low attribute score	
957	Hydrophis elegans	Elegant seasnake	0	N	2	0	2.14	1.22	2.47	N	Low		
Teleost													
308	Heteroclinus perspicillatus	Common weedfish	0	N	3	0	2.29	1.22	2.59	N	Low		
1074	Solenostomus cyanopterus	Blue-finned Ghost Pipefish, Robust Ghost	0	N	3	0	2.14	1.22	2.47	N	Low		
1075	Solenostomus paradoxus	Harlequin Ghost Pipefish, Ornate Ghost Pipefish	0	N	3	0	2.14	1.22	2.47	N	Low		

1667	Hippocampus kuda	Spotted Seahorse, Yellow Seahorse	0	N	0	0	1.57	1.67	2.29	N	Low
1548	Heraldia sp. 1 [in Kuiter, 2000]	Western upsidedown pipefish	0	N	0	0	1.43	1.67	2.20	N	Low
1666	Hippocampus kelloggi	Kellogg's Seahorse	0	N	0	0	1.43	1.67	2.20	N	Low
1668	Hippocampus subelongatus	West Australian Seahorse	0	N	0	0	1.43	1.67	2.20	N	Low
1699	Idiotropiscis australe	Southern Pygmy Pipehorse	0	N	0	0	1.43	1.67	2.20	N	Low
1010	Phycodurus eques	Leafy Seadragon	0	N	0	0	1.57	1.22	1.99	N	Low
1011	Phyllopteryx taeniolatus	Weedy Seadragon, Common Seadragon	0	N	0	0	1.57	1.22	1.99	N	Low
949	Hippocampus taeniopterus	Spotted Seahorse, Yellow Seahorse	0	N	0	0	1.57	1.22	1.99	N	Low
569	Doryrhamphus melanopleura	Bluestripe Pipefish	0	N	0	0	1.57	1.22	1.99	N	Low
983	Maroubra perserrata	Sawtooth Pipefish	0	N	0	0	1.57	1.15	1.95	N	Low
320	Solegnathus guentheri	Indonesian Pipefish, Gunther's Pipehorse	0	N	0	0	1.43	1.22	1.88	N	Low
1072	Solegnathus robustus	Robust Spiny Pipehorse, Robust Pipehorse	0	N	0	0	1.43	1.22	1.88	N	Low
549	Hippocampus angustus	Western Spiny Seahorse	0	N	0	0	1.43	1.22	1.88	N	Low
1089	Trachyrhamphus bicoarctatus	Bend Stick Pipefish, Short-tailed Pipefish	0	N	0	0	1.43	1.22	1.88	N	Low
1092	Urocampus carinirostris	Hairy Pipefish	0	N	0	0	1.43	1.22	1.88	N	Low
980	Lissocampus runa	Javelin Pipefish	0	N	0	0	1.43	1.22	1.88	N	Low
946	Hippocampus bleekeri	pot bellied seahorse	0	N	0	0	1.43	1.22	1.88	N	Low
953	Histiogamphelus briggsii	Briggs' Crested Pipefish, Briggs' Pipefish	0	N	0	0	1.43	1.22	1.88	N	Low
961	Hypselognathus rostratus	Knife-snouted Pipefish	0	N	0	0	1.43	1.22	1.88	N	Low
978	Leptoichthys fistularius	Brushtail Pipefish	0	N	0	0	1.43	1.22	1.88	N	Low
966	Kaupus costatus	Deep-bodied Pipefish	0	N	0	0	1.43	1.22	1.88	N	Low
995	Mitotichthys semistriatus	Half-banded Pipefish	0	N	0	0	1.43	1.22	1.88	N	Low
979	Lissocampus caudalis	Australian Smooth Pipefish, Smooth Pipefish	0	N	0	0	1.43	1.22	1.88	N	Low
1026	Stigmatopora argus	Spotted Pipefish	0	N	0	0	1.43	1.22	1.88	N	Low
1027	Stigmatopora nigra	Wide-bodied Pipefish, Black Pipefish	0	N	0	0	1.43	1.22	1.88	N	Low
1028	Stipecampus cristatus	Ring-backed Pipefish	0	N	0	0	1.43	1.22	1.88	N	Low
1061	Pugnaso curtirostris	Pug-nosed Pipefish	0	N	0	0	1.43	1.22	1.88	N	Low

994	Mitotichthys mollisoni	Mollison's Pipefish	0	N	0	0	1.43	1.22	1.88	N	Low
1095	Vanacampus poecilolaemus	Australian Long-snout Pipefish, Long-snouted Pipefish	0	N	0	0	1.43	1.22	1.88	N	Low
996	Mitotichthys tuckeri	Tucker's Pipefish	0	N	0	0	1.43	1.22	1.88	N	Low
952	Hippocampus whitei	white's seahorse	0	N	0	0	1.43	1.22	1.88	N	Low
1073	Solegnathus spinosissimus	spiny pipehorse	0	N	0	0	1.43	1.22	1.88	N	Low
938	Halicampus grayi	Mud Pipefish, Gray's Pipefish	0	N	0	0	1.43	1.22	1.88	N	Low
114	Acentronura breviperula	Hairy Pygmy Pipehorse	0	N	0	0	1.43	1.22	1.88	N	Low
578	Corythoichthys ocellatus	Orange-spotted Pipefish, Ocellated Pipefish	0	N	0	0	1.43	1.22	1.88	N	Low
401	Cosmocampus banneri	Roughridge Pipefish	0	N	0	0	1.43	1.22	1.88	N	Low
580	Cosmocampus howensis	Lord Howe Pipefish	0	N	0	0	1.43	1.22	1.88	N	Low
904	Festucalex cinctus	Girdled Pipefish	0	N	0	0	1.43	1.22	1.88	N	Low
321	Festucalex scalaris	Ladder Pipefish	0	N	0	0	1.43	1.22	1.88	N	Low
914	Filicampus tigris	Tiger Pipefish	0	N	0	0	1.43	1.22	1.88	N	Low
54	Halicampus brocki	Brock's Pipefish	0	N	0	0	1.43	1.22	1.88	N	Low
1592	Halicampus macrorhynchus	[a pipefish]	0	N	0	0	1.43	1.22	1.88	N	Low
942	Heraldia nocturna	Upside-down Pipefish	0	N	0	0	1.43	1.22	1.88	N	Low
943	Hippichthys cyanospilos	Blue-speckled Pipefish, Blue-spotted Pipefish	0	N	0	0	1.43	1.22	1.88	N	Low
944	Hippichthys heptagonus	Madura Pipefish	0	N	0	0	1.43	1.22	1.88	N	Low
945	Hippichthys penicillus	Beady Pipefish, Steep-nosed Pipefish	0	N	0	0	1.43	1.22	1.88	N	Low
951	Hippocampus planifrons	Flat-face Seahorse	0	N	0	0	1.43	1.22	1.88	N	Low
954	Histiogamphelus cristatus	Rhino Pipefish, Macleay's Crested Pipefish	0	N	0	0	1.43	1.22	1.88	N	Low
960	Hypselognathus horridus	Shaggy Pipefish, Prickly Pipefish	0	N	0	0	1.43	1.22	1.88	N	Low
967	Kimblaeus bassensis	Trawl Pipefish, Kimbla Pipefish	0	N	0	0	1.43	1.22	1.88	N	Low
390	Lissocampus fatiloquus	Prophet's Pipefish	0	N	0	0	1.43	1.22	1.88	N	Low
992	Micrognathus andersonii	Anderson's Pipefish, Shortnose Pipefish	0	N	0	0	1.43	1.22	1.88	N	Low
1604	Micrognathus pygmaeus	[a pipefish]	0	N	0	0	1.43	1.22	1.88	N	Low
798	Microphis manadensis	Manado River Pipefish, Manado Pipefish	0	N	0	0	1.43	1.22	1.88	N	Low

1243	Mitotichthys meraculus	Western Crested Pipefish	0	N	0	0	1.43	1.22	1.88	N	Low
1242	Nannocampus subosseus	Bony-headed Pipefish	0	N	0	0	1.43	1.22	1.88	N	Low
1001	Notiocampus ruber	Red Pipefish	0	N	0	0	1.43	1.22	1.88	N	Low
1070	Solegnathus dunckeri	Duncker's Pipehorse	0	N	0	0	1.43	1.22	1.88	N	Low
1071	Solegnathus sp. 1 [in Kuiter, 2000]	Pipehorse	0	N	0	0	1.43	1.22	1.88	N	Low
1029	Syngnathoides biaculeatus	Double-ended Pipehorse, Alligator Pipefish	0	N	0	0	1.43	1.22	1.88	N	Low
1093	Vanacampus margaritifer	Mother-of-pearl Pipefish	0	N	0	0	1.43	1.22	1.88	N	Low
1096	Vanacampus vercoi	Verco's Pipefish	0	N	0	0	1.43	1.22	1.88	N	Low
950	Hippocampus minotaur	Bullneck Seahorse	0	N	0	0	1.43	1.22	1.88	N	Low
1591	Halicampus boothae	[a pipefish]	0	N	0	0	1.43	1.22	1.88	N	Low
948	Hippocampus queenslandicus	Kellogg's Seahorse	0	N	0	0	1.43	1.22	1.88	N	Low
1602	Hippocampus tristis	[a pipefish]	0	N	0	0	1.43	1.22	1.88	N	Low
1664	Hippocampus abdominalis	Big-bellied / southern potbellied seahorse	0	N	0	0	1.43	1.22	1.88	N	Low
548	Hippocampus subelongatus	West Australian Seahorse	0	N	0	0	1.43	1.22	1.88	N	Low
947	Hippocampus breviceps	Short-head Seahorse, Short-snouted Seaho	0	N	0	0	1.43	1.15	1.83	N	Low
105	Acentronura australe	Southern Pygmy Pipehorse	0	N	0	0	1.43	1.15	1.83	N	Low
287	Campichthys galei	Gale's Pipefish	0	N	0	0	1.43	1.15	1.83	N	Low
288	Campichthys tryoni	Tryon's Pipefish	0	N	0	0	1.43	1.15	1.83	N	Low
389	Choeroichthys suillus	Pig-snouted Pipefish	0	N	0	0	1.43	1.15	1.83	N	Low
563	Corythoichthys amplexus	Fijian Banded Pipefish, Brown-banded Pipefish	0	N	0	0	1.43	1.15	1.83	N	Low
1094	Vanacampus phillipi	Port Phillip Pipefish	0	N	0	0	1.29	1.22	1.77	N	Low

Summary of Habitat PSA results

Habitats were eliminated at the end of Level 1

Summary of Community PSA results

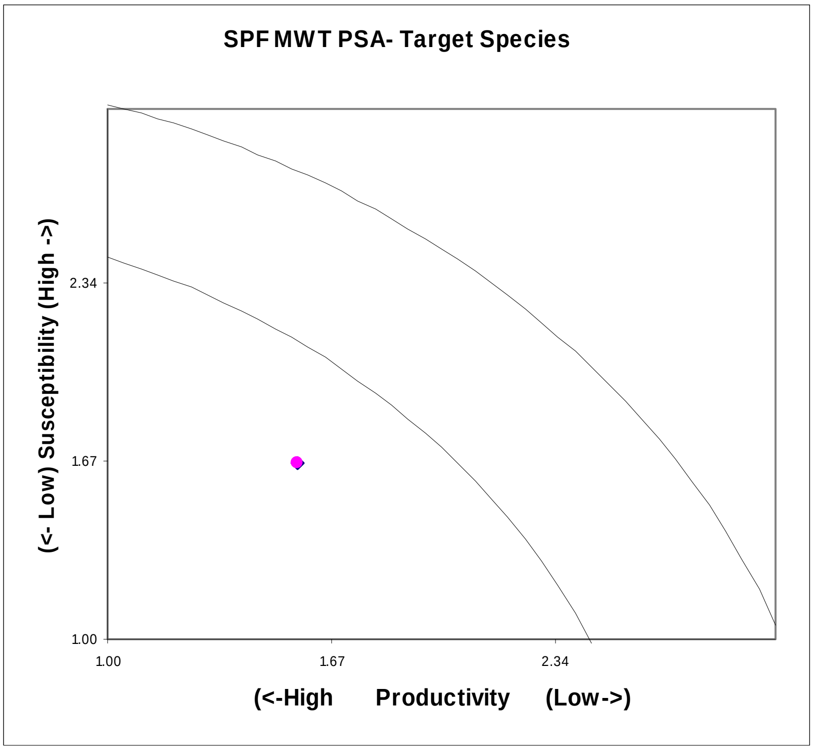
The Community component was not examined in this version; it remains a future task.

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

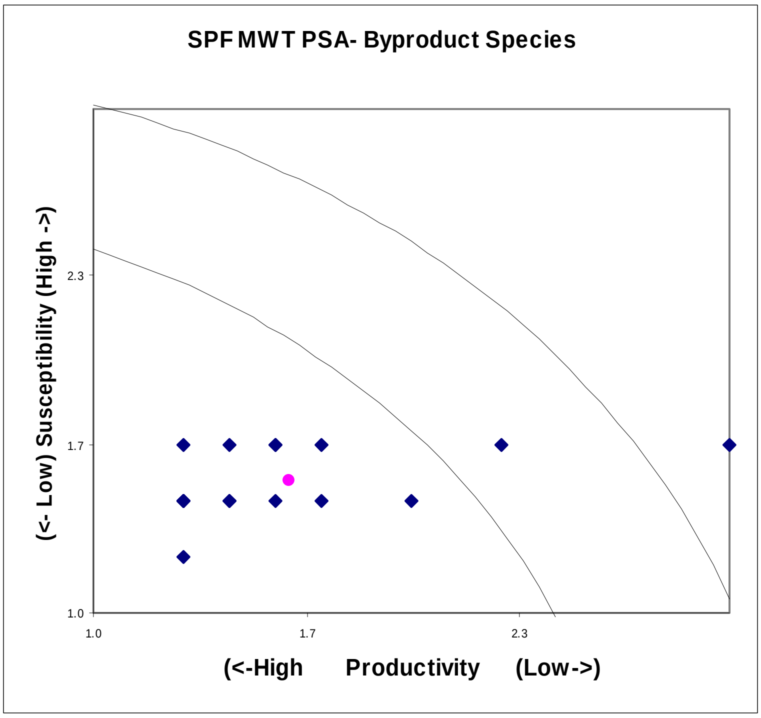
The average productivity and susceptibility scores for each unit of analysis (e.g. for each species) are then used to place the individual units of analysis on 2D plots (as below). The relative position of the units on the plot will determine relative risk at the unit level as per PSA plot below. The 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

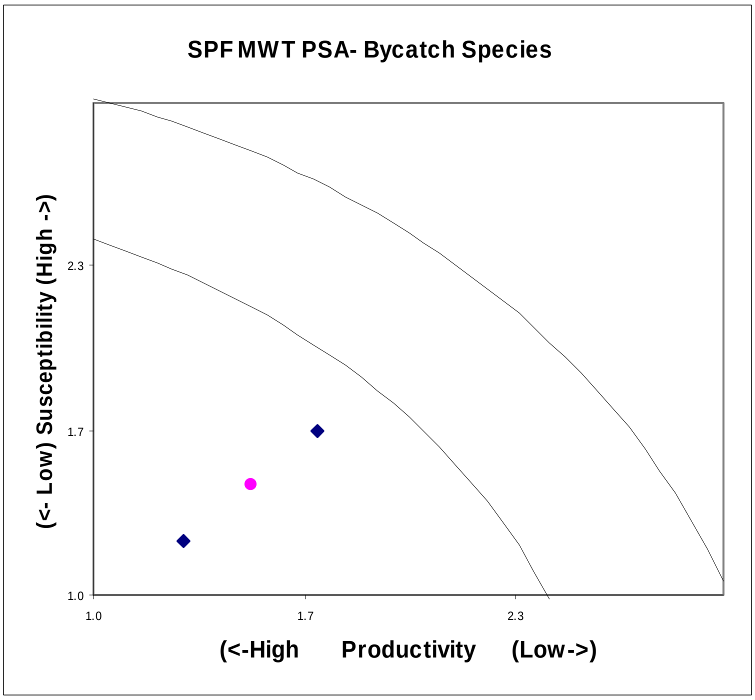
PSA plot for target species in the SPF midwater trawl fishery. The magenta dot in the centre of the blue diamonds is the average risk for this component.



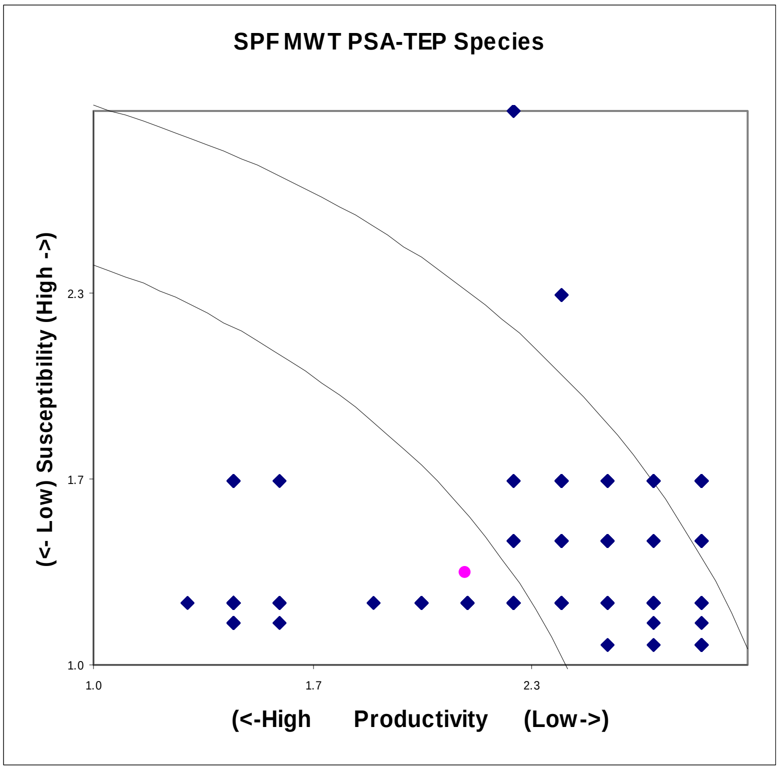
PSA plot for byproduct species in the SPF midwater trawl fishery. The magenta dot in the centre of the blue diamonds is the average risk for this component.



PSA plot for bycatch species in the SPF midwater trawl fishery. The magenta dot in the centre of the blue diamonds is the average risk for this component.



PSA plot for TEP species in the SPF midwater trawl fishery. The magenta dot in the centre of the blue diamonds is the average risk for this component.



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**).

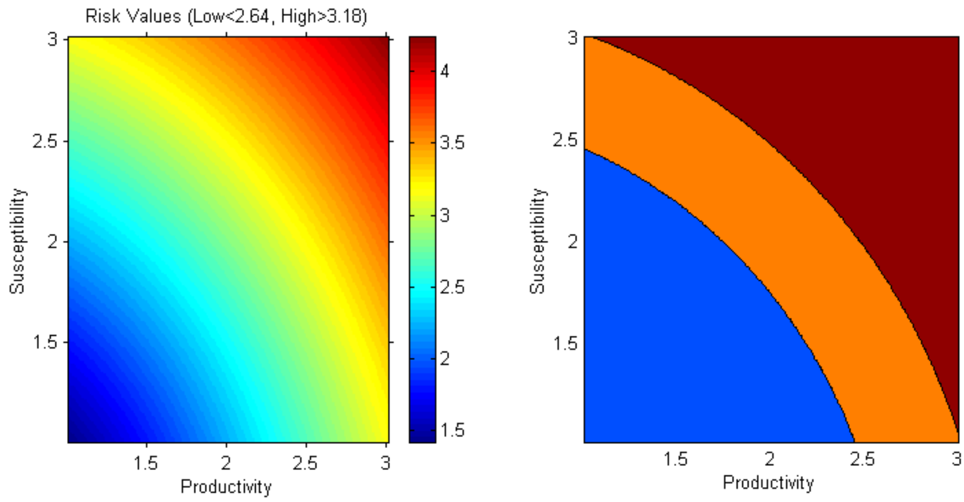


Figure 17. Overall risk values in the PSA plot. Left panel. Colour map of the distribution of the Euclidean overall risk values. Right panel. The PSA plot contoured to show the low (blue) risk, medium (orange) risk and high (red) risk values.

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 prioritisation 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.

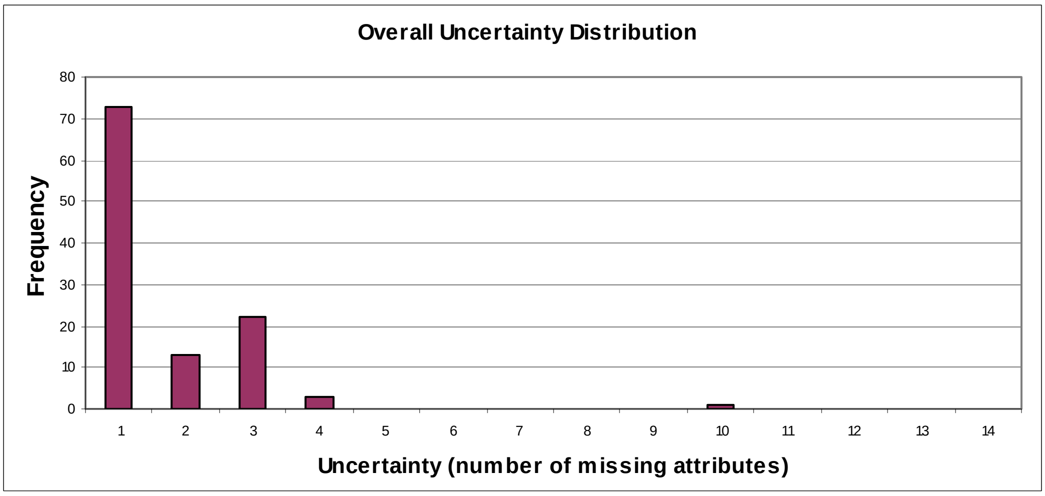
The validity of the ranking can also be examined by comparing the results with those from other data sources or modelling approaches that have already been undertaken in specific fisheries. For example, the PSA results of the individual species (target, byproduct and bycatch and TEP) can be compared 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.

<u>Availability of information</u>
The ability to score each species based on information on each attribute varied slightly between the attributes (as per summary below). With regard to the productivity attributes, trophic level was missing in 42% of species, and so the most conservative score was used, while information on reproductive strategy could be found or calculated for all but one species (the slipper lobster family). The current method of scoring the 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	Reproductive strategy	Trophic level (FishBase)
Total species scores for attribute	214	201	225	236	236	237	138
n species scores with attribute unknown, (conservative score used)	24	37	13	2	2	1	100
% unknown information	10	16	5	1	1	0	42
Susceptibility Attributes	Availability	Encounter ability		Selectivity	PCM		
		Bathymetry overlap	Habitat				
Total species scores for attribute	238	238	238	238	238		
n species scores with attribute unknown, (conservative score used)	0	0	0	0	0		
% unknown information	0.0	0.0	0.0	0.0	0.0		

Each species considered in the analysis had information for an average of 6.25 (out of 7) productivity attributes and 5 susceptibility attributes. This meant that, on average, conservative scores were used for less than 0.79 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

<u>Correlation between attributes:</u> *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 reproductive strategy and fecundity (0.90). This is why the attributes for productivity are averaged, as they are all 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 correlations were very weak (see matrix below).

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	Fecundity	Max size	Min size at maturity	Reproductive strategy	Trophic level
Age at maturity	X						
Max age	0.65	X					
Fecundity	0.49	0.62	X				
Max size	0.34	0.48	0.32	X			
Min size at maturity	0.44	0.65	0.53	0.85	X		
Reproductive strategy	0.47	0.63	0.90	0.34	0.56	X	
Trophic level	0.53	0.80	0.75	0.40	0.61	0.77	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. Correlations with the post-capture mortality could not be calculated, as this attribute was scored as 3 for all species.

	Availability	Encounterability	Selectivity	Post-capture mortality
Availability	X			
Encounterability	-0.07	X		
Selectivity	0.08	-0.02	X	
Post-capture mortality	NA	NA	NA	X

Productivity and susceptibility values for Species

The average productivity score for all species was 2.09 ± 0.11 (mean ± SD of scores calculated using n-1 attributes) and the mean susceptibility score was 1.35 (as per summary of average productivity and susceptibility scores as below). Individual scores are shown in Summary of Species PSA results (Section 2.4.2). The small variation in the average of the boot-strapped values (using n-1 attributes), indicates the productivity scores are robust to elimination or mis-estimation of a single attribute. Information for a single attribute does no have a disproportionately large effect on the productivity scores. Uncertainty cannot be calculated in the same way for susceptibility, as this is a multiplicative approach, and so dropping one variable to estimate uncertainty is less straight-forward.

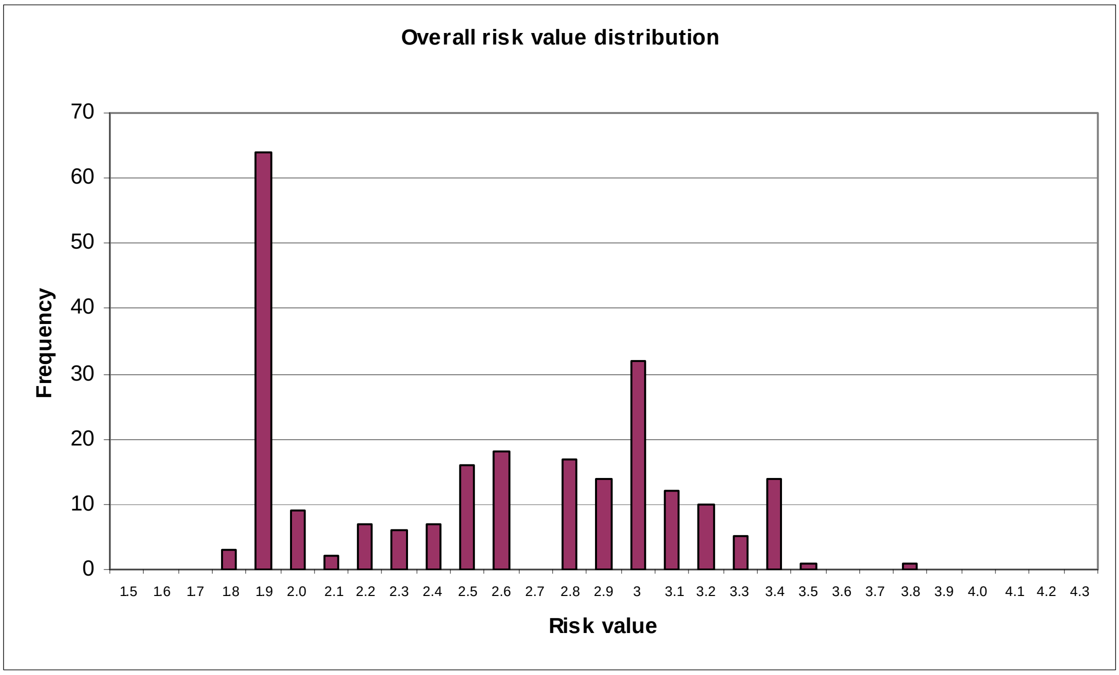
Overall Risk Values for Species

The overall risk values (Euclidean distance on the PSA plot) could fall between 1 and 4.24 (scores of 1&1 and 3&3 for both productivity and susceptibility respectively). The mean observed overall risk score was 2.51, with a range of 1.8-3.8.

The actual values for each species are shown in Summary of PSA results (above). A total of 27 species (11%) were classed as high risk, 79 (33%) were in the medium risk category, and 132 (59%) as low risk.

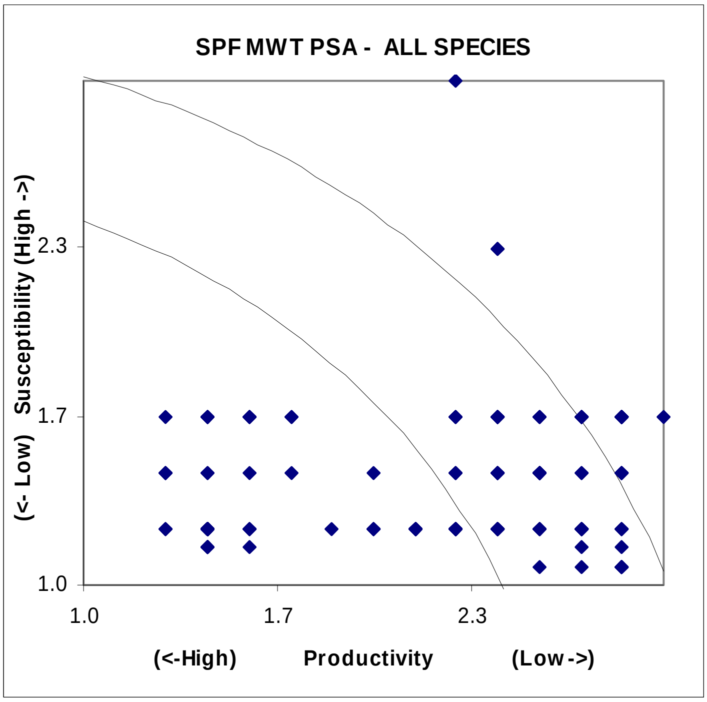
Results: Frequency distribution of the overall PSA risk values

Frequency distribution of the overall risk values generated for the 238 species in the SPF midwater trawl sub-fishery PSA.



The distribution of the overall risk values of all species is shown on the PSA plot below. The species are distributed in the lower left and lower right parts of the plot, indicating that there are clusters of low susceptibility, high productivity species (lower left), and low susceptibility, low productivity (lower right) in the purse-seine sub-fishery.

PSA plot for all species in the SPF midwater trawl sub-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.

All attributes are treated equally in the PSA; however, information on some attributes may be of low quality. There was a lack of data on the foraging range of birds and their trophic level. The single high risk byproduct species was missing all the biological information, as it was only resolved at the family level.

2.4.6 Evaluation of the PSA results (Step 6)

Species Components:
The PSA analysis of the midwater trawl was presented to industry and management during September 2005. The PSA methodology has since been reviewed and revised. The following results reflect the revised methodology (as at 10 April 2006 See **Appendix B Table L2.1**).

<u>Overall</u>

Of the 237 species assessed at Level 2 using the PSA analysis, expert/observer over-rides were used on 95 species. A total of 26 species were found to be at high risk. Of these, 1 species had more than 3 missing attributes.

For most species there was little missing data. The average number of missing attributes was 0.82 out of a possible 12. There were only 30 high risk species. None of the target, byproduct or discard species were high risk, apart from one byproduct invertebrate with missing attributes. The high risk species (29) included 23 species of small beaked and whales and dolphins. There were 3 species of birds that were evaluated as high risk. One species of marine reptile was scored high risk because of missing attributes.

Summary of average productivity, susceptibility and overall risk scores.

Component	Measure	
All species	Number of species	237
	Average of productivity total	2.09
	Average of susceptibility total	1.35
	Average of overall risk value (2D)	2.51
	Average number of missing attributes	0.82
Target species	Number of species	1
	Average of productivity total	1.57
	Average of susceptibility total	1.67
	Average of overall risk value (2D)	2.29
	Average number of missing attributes	1.00
Byproduct species	Number of species	16

	Average of productivity total	1.61
	Average of susceptibility total	1.52
	Average of overall risk value (2D)	2.23
	Average number of missing attributes	0.71
Bycatch species	Number of species	2
	Average of productivity total	1.50
	Average of susceptibility total	1.44
	Average of overall risk value (2D)	2.08
	Average number of missing attributes	0.50
TEP species	Number of species	218
	Average of productivity total	2.14
	Average of susceptibility total	1.33
	Average of overall risk value (2D)	2.54
	Average number of missing attributes	0.83

PSA 2D (productivity and susceptibility) risk categories for each species component.

Risk category	High	Medium	Low	Total
Target species			1	1
Byproduct species		1	15	16
Bycatch species			2	2
TEP species	26	79	113	218
Total	26	80	131	237

PSA 2D (productivity and susceptibility) risk categories for each taxon.

Risk category	High	Medium	Low	Total
Chondrichthyan		3		3
Invertebrate			1	1
Marine bird	3	42	33	78
Marine mammal	23	25	1	49
Marine reptile		9	1	10
Teleost		1	95	96
Total	26	80	131	237

Discussion

Target species

The single target species, redbait, was classified as low risk. The low risk score reflects the distribution of this species widely outside the range of the sub-fishery. However, some caution is needed. The analysis assumes most of the populations are outside the range of effort at any given time. For some migratory schooling species, there is the potential for the range of a stock to be restricted in its range during seasonal migrations, resulting higher than expected availability to targeting.

Byproduct species

One byproduct species, Ocean sunfish, was evaluated as medium risk but this species is widely distributed outside the fishery. With the exception of ocean sunfish, all other byproduct species taken were evaluated as low risk. The largest catches of byproduct were barracouta – averaging over 50 t per year from 2001 – 2004. Byproduct species include a number of demersal species managed by quota in the SESS. Among these, spotted warehou catches are largest, averaging 9 t per year from 2001-2004.

Bycatch species

There were only two discard species: southern frostfish and butterfly gurnard. Both species were evaluated as low risk. Butterfly gurnard is a bottom dweller. Frostfish move up into the water column but have high productivity and occur widely outside the range of current effort in the fishery.

TEP species

Chondrichthyans

The three chondrichthyans were evaluated as medium risk. No captures have been recorded in observer data to date.

Marine birds

Only three species of birds were evaluated as high risk, mainly because detailed species specific observer data has reduced the risk scores for the other species. Two of the high risk bird species are large species observed in high numbers on the fishing grounds: black-browed albatross and shy albatross. No captures of these birds have been recorded in the SPF but albatross have been killed in other Commonwealth mid-water trawl fisheries through warp strikes which are a concern overseas, particularly in New Zealand and other southern hemisphere countries. There are no estimates of what a sustainable mortality rate is likely to be for these species. The remaining bird species that scored high risk (Chatham albatross) had 4 missing attributes.

Marine mammals

Most of the high risk TEP species (23/26) were marine mammals and most of these species (20/23) were small whales. There are concerns that dolphins and small beaked whales can be attracted to the catch of small pelagic fishes which are the natural diet of some of these species (See 2.5 below).

The remaining three high risk TEP marine mammals were seals: Australian fur seal, leopard seal, and elephant seal. Australian fur seals are observed on the grounds in significant numbers and there have been a small number of recent captures (~10 in last 12 months; Lyle *et al*, unpublished); current effort in the fishery is close to the Bass Strait breeding grounds for this species and these seals have been caught in other trawl fisheries around Tasmania. Leopard seals and elephant seals breed in the Antarctic region but both are regular visitors to Australian continental waters and both have been captured in commonwealth fisheries around southern Tasmania.

Habitat Component:

Excluded at Level 1

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 be further examined 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.

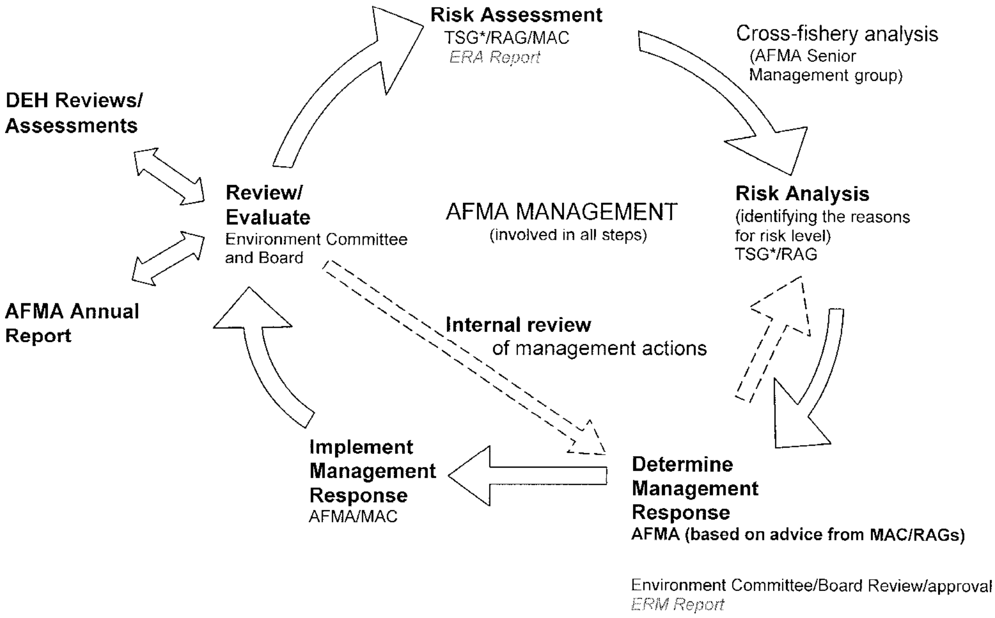
For example, if in a Level 2 analysis of habitat types, two of seven habitat types were determined to have risk from the sub-fishery, only those two habitat types would be considered at Level 3.

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 data 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.

Of the 26 species classified as high risk in the SPF MWT fishery, 1 had missing data (Category 1), 22 were scored low on one susceptibility attribute (Category 3), and 3 had spatial uncertainty (Category 4). There were no Other high risk species.

Risk Category	Description	Total
Category 1	High risk - Missing data	1
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	22
Category 4	High risk - Spatial uncertainty	3
Category 5	High risk - Other	0
	Total High risk	26

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

A number of studies have been undertaken that might support Level 3 analyses, however, at present these are only suggested for species identified at high risk at Level 2. These species were all in the TEP component. For completeness, some other Level 3 type information for species that were not at risk that is also available will be summarized here. In particular, for the community component that has not been evaluated, there are some pertinent studies. This research is also relevant to the other SPF sub-fishery, the midwater trawl. Full citations for these studies are provided at the end of the references section.

With regard to the biology of the target species, there has been a synopsis of the small pelagic fishery (purse seine and mid-water trawl) and biological data (Welsford and Lyle 2003). In the southeast a number of studies in the late 1980's documented the influence of the environment on the recruitment and distribution of some of the target species (e.g. Harris *et al*. 1987, Harris *et al*. 1988, Harris *et al*. 1991; Harris *et al*. 1992.

Although the community component was not assessed at Level 2 in this report there is some relevant information that would inform both Level 3 and Level 2 analysis of this component. These studies include

- Diet of redbait – Meyer and Smale1991
- Trophic links to shy albatross – Hedd and Gales 2001
- Trophic links to fur seals – Gales and Pemberton 1994
- Trophic links to seabirds – Brothers *et al*. 1993 1994
- Trophic links to commercial teleosts – Meyer and Smale 1991
- Trophic role of redbait – Young and Davis (1992), Young *et al* (1993, 1997), Bulman *et al* 2001

With regard to the TEP species and direct impacts, there are no studies that can estimate the sustainable level of take, although this may be important if there are demonstrated interactions that result in the death of the TEP species identified at Level 2. There has been detailed study of the Australian fur seals, and estimates of sustainable take could be made based on this research.

Research into the behaviour of seals and dolphins around the gear and the effectiveness of seal excluder devices occurred in 2005, and the results of that analysis have been presented to AFMA (Browne *et al* 2005). The study showed that some gear modifications may further reduce mortality, but also that seal behaviour may be very difficult to moderate, and they were increasingly attracted to vessels as they fished in an area (Browne *et al* 2005).

3. General discussion and research implications

3.1 Level 1

The results of the Level 1 analysis for the purse seine sub-fishery were discussed in Section 2.3.12. A total of 19 out of 32 impact activities were considered across the five components, and only four scenarios generated risk scores of moderate (3). There were no major risks identified at Level 1 (scores of 4 or above). The Level 1 SICA showed that the impacts of this fishery as it is currently practiced are limited to the direct effect of fishing, and this activity was identified across four components. Habitat was the only component eliminated.

3.2 Level 2

The Level 2 results were presented in detail in Section 2.4.6.; results are briefly recapped here. The three species components that Level 1 analyses suggested were at risk from fishing were target species, bycatch and byproduct, and TEP species. This assessment then considered 237 species in the Level 2 analyses, and a number (26) of species in the TEP component were found to be at high risk.

3.2.1 Species at risk

Of the list of species rated as high risk from the PSA analyses, the authors consider that 23 species need further evaluation or management response. This expert judgment is based on taxonomy/identification, distribution, stock structure, movements, conservation status and overlap with this/other fisheries as discussed below (sorted by taxa). These species are discussed further below.

Species	*Risk Category*	Role
Marine birds		
• Shy albatross	Low overlap	TEP
• Black-browed Albatross	Low attribute score	TEP
Marine mammals		
• Pygmy Killer Whale	Low attribute score	TEP
• Short-finned Pilot Whale	Low attribute score	TEP
• Long-finned Pilot Whale	Low attribute score	TEP
• False Killer Whale	Low attribute score	TEP
• Andrew's Beaked Whale	Low attribute score	TEP
• Blainville's Beaked Whale	Low attribute score	TEP
• Gingko Beaked Whale	Low attribute score	TEP
• Hector's Beaked Whale	Low attribute score	TEP
• True's Beaked Whale	Low attribute score	TEP
• Southern Bottlenose Whale	Low attribute score	TEP
• Gray's Beaked Whale	Low attribute score	TEP
• Strap-toothed Beaked Whale	Low attribute score	TEP
• Cuvier's Beaked Whale	Low attribute score	TEP
• Risso's Dolphin	Low attribute score	TEP

- Bottlenose Dolphin Low attribute score TEP
- Indian Ocean bottlenose Dolphin Low attribute score TEP
- Fraser's Dolphin Low attribute score TEP
- Hourglass Dolphin Low attribute score TEP
- Southern Right Whale Dolphin Low attribute score TEP
- Striped Dolphin Low attribute score TEP
- Australian Fur Seal Low attribute score TEP

Of the 26 TEP species found to be at high risk, three of these were albatross species. Two of these species (shy albatross and black-browed albatross) are known from the fishing grounds, have records of mortalities in domestic fisheries with similar gear, and are likely to suffer similar low mortality rates in this fishery. The third albatross (Chatham) was missing some biological information, and may be eliminated with more data.

Most of the high risk TEP species (23/26) were marine mammals and most of these species (20/23) were small whales or dolphins. There are concerns that dolphins and small beaked whales can be attracted to the catch of small pelagic fishes which are the natural diet of some of these species. In other fisheries, dolphins have been killed in significant numbers, and in this midwater trawl fishery, dolphin mortality was recorded in 2005.

Of the remaining three TEP species all were seals. Two species, the leopard and elephant seals, are rare within the range of current effort in the fishery, although they have been captured in other fisheries around Tasmania. Seals of a number of species are known to be caught in significant numbers by trawling around the world. The SPF sub-fishery is working to develop effective mitigation for marine mammals. A recent camera survey in this SPF sub-fishery found that Australian fur seals were present in the vicinity of the nets in 89% of observed shots (17/19), and that two seals were killed following entrapment (Browne *et al*, 2005).

Growing seal populations are likely to represent an ongoing challenge to trawl fishermen in avoiding capture of this protected species. Although explicit population models of seals have not been developed, this may be important if this fishery is to demonstrate that any take is not detrimental to the seal populations.

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 relevant; eliminated at Level 1

3.2.3 Communities at risk

Communities not evaluated as methods not complete.

3.3 Key Uncertainties / Recommendations for Research and Monitoring

In assessing risk to byproduct, bycatch and TEP species, it is not possible to assess absolute risk without supplementary information on either abundance or total mortality rates, and such data are not available for the vast majority of such species. However it may be possible to draw inferences from information that may be available for some species, either from catch records of occurrence from other fisheries, from fishery independent survey data, or from examination of trends in CPUE from observer data. Such data should be sought and examined for the high risk species identified in this analysis.

This sub-fishery has been extremely proactive in developing a research and observer program that will allow these risks to be identified and potentially mitigated. In the preparation of the ERAEF reports for fisheries around Australia, the observer data available from this fishery was second to none.

Research needs
Specific recommendations arising from this assessment include:

- Continue the high coverage and observation set collected in recent years on vessels in this fishery. Expand the programs to include operations in the Great Australian Bight if midwater trawl effort expands there. The information about the interactions with the gear may offer a solution to mitigate the known impact on marine mammals. In particular, the collection of underwater video data on the behaviour of marine mammals around the fishing gear may be the way forward.
- The relationship between the number of shots and the association of marine mammals with the vessels should be further investigated; this offers the chance to mitigate via restriction of the number of shots per trip.
- Further research and data collection for determining marine mammal distribution in the area of the fishery is required.
- Develop trophic models to ensure that removal of current catches of small pelagics will not have an unsustainable impact on predatory birds and mammals including shy albatross and the Australian fur seal.
- Determine the impact of Australian fur seal mortality on the viability of the seal population. This may allow an acceptable take to be specified, along with triggers if these levels are exceeded.

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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 a fishery, usually of low value and often discarded (see also Byproduct).
Byproduct species	A non-target species captured in a fishery, but it may have value to the fisher and be retained for sale.
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
Sept 28 2006	Written comment 1 from AFMA specific to midwater trawl	The group questioned the species lists and the roles and where this information has come from.	Action MWT1 Explanation: BRS, AFMA, DEH. Details given on a species by species basis in scoping documents
Sept 28 2006	Written comment 2 from AFMA	There are more discards. The report indicates that there are 2. Ocean sunfish is not a by-product it is a discard. The are also ~4-5 shark species	Explanation: See MWT1. Would be prepared to consider adding additional species if supporting data or sources could be provided Action 2: Role for sunfish changed
Sept 28 2006	Written comment 3 from AFMA specific to midwater trawl	Report refers to redbait as the only target species. This is not true. It has not been targeted for years. There is actually more, Jack Mackerel, blue mackerel	Action MWT3: Five observer reports from the 2005 fishery were reviewed that give redbait as the only target species. Not e added that there is some targeting of other species
Sept 28 2006	Written comment 4 from AFMA specific to midwater trawl	Lot of observer data for the midwater trawl – why so many TEP still high?	Action MWT4: Explanation: The report considers 218 TEP species. Observer over-rides have reduced the scores for most of these. One or two of the dolphin and one of the seal species have been captured in the fishery. There are about 20 other species of dolphins and beaked whales that potentially could interact with the fishery in the same way because they have similar size, morphology and are likely to be attracted to schools of small fish. For this reason, over-rides were not applied to some species of small cetaceans. For birds - see below
Sept 28 2006	Written comment 5 from AFMA	Why 3 birds remaining when all others removed?	Action MWT 5: Explained in the summary and discussion
Sept 28 2006	Written general comment 1 from AFMA on SPF	Check for grammatical errors and readability. Eg Scoping doc S1 General Fishery characteristics under “How gear is set” gear is spelt gar. Under Community issues and interactions it says “The fishery has removed34 k t of redbait. This unit requires fixing.	Action G1: Document checked.’gar’ changed to gear. 34 K t of redbait replaced with 34,000 t redbait. Spelling/grammatical checked and corrected as appropriate
Sept 28 2006	Written general comment 2 from AFMA on SPF	Why are slipper lobsters in the assessment?	ActionG2: See deleted taxa and Action MWT1 (top of table)
Sept 28 2006	Written general comment 3 from AFMA on SPF	The results do not pick up on seasonal variations or diurnal migrations. This should be included somewhere to put fishery into context.	No Action G3: Assessment of temporal variation is part of level 3 assessment process
Sept 28	Written general	Blue Mackerel attributes not correct	No action G4: No alternative values or sources provided.

Date	Format received	Comment from stakeholder	Action/explanation
2006	comment 4 from AFMA on SPF		
Sept 28 2006	Written general comment 5 from AFMA on SPF	Species list incomplete – many more byproduct/bycatch species in trawl sector	See MWT1 (top of table)
Sept 28 2006	Written general comment 6 from AFMA on SPF	I believe there are far too many "high" risk species left in after stage 2 of the assessment. I believe a panel of experts should have been consulted during stage 2, to help eliminate all species that were "obviously" not highly endangered by fishing. Confidence in the process may be lessened by leaving many species in beyond stage 2, when they are there because of obvious false positives. We should not rely on a management process at a later date to eliminate them, when it could be simply done at stage 2, by experts.	No Action G6: As recommended by AFMA
Sept 28 2006	Written comment 1 from BRS specific to midwater trawl	Result for slipper lobster does not seem logical	Action BRS 1: See MWT (top of table)
Sept 28 2006	Written comment 2 from BRS specific to midwater trawl	Surprised that two species have higher susceptibility than the target species	Action BRS 2 explanation given: We recognize the susceptibility of birds and mammals is hard to assess, and will be working to improve the method for these taxa in future iterations. Clearly these species are not going to be captured in high numbers as are the target species. The difficulty here is that it is difficult to determine what level of mortality would constitute low risk relative to the population size. For example there are two populations of black-browed albatross. One has 60,000 birds, the other 60. Would a single mortality of black-browed albatross be acceptable? It would depend on which population the bird was from. If more information could be brought to bear on the population sizes and distributions of these species it would be possible to review these scores, potentially reducing the encounterability risk score.
Sept 28 2006	Written comment 3 from BRS specific to midwater trawl	Discussion of fur seals in summary contains subjective comments	Action BRS3: Replaced with objective comments: ‘Captures of seals and dolphins has resulted in mortality in

Date	Format received	Comment from stakeholder	Action/explanation
			the fishery (Browne *et al*, 2005, Observer Reports)’
Sept 28 2006	Written comment 4 from BRS specific to midwater trawl	Discussion of fur seals in the summary contains assumptions	Action BRS 4: This is clarified in BRS 3. The sources indicate that captured seals and dolphins died after capture. This is not an assumption
Sept 28 2006	Written comment 5 from BRS specific to midwater trawl	Assumptions about TEP mortality in exec summary are not outlined	Action BRS 5: See BRS3 and BRS 4
Sept 28 2006	Written comment 6 from BRS specific to midwater trawl	Slipper lobster not eliminated from assessment	Action BRS 6: Deleted: See MWT 1(top of table)
Sept 28 2006	Written comment 7 from BRS specific to midwater trawl	Surprised that the slipper lobster has higher susceptibility than the target species	Action BRS 7: Deleted: See MWT 1(top of table)
Sept 28 2006	Written comment 8 from BRS specific to midwater trawl	Surprised that the whale shark has higher susceptibility than the white and grey nurse shark	Action BRS 8 explanation: This question relates to the precision of the methodology, rather than the accuracy. All three species have low susceptibility (close to 1) but with low productivity which balance each other producing an overall risk of medium. The methodology is intended to categorise species in this manner. In order to determine the precise order of risk among species within a risk category it would be necessary to use Level 3 methods.
Sept 28 2006	Written comment 9 from BRS specific to midwater trawl	Surprised that two specie of albatross are more susceptible than the target species	Action BRS9: For most species of birds in the assessment, the availability risk scored have been reduced based on observer data. Observer data indicates that shy albatross and black-browed albatross occur on the fishing grounds. To date these species have not been captured. Albatross are known to strike warps in other trawl fisheries and it is conceivable that a small level of mortality could occur. It is not clear if a low level of mortality would be sustainable. More information on population size and distribution could reduce the risk associated with uncertainty in this case. See also Action BRS 2, Above
Sept 28 2006	Written comment 10 from BRS specific to midwater trawl	Surprised that the susceptibility score of the short-tailed shearwater is the same as the target species	Action BRS 10:Refer to Action BRS9 and BRS2
Sept 28	Written comment 11	Why do species of small whales have the same	Action BRS11 Explanation: Small whales may be attracted to the schools

Date	Format received	Comment from stakeholder	Action/explanation
2006	from BRS specific to midwater trawl	susceptibility as the target species	of bait fish being targeted – as noted in the discussion which is cross referenced to Level 3 references.
Sept 28 2006	Written comment 12 from BRS specific to midwater trawl	Why does the dugong have a susceptibility score of 1.2	Action BRS12 Explanation: This is a tropical species. The lowest possible susceptibility score is 1. There is no current effort in the tropics, hence the score is close to the minimum
Sept 28 2006	Written comment 13 from BRS specific to midwater trawl	Is the susceptibility of the blue whale realistic	Action BRS13 Explanation: The susceptibility score was 1.07 which is close to the minimum score of 1. This score is relative and can not be zero or less than one. A medium risk score overall. Low productivity prevents it from having a low overall score
Sept 28 2006	Written comment 14 from BRS specific to midwater trawl	Is the leathery turtle really as susceptible as the target species	Action BRS14 Explanation: Most of the turtles examined had lower encounterability scores than the target species because they are restricted to the inner shelf whereas effort is in deeper waters. The leathery turtle is distributed from the inner shelf to oceanic waters. This turtle does dive into the water column but is unlikely spend as much time there as the target species. Application of expert knowledge could probably eliminate risk associated with uncertainty in this case to reduce the risk score
Sept 28 2006	Written comment 15 from BRS specific to midwater trawl	How can five species of seahorse have the same susceptibility as the target species	Action BRS15 Explanation: It could be assumed that seahorses only occur in shallow water and that mid-water gear never contacts the bottom. In fact some seahorses occur as deep as 180 m and observer data indicates the gear does contact the bottom, as does the capture of benthic species including flathead. Such assumptions are avoided in the assessment. However, with clarification of the species captured in the fishery and the frequency of interaction with the bottom the risk scores of a number of species could be reduced without making assumptions.
Sept 28 2006	Written comment 16 from BRS specific to midwater trawl	Concerns that the susceptibility criteria are not working properly in the case of the mid-water fishery	Action BRS16 Explanation: This issue is confounded by the original inclusion of slipper lobster in the AFMA data - see G2 and MWT1
Sept 28 2006	Written comment 17 from BRS specific to midwater trawl	There is a need for decision rules to determine when observer information is included in susceptibility or overrides	Action BRS17 Explanation: Decision rules are outlined in the methodology. Observer coverage is described in General Fishery Characteristics
Sept 28 2006	Written comment 18 from BRS -MWT	Repeats 17 except that it relates specifically to birds	Action BRS17 Explanation: Refer to Action BRS17

Appendix B: PSA results summary of stakeholder discussions

Level 2 (PSA) Document L2.1. Summary table of stakeholder discussion regarding PSA results.

The following species were discussed at the Small Pelagic Fishery meeting on INSERT DATE and LOCATION. Selected high risk species were discussed.

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

Appendix C: SICA consequence scores for ecological components

Table 5A. 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 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 5B. 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 vulnerability 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 variability for this	**2. Geographic range** Possible detectable change in geographic range but minimal impact on population range and none on dynamics, change in	**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
	population.	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 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	**5. Reproductive capacity** Change in reproductive capacity adversely affecting long-term recruitment dynamics. Time to recovery up to 5 generations free from	**5. Reproductive capacity** Change in reproductive capacity adversely affecting long-term recruitment dynamics. Time to recovery up to 10	**5. Reproductive capacity** Change in reproductive capacity adversely affecting long-term recruitment dynamics. Time to recovery > 100 generations free from impact.

Sub-component	Score/level					
	1 Negligible	2 Minor	3 Moderate	4 Major	5 Severe	6 Intolerable
			recruitment dynamics not adversely damaged.	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 5C. 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**. States 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/ movement.	**6. Behaviour/ movement** No detectable change in behaviour/ movement. Time to return to original	**6. Behaviour/ movement** Possible detectable change in behaviour/ movement but minimal impact on	**6. Behaviour/ movement** Detectable change in behaviour/ movement with the potential for some impact on	**6. Behaviour/ movement** Change in behaviour/ movement, impact adversely affecting population dynamics.	**6. Behaviour/ movement** Change in behaviour/ movement. Impact adversely affecting population dynamics.

Sub-component	Score/level					
	1 Negligible	2 Minor	3 Moderate	4 Major	5 Severe	6 Intolerable
		behaviour/ movement on the scale of hours.	population dynamics. Time to return to original behaviour/ movement on the scale of days to weeks	population dynamics. Time to return to original behaviour/ movement on the scale of weeks to months	Time to return to original behaviour/ movement on the scale of months to years.	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 5D. 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 detectable. Time taken to recover to pre-disturbed state on	**2. Water quality** Detectable impact on water quality. Time to recover from local impact on the scale of days to weeks, at larger spatial scales	**2. Water quality** Moderate impact on water quality. Time to recover from local impact on the scale of weeks to months, at larger spatial scales	**2. Water quality** Time to recover from local impact on the scale of months to years, at larger spatial scales recovery time of weeks to months.	**2. Water quality** Impact on water quality with 50 - 90% of the habitat affected or removed by the activity which may seriously endanger its	**2. Water quality** The dynamics of the entire habitat is in danger of being changed in a major way, or > 90% of habitat destroyed.

Sub-component	Score/level					
	1 Negligible	2 Minor	3 Moderate	4 Major	5 Severe	6 Intolerable
	the scale of hours.	recovery time of hours to days.	recovery time of days to weeks.		long-term survival and result in changes to ecosystem function. Recovery period measured in years to decades.	
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 to months.	**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 of months to < one year.	**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 extent. Time to recover from impact on the scale of > one year to < decadal timeframes.	**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 from original spatial pattern. If reversible, will require a long-term recovery period, on the scale of decades

Sub-component	Score/level					
	1 Negligible	2 Minor	3 Moderate	4 Major	5 Severe	6 Intolerable
						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.

Table 5E. 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/increasin g 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/increasin g 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 community	3. Distribution of the community	3. Distribution of the community	3. Distribution of the community	3. Distribution of the community	3. Distribution of the community	3. Distribution of the community

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	Interactions which affect the distribution of communities unlikely to be detectable against natural variation.	Possible detectable change in geographic range of communities but minimal impact on community dynamics change in geographic range up to 5 % of original.	Detectable change in geographic range of communities with some impact on community dynamics Change in geographic range up to 10 % of original.	Geographic range of communities, ecosystem function altered measurably and some functional groups are locally missing/declining/increasin g outside of historical range. Change in geographic range for up to 25 % of the species. Recovery period measured in months to years.	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.	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/increasin g 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 cycles	5. Bio- and geochemical cycles Interactions which affect bio- &	5. Bio- and geochemical cycles Only minor changes in relative	5. Bio- and geochemical cycles Changes in relative abundance of other	5. Bio- and geochemical cycles Changes in relative abundance of constituents	5. Bio- and geochemical cycles Changes in relative abundance of	5. Bio- and geochemical cycles Ecosystem function catastrophically

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	geochemical cycling unlikely to be detectable against natural variation.	abundance of other constituents leading to minimal changes to bio- & geochemical cycling up to 5%.	constituents leading to minimal changes to bio- & geochemical cycling, up to 10%.	leading to major changes to bio- & geochemical cycling, up to 25%.	constituents leading to Severe changes to bio- & geochemical cycling. Recovery period measured in years to decades.	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.