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Ecological Risk Assessment for Effects of Fishing

REPORT FOR THE SOUTHERN SQUID JIG SUB-FISHERY

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This fishery Ecological Risk Assessment (ERA) report should be cited as

Furlani, D., S. Ling, A. Hobday, J. Dowdney, C. Bulman, M. Sporcic, M. Fuller. (2007) Ecological Risk Assessment for the Effects of Fishing: Southern Squid Jig Sub-fishery. Report for the Australian Fisheries Management Authority, Canberra.

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

ERAEF proceeds through four stages of analysis: scoping; an expert judgment 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.

For the Southern Squid Jig Sub-fishery, the ERA was concluded at the Level 1, as no risks were sufficient to move the assessment to Level 2.

This assessment of the Southern Squid Jig Sub-fishery includes the following:

- Scoping
- Level 1 results for all components
- <u>No</u> Level 2 analyses were required.

Fishery Description

Gear:	Jigging method using automatic jigging machines and lines with unbaited barbless hooks, occasionally handheld jigging.
Area:	Commonwealth waters from Sandy Cape on Fraser Island (24°30'S), to the South Australian and Western Australian border (129°E) and includes all Commonwealth waters around Tasmania; predominantly Bass Strait and off western Victoria, particularly grounds between Queenscliff and Portland, and south of Kangaroo Island, South Australia
Depth range:	50-120 m depth
Fleet size:	January 2005, 80 annual entitlements reissued, although only 14 entitlements were actually fished
Effort:	Predominantly January to July. Significant annual variation reported in effort; 6,464 hours recorded in 2003/04 year
Landings:	Significant annual variation recorded for landings, e.g. 2001 catch 1,838 t; 2002 catch 663 t; 2003 catch 1,239 t; most recent landings 1,587 tonnes (2003/04)
Discard rate:	Minimal discarding occurs – fishing method is highly selective for target species
Main target species:	Arrow squid (*Nototodarus gouldi*)
Management:	2005 Management Plan established, with a catch trigger of 4,000 tonnes for the SSJF; gear SFRs and TAEs are now in place; a limited entry arrangement exists – maximum of 84 permits.
Observer program:	Observer coverage is not required as a permit condition. Previous observer coverage has been for specific scientific studies only.

Ecological Units Assessed

Target species:	1
By-product and bycatch species:	4 and 4 respectively
TEP species:	216 in the area of the fishery
Habitats:	1 pelagic, 180 benthic with fishery area
Communities:	5 (1 pelagic, 4 underlying demersal)

Level 1 Results

All 5 ecological components were eliminated at Level 1 for the internal fishing activities. Risk scores of 1 or 2 only were recorded. There were no hazards assessed to have a risk score of 3 – moderate – or above for any of these internal fishing activities.

Significant external hazards included
- other fisheries in the region (impact on TEP and Communities component);
- other extractive activities (impact on Habitat component); and
- other non-extractive activities (impact on Habitat components).

No risks were rated as major or above (risk scores 4 or 5).

For the Southern Squid Jig Sub-fishery, impacts from fishing on all species components and on habitats or communities did not need assessment at Level 2.

Level 2 Results

Level 2 analysis was not required for any component.

Species
No Southern Squid Jig Sub-fishery species were assessed at Level 2 using the PSA analysis.

Habitats
No Southern Squid Jig Sub-fishery habitats were assessed at Level 2 using the habitat PSA analysis.

Communities
No Southern Squid Jig Sub-fishery communities were assessed at Level 2 using the community PSA analysis.

Summary

Three key issues emerged from the ERAEF Level 1 analysis of the Southern Squid Jig sub-fishery. Each of these issues was associated with an external hazard, which is beyond the management control of this fishery:

- other fisheries in the region (TEP and Communities component);
- other extractive activities (Habitat component); and
- other non-extractive activities (Habitat component).

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.

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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.

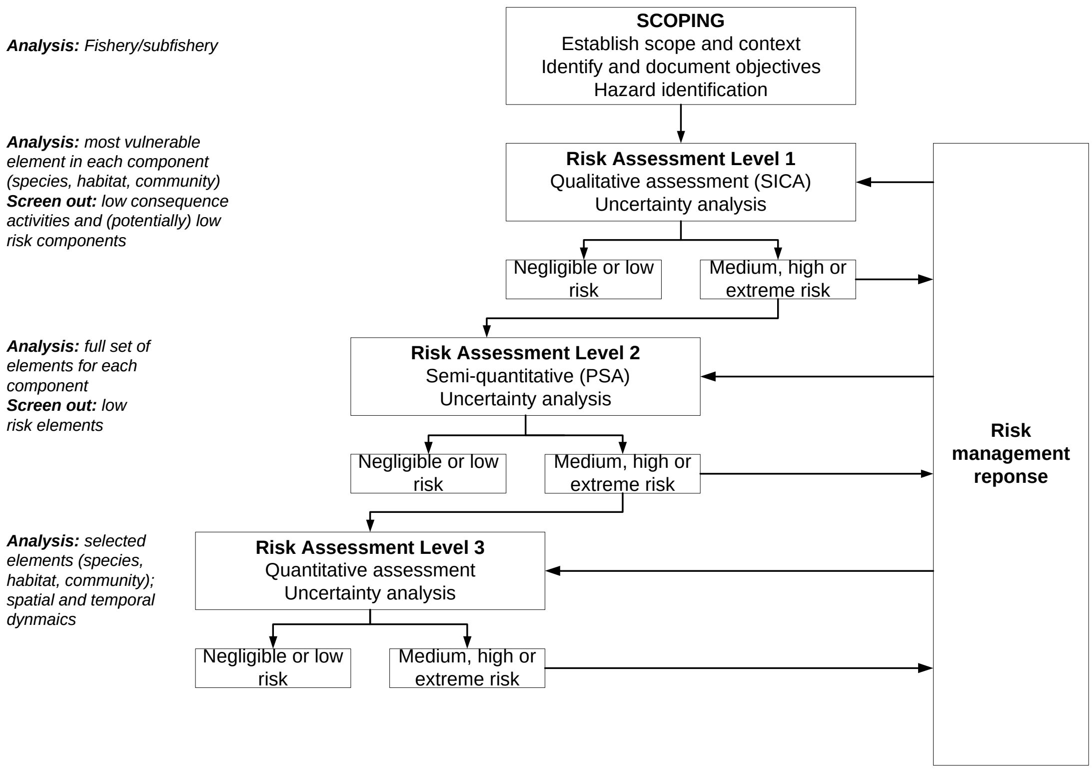


Figure 1. Overview of ERAEF showing focus of analysis for each level at the left in italics.

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.

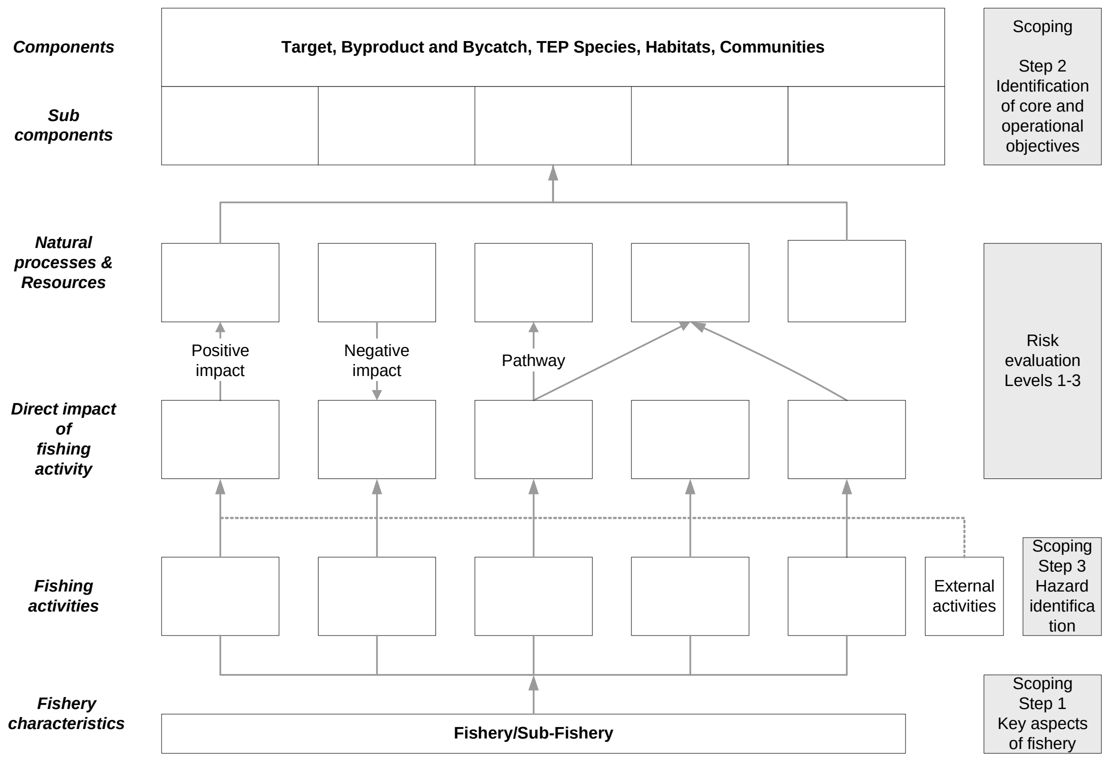


Figure 2. Generic conceptual model used in ERAEF.

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. <u>Identification of units of analysis</u> (species, habitats and communities) potentially impacted by fishery activities (Section 2.2.2; Scoping Documents S2A, S2B and S2C).
2. <u>Selection of objectives</u> (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. <u>Selection of activities</u> (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 Southern Squid Jig Sub-fishery does not extend to a Level 2 analysis. Nevertheless, information regarding Level 2 analysis is included to provide a full understanding of the ERAEF process.

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 high 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 reevaluated, 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 reevaluated.

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 are 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 the Southern Squid Jig Sub-fishery.

2.1 Stakeholder Engagement

2.1 Summary Document SD1. Summary of stakeholder involvement for Southern Squid Jig fishery

ERA report stage	Type of stakeholder interaction	Date of stakeholder interaction	Composition of stakeholder group (names or roles)	Summary of outcome
Scoping	Phone calls and email Review by fishers	Jan – August 03 July 12, 2003, Melbourne.	AFMA fishery manager, AFMA logbook manager Squid MAC #7 (managers, fishers, science, environment)	Information considered sufficient to move to Level 1 July 12, feedback on preferred objectives was provided. Hazards agreed on.
Level 1 (SICA)	Workshop	Jan 14, 2004, Melbourne.	Focus group comprising MAC members, managers and industry representation	Debated the credible scenarios, and required explanation of the consequence scoring. Agreed that Level 1 is acceptable
Preliminary Level 2 (PSA)	Workshop	Jan 14, 2004, Melbourne.	Focus group comprising MAC members, managers and industry representation (Mandy Goodspeed, George Jackson, Lisle Elleway).	Level 2 analysis was presented and discussed with the focus group. Information regarding susceptibility to gear and operable depth of fishing gear was provided. Some productivity measures were also supplied by squid expert George Jackson.
Level 1 (SICA) Preliminary report dicussed	Workshop: Observer information sought on issues considered at risk	October 2005	RAG meeting	Additional data sought to reduce uncertainty of TEP issues Observer reports received. Information added to Scoping documents and used to reassess risks. TEP risk consequently reduced. Discuss revised assessment that resulted Level 1 assessment not leading to a final Level 2 assessment. Availability of new verified information (observer coverage) that could be used at Level 1 was important.
Final report	Email and circulation by AFMA	July-August 2006	Various, coordinated by AFMA	General and specific comments on the draft (delivered May 30) considered and incorporated where appropriate.

2.2 Scoping

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

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

2.2.1 General Fishery Characteristics (Step 1).

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

Scoping Document S1 General Fishery Characteristics

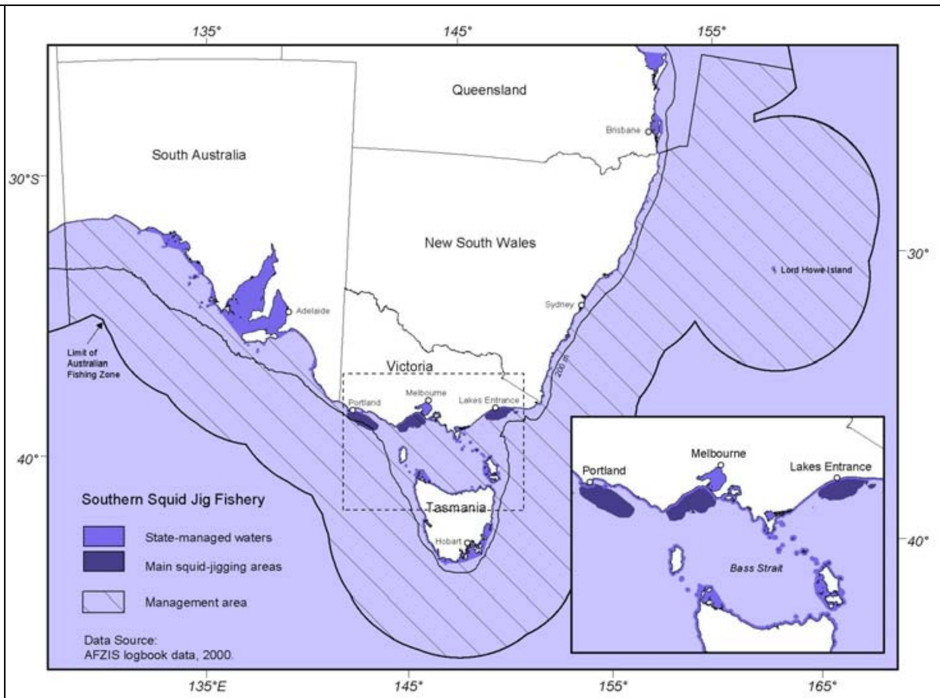
Fishery Name: Southern Squid Jig Sub-fishery (SSJF)
Date of assessment: March 2004, revised June 2006
Assessor: Scott Ling, Dianne Furlani

General Fishery Characteristics	
Fishery Name	Southern Squid Jig Fishery
Sub-fisheries	Southern Squid Jig Fishery (SSJF). The Southern Squid Jig Fishery is defined as encompassing operators who must hold a Fishing Permit authorising the taking of squid by the jigging method.
Sub-fisheries assessed	*Identify sub-fisheries on the basis of fishing method/area. If there is only one major sub-fishery/method, note that this report will consider only that method* Jigging is the only method, and hence sub-fishery, considered in this assessment.
Start date/history	*Provide an indication of the length of time the fishery has been operating.* Prior to 1972, annual landings of arrow squid totaled less than 100 tonnes and were taken mainly as bycatch of demersal trawling and trolling off south-eastern Australia. In December 1972, large numbers of arrow squid were found in the Derwent estuary near Hobart during squid jigging trials and up to 30 domestic commercial vessels fished the schools over the following two months using improvised fishing gear. A total of 154 tonnes were caught during this period. Feasibility studies were conducted in Tasmanian waters in 1972-1973 and off Victoria in 1973-1974 but with no subsequent development of the Fishery. Commercial and research vessels from Japan undertook surveys during the late 1970s and 1980s to assess the commercial potential for exploiting the south-eastern squid fishery. The Japanese Marine Fishery Resources Research Centre (JAMARC) conducted four surveys during the seasons from 1977/78 to 1980/81

	covering most of the waters of the continental shelf off Tasmania, Victoria and south-eastern South Australia. During this period there were also a number of joint venture fishing operations by Australian and Japanese companies and, in subsequent years, licensed foreign squid fishing by Korean and some Taiwanese vessels in Bass Strait. Foreign fishing under bilateral agreements and joint ventures continued until 1988 (Table S1.1). Table S1.1: Total hours fishing effort (Sept-Aug) for foreign fishing vessels (AFMA).

Season	Japan	Korea	Taiwan
1978	1305		
1979	1222	204	
1980	71835	3427	443
1981	1027		
1982			
1983			
1984		1283	5569
1985		8835	
1986		758	
1987	228	878	

	The domestic squid jig fishery for arrow squid (*Nototodarus gouldi*) started in the 1986-87 fishing season with a single vessel and has developed into a fishery of up to 41 active vessels in recent years. There is still the possibility of further development in the Fishery as 82 Commonwealth Southern Squid Jig entitlements exist (AFMA 2003).
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 Southern Squid Jig Fishery is defined as encompassing Commonwealth waters from Sandy Cape on Fraser Island (24°30'S), to the South Australian and Western Australian border (129°E) and includes all Commonwealth waters around Tasmania (Figure S1.1).

	 **Figure S1.1. Southern Squid Jig Fishery and State managed waters (AFMA)**
Regions or Zones within the fishery	*Any regions or zones used within the fishery for management purposes and the reason for these zones if known* The main area fished is in western Bass Strait and off western Victoria. In recent years, the most productive fishing grounds have been between Queenscliff and Portland, off the Victorian coastline (depth of 50–100 m) (AFMA 2003) and extending south of Kangaroo Island in recent years.
Fishing season	*What time of year does fishing in each sub-fishery occur?* The jig fishing season typically lasts from January to July each year with the highest catches concentrated between April and June.
Target species and stock status	*Species targeted and where known stock status.* A single species, Nototodarus gouldi, is targeted in this sub-fishery. Significant uncertainty exists in the understanding of the population biology, age structure and recruitment relationships of the arrow squid. As a result, reliable estimates of the stock size and sustainable yields have not been able to be produced and are unlikely to be produced for the fishery for at least five years. The current limited knowledge of arrow squid in the Southern Squid Jig Fishery has hindered a stock assessment and, as yet, no reliable quantitative stock assessment has been produced. More understanding is also required on the spatial and temporal distribution and abundance of squid as well as the influence of environmental conditions such as sea surface temperature on squid population dynamics. Dr George Jackson (University of Tasmania) has completed a research program entitled “Arrow squid in southern Australian waters” which examined arrow squid biology, reproductive biology and genetic population parameters.
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.*

	No bait is used
Current entitlements	*The number of current entitlements in the fishery. Note latent entitlements. Licences/permits/boats and number active.* As of January 2005, 80 annual entitlements were reissued, although only 14 actually fished.
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 recent quota levels in the fishery by fishing method (sub-fishery).In table form* No TAC or quota has previously been set for this sub-fishery. An Apportionment Policy was developed by AFMA for implementation in 2005, with a total squid catch trigger of 6,000 tonnes for the SSJF, SEFT and BAGTF combined, or 4,000 tonnes for the SSJF alone. The Southern Squid Jig Fisheries Management Plan (AFMA 2005), the first management plan for this sub-fishery, was initiated in 2005 with gear Statutory Fishing Rights (SFR) attached to a Total Allowable Effort (TAE), to be set annually. This will allow a set number of standard jigging machines to be allocated to each SFR for a nominated boat. Prior approval must be sought from AFMA before transfer of SFRs can occur.
Current and recent fishery effort trends by method	*The most recent estimate of effort levels in the fishery by fishing method (sub-fishery). Summary of the recent effort trends in the fishery by fishing method (sub-fishery). In table form* As the name implies, arrow squid are targeted with jigs in the Southern Squid Jig Fishery. Southern Squid Jig Fishery effort is seasonal and there is significant variation between years corresponding to the variations in annual catches. Stars indicate approximate catches.

Season	Active vessels	SSJF effort hrs	SSJF catch tonnes	SETF catch tonnes	GAB catch tonnes
1986	1			13215	18
1987				15590	12
1988				7591	19
1989				13236	23
1990			113*	5194	29
1991			107*	13215	37
1992			335*	15590	36
1993			383*	7591	18
1994			340*	13236	25
1995			1260*	5194	70
1996	42	13215	1281	13215	67
1997	40	15590	2001	15590	87
1998	34	7591	443	7591	39

	(continued table, see below)

2000	29	5194	360	5194	19
2001	26	9851	1838	13215	53
2002	11	2868	663	542	43
2003	16		1,236	893	178

Current and recent fishery catch trends by method

The most recent estimate of catch levels in the fishery by fishing method (sub-fishery) (total and/or by target species). Summary of the recent catch trends in the fishery by fishing method (sub-fishery). In table form

Squid abundance appears to be largely seasonal and there is significant variation between annual catches. See table above.

Current and recent value of fishery ($)

Note current and recent value trends by sub-fishery.

Current Gross Value Production (GVP) for 2002/2003 was $1,158,300 (Department of Agriculture, Fisheries and Forestry determined figures, October 2003 *cited in* AFMA 2003).

2001 SSJF: A$2.9m
2002 SSJF: A$0.7m
2003 SSJF: unknown, not reported separately in ABARE 2005
2004 SSJF: unknown, not reported separately in ABARE 2005

Relationship with other fisheries

Commercial and recreational, state, national and international fisheries List other fisheries operating in the same region any interactions

Demersal trawl vessels operating in the South East and Great Australian Bight Trawl Fisheries catch arrow squid as a byproduct of target fishing for finfish on shelf grounds, particularly in the 100-270 metre depth range. The most significant trawl catches of Arrow Squid occur in the South East Trawl Fishery with some operators infrequently targeting demersal aggregations of arrow squid at certain times of the year (Table S1.2).

Table S1.2: Active vessels, total hours fishing effort for Southern Squid Jig Fishery (SSJF) and catch (tonnes) of Arrow Squid (*Nototodarus gouldi*) for SSJF, South East Trawl Fishery (SETF) and Great Australian Bight Trawl Fishery (GAB). * Financial years (1990/91 to 1995/96) (AFMA).

Season	Active vessels	SSJF effort hrs	SSJF catch tonnes	SETF catch tonnes	GAB catch tonnes
1986	1			13215	18
1987				15590	12
1988				7591	19
1989				13236	23
1990			113*	5194	29
1991			107*	13215	37
1992			335*	15590	36
1993			383*	7591	18

1995			1260*	5194	70
1996	42	13215	1281	13215	67
1997	40	15590	2001	15590	87
1998	34	7591	443	7591	39
1999	38	13236	1669	13236	24
2000	29	5194	360	5194	19
2001	26	9851	1838	13215	53
2002	11	2868	663	542	43
2003	16		1,236	893	178
2004	14		1,567	599	147

Many of the squid jiggers also hold Fishing Permits for other fisheries such as Southern Shark and Bass Strait Central Zone Scallop fisheries, in which they work outside the peak squid jigging season or when economic returns dictate. Inside the 3 nm limit, squid jigging is managed by State governments. Many fishers from the Commonwealth Southern Squid Jig Fishery also hold Victorian and Tasmanian licenses (AFMA).

Arrow squid are not normally a target of recreational fishers, although they may be caught as bycatch of some fishing methods. Anglers hand-jigging for southern calamari in Victoria catch some arrow squid but normally discard the catch in preference for the calamari. Fishers trolling for fish species such as barracouta and Australian salmon may also take arrow squid. A daily bag limit of 10 individuals of any squid species applies in Victoria and there are no regulations specific to arrow squid in other States (AFMA).

The available information supports that there is little non-target catch from jigging thus there appears to be no interaction with other fisheries through non-

Gear	
Fishing gear and methods	*Description of the methods and gear in the fishery, average number days at sea per trip.* Operators in the Southern Squid Jig Fishery hold a Fishing Permit authorising the taking of squid by the jigging method. The Fishery operates at night using automatic jigging machines with bright overhead lights to exploit the squids' strong attraction to light, and lines with several barbless lures to land most of the catch. Fishers target the 50 to 100 m depth contours with jigs operating to max depth of 120 m (note that deep water lights can be lowered to depths of ~300 m and attract squid to the surface). Manual hand-held jigging is sometimes practiced. The catch by domestic jig and trawl vessels is chilled on board and returned to port for processing and freezing within 24 hours of landing. Most of the Australian catch of arrow squid is sold on the domestic market through the Sydney Fish Market, the Melbourne Wholesale Fish Market or directly to processors.
Fishing gear	*Description of the selectivity of the sub-fishery methods*

restrictions	The Southern Squid Jig Fisheries Management Plan (AFMA 2005), the first management plan for this sub-fishery, was initiated in 2005 with gear Statutory Fishing Rights (SFR) attached to a Total Allowable Effort (TAE), to be set annually. This will allow a set number of standard jigging machines to be allocated to each SFR for a nominated boat. Prior approval must be sought from AFMA before transfer of SFRs can occur.
Selectivity of gear and fishing methods	*Description of where gear set i.e. continental shelf, shelf break, continental slope (range nautical miles from shore)* Fishers target the 50 to 100 m depth contours with jigs operating to max depth of 120 m. The jigging technique uses unbaited, barbless lures and is highly attuned to the predatory behaviour and high visual acuity of squid species and is therefore considered highly selective.
Spatial gear zone set	*Depth range gear set at in metres* Predominantly 50-100, but may extend to 120m depth
Depth range gear set	*Description of how set, pelagic in water column, benthic set (weighted) on seabed* Jigging is a pelagic fishing method, predominantly fishing in 50-100m depths. Jigging gear can operate to 120m.
How gear set	*Description of area impacted by gear per set (square metres)* Jigging lines are deployed from a spool directed over a reel on the side of the boat. Lines are dropped into the water and lowered to the desired depth and then retrieved. As the jig moves back over the reel and caught squid are dislodged into baskets. Jigs are wound up and down continually over the night. Light on the boat attract Squid are attracted to the shadow under the boat, created by the use of lights. The squid come out into the light to feed, where they are then caught on the jigs.
Area of gear impact per set or shot	*Description of number of hooks per set, net size weight per trawl shot* Impacting on pelagic zone only, in close proximity to the boat. Generally 8-10 jigging machines per boat (4-5 each side) with up to 125 m of line per spool, and 20-25 jigs per line. Jigs are spaced at 1-2 m intervals.
Effort per annum all boats	*Description of the methods and gear in the fishery, average number days at sea per trip.* See table above, in "**Relationship with other fisheries"** section.
Lost gear and ghost fishing	*Description of how gear is lost, whether lost gear is retrieved, and what happens to gear that is not retrieve, and impacts of ghost fishing* Although no data has been recorded specifically, gear loss is thought to be minimal. Observer Reports note that crew change gear regularly to minimize gear loss, and marriage lines are attached to minimise loss if the line breaks, and also allows broken lines to be wound in (ObserverRecords 2005).
Issues	
Species lists by component	*Species list by component (including target, by-catch/by-product and TEP), habitat and community tables (Scoping Document S1.2).* Target*:*

	Nototodarus gouldi Arrow squid/Goulds squid <u>Byproduct</u>: *Sepioteuthis australis* Southern calamari *Ommastrephes bartramii* Red ocean squid *Todarodes filippovae* Southern Ocean arrow squid *Thyrsites atun* Barracouta <u>Bycatch</u>: *Carcharhinus obscurus* Dusky Shark *Prionace glauca* Blue Shark *Isurus oxyrinchus* Shortfinned Mako or Blue Pointer *Hyporhamphus melanochir* Garfish <u>TEP</u>: See listing below, at **Scoping document S2A.**
Target species issues	*List any issues, including biological information such as spawning season and spawning location, major uncertainties about biology or management, interactions etc* Arrow squid (*Nototodarus gouldi*) - also known as Gould's, flying or torpedo squid - is the most significant commercial squid species in southern Australian waters. They are distributed from southern Queensland to Geraldton in Western Australia, including Bass Strait and Tasmania. Arrow squid also inhabit the northern waters of New Zealand. They are most abundant over the continental shelf and slope in the 50 to 200 m depth range and inhabit waters with sea surface temperatures from 11ºC to over 25ºC.
Byproduct and bycatch issues and interactions	*List any issues, as for the target species above* Information below is taken from AFMA Bycatch Action Plan 2003 There is very little information on bycatch in the Fishery, possibly because it is such a small component of the catch (Harris and Ward 1999). To date, fishers have not had any specific capacity to record bycatch information in the Fishery logbook. A global assessment of bycatch and discards across world fisheries found that the method of jigging was one of the most specific fishing methods and had almost no bycatch (Alverson et al 1992, cited in Harris and Ward 1999). The jigging technique uses unbaited, barbless (approximately 15 mm by 1.4 mm) lures and is highly attuned to the predatory behaviour and high visual acuity of squid species. It is possible that other predatory fish species with high visual acuity, such as barracouta (*Thyrsites atun*), are caught incidentally during a jigging operation (Harris and Ward 1999). This reflects anecdotal information, which suggests that very small quantities of barracouta are caught as bycatch in the Fishery. The most recent logbook data supports this information and indicates that 100 kg of barracouta were taken in the Fishery during the 1999-2000 jigging season. If vessels begin catching barracouta, they cease fishing in the area and move to commence jigging elsewhere. Being of little commercial value, the fish are usually discarded. This logbook data also reports 30 kg of garfish taken in the Fishery but does not distinguish between that part of the catch which is by-product and that which is bycatch. The quality of the logbook information is not certain. The catch of arrow squid in the 1999-2000 season totalled 366,310 kg.

	A qualitative risk assessment using existing anecdotal and AFMA logbook information identified that there is a medium risk of interactions with seals during jigging operations. Seals are sometimes observed around jigging vessels, possibly to feed on squid, and may interfere with jig lines in order to take squid off lures. Harris and Ward (1999) suggested that there were anecdotal reports that seals are sometimes hooked, citing V. Wadley from CSIRO and S. Kalish from AFMA. These reports have since been refuted (S. Kalish, August 2000, personal communication; V. Wadley, August 2000, personal communication). There have been no reports of hooked seals in the squid logbooks. Even if seals were hooked, the breaking strain of the gear would prevent the seal being brought aboard the vessel and the barbless hooks would likely get dislodged. Schools of blue sharks (*Prionace glauca*), which are not protected, are occasionally encountered while jigging. They may interfere with jig lines and sometimes become hooked (Caton and McLoughlin 2000; Wadley 1997, cited in Harris and Ward 1999). Anecdotal evidence supports this information. Tangled or hooked blue sharks either break free from the line, are cut from the gear or killed, or are taken aboard the vessel and discarded. The 1999-2000 logbook data state that the total bycatch of blue shark for that jigging season was 5 kg. No other shark species have been reported as bycatch in the Fishery. Seal and shark aggregations around a commercial vessel disperse the squid and are a nuisance, so fishers exercise move-on measures to minimise the interaction with these species. The likelihood of a seabird swallowing a hooked squid is remote due to the nature of the jigging operation (Harris and Ward 1999), for example, the design of the jigging machines and jigs themselves and the fact that jigging is carried out at night. No species have been identified as significant bycatch in the Fishery. There have been no reports of any listed marine species protected under the EPBC Act being taken as bycatch, except for the interaction of seals with fishing gear. Since the available information supports that there is little non-target catch from jigging there appears to be no interaction with other fisheries through non-target species (Harris and Ward 1999). Trophic interactions involving arrow squid and the broader ecological effects of the Fishery are issues that are beyond the scope of this Plan but will be addressed in the Strategic Assessment of the Fishery under the EPBC Act.
TEP issues and interactions	*List any issues. This section should consider all TEP species groups: marine mammals, chondrichthyans (sharks, rays etc.), marine reptiles, seabirds, teleosts (bony fishes), include any key spawning/breeding/aggregation locations that might overlap with the fishery/sub-fishery.* There have been interactions with seals (Australian fur seal - *Arctocephalus pusillus doriferus*) and occasionally other species including birds (short-tail shearwater - *Puffinus tenuirostris*, shy albatross - *Thalassarche cauta* and fairy penguin - *Eudyptula minor*) and cetaceans (common dolphin - *Delphinus delphis*) (Whitelaw 2002). No species have been identified as significant bycatch in the Fishery. There have been no reports of any listed marine species protected under the EPBC Act being taken as bycatch, except for the interaction

	of seals with fishing gear (AFMA 2003). In recent years there have been increasing reports from squid jig fishers of fur seals interacting with jigging operations. Seals are sometimes observed around jigging vessels, possibly to feed on squid, and may interfere with jig lines in order to take squid off lures (Arnould 2002). A qualitative risk assessment using existing anecdotal, AFMA logbook and observer programme information identified that there is a medium risk of interactions with seals during jigging operations. There has also been a study on the effectiveness of seal deterrent devices including crackers to find the best practice for deterring seals to prevent bycatch and the impact of these devices on other fauna (AFMA 2003). The likelihood of a seabird swallowing a hooked squid is remote due to the nature of the jigging operation, for example, the design of the jigging machines and jigs themselves and the fact that jigging is carried out at night
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* No identified issues associated with any protected, threatened or listed habitats. Jig lines are set so that sinkers at the bottom of the jig lines do not touch the benthos to eliminate the risk of fouled gear (AFMA 2003).
Community issues and interactions	*List any issues for any of the community units identified in **Scoping Document S1.2**.* In south-eastern Australian waters, arrow squid are eaten by a number of fish species including school shark (*Galeorhinus galeus*), gummy shark (*Mustelus antarcticus*) and whiskery shark (*Furgaleus macki*), tunas and John Dory (*Zeus faber*), as well as other non-commercial fish species, whales, seals and birds. Arrow squid feed on crustaceans, fish and other cephalopods. In Bass Strait the most important fish species in the squids' diet are pilchards (*Sardinops neopilchardus*) and juvenile barracouta (Harris and Ward 1999; Coleman and Mobley 1984, O'Sullivan and Cullen 1983 and Winstanley et al 1983, cited in Kailola et al 1993). According to Coleman and Hobday (1982), the importance of squid in the food chain was queried following exploratory squid fishing to assess the feasibility of an arrow squid fishery, which was undertaken off south-eastern Australia in the 1980s. At the time, Victorian fishers raised concerns that increased squid jigging resulting from the establishment of a squid fishery might lead to the depletion of commercial fish stocks which depend on squid for food. In response to these concerns, a study of the diets of 52 commercial fish species from Bass Strait and adjacent Victorian waters was undertaken by Coleman and Hobday between August 1980 and December 1981. The study aimed to make preliminary estimates of the extent to which arrow squid occurs and is important in the diets of commercial fish caught off the Victorian coast by examining the stomach contents of those fish. The study concluded that, although arrow squid was identified in the diets of several species, in no case was there evidence that it consistently formed a major part of the diet. Gummy and school shark, considered the most important commercial species in Victoria at the time, were found to eat arrow squid but only a small proportion of the diet (5 to 6 per cent, on average) was attributable to this source. Squid was absent from, or poorly represented in, the diet of other major commercial species and it appears that octopus, rather than squid, is the most significant item in the diet of those

	species that eat large amounts of cephalopods. It was concluded that fears that increased squid jigging would deplete fish stocks through the removal of an essential food source had little basis.
Discarding	*Summary of discarding practices by sub-fishery, including by-catch, juveniles of target species, high-grading, processing at sea.* Discarding practices unknown. The quality of available information has significantly improved since the introduction of the Commonwealth Squid Jig Logbook in 1995. AFMA is also in the process of redesigning the logbook for the Fishery to include the capacity to collect information on bycatch species.
Management: planned and those implemented	
Management Objectives	*The management objectives from the most recent management plan* The management objectives for the Fishery are to: • Control fishing effort to a level which is consistent with the current state of knowledge of the stock • Collect further scientific data so that management decisions can be based on a sound understanding of the biological and operational characteristics of the Fishery • Minimise the adverse impact of the Fishery on the marine environment • Facilitate participants to maximise their return from harvesting the resource by removing unnecessary restrictions on their fishing activities. The management strategies that are currently adopted for the Fishery are: • Develop and implement appropriate ecologically sustainable management arrangements for the Fishery • Collect accurate and up-to-date data for analysis and stock assessment • Review research priorities in accordance with the Five Year Strategic Research Plan. • Setting of gear SFR associated with annually established TAE and catch triggers. Investigate measures to provide operators with flexibility to marry fishing activities with management arrangements
Fishery management plan	*Is there a fisheries management plan is it in the planning stage or implemented what are the key features* A Management Plan was accepted in April 2005 with key features being the allocation of the number of standard jigging machines to nominated permit boats and a total effort to be determined annually. This Plan is to operate in association with an AFMA Apportionment Policy for annual Catch Trigger setting. If catch triggers are met, the SquidFAG will be asked to review the species stock status.
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.* The Fishery is not currently subject to a formal Management Plan but is managed by limited entry licensing arrangements. Operators in the SSJF must hold a Fishing Permit authorising the taking of squid by the jigging method. Fishing Permits are currently granted for one year only but may be reissued upon application. Under the current arrangements, access to the SSJF is limited to the existing 84 permit holders. This acknowledges the fact

	that the Fishery has been established for some time, if only on a seasonal basis, and that there are already substantial numbers of operators (including a large latent effort component) permitted to take squid in Commonwealth waters. Despite this, it is recognised that parts of the Fishery may not be fully utilised and that there may be scope for further development in these areas. Operators taking squid by trawling (usually as byproduct only) must hold a Fishing Concession authorising the use of trawl gear in the area in which they are operating. Squid is a non-quota species in the South East Trawl Fishery and, as such, are not subject to a total allowable catch or individual transferable quotas. There are no specific Permit conditions relating to this species on demersal trawl Permits in the South East Trawl Fishery and Great Australian Bight Trawl Fishery. The only restriction on access is that there is an upper limit on the number of boats in the South East Trawl Fishery and in the Great Australian Bight Trawl Fishery, and no additional entitlements will be granted
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.* In addition to the taking of squid, the Southern Squid Jig Fishing Permit allows the taking of up to a total of 100 kg of fish (of the superclass Pisces) per trip, but does not allow the taking of any Blue Eye Trevalla, Pink Ling, Blue Warehou or Gemfish. April 2005 saw the acceptance of the Management Plan which includes setting of SFR and TAEs for this sub-fishery, as discussed in "**Current and recent TACs, quota trends by method"** section 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.* No technical measures in the fishery but a Discussion Paper has been developed by SquidMAC in consultation with AFMA to promote discussion regarding future management arrangements for the Southern Squid Jig Fishery and other fisheries that take squid.
Regulations	*Regulations regarding species (by-catch and by-product, TEP), habitat, and community; MARPOL and pollution; rules regarding activities at sea such as discarding offal and/or processing at sea.* No AFMA regulations currently in place for Southern Squid jig fishery regarding species (bycatch and byproduct, TEP), habitat, and communities.
Initiatives and strategies	*BAPs; TEDs; industry codes of conduct, MPAs, Reserves* Limited annual concessions apply. AFMA management have proposed input controls based upon a system of transferable gear units. Knowledge of squid resources was considered to be too poor for responsible management using a Total Allowable Catch (TAC). Gear units can be justified as an appropriate input control as the number of jigging machines determines the rate and quantity of squid which may be caught. Ten gear units would be measured as 1 standard squid jigging machine. In the same manner as a TAC, the Total Allowable Gear Units can be reduced if a reduction in effort is required. Triggers for the apportionment process will be considered by the AFMA Board which will consider advice received from the SquidMAC, GABMAC and SETMAC
Enabling	*Monitoring (logbooks, observer data, scientific surveys); assessment (stock*

processes	*assessments); performance indicators (decision rules, processes, compliance; education; consultation process* Commonwealth logbooks records must be submitted. No reliable quantitative stock assessments are available for this sub-fishery.
Other initiatives or agreements	*State, national or international conventions or agreements that impact on the management of the fishery/sub-fishery being evaluated.* This Discussion Paper has been developed by SquidMAC in consultation with AFMA to promote discussion regarding future management arrangements for the Southern Squid Jig Fishery and other fisheries that take squid. It is not a statement of AFMA policy either for the Fishery or for fisheries management generally and must not be published or relied upon as being the final management plan for the Fishery. Future fishing access in the MPAs to be created under National Oceans Office policy has not yet been determined.
Data	
Logbook data	*Verified logbook data; data summaries describe programme* Due to the low effort levels in this sub-fishery logbook data verification has not been considered necessary. There is provision for the future introduction of landing reports and catch disposal records.
Observer data	*Observer programme describe parameters as below* No observer program is in operation for the Southern Squid Jig Sub-fishery, but Observer coverage is available when scientific studies are taking place, and operators are obliged to carry an Observer if asked by AFMA to do so.
Other data	*Studies, surveys* No other data is available.

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	4	4	216	180 benthic 1 pelagic	4 demersal 1 pelagic

Scoping Document S2A Species

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

Target species *Southern Squid Jig sub-fishery*

This list was obtained by reviewing all Logbook data and Observer Reports.

CAAB	**Family**	**Species name**	**Common name**	**Role**	**Source**
23636004	Ommastrephidae	Nototodarus gouldi	Arrow Squid	Target	Logbook data

Byproduct species *Southern Squid Jig sub-fishery*

Byproduct refers to any part of the catch which is kept or sold by the fisher but which is not a target species.

CAAB	**Family**	**Species name**	**Common name**	**Role**	**Source**
23617005	Loliginidae	*Sepioteuthis australis*	Southern calamari	Byproduct	Observer data
23636007	Ommastrephidae	*Ommastrephes bartramii*	Red ocean squid	Byproduct	Observer data
23636011	Ommastrephidae	*Todarodes filippovae*	Southern Ocean arrow squid	Byproduct	Observer data
37439001	Gempylidae	*Thyrsites atun*	Barracouta	Byproduct	Observer data

Bycatch species *Southern Squid Jig sub-fishery*

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

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

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.

CAAB	Family	Species name	Common name	Role	Source
37018003	Carcharhinidae	*Carcharhinus obscurus*	Dusky Shark	Discard	Observer data
37018004	Carcharhinidae	*Prionace glauca*	Blue Shark	Discard	Observer data
37010001	Lamnidae	*Isurus oxyrinchus*	Shortfinned Mako or Blue Pointer	Discard	Observer data
37234001	Hemiramphidae	*Hyporhamphus melanochir*	Garfish	Discard	Observer data

TEP species *Southern Squid Jig sub-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.

Taxa Name	Family Name	Common Name	Scientific Name	Caab Code	Role	Source
Chondrichthyan	Lamnidae	white shark	*Carcharodon carcharias*	37010003	TEP	DEH

Taxa Name	Family Name	Common Name	Scientific Name	Caab Code	Role	Source
Chondrichthyan	Odontaspididae	grey nurse shark	*Carcharias taurus*	37008001	TEP	DEH
Chondrichthyan	Rhincodontidae	whale shark	*Rhincodon typus*	37014001	TEP	DEH
Marine bird	Diomedeidae	White-capped Albatross	*Thalassarche steadi*		TEP	DEH
Marine bird	Diomedeidae	Buller's Albatross	*Thalassarche bulleri*	40040001	TEP	DEH
Marine bird	Diomedeidae	Shy Albatross	*Thalassarche cauta*	40040002	TEP	DEH
Marine bird	Diomedeidae	Yellow-nosed Albatross	*Thalassarche chlororhynchos*	40040003	TEP	DEH
Marine bird	Diomedeidae	Grey-headed Albatross	*Thalassarche chrysostoma*	40040004	TEP	DEH
Marine bird	Diomedeidae	Southern Royal Albatross	*Diomedea epomophora*	40040005	TEP	DEH
Marine bird	Diomedeidae	Wandering Albatross	*Diomedea exulans*	40040006	TEP	DEH
Marine bird	Diomedeidae	Black-browed Albatross	*Thalassarche melanophrys*	40040007	TEP	DEH
Marine bird	Diomedeidae	Sooty Albatross	*Phoebetria fusca*	40040008	TEP	DEH
Marine bird	Diomedeidae	Light-mantled Albatross	*Phoebetria palpebrata*	40040009	TEP	DEH
Marine bird	Diomedeidae	Gibson's Albatross	*Diomedea gibsoni*	40040010	TEP	DEH
Marine bird	Diomedeidae	Antipodean Albatross	*Diomedea antipodensis*	40040011	TEP	DEH
Marine bird	Diomedeidae	Northern Royal Albatross	*Diomedea sanfordi*	40040012	TEP	DEH
Marine bird	Diomedeidae	Campbell Albatross	*Thalassarche impavida*	40040013	TEP	DEH
Marine bird	Diomedeidae	Indian Yellow-nosed Albatross	*Thalassarche carteri*	40040014	TEP	DEH
Marine bird	Diomedeidae	Salvin's albatross	*Thalassarche salvini*	40040016	TEP	DEH
Marine bird	Diomedeidae	Chatham albatross	*Thalassarche eremita*	40040017	TEP	DEH
Marine bird	Diomedeidae	Amsterdam Albatross	*Diomedea amsterdamensis*	40040018	TEP	DEH
Marine bird	Diomedeidae	Tristan Albatross	*Diomedea dabbenena*	40040019	TEP	DEH
Marine bird	Hydrobatidae	White-bellied Storm-Petrel (Tasman Sea),	*Fregetta grallaria*	40042001	TEP	DEH
Marine bird	Hydrobatidae	Black-bellied Storm-Petrel	*Fregetta tropica*	40042002	TEP	DEH
Marine bird	Hydrobatidae	Grey-backed storm petrel	*Garrodia nereis*	40042003	TEP	DEH
Marine bird	Hydrobatidae	Wilson's storm petrel (subantarctic)	*Oceanites oceanicus*	40042004	TEP	DEH
Marine bird	Hydrobatidae	White-faced Storm-Petrel	*Pelagodroma marina*	40042007	TEP	DEH
Marine bird	Laridae	Common noddy	*Anous stolidus*	40128002	TEP	DEH
Marine bird	Laridae	Great Skua	*Catharacta skua*	40128005	TEP	DEH
Marine bird	Laridae	Kelp Gull	*Larus dominicanus*	40128012	TEP	DEH
Marine bird	Laridae	Silver Gull	*Larus novaehollandiae*	40128013	TEP	DEH

Taxa Name	Family Name	Common Name	Scientific Name	Caab Code	Role	Source
Marine bird	Laridae	Pacific Gull	*Larus pacificus*	40128014	TEP	DEH
Marine bird	Laridae	grey ternlet	*Procelsterna cerulea*	40128018	TEP	DEH
Marine bird	Laridae	Little tern	*Sterna albifrons*	40128022	TEP	DEH
Marine bird	Laridae	Bridled Tern	*Sterna anaethetus*	40128023	TEP	DEH
Marine bird	Laridae	Lesser crested tern	*Sterna bengalensis*	40128024	TEP	DEH
Marine bird	Laridae	Crested Tern	*Sterna bergii*	40128025	TEP	DEH
Marine bird	Laridae	Caspian Tern	*Sterna caspia*	40128026	TEP	DEH
Marine bird	Laridae	Sooty tern	*Sterna fuscata*	40128028	TEP	DEH
Marine bird	Laridae	Common tern	*Sterna hirundo*	40128029	TEP	DEH
Marine bird	Laridae	Arctic tern	*Sterna paradisaea*	40128032	TEP	DEH
Marine bird	Laridae	White-fronted Tern	*Sterna striata*	40128033	TEP	DEH
Marine bird	Laridae	Black-naped tern	*Sterna sumatrana*	40128034	TEP	DEH
Marine bird	Nephropidae	Black Noddy	*Anous minutus*	40128001	TEP	DEH
Marine bird	Phaethontidae	Red-tailed Tropicbird	*Phaethon rubricauda*	40045002	TEP	DEH
Marine bird	Phalacrocoracidae	Black cormorant	*Phalacrocorax carbo*	40048002	TEP	DEH
Marine bird	Phalacrocoracidae	Black faced cormorant	*Phalacrocorax fuscescens*	40048003	TEP	DEH
Marine bird	Phalacrocoracidae	Little pied cormorant	*Phalacrocorax melanoleucos*	40048004	TEP	DEH
Marine bird	Phalacrocoracidae	Little black cormorant	*Phalacrocorax sulcirostris*	40048005	TEP	DEH
Marine bird	Physeteridae	Masked Booby	*Sula dactylatra*	40047004	TEP	DEH
Marine bird	Procellariidae	streaked shearwater	*Calonectris leucomelas*	40041002	TEP	DEH
Marine bird	Procellariidae	Cape Petrel	*Daption capense*	40041003	TEP	DEH
Marine bird	Procellariidae	Southern fulmar	*Fulmarus glacialoides*	40041004	TEP	DEH
Marine bird	Procellariidae	Blue Petrel	*Halobaena caerulea*	40041005	TEP	DEH
Marine bird	Procellariidae	Kerguelen Petrel	*Lugensa brevirostris*	40041006	TEP	DEH
Marine bird	Procellariidae	Southern Giant-Petrel	*Macronectes giganteus*	40041007	TEP	DEH
Marine bird	Procellariidae	Northern Giant-Petrel	*Macronectes halli*	40041008	TEP	DEH
Marine bird	Procellariidae	Fairy Prion	*Pachyptila turtur*	40041013	TEP	DEH
Marine bird	Procellariidae	Common Diving-Petrel	*Pelecanoides urinatrix*	40041017	TEP	DEH
Marine bird	Procellariidae	White-chinned Petrel	*Procellaria aequinoctialis*	40041018	TEP	DEH
Marine bird	Procellariidae	Grey petrel	*Procellaria cinerea*	40041019	TEP	DEH

Taxa Name	Family Name	Common Name	Scientific Name	Caab Code	Role	Source
Marine bird	Procellariidae	Black Petrel	*Procellaria parkinsoni*	40041020	TEP	DEH
Marine bird	Procellariidae	Westland Petrel	*Procellaria westlandica*	40041021	TEP	DEH
Marine bird	Procellariidae	Tahiti Petrel	*Pseudobulweria rostrata*	40041022	TEP	DEH
Marine bird	Procellariidae	White-necked Petrel	*Pterodroma cervicalis*	40041025	TEP	DEH
Marine bird	Procellariidae	White-headed petrel	*Pterodroma lessoni*	40041029	TEP	DEH
Marine bird	Procellariidae	Gould's Petrel	*Pterodroma leucoptera*	40041030	TEP	DEH
Marine bird	Procellariidae	Great-winged Petrel	*Pterodroma macroptera*	40041031	TEP	DEH
Marine bird	Procellariidae	Soft-plumaged Petrel	*Pterodroma mollis*	40041032	TEP	DEH
Marine bird	Procellariidae	Kermadec Petrel (western)	*Pterodroma neglecta*	40041033	TEP	DEH
Marine bird	Procellariidae	Black-winged Petrel	*Pterodroma nigripennis*	40041034	TEP	DEH
Marine bird	Procellariidae	Providence Petrel	*Pterodroma solandri*	40041035	TEP	DEH
Marine bird	Procellariidae	Little Shearwater (Tasman Sea)	*Puffinus assimilis*	40041036	TEP	DEH
Marine bird	Procellariidae	Buller's Shearwater	*Puffinus bulleri*	40041037	TEP	DEH
Marine bird	Procellariidae	Flesh-footed Shearwater	*Puffinus carneipes*	40041038	TEP	DEH
Marine bird	Procellariidae	Fluttering Shearwater	*Puffinus gavia*	40041040	TEP	DEH
Marine bird	Procellariidae	Sooty Shearwater	*Puffinus griseus*	40041042	TEP	DEH
Marine bird	Procellariidae	Hutton's Shearwater	*Puffinus huttoni*	40041043	TEP	DEH
Marine bird	Procellariidae	Wedge-tailed Shearwater	*Puffinus pacificus*	40041045	TEP	DEH
Marine bird	Procellariidae	Short-tailed Shearwater	*Puffinus tenuirostris*	40041047	TEP	DEH
Marine bird	Spheniscidae	Little Penguin	*Eudyptula minor*	40001008	TEP	DEH
Marine bird	Sulidae	Cape gannet	*Morus capensis*	40047001	TEP	DEH
Marine bird	Sulidae	Australasian Gannet	*Morus serrator*	40047002	TEP	DEH
Marine bird	Sulidae	Brown boobies	*Sula leucogaster*	40047005	TEP	DEH
Marine bird	Thalassarche	Pacific Albatross	*Thalassarche nov. sp.*		TEP	DEH
Marine bird		Herald Petrel	*Pterodroma heraldica*		TEP	DEH
Marine mammal	Balaenidae	Southern Right Whale	*Eubalaena australis*	41110001	TEP	DEH
Marine mammal	Balaenidae	Pygmy Right Whale	*Caperea marginata*	41110002	TEP	DEH
Marine mammal	Balaenidae	Antarctic Minke Whale	*Balaenoptera bonaerensis*	41112007	TEP	DEH
Marine mammal	Balaenopteridae	Minke Whale	*Balaenoptera acutorostrata*	41112001	TEP	DEH
Marine mammal	Balaenopteridae	Sei Whale	*Balaenoptera borealis*	41112002	TEP	DEH

Taxa Name	Family Name	Common Name	Scientific Name	Caab Code	Role	Source
Marine mammal	Balaenopteridae	Bryde's Whale	*Balaenoptera edeni*	41112003	TEP	DEH
Marine mammal	Balaenopteridae	Blue Whale	*Balaenoptera musculus*	41112004	TEP	DEH
Marine mammal	Balaenopteridae	Fin Whale	*Balaenoptera physalus*	41112005	TEP	DEH
Marine mammal	Balaenopteridae	Humpback Whale	*Megaptera novaeangliae*	41112006	TEP	DEH
Marine mammal	Delphinidae	Common Dolphin	*Delphinus delphis*	41116001	TEP	DEH
Marine mammal	Delphinidae	Pygmy Killer Whale	*Feresa attenuata*	41116002	TEP	DEH
Marine mammal	Delphinidae	Short-finned Pilot Whale	*Globicephala macrorhynchus*	41116003	TEP	DEH
Marine mammal	Delphinidae	Long-finned Pilot Whale	*Globicephala melas*	41116004	TEP	DEH
Marine mammal	Delphinidae	Risso's Dolphin	*Grampus griseus*	41116005	TEP	DEH
Marine mammal	Delphinidae	Fraser's Dolphin	*Lagenodelphis hosei*	41116006	TEP	DEH
Marine mammal	Delphinidae	Hourglass dolphin	*Lagenorhynchus cruciger*	41116007	TEP	DEH
Marine mammal	Delphinidae	Dusky Dolphin	*Lagenorhynchus obscurus*	41116008	TEP	DEH
Marine mammal	Delphinidae	Southern Right Whale Dolphin	*Lissodelphis peronii*	41116009	TEP	DEH
Marine mammal	Delphinidae	Irrawaddy dolphin	*Orcaella brevirostris*	41116010	TEP	DEH
Marine mammal	Delphinidae	Killer Whale	*Orcinus orca*	41116011	TEP	DEH
Marine mammal	Delphinidae	Melon-headed Whale	*Peponocephala electra*	41116012	TEP	DEH
Marine mammal	Delphinidae	False Killer Whale	*Pseudorca crassidens*	41116013	TEP	DEH
Marine mammal	Delphinidae	Indo-Pacific Humpback Dolphin	*Sousa chinensis*	41116014	TEP	DEH
Marine mammal	Delphinidae	Spotted Dolphin	*Stenella attenuata*	41116015	TEP	DEH
Marine mammal	Delphinidae	Striped Dolphin	*Stenella coeruleoalba*	41116016	TEP	DEH
Marine mammal	Delphinidae	Long-snouted Spinner Dolphin	*Stenella longirostris*	41116017	TEP	DEH
Marine mammal	Delphinidae	Rough-toothed Dolphin	*Steno bredanensis*	41116018	TEP	DEH
Marine mammal	Delphinidae	Bottlenose Dolphin	*Tursiops truncatus*	41116019	TEP	DEH
Marine mammal	Delphinidae	Indian Ocean bottlenose dolphin	*Tursiops aduncus*	41116020	TEP	DEH
Marine mammal	Dugongidae	Dugong	*Dugong dugon*	41206001	TEP	DEH
Marine mammal	Otariidae	New Zealand Fur-seal	*Arctocephalus forsteri*	41131001	TEP	DEH
Marine mammal	Otariidae	Australian Fur Seal	*Arctocephalus pusillus doriferus*	41131003	TEP	DEH
Marine mammal	Otariidae	Subantarctic fur seal	*Arctocephalus tropicalis*	41131004	TEP	DEH
Marine mammal	Otariidae	Australian Sea-lion	*Neophoca cinerea*	41131005	TEP	DEH
Marine mammal	Phocidae	Leopard seal	*Hydrurga leptonyx*	41136001	TEP	DEH

Taxa Name	Family Name	Common Name	Scientific Name	Caab Code	Role	Source
Marine mammal	Phocidae	Elephant seal	*Mirounga leonina*	41136004	TEP	DEH
Marine mammal	Physeteridae	Pygmy Sperm Whale	*Kogia breviceps*	41119001	TEP	DEH
Marine mammal	Physeteridae	Dwarf Sperm Whale	*Kogia simus*	41119002	TEP	DEH
Marine mammal	Physeteridae	Sperm Whale	*Physeter catodon*	41119003	TEP	DEH
Marine mammal	Ziphiidae	Arnoux's Beaked Whale	*Berardius arnuxii*	41120001	TEP	DEH
Marine mammal	Ziphiidae	Southern Bottlenose Whale	*Hyperoodon planifrons*	41120002	TEP	DEH
Marine mammal	Ziphiidae	Andrew's Beaked Whale	*Mesoplodon bowdoini*	41120004	TEP	DEH
Marine mammal	Ziphiidae	Blainville's Beaked Whale	*Mesoplodon densirostris*	41120005	TEP	DEH
Marine mammal	Ziphiidae	Gingko Beaked Whale	*Mesoplodon gingkodens*	41120006	TEP	DEH
Marine mammal	Ziphiidae	Gray's Beaked Whale	*Mesoplodon grayi*	41120007	TEP	DEH
Marine mammal	Ziphiidae	Hector's Beaked Whale	*Mesoplodon hectori*	41120008	TEP	DEH
Marine mammal	Ziphiidae	Strap-toothed Beaked Whale	*Mesoplodon layardii*	41120009	TEP	DEH
Marine mammal	Ziphiidae	True's Beaked Whale	*Mesoplodon mirus*	41120010	TEP	DEH
Marine mammal	Ziphiidae	Tasman Beaked Whale	*Tasmacetus shepherdi*	41120011	TEP	DEH
Marine mammal	Ziphiidae	Cuvier's Beaked Whale	*Ziphius cavirostris*	41120012	TEP	DEH
Marine reptile	Cheloniidae	Loggerhead	*Caretta caretta*	39020001	TEP	DEH
Marine reptile	Cheloniidae	Green turtle	*Chelonia mydas*	39020002	TEP	DEH
Marine reptile	Cheloniidae	Hawksbill turtle	*Eretmochelys imbricata*	39020003	TEP	DEH
Marine reptile	Cheloniidae	Olive Ridley turtle	*Lepidochelys olivacea*	39020004	TEP	DEH
Marine reptile	Cheloniidae	Flatback turtle	*Natator depressus*	39020005	TEP	DEH
Marine reptile	Dermochelyidae	Leathery turtle	*Dermochelys coriacea*	39021001	TEP	DEH
Marine reptile	Hydrophiidae	Horned Seasnake	*Acalyptophis peronii*	39125001	TEP	DEH
Marine reptile	Hydrophiidae	Stokes' seasnake	*Astrotia stokesii*	39125009	TEP	DEH
Marine reptile	Hydrophiidae	spectacled seasnake	*Disteira kingii*	39125010	TEP	DEH
Marine reptile	Hydrophiidae	Elegant seasnake	*Hydrophis elegans*	39125021	TEP	DEH
Marine reptile	Hydrophiidae	seasnake	*Hydrophis ornatus*	39125028	TEP	DEH
Marine reptile	Hydrophiidae	seasnake	*Hydrophis ornatus*	39125028	TEP	DEH
Marine reptile	Hydrophiidae	yellow-bellied seasnake	*Pelamis platurus*	39125033	TEP	DEH
Teleost	Clinidae	Common weedfish	*Heteroclinus perspicillatus*	37416013	TEP	DEH
Teleost	Solenostomidae	Blue-finned Ghost Pipefish, Robust Ghost	*Solenostomus cyanopterus*	37281001	TEP	DEH

Taxa Name	Family Name	Common Name	Scientific Name	Caab Code	Role	Source
Teleost	Solenostomidae	Harlequin/ Ornate Ghost Pipefish	*Solenostomus paradoxus*	37281002	TEP	DEH
teleost	Syngnathidae	Big-bellied / southern potbellied seahorse	*Hippocampus abdominalis*		TEP	DEH
teleost	Syngnathidae	Kellogg's Seahorse	*Hippocampus kelloggi*		TEP	DEH
teleost	Syngnathidae	Spotted Seahorse, Yellow Seahorse	*Hippocampus kuda*		TEP	DEH
teleost	Syngnathidae	Southern Pygmy Pipehorse	*Idiotropiscis australe*		TEP	DEH
Teleost	Syngnathidae	Leafy Seadragon	*Phycodurus eques*	37282001	TEP	DEH
Teleost	Syngnathidae	Weedy Seadragon, Common Seadragon	*Phyllopteryx taeniolatus*	37282002	TEP	DEH
Teleost	Syngnathidae	Robust Spiny Pipehorse	*Solegnathus robustus*	37282004	TEP	DEH
Teleost	Syngnathidae	Bend Stick Pipefish, Short-tailed Pipefish	*Trachyrhamphus bicoarctatus*	37282006	TEP	DEH
Teleost	Syngnathidae	Hairy Pipefish	*Urocampus carinirostris*	37282008	TEP	DEH
Teleost	Syngnathidae	Javelin Pipefish	*Lissocampus runa*	37282009	TEP	DEH
Teleost	Syngnathidae	Briggs' Crested Pipefish, Briggs' Pipefish	*Histiogamphelus briggsii*	37282011	TEP	DEH
Teleost	Syngnathidae	Knife-snouted Pipefish	*Hypselognathus rostratus*	37282012	TEP	DEH
Teleost	Syngnathidae	Brushtail Pipefish	*Leptoichthys fistularius*	37282013	TEP	DEH
Teleost	Syngnathidae	Deep-bodied Pipefish	*Kaupus costatus*	37282014	TEP	DEH
Teleost	Syngnathidae	Half-banded Pipefish	*Mitotichthys semistriatus*	37282015	TEP	DEH
Teleost	Syngnathidae	Australian Smooth Pipefish	*Lissocampus caudalis*	37282016	TEP	DEH
Teleost	Syngnathidae	Spotted Pipefish	*Stigmatopora argus*	37282017	TEP	DEH
Teleost	Syngnathidae	Wide-bodied Pipefish, Black Pipefish	*Stigmatopora nigra*	37282018	TEP	DEH
Teleost	Syngnathidae	Ring-backed Pipefish	*Stipecampus cristatus*	37282019	TEP	DEH
Teleost	Syngnathidae	Pug-nosed Pipefish	*Pugnaso curtirostris*	37282021	TEP	DEH
Teleost	Syngnathidae	Mollison's Pipefish	*Mitotichthys mollisoni*	37282022	TEP	DEH
Teleost	Syngnathidae	Port Phillip Pipefish	*Vanacampus phillipi*	37282023	TEP	DEH
Teleost	Syngnathidae	Australian Long-snout/Long-snouted Pipefish	*Vanacampus poecilolaemus*	37282024	TEP	DEH
Teleost	Syngnathidae	Tucker's Pipefish	*Mitotichthys tuckeri*	37282025	TEP	DEH
Teleost	Syngnathidae	Short-head Seahorse, Short-snouted Seaho	*Hippocampus breviceps*	37282026	TEP	DEH
Teleost	Syngnathidae	white's seahorse	*Hippocampus whitei*	37282027	TEP	DEH
Teleost	Syngnathidae	spiny pipehorse	*Solegnathus spinosissimus*	37282029	TEP	DEH
Teleost	Syngnathidae	Mud Pipefish, Gray's Pipefish	*Halicampus grayi*	37282030	TEP	DEH

Taxa Name	Family Name	Common Name	Scientific Name	Caab Code	Role	Source
Teleost	Syngnathidae	Spotted Seahorse, Yellow Seahorse	*Hippocampus taeniopterus*	37282033	TEP	DEH
Teleost	Syngnathidae	Southern Pygmy Pipehorse	*Acentronura australe*	37282034	TEP	DEH
Teleost	Syngnathidae	Hairy Pygmy Pipehorse	*Acentronura breviperula*	37282035	TEP	DEH
Teleost	Syngnathidae	Gale's Pipefish	*Campichthys galei*	37282039	TEP	DEH
Teleost	Syngnathidae	Tryon's Pipefish	*Campichthys tryoni*	37282041	TEP	DEH
Teleost	Syngnathidae	Fijian Banded/ Brown-banded	*Corythoichthys amplexus*	37282047	TEP	DEH
Teleost	Syngnathidae	Orange-spotted Pipefish, Ocellated Pipefish	*Corythoichthys ocellatus*	37282050	TEP	DEH
Teleost	Syngnathidae	Lord Howe Pipefish	*Cosmocampus howensis*	37282055	TEP	DEH
Teleost	Syngnathidae	Girdled Pipefish	*Festucalex cinctus*	37282061	TEP	DEH
Teleost	Syngnathidae	Tiger Pipefish	*Filicampus tigris*	37282064	TEP	DEH
Teleost	Syngnathidae	[a pipefish]	*Halicampus macrorhynchus*	37282067	TEP	DEH
Teleost	Syngnathidae	Upside-down Pipefish	*Heraldia nocturna*	37282071	TEP	DEH
Teleost	Syngnathidae	Blue-speckled/Blue-spotted Pipefish	*Hippichthys cyanospilos*	37282072	TEP	DEH
Teleost	Syngnathidae	Madura Pipefish	*Hippichthys heptagonus*	37282073	TEP	DEH
Teleost	Syngnathidae	Beady Pipefish, Steep-nosed Pipefish	*Hippichthys penicillus*	37282075	TEP	DEH
Teleost	Syngnathidae	Flat-face Seahorse	*Hippocampus planifrons*	37282078	TEP	DEH
Teleost	Syngnathidae	Rhino Pipefish, Macleay's Crested Pipefish	*Histiogamphelus cristatus*	37282081	TEP	DEH
Teleost	Syngnathidae	Shaggy Pipefish, Prickly Pipefish	*Hypselognathus horridus*	37282082	TEP	DEH
Teleost	Syngnathidae	Trawl Pipefish, Kimbla Pipefish	*Kimblaeus bassensis*	37282083	TEP	DEH
Teleost	Syngnathidae	Sawtooth Pipefish	*Maroubra perserrata*	37282085	TEP	DEH
Teleost	Syngnathidae	Anderson's Pipefish, Shortnose Pipefish	*Micrognathus andersonii*	37282086	TEP	DEH
Teleost	Syngnathidae	[a pipefish]	*Micrognathus pygmaeus*	37282087	TEP	DEH
Teleost	Syngnathidae	Manado River Pipefish, Manado Pipefish	*Microphis manadensis*	37282091	TEP	DEH
Teleost	Syngnathidae	Bony-headed Pipefish	*Nannocampus subosseus*	37282094	TEP	DEH
Teleost	Syngnathidae	Red Pipefish	*Notiocampus ruber*	37282095	TEP	DEH
Teleost	Syngnathidae	Duncker's Pipehorse	*Solegnathus dunckeri*	37282098	TEP	DEH
Teleost	Syngnathidae	Pipehorse	*Solegnathus sp. 1 [in Kuiter, 2000]*	37282099	TEP	DEH
Teleost	Syngnathidae	Double-ended Pipehorse, Alligator Pipefish	*Syngnathoides biaculeatus*	37282100	TEP	DEH
Teleost	Syngnathidae	Mother-of-pearl Pipefish	*Vanacampus margaritifer*	37282102	TEP	DEH
Teleost	Syngnathidae	Verco's Pipefish	*Vanacampus vercoi*	37282103	TEP	DEH

Taxa Name	Family Name	Common Name	Scientific Name	Caab Code	Role	Source
Teleost	Syngnathidae	Bullneck Seahorse	*Hippocampus minotaur*	37282105	TEP	DEH
Teleost	Syngnathidae	[a pipefish]	*Halicampus boothae*	37282107	TEP	DEH
Teleost	Syngnathidae	Kellogg's Seahorse	*Hippocampus queenslandicus*	37282110	TEP	DEH
Teleost	Syngnathidae	[a pipefish]	*Hippocampus tristis*	37282117	TEP	DEH
Teleost	Syngnathidae	[a pipefish]	*Hippocampus procerus*	37282122	TEP	DEH
Teleost	Syngnathidae	Western upsidedown pipefish	*Heraldia sp. 1 [in Kuiter, 2000]*	37282130	TEP	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 bioregionalization 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 Southern Squid Jig fishery. Shading denotes habitats occurring within the jurisdictional boundary of the sub-fishery that are not subject to effort from Squid jigging.

ERAEF record No.	ERAEF Habitat Number	Sub-biome	Feature	Habitat type	SGF Score	Depth (m)	Image available	Reference image location
0133	012	inner shelf	Shelf	fine sediments, unrippled, large sponges	101	25- 100	Y	SE & GAB Image Collection
0917	094	inner shelf	Shelf	fine sediments, unrippled, small sponges	102	25- 100	N	SE & GAB Image Collection
0169	016	inner shelf	Shelf	fine sediments, unrippled, mixed faunal community	103	25- 100	Y	SE & GAB Image Collection
0905	093	inner shelf	Shelf	fine sediments, unrippled, bioturbators	109	25- 100	N	SE & GAB Image Collection
0157	014	inner shelf	Shelf	fine sediments, wave rippled, large sponges	111	25- 100	Y	SE & GAB Image Collection
0929	095	inner shelf	Shelf	fine sediments, wave rippled, no fauna	120	25- 100	N	SE & GAB Image Collection
0942	096	inner shelf	Shelf	fine sediments, wave rippled, small sponges	122	25- 100	N	SE & GAB Image Collection
2101	201	inner shelf	Shelf	fine sediments, wave rippled, encrustors	126	25- 100	N	SE & GAB Image Collection
0881	091	inner shelf	Shelf	fine sediments, irregular, large sponges	131	25- 100	N	SE & GAB Image Collection
0893	092	inner shelf	Shelf	fine sediments, irregular, small sponges	132	25- 100	N	SE & GAB Image Collection
0145	013	inner shelf	Shelf	coarse sediments, unrippled, large sponges	201	25- 100	Y	SE & GAB Image Collection
0108	010	inner shelf	Shelf	coarse sediments, current rippled, no fauna	210	25- 100	Y	SE & GAB Image Collection
0869	090	inner shelf	Shelf	coarse sediments, current rippled, bioturbators	219	25- 100	N	SE & GAB Image Collection
0121	011	inner shelf	Shelf	coarse sediments, wave rippled, large sponges	221	25- 100	Y	SE & GAB Image Collection
2003	191	inner shelf	Shelf	coarse sediments, wave rippled, small sponges	222	25- 100	N	SE & GAB Image Collection
2092	200	inner shelf	Shelf	coarse sediments, wave rippled, encrustors	226	25- 100	N	SE & GAB Image Collection

ERAEF record No.	ERAEF Habitat Number	Sub-biome	Feature	Habitat type	SGF Score	Depth (m)	Image available	Reference image location
0096	009	inner shelf	Shelf	coarse sediments, wave rippled, sedentary	227	25- 100	Y	SE & GAB Image Collection
0857	089	inner shelf	Shelf	coarse sediments, irregular, encrustors	236	25- 100	N	SE & GAB Image Collection
0072	006	inner shelf	Shelf	coarse sediments, subcrop, large sponges	251	25- 100	Y	SE & GAB Image Collection
0012	001	inner shelf	Shelf	gravel, current rippled, mixed faunal community	313	25- 100	Y	SE & GAB Image Collection
0966	098	inner shelf	Shelf	gravel, wave rippled, no fauna	320	25- 100	Y	SE & GAB Image Collection
0954	097	inner shelf	Shelf	gravel, wave rippled, bioturbators	329	25- 100	Y	SE & GAB Image Collection
0084	007	inner shelf	Shelf	gravel, debris flow, mixed faunal community	343	25- 100	Y	SE & GAB Image Collection
2079	199	inner shelf	Shelf	cobble, wave rippled, low/ encrusting mixed fauna	426	25- 100	N	SE & GAB Image Collection
0060	005	inner shelf	Shelf	cobble, debris flow, large sponges	441	25- 100	Y	SE & GAB Image Collection
0978	099	inner shelf	Shelf	Igneous rock, high outcrop, large sponges	591	25- 100	N	SE & GAB Image Collection
0048	004	inner shelf	Shelf	Sedimentary rock, outcrop, large sponges	671	25- 100	Y	SE & GAB Image Collection
0024	002	inner shelf	Shelf	Sedimentary rock, outcrop, large sponges	691	25- 100	Y	SE & GAB Image Collection
0036	003	inner shelf	Shelf	Sedimentary rock, outcrop, mixed faunal community	693	25- 100	Y	SE & GAB Image Collection
1846	173	outer shelf	shelf-break	mud, unrippled, no fauna	000	100- 200, 200- 700	N	SE & GAB Image Collection
1891	177	outer shelf	Shelf	mud, unrippled, low encrusting sponges	002	100- 200	N	SE & GAB Image Collection
0990	100	outer shelf	Shelf	mud, unrippled, sedentary	007	100- 200	Y	SE & GAB Image Collection
1858	174	outer shelf	shelf-break	mud, unrippled, sedentary	007	100- 200, 200- 700	N	SE & GAB Image Collection
1900	178	outer shelf	Shelf	mud, unrippled, bioturbators	009	100- 200	N	SE & GAB Image Collection
1909	179	outer shelf	Shelf	mud, subcrop, erect sponges	051	100- 200	N	SE & GAB Image Collection
1305	125	outer shelf	Shelf	mud, subcrop, small sponges	052	100- 200	Y	SE & GAB Image Collection
1918	180	outer shelf	Shelf	mud, subcrop, low encrusting mixed fauna	056	100- 200	N	SE & GAB Image Collection
1141	112	outer shelf	Shelf	fine sediments, unrippled, no fauna	100	100- 200	Y	SE & GAB Image Collection
1810	170	outer shelf	shelf-break	fine sediments, unrippled, no fauna	100	100- 200, 200- 700	N	SE & GAB Image Collection
1128	111	outer shelf	Shelf	fine sediments, unrippled, large sponges	101	100- 200	Y	SE & GAB Image Collection
1154	113	outer shelf	Shelf	fine sediments, unrippled, small sponges	102	100- 200	Y	SE & GAB Image Collection
1822	171	outer shelf	shelf-break	fine sediments, unrippled, octocorals	105	100- 200, 200- 700	N	SE & GAB Image Collection
1927	181	outer shelf	Shelf	fine sediments, unrippled, encrustors	106	100- 200	N	SE & GAB Image Collection
1116	110	outer shelf	Shelf	fine sediments, unrippled, bioturbators	109	100- 200	Y	SE & GAB Image Collection

ERAEF record No.	ERAEF Habitat Number	Sub-biome	Feature	Habitat type	SGF Score	Depth (m)	Image available	Reference image location
1798	169	outer shelf	shelf-break	fine sediments, unrippled, bioturbators	109	100- 200, 200- 700	N	SE & GAB Image Collection
1936	183	outer shelf	Shelf	fine sediments, current rippled, no fauna	110	100- 200	N	SE & GAB Image Collection
1945	184	outer shelf	Shelf	fine sediments, current rippled, low/ encrusting sponges	112	100- 200	N	SE & GAB Image Collection
1040	104	outer shelf	Shelf	fine sediments, current rippled, bioturbators	119	100- 200	Y	SE & GAB Image Collection
1204	117	outer shelf	Shelf	fine sediments, wave rippled, no fauna	120	100- 200	N	SE & GAB Image Collection
1191	116	outer shelf	Shelf	fine sediments, wave rippled, large sponges	121	100- 200	N	SE & GAB Image Collection
1228	119	outer shelf	Shelf	fine sediments, wave rippled, small sponges	122	100- 200	N	SE & GAB Image Collection
1179	115	outer shelf	Shelf	fine sediments, wave rippled, encrustors	126	100- 200	N	SE & GAB Image Collection
1216	118	outer shelf	Shelf	fine sediments, wave rippled, sedentary	127	100- 200	N	SE & GAB Image Collection
1167	114	outer shelf	Shelf	fine sediments, wave rippled, bioturbators	129	100- 200	Y	SE & GAB Image Collection
1065	106	outer shelf	Shelf	fine sediments, irregular, no fauna	130	100- 200	N	SE & GAB Image Collection
1052	105	outer shelf	Shelf	fine sediments, irregular, large sponges	131	100- 200	N	SE & GAB Image Collection
1078	107	outer shelf	Shelf	fine sediments, irregular, small sponges	132	100- 200	N	SE & GAB Image Collection
1786	168	outer shelf	shelf-break	fine sediments, irregular, small sponges	132	100- 200, 200- 700	N	SE & GAB Image Collection
1954	185	outer shelf	Shelf	fine sediments, irregular, low encrusting mixed fauna	136	100- 200	N	SE & GAB Image Collection
1774	167	outer shelf	shelf-break	fine sediments, irregular, bioturbators	139	100- 200, 200- 700	N	SE & GAB Image Collection
1963	187	outer shelf	Shelf	fine sediments, irregular, bioturbators	139	100- 200	N	SE & GAB Image Collection
1972	188	outer shelf	Shelf	fine sediments, rubble banks, low encrusting sponges	142	100- 200	N	SE & GAB Image Collection
0182	017	outer shelf	Shelf	fine sediments, subcrop, large sponges	151	100- 200	Y	SE & GAB Image Collection
1103	109	outer shelf	Shelf	fine sediments, subcrop, small sponges	152	100- 200	Y	SE & GAB Image Collection
1090	108	outer shelf	Shelf	fine sediments, subcrop, mixed faunal community	153	100- 200	N	SE & GAB Image Collection
1981	189	outer shelf	Shelf	fine sediments, subcrop, mixed low fauna	156	100- 200	N	SE & GAB Image Collection
1990	190	outer shelf	Shelf	coarse sediments, unrippled, no fauna	200	100- 200	N	SE & GAB Image Collection
0329	030	outer shelf	Shelf	coarse sediments, unrippled, mixed faunal community	203	100- 200	Y	SE & GAB Image Collection
0280	026	outer shelf	Shelf	coarse sediments, unrippled, encrustors	206	100- 200	Y	SE & GAB Image Collection
0293	027	outer shelf	Shelf	coarse sediments, current rippled, no fauna	210	100- 200	Y	SE & GAB Image Collection
0268	025	outer shelf	Shelf	coarse sediments, wave rippled, no fauna	220	100- 200	Y	SE & GAB Image Collection
1028	103	outer shelf	Shelf	coarse sediments, wave rippled, small sponges	222	100- 200	N	SE & GAB Image Collection
1016	102	outer shelf	Shelf	coarse sediments, wave rippled, encrustors	226	100- 200	N	SE & GAB Image Collection

ERAEF record No.	ERAEF Habitat Number	Sub-biome	Feature	Habitat type	SGF Score	Depth (m)	Image available	Reference image location
0317	029	outer shelf	Shelf	coarse sediments, irregular, large sponges	231	100- 200	Y	SE & GAB Image Collection
0207	019	outer shelf	Shelf	coarse sediments, subcrop, large sponges	251	100- 200	Y	SE & GAB Image Collection
1004	101	outer shelf	Shelf	coarse sediments, subcrop, small sponges	252	100- 200	N	SE & GAB Image Collection
2012	192	outer shelf	Shelf	gravel/ pebble, current rippled, large sponges	311	100- 200	N	SE & GAB Image Collection
2021	193	outer shelf	Shelf	gravel/ pebble, current rippled, mixed low fauna	316	100- 200	N	SE & GAB Image Collection
1241	120	outer shelf	Shelf	gravel, current rippled, bioturbators	319	100- 200	N	SE & GAB Image Collection
1292	124	outer shelf	Shelf	gravel, wave rippled, no fauna	320	100- 200	N	SE & GAB Image Collection
1279	123	outer shelf	Shelf	gravel, wave rippled, large sponges	321	100- 200	N	SE & GAB Image Collection
2030	194	outer shelf	Shelf	gravel/ pebble, wave rippled, low encrusting sponges	322	100- 200	N	SE & GAB Image Collection
1266	122	outer shelf	Shelf	gravel, wave rippled, encrustors	326	100- 200	N	SE & GAB Image Collection
2039	195	outer shelf	Shelf	gravel, wave rippled, encrustors	326	100- 200	N	SE & GAB Image Collection
1254	121	outer shelf	Shelf	gravel, wave rippled, bioturbators	329	100- 200	Y	SE & GAB Image Collection
0255	024	outer shelf	Shelf	gravel, irregular, encrustors	336	100- 200	Y	SE & GAB Image Collection
2048	196	outer shelf	Shelf	gravel, wave rippled, encrustors	346	100- 200	N	SE & GAB Image Collection
0305	028	outer shelf	Shelf	cobble, unrippled, large sponges	401	100- 200	Y	SE & GAB Image Collection
2057	197	outer shelf	Shelf	cobble, unrippled, low/ encrusting mixed fauna	406	100- 200	N	SE & GAB Image Collection
2066	198	outer shelf	Shelf	cobble, current rippled, low/ encrusting mixed fauna	416	100- 200	N	SE & GAB Image Collection
0341	032	outer shelf	Shelf	cobble, subcrop, crinoids	454	100- 200	Y	SE & GAB Image Collection
0219	020	outer shelf	Shelf	cobble, outcrop, crinoids	464	100- 200	Y	SE & GAB Image Collection
1834	172	outer shelf	shelf-break	Igneous rock,high outcrop,no fauna	590	100- 200, 200- 700	N	SE & GAB Image Collection
1317	126	outer shelf	Shelf	Sedimentary rock, subcrop, large sponges	651	100- 200	Y	SE & GAB Image Collection
1330	127	outer shelf	Shelf	Sedimentary rock, subcrop, small sponges	652	100- 200	Y	SE & GAB Image Collection
1882	176	outer shelf	shelf-break	Sedimentary rock, subcrop, small sponges	652	100- 200, 200- 700	N	SE & GAB Image Collection
0231	022	outer shelf	Shelf	Sedimentary rock, subcrop, mixed faunal community	653	100- 200	Y	SE & GAB Image Collection
1870	175	outer shelf	shelf-break	Sedimentary rock, subcrop, crinoids	654	100- 200, 200- 700	N	SE & GAB Image Collection
0243	023	outer shelf	Shelf	Sedimentary rock, outcrop, large sponges	671	100- 200	Y	SE & GAB Image Collection
0677	065	outer shelf	canyon	Sedimentary rock, outcrop, small sponges	672	100- 200	Y	SE & GAB Image Collection
0194	018	outer shelf	Shelf	Sedimentary rock, outcrop, encrustors	696	100- 200	Y	SE & GAB Image Collection
1762	166	outer shelf	shelf-break	Bryozoan based commmunities	xx6	100- 200,	N	SE & GAB Image Collection

ERAEF record No.	ERAEF Habitat Number	Sub-biome	Feature	Habitat type	SGF Score	Depth (m)	Image available	Reference image location
						200- 700		
1510	143	upper slope	Slope	mud, unrippled, large sponges	001	200- 700	N	SE & GAB Image Collection
1498	142	upper slope	Slope	mud, unrippled, encrustors	006	200- 700	Y	SE & GAB Image Collection
1522	144	upper slope	Slope	mud, unrippled, sedentary	007	200- 700	Y	SE & GAB Image Collection
1486	141	upper slope	Slope	mud, unrippled, bioturbators	009	200- 700	Y	SE & GAB Image Collection
1474	140	upper slope	Slope	mud, irregular, bioturbators	039	200- 700	Y	SE & GAB Image Collection
0473	046	upper slope	Slope	fine sediments, unrippled, no fauna	100	200- 700	Y	SE & GAB Image Collection
1438	137	upper slope	Slope	fine sediments, unrippled, small sponges	102	200- 700	N	SE & GAB Image Collection
1426	136	upper slope	Slope	fine sediments, unrippled, encrustors	106	200- 700	Y	SE & GAB Image Collection
0797	078	upper slope	canyon	fine sediments, unrippled, sedentary	107	200- 700	Y	SE & GAB Image Collection
0449	044	upper slope	Slope, canyon	fine sediments, unrippled, bioturbators	109	200- 700	Y	SE & GAB Image Collection
1402	133	upper slope	Slope	fine sediments, current rippled, no fauna	110	200- 700	N	SE & GAB Image Collection
0761	073	upper slope	canyon	fine sediments, irregular, encrustors	136	200- 700	Y	SE & GAB Image Collection
0425	041	upper slope	Slope	fine sediments, irregular, bioturbators	139	200- 700	Y	SE & GAB Image Collection
1414	134	upper slope	Slope	fine sediments, subcrop, large sponges	151	200- 700	N	SE & GAB Image Collection
0785	077	upper slope	canyon, slope	fine sediments, subcrop, small sponges	152	200- 700	Y	SE & GAB Image Collection
0413	040	upper slope	Slope	fine sediments, subcrop, sedentary	157	200- 700	Y	SE & GAB Image Collection
0437	043	upper slope	Slope	coarse sediments, unrippled, low mixed encrustors	206	200- 700	Y	SE & GAB Image Collection
0461	045	upper slope	Slope	coarse sediments, unrippled, sedentary	207	200- 700	Y	SE & GAB Image Collection
0773	076	upper slope	canyon, slope	coarse sediments, irregular, low mixed encrustors	236	200- 700	Y	SE & GAB Image Collection
0749	072	upper slope	canyon	coarse sediments, irregular, bioturbators	239	200- 700	Y	SE & GAB Image Collection
1462	139	upper slope	Slope	gravel, debris flow, no fauna	340	200- 700	N	SE & GAB Image Collection
1450	138	upper slope	Slope	gravel, debris flow, encrustors	346	200- 700	Y	SE & GAB Image Collection
1366	130	upper slope	Slope	cobble, debris flow, no fauna	440	200- 700	Y	SE & GAB Image Collection
1390	132	upper slope	Slope	cobble, debris flow, small sponges	442	200- 700	Y	SE & GAB Image Collection
1378	131	upper slope	Slope	cobble, debris flow, octocorals	445	200- 700	N	SE & GAB Image Collection
1354	129	upper slope	Slope	cobble, debris flow, encrustors	446	200- 700	Y	SE & GAB Image Collection
0713	069	upper slope	canyon	cobble, outcrop, crinoids	464	200- 700	Y	SE & GAB Image Collection
0821	081	upper slope	seamount	Sedimentary rock, unrippled, no fauna	600	200- 700	Y	SE & GAB Image Collection
0845	085	upper slope	seamount	Sedimentary rock, unrippled, encrustors	606	200- 700	Y	SE & GAB Image Collection

ERAEF record No.	ERAEF Habitat Number	Sub-biome	Feature	Habitat type	SGF Score	Depth (m)	Image available	Reference image location
0701	067	upper slope	canyon, slope	Sedimentary rock, subcrop, large sponges	651	200- 700	Y	SE & GAB Image Collection
0725	070	upper slope	canyon	Sedimentary rock, subcrop, small sponges	652	200- 700	Y	SE & GAB Image Collection
0353	033	upper slope	Slope	Sedimentary rock, subcrop, mixed faunal community	653	200- 700	Y	SE & GAB Image Collection
1558	148	upper slope	Slope	Sedimentary rock, subcrop, octocorals	655	200- 700	N	SE & GAB Image Collection
0389	036	upper slope	Slope	Sedimentary rock, subcrop, encrustors	656	200- 700	Y	SE & GAB Image Collection
0377	035	upper slope	Slope	Sedimentary rock, outcrop, encrustors	666	200- 700	Y	SE & GAB Image Collection
1534	145	upper slope	Slope	Sedimentary rock, low outcrop, large sponges	671	200- 700	N	SE & GAB Image Collection
1546	146	upper slope	Slope	Sedimentary rock, low outcrop, small sponges	672	200- 700	Y	SE & GAB Image Collection
0737	071	upper slope	canyon	Sedimentary rock, outcrop, encrustors	676	200- 700	Y	SE & GAB Image Collection
0809	080	upper slope	seamount	Sedimentary rock, outcrop, encrustors	676	200- 700	Y	SE & GAB Image Collection
0401	039	upper slope	Slope	Sedimentary rock, outcrop, crinoids	684	200- 700	Y	SE & GAB Image Collection
0689	066	upper slope	canyon	Sedimentary rock, outcrop, crinoids	694	200- 700	Y	SE & GAB Image Collection
0365	034	upper slope	Slope	Sedimentary rock, outcrop, encrustors	696	200- 700	Y	SE & GAB Image Collection
1342	128	upper slope	Slope	Bryozoan based communities	xx6	200- 700	N	SE & GAB Image Collection
1702	161	mid-slope	Slope	mud, unrippled, small sponges	002	700- 1500	N	SE & GAB Image Collection
1666	158	mid-slope	Slope	mud, current rippled, bioturbators	019	700- 1500	N	SE & GAB Image Collection
1690	160	mid-slope	Slope	mud, irregular, sedentary	037	700- 1500	N	SE & GAB Image Collection
1678	159	mid-slope	Slope	mud, irregular, bioturbators	039	700- 1500	N	SE & GAB Image Collection
1642	156	mid-slope	Slope	fine sediments, unrippled, no fauna	100	700- 1500	N	SE & GAB Image Collection
0653	063	mid-slope	Slope	fine sediments, unrippled, octocorals	105	700- 1500	Y	SE & GAB Image Collection
0629	061	mid-slope	Slope	fine sediments, irregular, bioturbators	139	700- 1500	Y	SE & GAB Image Collection
0581	057	mid-slope	Slope	fine sediments, subcrop, bioturbators	150	700- 1500	Y	SE & GAB Image Collection
1606	153	mid-slope	Slope	coarse sediments, unrippled, no fauna	200	700- 1500	N	SE & GAB Image Collection
0641	062	mid-slope	Slope	coarse sediments, unrippled, octocorals	205	700- 1500	Y	SE & GAB Image Collection
1570	150	mid-slope	Slope	coarse sediments, current rippled, no fauna	210	700- 1500	N	SE & GAB Image Collection
1582	151	mid-slope	Slope	coarse sediments, current rippled, octocorals	215	700- 1500	N	SE & GAB Image Collection
1594	152	mid-slope	Slope	coarse sediments, current rippled, sedentary	217	700- 1500	N	SE & GAB Image Collection
0605	059	mid-slope	Slope	coarse sediments, irregular,low encrusting	236	700- 1500	Y	SE & GAB Image Collection
0593	058	mid-slope	Slope	cobble, unrippled, small sponges	402	700- 1500	Y	SE & GAB Image Collection
1618	154	mid-slope	Slope	cobble, debris flow, crinoids	444	700- 1500	N	SE & GAB Image Collection

ERAEF record No.	ERAEF Habitat Number	Sub-biome	Feature	Habitat type	SGF Score	Depth (m)	Image available	Reference image location
1630	155	mid-slope	Slope	slabs/ boulders, debris flow, octocorals	445	700- 1500	Y	SE & GAB Image Collection
0497	050	mid-slope	Slope	cobble, debris flow, encrustors	446	700- 1500	Y	SE & GAB Image Collection
0509	051	mid-slope	Slope	cobble, outcrop, no fauna	460	700- 1500	Y	SE & GAB Image Collection
0617	060	mid-slope	Slope	cobble, outcrop, crinoids	464	700- 1500	Y	SE & GAB Image Collection
0665	064	mid-slope	Slope	Sedimentary slab and mud boulders, outcrop, crinoids	464	700- 1500	Y	SE & GAB Image Collection
0533	053	mid-slope	Slope	Igneous rock, low outcrop, sedentary	567	700- 1500	Y	SE & GAB Image Collection
0485	049	mid-slope	Slope	Igneous rock, high outcrop, bioturbators	594	700- 1500	Y	SE & GAB Image Collection
1654	157	mid-slope	Slope	Igneous rock, high outcrop, octocorals	595	700- 1500	N	SE & GAB Image Collection
0557	055	mid-slope	Slope	Sedimentary rock, unrippled, sedentary	607	700- 1500	Y	SE & GAB Image Collection
1714	162	mid-slope	Slope	Sedimentary rock, debris flow, crinoids	644	700- 1500	N	SE & GAB Image Collection
1738	164	mid-slope	Slope	Sedimentary rock, subcrop, crinoids	654	700- 1500	Y	SE & GAB Image Collection
1750	165	mid-slope	Slope	Sedimentary rock, subcrop, octocorals	655	700- 1500	Y	SE & GAB Image Collection
0569	056	mid-slope	Slope, Slope, canyons, seamounts	Sedimentary rock, outcrop, mixed faunal community	673	700- 1500	Y	SE & GAB Image Collection
0521	052	mid-slope	Slope	Sedimentary rock, outcrop, octocorals	675	700- 1500	Y	SE & GAB Image Collection
0833	084	mid-slope	seamount	Sedimentary rock, outcrop, sedentary	677	700- 1500	Y	SE & GAB Image Collection
0545	054	mid-slope	Slope	Sedimentary rock, outcrop, crinoids	694	700- 1500	Y	SE & GAB Image Collection
1726	163	mid-slope	Slope	Sedimentary rock, high outcrop, octocorals	695	700- 1500	Y	SE & GAB Image Collection

Scoping Document S2B2. Pelagic Habitats

A list of the pelagic habitats for the Southern Squid Jig fishery. Blue denotes habitats occurring within the jurisdictional boundary of the sub-fishery that are not subject to effort from Squid jigging.

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) & (2)	dow167A1, A2, A4
P4	North Eastern Pelagic Province - Oceanic	0 – > 600	this is a compilation of the range covered by Oceanic Community (1) & (2)	dow167A1,

ERAEF Habitat Number	Pelagic Habitat type	Depth (m)	Comments	Reference
				A2, A4
P7	Southern Pelagic Province - Coastal	0 – 200	this is a compilation of the range covered by Coastal pelagic Tas & GAB	dow167A1, A2, A4
P8	Southern Pelagic Province - Oceanic	0 – > 600	this is a compilation of the range covered by Oceanic Communities (1, 2 & 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 & 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) & (2)	dow167A1, A2, A4
P14	North Eastern Pelagic Province - Coastal	0 – 200		dow167A1, A2, A4
P16	North Eastern Pelagic Province - Seamount oceanic	0 – > 600	this is a compilation of the range covered by Seamount Oceanic Communities (1) & (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 bioregionalisations for the slope (IMCRA 1998; Last *et al*. 2005). The spatial boundaries for the pelagic communities are based on pelagic bioregionalisations and on oceanography (Condie *et al*. 2003; Lyne and Hayes 2004). Fishery and region specific modifications to these boundaries are described in detail in Hobday *et al*. (2007) and briefly outlined in the footnotes to the community Tables below.

Demersal communities which underlie the pelagic communities in the Southern Squid Jig sub-fishery (x). Shaded cells indicate all communities within the province.

Demersal community	Cape	North Eastern	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]							x		x	x									
Outer Shelf 110 – 250m [1,2,]									x										
Upper Slope 250 – 565m [3]																			
Mid–Upper Slope 565 – 820m[3]																			
Mid Slope 820 – 1100m[3]																			
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																			
Plateau 0 – 110m																			

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

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: 2inner & outer shelves (0-250m), and 3upper and midslope communities combined (250-1000m). At Heard/McDonald Is: 4outer and upper slope plateau communities combined to form four communities: Shell Bank, inner and outer Heard Plateau (100-500m) and Western Banks (200-500m), 5mid 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, 7Great Barrier Reef in the North Eastern Province and Transition and 8 Rowley Shoals in North Western Transition

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Scoping Document S2C2. Pelagic Communities

Pelagic communities in which fishing activity occurs in the Southern Squid Jig sub-fishery (x). Shaded cells indicate all communities that exist in the province.

Pelagic community	North Eastern	Eastern	Southern	Western	Northern	North Western	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								
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 inclusion 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?"	*As shown in sub-component model diagrams at the beginning of this section.*	*"What you are specifically trying to achieve"*	*"What you are going to use to measure performance"*	*Rationale flagged as 'EMO' where Existing Management Objective in place, or 'AMO' where there is an existing AFMA Management Objective in place for other Commonwealth fisheries (assumed that squid fishery will fall into line).*
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 AMO/EPBC 1.2 AMO/EPBC 1.3 AMO 1.4 EPBC
		2. Geographic range	2.1 Geographic range of the population, in terms of size and continuity does not change outside acceptable bounds	Presence of population across the GAB	2.1 EPBC
		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 EPBC
		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 EPBC

Component	Core Objective	Sub-component	Example Operational Objectives	Example Indicators	**Rationale**
		5. Reproductive Capacity	5.1 Fecundity of the population does not change outside acceptable bounds (e.g. more than X% of reference population fecundity) 2 Recruitment to the population does not change outside acceptable bounds	Egg production of population Abundance of recruits	5.1 EPBC 5.2 EPBC
		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 EPBC
Byproduct and Bycatch	Avoid recruitment failure of the byproduct and bycatch species Avoid negative consequences for species or population sub-components	1. Population size	1.1 No trend in biomass 1.2 Species do not approach extinction or become extinct 1.3 Maintain biomass above a specified level 1.4 Maintain catch at specified level	Biomass, numbers, density, CPUE, yield	1.1 AMO/EPBC 1.2 EPBC 1.3 AMO/EPBC 1.4 AMO
		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 EPBC
		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 EPBC

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 EPBC
		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 EPBC
		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 EPBC
TEP species	Avoid recruitment failure of TEP species Avoid negative consequences for TEP species or population sub-components Avoid negative impacts on the population from fishing	1. Population size	1.1 Species do not further approach extinction or become extinct 1.2 No trend in biomass 1.3 Maintain biomass above a specified level 1.4 Maintain catch at specified level	Biomass, numbers, density, CPUE, yield	1.1 EPBC 1.2 EPBC 1.3 EPBC 1.4 EPBC
		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 EPBC

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 EPBC
		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 EPBC
		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 EPBC
		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 EPBC
		7. Interactions with fishery	7.1 Survival after interactions is maximised 7.2 Interactions do not affect the viability of the population or its ability to recover	Survival rate of species after interactions Number of interactions, biomass or numbers in population	7.1 EPBC 7.2 EPBC 7.3 EPBC
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 EPBC

Component	Core Objective	Sub-component	Example Operational Objectives	Example Indicators	**Rationale**
		2. Air quality	2.1 Air quality does not change outside acceptable bounds	Air chemistry, noise levels, visual pollution, pollutant concentrations, light pollution from artificial light	2.1 EPBC
		3. Substrate quality	3.1 Sediment quality does not change outside acceptable bounds	Sediment chemistry, stability, particle size, debris, pollutant concentrations	3.1 EPBC
		4. Habitat types	4.1 Relative abundance of habitat types does not vary outside acceptable bounds	Extent and area of habitat types, % cover, spatial pattern, landscape scale	4.1 EPBC
		5. Habitat structure and function	5.1 Size, shape and condition of habitat types does not vary outside acceptable bounds	Size structure, species composition and morphology of biotic habitats	5.1 EPBC
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 EPBC
		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 EPBC
		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 EPBC

Component	Core Objective	Sub-component	Example Operational Objectives	Example Indicators	**Rationale**
		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 EPBC
		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 EPBC

2.2.4 Hazard Identification (Step 4)

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

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

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

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

Scoping Document S4. Hazard Identification Scoring Sheet

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

Fishery Name: Southern Squid Jig Fishery
Sub-fishery Name: Southern Squid Jig Sub-fishery
Date: March 2004, checked and updated May 2006

Direct impact of Fishing	*Fishing Activity*	Score (0/1)	Documentation of Rationale
Capture	Bait collection	0	Not applicable to the SSJF as the fishery uses artificial jigs to capture squid.
	Fishing	1	Actual fishing, i.e. capture of species due to the deployment and retrieval of gear including target, by-product, and bycatch organisms.
	Incidental behaviour	1	Potential for capture of organisms due to crew behaviour e.g. fishing with hand lines
Direct impact without capture	Bait collection	0	Not applicable to the SSJF as the fishery uses artificial jigs to capture squid.
	Fishing	1	Disorientation/injury/mortality as a result of momentary entanglement with jig lines but animal able to free itself, e.g. barracouta.
	Incidental behaviour	1	Past use of firearms and ‘crackers’ as deterrents for scavenging species has been discontinued Occasional use of handlines to remove sharks from vicinity may have some impact.
	Gear loss	1	Gear loss that has potential to entangle animals includes jigs and lines etc. - requires monitoring.

Direct impact of Fishing	*Fishing Activity*	Score (0/1)	Documentation of Rationale
	Anchoring/ mooring	1	The possible use of pelagic sea parachute anchors may have some direct impacts (damage or mortality) on pelagic species coming into contact with anchor, chain or rope.
	Navigation/steaming	1	Steaming/navigation to fishing grounds may result in collisions (e.g. seabirds or whales vessel interactions), seabird collisions with nighttime lights/navigation lights.
Addition/ movement of biological material	Translocation of species (boat launching, reballasting)	0	Low impact as the fishery uses artificial jigs to capture squid and does not rely on biological material for bait. Only refrigerated sea water carried on vessels. Same issues as other fishing hulls in terms of translocation of species between ports, however port to port transfer not considered to pose ecological risk to SSJF fishing grounds.
	On board processing	0	Not currently applicable to the SSJF – could happen in the future.
	Discarding catch	1	Minimal discarding of species (dead/live) in the SSJF, typically less than 10 kg per trip per boat. Discards usually occur at location of capture.
	Stock enhancement	0	Not applicable to the SSJF as there is no stock enhancement program associated with the target species.
	Provisioning	0	Not applicable to the SSJF as bait or berley is not required to aggregate target species, however, lights are used to attract squid to the jigs.
	Organic waste disposal	1	Disposal of organic wastes (food scraps, sewage) as a result of general fishing vessel operations.
Addition of non-biological material	Debris	1	Very little possibility of the generation of debris due to general fishing activities.
	Chemical pollution	0	No chemical use or chemical pollution known to occur during jigging activities. Squid ink removed from deck in port.
	Exhaust	1	Exhaust as a result of diesel and other engines during general fishing operations.
	Gear loss	1	Possible gear loss, requires monitoring. Potential lost items includes jigs and jig lines.
	Navigation/ steaming	1	Fishing operations involve vessels navigating to and from fishing grounds, introducing noise and visual stimuli into the environment, e.g. attraction of foraging/scavenging birds to boats.
	Activity/ presence on water	1	Fishing operations involve the presence of several vessels on the fishing grounds –introducing noise and visual stimuli into the environment, e.g. attraction of foraging/scavenging animals.
Disturb physical processes	Bait collection	0	Not applicable to the SSJF as the fishery uses artificial jigs to capture squid.
	Fishing	1	SSJF is a pelagic fishery but is unlikely to disturb/disrupt local physical water flow patterns. Use of strong lights may disturb pelagic communities.
	Boat launching	0	Not applicable to the SSJF as vessels in the fishery come from designated ports.

Direct impact of Fishing	*Fishing Activity*	Score (0/1)	Documentation of Rationale
	Anchoring/ mooring	1	Anchoring is unlikely to occur during jig fishing operations. Parachute anchor used at times to hold position.
	Navigation/ steaming	1	Fishing operations involve vessels navigating to and from fishing grounds, may disturb physical pelagic processes e.g. mixed layer depth.
External Hazards (specify the particular example within each activity area)	Other capture fishery methods	1	Other fishery capture methods occur in the same region as the SSJF and include SEF trawl and Danish seine, and Small Pelagic Fishery. One of the species caught by these fisheries is the target species of ŧ SSJF.
	Aquaculture	0	Not applicable to the SSJF as there is no interactions of the species with aquaculture.
	Coastal development	0	Not applicable to the SSJF as species is offshore.
	Other extractive activities	1	Licenses for petroleum exploration apply in the region. Possible extraction in future e.g. Woodside exploratory activity may result in extraction off Western Victoria.
	Other non-extractive activities	1	Shipping lanes through fishing grounds; possible mining extraction in the future would lead to the creation of pipelines on the benthos.
	Other anthropogenic activities	1	Tourism (e.g. whale watching) and squid fishing at night likely to occur near the SSJF or in adjacent fisheries.

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 crews use to fish during their down time. This does not include impacts on predator species of removing their prey through fishing.
	Gear loss	Direct impacts (damage or mortality), without capture on organisms due to gear that has been lost from the fishing boat. This includes damage/mortality to species when the lost gear contacts them or if species swallow the lost gear.
	Anchoring/ mooring	Direct impact (damage or mortality) that occurs and when anchoring or mooring. This includes damage/mortality due to physical contact of the anchor, chain or rope with organisms, e.g. An anchor damaging live coral.
	Navigation/ steaming	Direct impact (damage or mortality) without capture may occur while vessels are navigating or steaming. This includes collisions with marine organisms or birds.
Addition/ movement of biological material		Any activities that result in the addition or movement of biological material to the ecosystem of the fishery.
	Translocation of species (boat movements,	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	Defense, 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:

- Southern Squid Jig Fishery Management Plan 2005
- Southern Squid Jig Fishery Management Advisory Committee (SquidMAC)
- Southern Squid Jig Fishery Resource Assessment Group (SquidRAG)
- AFMA Board policy on apportionment of a squid TAC (2005)
- AFMA At a glance web page http://www.afma.gov.au/fisheries/scallop_squid/squid_jig/at_a_glance.htm
- Data Summary Reports

Other publications that may provided information include

- BRS Fishery Status Reports
- Strategic Assessment Reports

The detailed bibliography for the Southern Squid Jig Sub-fishery is included in the reference section.

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, 17 out of 26 possible internal activities were identified as occurring in this fishery. Four out of 6 external activities were identified. Thus, a total of 21 activity-component scenarios will be considered at Level 1. This results in 105 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 **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

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

2.3.1 Level 1 (SICA) Documents L1.1 - Target Species Component

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
Capture	Bait collection	0									
	Fishing	1	4	5	Population size	arrow squid	1.1	3	2	1	Fishing activity occurs at a spatial scale of 100-500nm. Temporal scale of fishery is daily but only for ~6 months per year. Fishing considered to pose greatest risk to population size of arrow squid =>Intensity was scored moderate, i.e. fishing considered to have a severe local impact but only a moderate impact at larger spatial scales =>Consequence of fishing on arrow squid population size was scored minor, because at current fishing levels the long-term recruitment dynamics of arrow squid were not considered to be adversely damaged =>However, confidence in this assessment was low given a lack of a arrow squid stock assessment.
	Incidental behaviour	1	4	5	Population size	arrow squid	1.1	1	1	2	Fishing activity, hence possibility of incidental behaviour occurs at a spatial scale of 100-500nm. Temporal scale of fishery is daily but only for ~6 months per year, however incidental behaviour considered to occur less frequently, i.e. weekly; impact most likely on population size. =>Intensity considered negligible as incidental catch of squid considered rare at any spatial scale =>Consequence was scored negligible for arrow squid Population size, i.e. insignificant change to population growth rate (r), unlikely to be detectable against background variability for this population =>Confidence of assessment is considered high because fishers aim to maximise commercial catch of target species and are therefore unlikely to engage in incidental behavioural activities leading to catch or damage of target species stocks.
Direct impact	Bait collection	0									

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
without capture	Fishing	1	4	5	Population size	arrow squid	1.1	1	1	2	Fishing activity occurs at a spatial scale of 100-500nm. Temporal scale of fishery is daily but only for ~6 months per year. Non-capture impact of fishing considered most likely to affect population size of arrow squid due to mortality of hooked but uncaptured squid =>Intensity of non-capture direct impacts considered negligible because of remote likelihood of detection of impacts to the arrow squid population at any spatial or temporal scale =>Consequence was considered negligible, i.e. non-capture impact of fishing squid very unlikely to result in significant change to population growth rate (r), unlikely to be detectable against background variability for this population =>Confidence in the assessment was considered high because jigging thought to be a highly efficient method with low rates of escapee squid once hooked.
	Incidental behaviour	1	4	5	Population size	arrow squid	1.1	1	1	2	Fishing activity occurs at a spatial scale of 100-500nm. Temporal scale of fishery is daily but only for ~6 months per year, however incidental behaviour considered to occur less frequently, i.e. weekly. Direct impact of Incidental behaviour (not resulting in capture, but resulting in squid mortality) likely to affect population size =>Intensity considered negligible as incidental catch of squid considered rare at any spatial scale =>consequence was scored negligible for arrow squid Population size, i.e. insignificant change to population growth rate (r), unlikely to be detectable against background variability for this population =>Confidence of assessment is considered high because fishers aim to maximise commercial catch of target species and are therefore unlikely to engage in incidental behaviour leading to catch or damage of target species stocks.
	Gear loss	1	4	5	Population size	arrow squid	1.1	1	1	1	Fishing activity, hence gear loss, occurs at a spatial scale of 100-500nm. Temporal scale of fishery is daily but only for ~6 months per year, therefore gear loss (e.g. jigs) is considered also to occur daily. Gear loss considered to impact population size of arrow squid by leading to mortalities of squid caught or entangled in lost fishing gear =>Intensity was considered negligible as significant gear loss considered rare. =>Consequence was scored negligible at any spatial or temporal scale =>Confidence of assessment was considered low given a lack of information of rates and types of gear loss in the Southern Squid Jig Fishery. However, observer data suggest gear loss minimal, to minimise

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
											gear loss crew change gear regularly, marriage lines attached to minimise loss if line breaks, and allows lines to be wound in (observer records 2005).
	Anchoring/ mooring	1	4	5	Behaviour/ movement	arrow squid	6.1	1	1	2	Fishing activity, hence anchoring/ mooring possible at a spatial scale of 100-500nm. Temporal scale of anchoring/ mooring considered to occur daily but only for ~6 months per year. Anchoring/ mooring considered to impact Behaviour/ movement of arrow squid e.g. leading to dispersal of squid away from anchor/ mooring lines =>Intensity was considered negligible as Behaviour/ movement of squid in response to anchoring/ mooring was considered rare and constrained by logical considerations =>Consequence was scored negligible at any spatial or temporal scale =>Confidence of assessment was high given logical constraints. Boats may use parachute anchors to hold position.
	Navigation/ steaming	1	4	5	Behaviour/ movement	arrow squid	6.1	1	1	2	Fishing activity, hence navigation/ steaming occurs at a spatial scale of 100-500nm. Temporal scale of Navigation/ steaming occurs daily but only for ~6 months per year. Navigation/ steaming considered to impact Behaviour/ movement of arrow squid by leading to dispersal of squid away from steaming vessels =>Intensity was considered negligible as changes in Behaviour/ movement of squid was considered rare =>Consequence was scored negligible at any spatial or temporal scale, i.e. 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 =>Confidence of assessment was high given logical constraints.
Addition/ movement of biological material	Translocation of species	0									
	On board processing	0									
	Discarding catch	1	4	5	Population size	arrow squid	1.1	1	1	2	Discarding catch activity occurs over spatial scale of 100-500nm. Temporal scale of Discarding catch considered to occur daily over the 6 month fishing season. Impact most likely on population size of arrow squid as a result of attracting predators into the vicinity of the target species =>Intensity considered negligible as activity occurs rarely =>Consequence negligible at any spatial or temporal scale, insignificant change to population growth rate (r), 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 (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
											background variability for this population. =>Confidence of assessment is considered high given logical considerations.
	Stock enhancement	0									
	Provisioning	0									
	Organic waste disposal	1	4	5	Behaviour/ movement	arrow squid	6.1	1	1	2	Organic waste disposal activity occurs over spatial scale of 100-500nm. Temporal scale of Organic waste disposal considered to be daily but only for ~6 months per year. Impact most likely on Behaviour/ movement of arrow squid, i.e. squid likely to be repelled from local areas with high organic waste load =>Intensity considered negligible as activity occurs rarely, and when it does considered to only affect small localised area for a short time =>Consequence was scored negligible for any spatial or temporal scale, i.e. 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. =>Confidence of assessment was high given logical constraints.
Addition of non-biological material	Debris	1	4	5	Behaviour/ movement	arrow squid	6.1	1	1	1	Fishing activity, hence Debris generation, possible over a spatial scale of 100-500nm. Temporal scale of fishery is daily but only for ~6 months per year, Debris considered to be generated less frequently, i.e. weekly. Debris considered to impact Behaviour/ movement of arrow squid by attraction toward small debris in the water column =>Intensity was considered negligible as significant Debris considered rare, plus fishers have a code of conduct which aims to eliminate Debris =>Consequence was scored negligible at any spatial or temporal scale =>Confidence of assessment was considered low given a lack of information of rates and types of Debris generated by the Southern Squid Jig Fishery.
	Chemical pollution	0									
	Exhaust	1	4	5	Behaviour/ movement	arrow squid	6.1	1	1	2	Exhaust emissions occur over a spatial scale of 100-500nm. Temporal scale of Exhaust emissions is daily during ~6 month fishing season. Impact most likely on Behaviour/ movement of arrow squid, i.e. squid likely to be repelled from local areas with high exhaust load =>Intensity considered negligible as activity considered to affect a very small area for short time given rapid dispersal of fumes =>Consequence was scored negligible for any spatial or temporal scale, i.e. no detectable change in behaviour/ movement. 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 (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
											background variability for this population. Time taken to recover to pre-disturbed state on the scale of hours =>Confidence of assessment was high given logical constraints.
	Gear loss	1	4	5	Population size	arrow squid	1.1	1	1	1	Gear loss minimal, to minimise gear loss crew change gear regularly, marriage lines attached to minimise loss if line breaks, and allows lines to be wound in (observer records 2005). Fishing activity, hence gear loss, possible over a spatial scale of 100-500nm. Temporal scale of fishery is daily but only for ~6 months per year, therefore gear loss e.g. jigs also considered to occur daily. Gear loss considered to impact population size of arrow squid by leading to mortalities of squid caught or entangled in lost fishing gear =>Intensity was considered negligible as significant gear loss considered rare=>Consequence was scored negligible at any spatial or temporal scale =>Confidence of assessment was considered low given a lack of information of rates and types of gear loss in the Southern Squid Jig Fishery, however fishers report low rates.
	Navigation/ steaming	1	4	5	Behaviour/ movement	arrow squid	6.1	1	1	1	Fishing activity, hence navigation/ steaming occurs at a spatial scale of 100-500nm. Temporal scale of Navigation/ steaming occurs daily but only for ~6 months per year. Navigation/ steaming considered to impact Behaviour/ movement of arrow squid by leading to dispersal of squid away from steaming vessels =>Intensity was considered negligible as changes in Behaviour/ movement of squid was considered rare =>Consequence was scored negligible at any spatial or temporal scale, i.e. 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 =>Confidence of assessment was low given a lack of information on squid vessel interactions.
	Activity/ presence on water	1	4	5	Behaviour/movement	arrow squid	6.1	3	2	2	Fishing activity, hence Activity/ presence of fishing vessels occurs at a spatial scale of 100-500nm. Temporal scale of Activity/ presence on water occurs daily but only for ~6 months per year. Activity/ presence considered to impact Behaviour/ movement of arrow squid by leading to attraction of squid to vessels (i.e. visual stimuli) =>Intensity was considered moderate, i.e. Moderate intensity at broader spatial scale, or severe but local changes in Behaviour/ movement of squid

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
											=>Consequence was scored as minor, i.e. 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 =>Confidence of assessment was high given that squid are known to be strongly attracted to vessel lights.
Disturb physical processes	Bait collection	0									
	Fishing	1	4	5	Behaviour/ movement	arrow squid	6.1	3	2	2	Fishing activity occurs at a spatial scale of 100-500nm. Temporal scale of fishing is daily but only for ~6 months per year. Disturbance of physical processes caused by fishing i.e. extreme light levels as a result of powerful fishing lights considered most likely to impact Behaviour/ movement of arrow squid by leading to attraction of squid toward fishing activity =>Intensity was considered moderate as changes in Behaviour/ movement was considered to be severe at the local scale and moderate at broader scales =>Consequence was scored minor i.e. detectable against background variability for this population however time taken to recover to pre-disturbed state on the scale of hours to days =>Confidence of assessment was high given that squid respond strongly to powerful fishing lights.
	Boat launching	0									
	Anchoring/ mooring	1	4	5	Behaviour/ movement	arrow squid	6.1	1	1	2	Fishing activity, hence anchoring/ mooring possible at a spatial scale of 100-500nm. Temporal scale of anchoring/ mooring considered to occur daily but only for ~6 months per year. Physical disturbance associated with Anchoring/ mooring considered to impact Behaviour/ movement of arrow squid e.g. leading to dispersal of squid away from anchor/ mooring lines =>Intensity was considered negligible as Behaviour/ movement of squid in response to anchoring/ mooring was considered rare and constrained by logical considerations =>Consequence was scored negligible at any spatial or temporal scale =>Confidence of assessment was high given logical constraints. Boats may use parachute anchors to hold position.
	Navigation/steaming	1	4	5	Behaviour/movement	arrow squid	6.1	1	1	1	Fishing activity, hence navigation/ steaming occurs at a spatial scale of 100-500nm. Temporal scale of Navigation/ steaming occurs daily but only for ~6 months per year. Navigation/ steaming, leading to physical disturbance of water, considered to impact Behaviour/ movement of

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
											arrow squid by leading to dispersal of squid away from steaming vessels =>Intensity was considered negligible as changes in Behaviour/ movement of squid, as a result of physical disturbance to water masses, was considered rare =>Consequence was scored negligible at any spatial or temporal scale, i.e. no detectable change in behaviour/ movement. Unlikely to be detectable against background variability for this population, time taken to recover from any perceivable impact on the scale of hours =>Confidence of assessment was low given a lack of information on squid vessel interactions.
External Impacts (specify the particular example within each activity area)	Other fisheries	1	6	6	Population size	arrow squid	1.1	3	2	1	Other fishery activity occurs on spatial scale >1000nm; temporal scale is daily. Other fisheries (e.g. SETF) considered to have greatest impact on Population size of arrow squid =>Intensity considered moderate, i.e. moderate fishing intensity at larger spatial/ temporal scale but often severe intensity at local spatial and short temporal scales =>Consequence scored as minor, take of squid by other fisheries considered to result in possible detectable change in growth rate (r) but minimal impact on population size and none on dynamics =>Confidence of assessment is considered low given a lack of stock assessment for arrow squid.
	Aquaculture	0									
	Coastal development	0									
	Other extractive activities	1	6	6	Behaviour/ Movement	arrow squid	6.1	2	2	2	Other extractive activities occur on spatial scale >1000nm; temporal scale is daily. Extractive activities considered to have greatest impact on Behaviour and movement of arrow squid causing squid to move outside local extractive activity, else be attracted toward if activity involves the use of night time lights. =>Intensity considered minor, i.e. minor extraction currently occurring =>Consequence scored as minor, possible detectable change in behaviour/ movement but minimal impact on population dynamics =>Confidence of assessment is considered high given that levels of extractive activities are closely monitored and unlikely to lead to significant changes in squid behaviour at current levels.
	Other non-extractive activities	1	6	6	Behaviour/ Movement	arrow squid	6.1	3	2	1	Shipping activities occur on spatial scale >1000nm; temporal scale is daily. Non-extractive activities considered to have greatest impact on

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
											Behaviour and movement of arrow squid causing squid to move outside shipping lanes, else will be attracted toward if ships due to night time navigations lights. =>Intensity considered moderate, i.e. moderate level of shipping activity occurs on squid fishing grounds =>Consequence scored as minor, possible detectable change in behaviour/ movement but minimal impact on population dynamics =>Confidence of assessment is considered low because of a lack of information/ observation of squid-ship interactions.
	Other anthropogenic activities	1	4	6	Population size	arrow squid	1.1	1	1	1	Shipping occurs across spatial scale >1000nm; temporal scale is daily; impact of recreational fishing for arrow squid will affect Population size of squid =>Intensity considered negligible, i.e. remote likelihood of detection of change at any spatial or temporal scale =>Consequence considered negligible, i.e. no detectable change in Population size of arrow squid above background =>Confidence of assessment is considered low due to a lack of information on recreational catches of arrow squid.

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 (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
Capture	Bait collection	0									
	Fishing	1	4	5	Population size	barracouta	1.1	2	2	1	Fishing activity occurs at a spatial scale of 100-500nm. Temporal scale of fishery is daily but only for ~6 months per year. Fishing considered to pose greatest risk to population size of by-catch species, barracouta in particular =>Intensity was scored minor, i.e. capture of barracouta occurs rarely or in few restricted locations and detectability even at these scales is rare =>Consequence of fishing on barracouta population size was scored minor, possible detectable change in growth rate (r) but minimal impact on population size and none on dynamics =>Confidence in this assessment was low given a lack of data on barracouta capture rates.
	Incidental behaviour	1	4	5	Population size	blue shark	1.1	2	2	1	Fishing activity, hence opportunity for incidental behaviour, occurs at a spatial scale of 100-500nm. Temporal scale of incidental behaviour considered weekly, i.e. during crew downtime for ~6 months per year. Incidental behaviour considered to pose greatest risk to population size of by-catch species, blue shark in particular =>Intensity was scored minor, i.e. capture of blue shark occurs rarely or in few restricted locations and detectability even at these scales is rare =>Consequence of capture incidental behaviour on blue shark population size was scored minor, i.e. possible detectable change in growth rate (r) but minimal impact on population size and none on dynamics =>Confidence in this assessment was low given a lack of verified data on blue shark capture rates.
Direct impact without capture	Bait collection	0									
	Fishing	1	4	5	Population size	blue shark	1.1	2	2	1	Fishing activity occurs at a spatial scale of 100-500nm. Temporal scale of fishery is daily but only for ~6 months per year. Fishing considered to pose greatest risk to population size of by-catch species, blue shark in particular =>Intensity was scored minor, i.e. non-capture impact on blue shark occurs in few restricted locations =>Consequence of fishing on blue shark population size was scored minor, possible detectable change in growth rate (r) but minimal impact on population size and none on dynamics =>Confidence in this assessment was low given a lack of verified data on blue shark capture rates.

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
	Incidental behaviour	1	4	5	Population size	blue shark	1.1	2	2	1	Fishing activity, hence opportunity for incidental behaviour, occurs at a spatial scale of 100-500nm. Temporal scale of incidental behaviour considered weekly, i.e. during crew downtime for ~6 months per year. Incidental behaviour considered to pose greatest risk to population size of by-catch species, blue shark in particular =>Intensity was scored minor, i.e. capture of blue shark occurs rarely or in few restricted locations and detectability even at these scales is rare =>Consequence of non-capture incidental behaviour on blue shark population size was scored minor, i.e. possible detectable change in growth rate (r) but minimal impact on population size and none on dynamics =>Confidence in this assessment was low given a lack of verified data on blue shark capture rates.
	Gear loss	1	4	5	Population size	barracouta	1.1	2	1	2	Fishing activity, hence opportunity for gear loss, occurs at a spatial scale of 100-500nm. Temporal scale for gear loss considered daily, i.e. loss of jig lines, during ~6 month annual fishing season. Gear loss considered to pose greatest risk to population size of by-catch species, barracouta in particular =>Intensity was scored minor, i.e. death of barracouta resulting from lost jigging gear was considered to occur rarely =>Consequence of lost gear on barracouta populations was considered negligible, i.e. any occasional deaths resulting from gear loss not considered to change population growth rate =>Confidence in this assessment was high given logical constraints. Gear loss minimal, to minimise gear loss crew change gear regularly, marriage lines attached to minimise loss if line breaks, and allows lines to be wound in (observer records 2005).
	Anchoring/ mooring	1	4	5	Behaviour/movement	blue shark	6.1	1	1	2	Fishing activity, hence anchoring/ mooring occurs at a spatial scale of 100-500nm. Temporal scale for anchoring considered to be daily during ~6 month annual fishing season. Anchoring/ mooring considered to pose greatest risk to Behaviour/ movement patterns of by-catch species, blue shark in particular =>Intensity was scored negligible, i.e. change in movement patterns of blue shark resulting from anchoring/ mooring considered remote =>Consequence of anchoring/ mooring on blue shark behaviour and movement was therefore also considered negligible =>Confidence in this assessment was high given logical constraints. Boats may use parachute anchors to hold position.

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
	Navigation/ steaming	1	4	5	Behaviour/movement	blue shark	6.1	1	1	2	Navigation/ steaming activity occurs at a spatial scale of 100-500nm, i.e. over the breadth of the fishing grounds. Temporal scale for Navigation/ steaming is daily during ~6 month fishing season. Navigation/ steaming considered to pose greatest risk to Behaviour/ movement patterns of by-catch species, blue shark in particular =>Intensity was scored negligible, i.e. change in movement patterns of blue shark resulting from Navigation/ steaming considered remote =>Consequence of Navigation/ steaming on blue shark behaviour and movement was therefore also considered negligible =>Confidence in this assessment was high given logical constraints.
Addition/ movement of biological material	Translocation of species	0									
	On board processing	0									
	Discarding catch	1	4	5	Behaviour/ movement	blue shark	6.1	1	1	2	Discarding catch activity occurs at a spatial scale of 100-500nm, i.e. over the breadth of the fishing grounds. Temporal scale of Discarding catch was considered to be daily during ~6 month fishing season. Discarding catch considered to pose greatest risk to Behaviour/ movement patterns of by-catch species, blue shark in particular =>Intensity was scored negligible, i.e. change in movement patterns of blue shark resulting from Discarding catch considered remote, given low levels of discards =>Consequence of Discarding catch on blue shark behaviour and movement was therefore also considered negligible =>Confidence in this assessment was high given that discards are few in the SSJF.
	Stock enhancement	0									
	Provisioning	0									
	Organic waste disposal	1	4	5	Behaviour/ movement	blue shark	6.1	1	1	2	Organic waste disposal activity occurs at a spatial scale of 100-500nm, i.e. over the breadth of the fishing grounds. Temporal scale of Organic waste disposal was considered to be daily during ~6 month fishing season. Organic waste disposal considered to pose greatest risk to Behaviour/ movement patterns of by-catch species, blue shark in particular, e.g. by attracting them toward vessels disposing of organic waste =>Intensity was scored negligible, i.e. change in movement patterns of blue shark resulting from Organic waste disposal was

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
											considered remote, given low levels of disposal and diffuse nature =>Consequence of Organic waste disposal on blue shark behaviour and movement was therefore also considered negligible, i.e. time taken to recover to pre-disturbed state on the scale of hours =>Confidence in this assessment was high given that Organic disposal, as a result of general fishing operations, was considered low.
Addition of non-biological material	Debris	1	4	5	Behaviour/ movement	blue shark	6.1	1	1	1	Fishing activity, hence Debris generation, possible over a spatial scale of 100-500nm. Temporal scale of fishery is daily but only for ~6 months per year, Debris considered to be generated less frequently, i.e. weekly. Debris considered to impact Behaviour/ movement of by-catch species in particular blue shark by attraction toward small debris in the water column =>Intensity was considered negligible as significant Debris considered rare, plus fishers have a code of conduct which aims to eliminate Debris =>Consequence was scored negligible at any spatial or temporal scale, time taken to recover to pre-disturbed state on the scale of hours =>Confidence of assessment was considered low given a lack of information of rates and types of Debris generated by the Southern Squid Jig Fishery.
	Chemical pollution	0									
	Exhaust	1	4	5	Behaviour/movement	blue shark	6.1	1	1	2	Fishing activity, hence Exhaust emissions occur over a spatial scale of 100-500nm. Temporal scale of Exhaust emissions is daily during ~6 month fishing season. Exhaust considered to impact Behaviour/ movement of by-catch species in particular blue shark by repulsion from exhaust source =>Intensity was considered negligible as significant Exhaust considered rare =>Consequence was scored negligible, i.e. no detectable change in behaviour/ movement, any change unlikely to be detectable against background variability for this population, time taken to recover to pre-disturbed state on the scale of hours =>Confidence of assessment was considered high given logical constraints.
	Gear loss	1	4	5	Population size	barracouta	1.1	2	1	2	Fishing activity, hence opportunity for gear loss, occurs at a spatial scale of 100-500nm. Temporal scale for gear loss considered daily, i.e. loss of jig lines, during ~6 month annual fishing season. Gear loss considered to pose greatest risk to population size of by-catch species, barracouta in particular =>Intensity was scored minor, i.e. death of barracouta resulting from lost jigging gear was considered to occur rarely

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
											=>Consequence of lost gear on barracouta populations was considered negligible, i.e. any occasional deaths resulting from gear loss not considered to change population growth rate =>Confidence in this assessment was high given logical constraints. Gear loss minimal, to minimise gear loss crew change gear regularly, marriage lines attached to minimise loss if line breaks, and allows lines to be wound in (observer records 2005).
	Navigation/ steaming	1	4	5	Behaviour/movement	blue shark	6.1	1	1	2	Navigation/ steaming activity occurs at a spatial scale of 100-500nm, i.e. over the breadth of the fishing grounds. Temporal scale for Navigation/ steaming is daily during ~6 month fishing season. Navigation/ steaming considered to pose greatest risk to Behaviour/ movement patterns of by-catch species, blue shark in particular =>Intensity was scored negligible, i.e. change in movement patterns of blue shark resulting from Navigation/ steaming considered remote =>Consequence of Navigation/ steaming on blue shark behaviour and movement was therefore also considered negligible =>Confidence in this assessment was high given logical constraints.
	Activity/ presence on water	1	4	5	Behaviour/movement	blue shark	6.1	3	2	1	Fishing activity, hence Activity/ presence of vessels on the water occurs at a spatial scale of 100-500nm, i.e. over the breadth of the fishing grounds. Temporal scale for Activity/ presence is daily during ~6 month fishing season. Activity/ presence considered to pose greatest risk to Behaviour/ movement patterns of by-catch species, blue shark in particular, e.g. vessel presence (bright lights) creates visual stimuli which may attract blue shark =>Intensity was considered moderate, i.e. Moderate intensity at broader spatial scale, or severe but local changes in Behaviour/ movement of sharks =>Consequence was scored minor, i.e. 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 =>Confidence of assessment was low given a lack of data on blue shark interactions with vessel lights.
Disturb physical processes	Bait collection	0									
	Fishing	1	4	5	Behaviour/ movement	blue shark	6.1	3	2	1	Fishing activity occurs at a spatial scale of 100-500nm. Temporal scale of Activity/ presence on water occurs daily but only for ~6 months per year. Activity/ presence on water considered to impact 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 (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
											movement of blue shark as a result of attracting them toward squid vessels using powerful fishing lights at night (i.e. visual stimuli) =>Intensity was considered moderate, i.e. Moderate intensity at broader spatial scale, or severe but local changes in Behaviour/ movement of sharks =>Consequence was scored minor, i.e. 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 =>Confidence of assessment was low given a lack of data on blue shark interactions with vessel lights.
	Boat launching	0									
	Anchoring/ mooring	1	4	5	Behaviour/ movement	blue shark	6.1	1	1	2	Fishing activity, hence anchoring/ mooring occurs at a spatial scale of 100-500nm. Temporal scale for anchoring considered to be daily during ~6 month annual fishing season. Anchoring/ mooring considered to pose greatest risk to Behaviour/ movement patterns of by-catch species, blue shark in particular =>Intensity was scored negligible, i.e. change in movement patterns of blue shark resulting from physical disturbance by anchoring/ mooring considered remote =>Consequence of anchoring/ mooring on blue shark behaviour and movement was therefore also considered negligible =>Confidence in this assessment was high given logical constraints. Boats may use parachute anchors to hold position.
	Navigation/steaming	1	4	5	Behaviour/ movement	blue shark	6.1	1	1	2	Navigation/ steaming activity occurs at a spatial scale of 100-500nm, i.e. over the breadth of the fishing grounds. Temporal scale for Navigation/ steaming is daily during ~6 month fishing season. Physical disturbance to the water column as a result of Navigation/ steaming considered to pose greatest risk to Behaviour/ movement patterns of by-catch species, blue shark in particular =>Intensity was scored negligible, i.e. change in movement patterns of blue shark resulting from Navigation/ steaming considered remote =>Consequence of Navigation/ steaming on blue shark behaviour and movement was therefore also considered negligible, i.e. time to recover from any disturbance on the scale of hours =>Confidence in this assessment was high given 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 (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	Southern ocean arrow squid	1.1	1	2	1	Other fishery activity occurs on spatial scale >1000nm; temporal scale is daily. Other fisheries are considered to have greatest impact on Population size of Southern ocean arrow squid =>Intensity considered negligible, i.e. remote likelihood of capture =>Consequence scored as minor, take of squid by other fisheries considered to result in possible detectable change in growth rate (r) but minimal impact on population size and none on dynamics =>Confidence of assessment is considered low given a lack of stock assessment or catch rates of Southern ocean arrow squid by other fisheries.
	Aquaculture	0									
	Coastal development	0									
	Other extractive activities	1	6	6	Behaviour/ Movement	barracouta	6.1	2	2	2	Other extractive activities occur on spatial scale >1000nm; temporal scale is daily. Extractive activities considered to have greatest impact on Behaviour and movement of bycatch/ byproduct species, barracouta in particular, causing barracouta to move outside local extractive activity, else be attracted toward if activity involves the use of night time lights=>Intensity considered minor, i.e. minor extraction currently occurring =>Consequence scored as minor, possible detectable change in behaviour/ movement but minimal impact on population dynamics =>Confidence of assessment is considered high given that levels of extractive activities are closely monitored and unlikely to lead to significant changes in barracouta behaviour at current levels.
	Other non-extractive activities	1	6	6	Behaviour/ Movement	barracouta	6.1	3	2	1	Shipping activities occur on spatial scale >1000nm; temporal scale is daily. Non-extractive activities considered to have greatest impact on Behaviour and movement of barracouta causing the fish to move outside shipping lanes else will be attracted toward if ships due to night time navigations lights. =>Intensity considered moderate, i.e. moderate level of shipping activity occurs on squid fishing grounds =>Consequence scored as minor, possible detectable change in behaviour/ movement but minimal impact on population dynamics =>Confidence of assessment is considered low because of a lack of information/ observation of barracouta-ship interactions.
	Other anthropogenic activities	1	4	6	Population size	blue shark	1.1	2	2	2	Recreational fishing occurs across spatial scale >1000nm; temporal scale is daily; impact most likely on Population size of by-catch 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 (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
											in particular blue shark =>Intensity considered minor, i.e. occurs rarely or in few restricted locations and detectability even at these scales was considered rare =>Consequence considered minor, i.e. minimal impact on blue shark stocks =>Confidence of assessment is considered high due to logical considerations.

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 (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
Capture	Bait collection	0									
	Fishing	1	4	5	Population size	White shark	1.1	1	1	2	Fishing activity, hence possibility of incidental behaviour considered at a spatial scale of 100-500nm. Temporal scale of fishery is daily but only for ~6 months per year, however incidental behaviour considered to occur less frequently, i.e. weekly. Fishing activity leading to capture most likely to impact Population size of TEP species, white shark in particular =>Intensity considered negligible as incidental catch of white shark considered rare at any spatial scale =>Consequence was scored negligible for white shark Population size, i.e. almost none are killed =>Confidence high as observer data indicates no/ few white shark interactions.
	Incidental behaviour	1	4	5	Population size	White shark	1.1	1	1	2	Fishing activity, hence possibility of incidental behaviour considered at a spatial scale of 100-500nm. Temporal scale of fishery is daily but only for ~6 months per year, however incidental behaviour considered to occur less frequently, i.e. weekly. Incidental behaviour leading to capture most likely to impact population size of TEP species, white shark in particular =>Intensity considered negligible as incidental catch of white shark considered rare at any spatial scale =>Consequence was scored negligible for white shark Population size, i.e. almost none are killed =>Confidence high as observer data indicates no/ few white shark interactions.
Direct impact without capture	Bait collection	0									
	Fishing	1	4	5	Interactions with fishery	Australian Fur Seal	1.1	2	2	2	Fishing activity occurs at a spatial scale of 100-500nm. Temporal scale of fishery is daily but only for ~6 months per year. Fishing impact, non-capture, considered to pose greatest risk to Interactions of Australian fur seals with the SSJF =>Intensity was scored minor, i.e. occurs commonly in some locations =>Consequence of fishing on Australian fur seal was scored minor, i.e. Moderate level of interaction with fishery =>Confidence in this assessment was high given that a qualitative risk assessment using existing anecdotal and AFMA logbook information identified that there are interactions with seals during jigging

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
											operations, removing squid from lures, but were not entangled or caught on the gear.
	Incidental behaviour	1	4	5	Population size	Australian Fur Seal	1.1	1	1	2	Fishing activity occurs at a spatial scale of 100-500nm. Temporal scale of fishery is daily but only for ~6 months per year. Incidental behaviour leading to non-capture impact, was considered to pose greatest risk to population size of Australian fur seals =>Intensity was scored negligible, i.e. occurs rarely or in few restricted locations and detectability even at these scales is rare =>Consequence of Incidental behaviour on Australian fur seal population size was scored negligible, i.e. fishing considered to have insignificant change on population growth rate =>Confidence in this assessment was high given observer data indicating that seal interactions are very rare.
	Gear loss	1	4	5	Population size	Australian Fur Seal	1.1	2	2	1	Fishing activity, hence opportunity for gear loss, occurs at a spatial scale of 100-500nm. Temporal scale for gear loss considered weekly, i.e. loss of jig lines, during ~6 month annual fishing season. Gear loss considered to pose greatest risk to population size of TEP species, Australian fur seals in particular =>Intensity was scored minor, i.e. occurs rarely or in few restricted locations =>Consequence of lost gear on Australian fur seals was considered minor, there is potential for seals to become entangled or harmed by lost jigs and jig lines =>Confidence in this assessment was low given a lack of data on the outcome of lost gear-seal interactions. Gear loss minimal, to minimise gear loss crew change gear regularly, marriage lines attached to minimise loss if line breaks, and allows lines to be wound in (observer records 2005).
	Anchoring/ mooring	1	4	5	Behaviour/ movement	Australian fur seal	6.1	1	1	2	Fishing activity, hence anchoring/ mooring possible at a spatial scale of 100-500nm. Temporal scale of anchoring/ mooring considered to occur daily but only for ~6 months per year. Anchoring/ mooring considered to impact Behaviour/ movement of TEP species, Australian fur seals in particular =>Intensity of seal anchor line interactions considered remote, i.e. negligible =>Consequence considered negligible, no detectable change in behaviour/ movement, if momentary change

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
											occurs time taken to return to original behaviour/ movement on the scale of hours =>Confidence of assessment was high given logical constraints. Boats may use parachute anchors to hold position.
	Navigation/ steaming	1	4	5	Population size	Short tailed shearwater	1.1	1	2	1	Fishing activity, hence navigation/ steaming occurs at a spatial scale of 100-500nm. Temporal scale of Navigation/ steaming occurs daily but only for ~6 months per year. Navigation/ steaming considered most likely to impact Population size of short tailed shearwaters, e.g. shearwaters may collide with vessels under nighttime lights =>Intensity considered negligible, i.e. shearwater vessel interactions occur rarely =>Consequence was scored minor, i.e. some birds may die as a result of collisions but change in population size as a result is very unlikely to be detected =>Confidence of assessment was low given a lack of information on shearwater – vessel interactions, specific to the squid fishery.
Addition/ movement of biological material	Translocation of species	0									
	On board processing	0									
	Discarding catch	1	4	5	Behaviour/ movement	Australian fur seal	6.1	1	2	2	Discarding catch activity occurs over spatial scale of 100-500nm. Temporal scale of Discarding catch considered to occur daily over the 6 month fishing season. Impact most likely on Behaviour/ movement of TEP species, Australian fur seals in particular, i.e. seals may scavenge discarded squid =>Intensity of discarding considered negligible, occurs rarely at any scale =>Consequence considered minor as time to return to original behaviour/ movement on the scale of hours, plus discarding considered once off events in space and time =>Confidence of assessment is considered high given observations that discarding catch occurs rarely.
	Stock enhancement	0									

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
	Provisioning	0									
	Organic waste disposal	1	4	5	Behaviour/ movement	albatross	6.1	2	2	2	Organic waste disposal activity occurs over spatial scale of 100-500nm. Temporal scale of Organic waste disposal considered to be daily but only for ~6 months per year. Impact most likely on Behaviour/ movement of albatross, i.e. likely to encourage scavenging =>Intensity of organic waste disposal activity considered minor, i.e. occurs rarely in few restricted locations in space and time =>Consequence of disposal on albatross Behaviour/ movement considered minor as time to return to original behaviour/ movement on the scale of hours =>Confidence of assessment is considered high given logical considerations.
Addition of non-biological material	Debris	1	4	5	Population size	Seabirds	1.1	1	1	1	Fishing activity, hence Debris generation, possible over a spatial scale of 100-500nm. Temporal scale of fishery is daily but only for ~6 months per year, Debris considered to be generated less frequently, i.e. weekly. Debris considered to impact Population size of seabird species by causing entanglement =>Intensity was considered negligible as significant Debris considered rare, plus fishers have a code of conduct which aims to eliminate Debris =>Consequence was scored negligible at any spatial or temporal scale =>Confidence of assessment was considered low given a lack of information of rates and types of Debris generated by the Southern Squid Jig Fishery.
	Chemical pollution	0									
	Exhaust	1	4	5	Behaviour/ movement	Little penguin	6.1	1	1	2	Exhaust emissions occur over a spatial scale of 100-500nm. Temporal scale of Exhaust emissions is daily during ~6 month fishing season. Impact most likely on Behaviour/ movement of Little penguins, i.e. penguins may be repelled from local areas with high exhaust load =>Intensity considered negligible as activity considered to affect a very small area for short time given rapid dispersal of fumes =>Consequence was scored negligible for any spatial or temporal scale, i.e. 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 =>Confidence of assessment was high given logical constraints.
	Gear loss	1	4	5	Population size	Australian Fur	1.1	2	2	1	Fishing activity, hence opportunity for gear loss, occurs at a spatial

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
						Seal					scale of 100-500nm. Temporal scale for gear loss considered weekly, i.e. loss of jig lines, during ~6 month annual fishing season. Gear loss considered to pose greatest risk to population size of TEP species, Australian fur seals in particular =>Intensity was scored minor, i.e. occurs rarely or in few restricted locations =>Consequence of lost gear on Australian fur seals was considered minor, there is potential for seals to become entangled or harmed by lost jigs and jig lines =>Confidence in this assessment was low given a lack of data on the outcome of lost gear-seal interactions. Gear loss minimal, to minimise gear loss crew change gear regularly, marriage lines attached to minimise loss if line breaks, and allows lines to be wound in (observer records 2005).
	Navigation/ steaming	1	4	5	Behaviour/ movement	seabirds	6.1	3	2	1	Fishing activity, hence navigation/ steaming occurs at a spatial scale of 100-500nm. Temporal scale of Navigation/ steaming occurs daily but only for ~6 months per year. Navigation/ steaming considered to impact Behaviour/ movement of seabird species, e.g. birds will follow vessels in view of scavenging =>Intensity was scored moderate, i.e. moderate impacts at larger scales or severe local impacts =>Consequence was scored minor, i.e. time for seabirds to return to original behaviour/ movement considered to occur on the scale of hours =>Confidence of assessment was low given a lack of information on seabird - squid vessel interactions.
	Activity/ presence on water	1	4	5	Behaviour/ movement	seabirds	6.1	3	2	1	Fishing activity, hence Activity/ presence of fishing vessels occurs at a spatial scale of 100-500nm. Temporal scale of Activity/ presence on water occurs daily but only for ~6 months per year. Activity/ presence on water considered to impact Behaviour/ movement of seabirds as a result of confusion/ collisions with squid vessels using powerful night lights (i.e. visual stimuli) =>Intensity was considered moderate, i.e. Minor intensity at broader spatial scale, or severe but local changes in Behaviour/ movement of seabirds =>Consequence was scored minor, i.e. 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 =>Confidence of assessment was low given a lack of data on seabird interactions with vessel lights.

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
Disturb physical processes	Bait collection	0									
	Fishing	1	4	5	Behaviour/movement	seabirds	6.1	3	2	1	Fishing activity occurs at a spatial scale of 100-500nm. Temporal scale of fishing is daily but only for ~6 months per year. Disturbance of physical processes caused by fishing i.e. extreme light levels as a result of powerful fishing lights considered most likely to impact Behaviour/ movement of seabirds by leading to attraction of birds toward fishing activity resulting in confusion/ disorientation =>Intensity was considered moderate as changes in Behaviour/ movement was considered to be severe at the local scale and moderate at broader scales =>Consequence was scored minor i.e. no detectable change in behaviour/ movement at the population level, time to return to original behaviour/ movement on the scale of hours =>Confidence of assessment was low given a lack of observer information of seabird interactions with powerful squid fishing lights.
	Boat launching	0									
	Anchoring/ mooring	1	4	5	Behaviour/movement	Australian Fur Seal	6.1	1	1	2	Fishing activity, hence anchoring/ mooring occurs at a spatial scale of 100-500nm. Temporal scale for anchoring considered to be daily during ~6 month annual fishing season. Anchoring/ mooring considered to pose greatest risk to Behaviour/ movement patterns of TEP species, Australian fur seals in particular =>Intensity was scored negligible, i.e. change in movement patterns of Australian fur seals resulting from physical disturbance by anchoring/ mooring considered remote =>Consequence of anchoring/ mooring on Behaviour/ movement of Australian fur seals was therefore also considered Negligible =>Confidence in this assessment was high given logical constraints. Boats may use parachute anchors to hold position.
	Navigation/steaming	1	4	5	Behaviour/movement	Little penguin	6.1	1	1	2	Navigation/ steaming activity occurs at a spatial scale of 100-500nm, i.e. over the breadth of the fishing grounds. Temporal scale for Navigation/ steaming is daily during ~6 month fishing season. Physical disturbance to the water column as a result of Navigation/ steaming considered to pose greatest risk to Behaviour/ movement patterns of TEP species, Little penguins in particular =>Intensity was scored negligible, i.e. change in movement patterns of seabirds resulting from

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
											Navigation/ steaming considered remote =>Consequence of Navigation/ steaming on Behaviour/ movement of seabirds was therefore also considered negligible, i.e. time to recover from any disturbance on the scale of hours =>Confidence in this assessment was high given logical constraints.
External Impacts (specify the particular example within each activity area)	Other fisheries	1	6	6	Population size	Albatross – yellow nosed and wandering	1.1	3	3	2	Other fishery activity occurs on spatial scale >1000nm; temporal scale is daily. Other fisheries are considered to have greatest impact on Population size of albatross species =>Intensity considered moderate, i.e. moderate impact at larger spatial scale but severe at local scales =>Consequence scored as moderate, State of reduction on the rate of increase are at the maximum acceptable level =>Confidence of assessment is high given observer data.
	Aquaculture	0									
	Coastal development	0									
	Other extractive activities	1	6	6	Behaviour/ Movement	Seabirds	6.1	2	2	1	Other extractive activities occur on spatial scale >1000nm; temporal scale is daily. Extractive activities considered to have greatest impact on Behaviour and movement of seabirds by creating artificial perch/ roosting structures =>Intensity considered minor, i.e. minor extraction currently occurring =>Consequence scored as minor, possible detectable change in behaviour/ movement but minimal impact on population dynamics =>Confidence of assessment is considered low given a lack of information on how artificial roosting sites affects population parameters.
	Other non-extractive activities	1	6	6	Behaviour/ Movement	Seabirds	6.1	3	2	1	Shipping activities occur on spatial scale >1000nm; temporal scale is daily. Shipping activities considered to have greatest impact on Behaviour and movement of seabirds by causing seabirds to follow vessels in search of scavengable ship waste =>Intensity considered moderate, i.e. moderate level of shipping activity occurs on squid fishing grounds =>Consequence scored as minor, possible detectable change in behaviour/ movement but minimal impact on population dynamics =>Confidence of assessment is considered low because of a lack of behavioural data describing seabird-ship 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 (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
	Other anthropogenic activities	1	4	6	Behaviour/movement	White shark	6.1	2	2	1	Recreational fishing occurs across spatial scale >1000nm, temporal scale is daily; impact most likely on Population size of TEP species, white sharks in particular e.g. entanglement in gill netting =>Intensity considered minor, i.e. occurs rarely or in few restricted locations and detectability even at these scales was considered rare =>Consequence considered minor, i.e. minimal impact on white shark stocks =>Confidence of assessment is considered low due to a lack of data on white shark captures as a result of recreational pursuits.

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 (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
Capture	Bait collection	0									
	Fishing	1	4	5	Habitat structure and function	Southern (Coastal) Pelagic Province	5.1	2	1	2	Fishing activity occurs at a spatial scale of 100-500nm, in depths of 60-120m. Fishing occurs daily, at night, but intensity of operations varies spatially (i.e. Waters outside Port Phillip Bay fished Feb-early March; Western Vic Jan-June). Gear is pelagic in nature, and does not intentionally contact the bottom. Squid Jigging considered to pose greatest risk to Southern (coastal) pelagic habitat structure and function. Mechanical action of jigging considered to mix water column, and disrupt column structure during duration of shot, which is not considered destructive for fluid habitat. =>Intensity minor. =>Consequence negligible. Mixed layer depth likely to be minimally affected by this gear type, with rapid return to pre-disturbed structure. =>Confidence high given relatively benign pelagic gear.
	Incidental behaviour	1	4	5	Habitat structure and function	Southern (Coastal) Pelagic Province	5.1	2	2	1	Opportunity for incidental behaviour occurs over the scale of effort (100-500nm), probably on a weekly basis during crew downtime for ~6 months per year. Recreational fishing activities by crew considered to pose risk to pelagic habitat structure and function, with removal of pelagic species, incidental mixing of water column and additional turbulence from associated boat movements in the process of capture. Considered unlikely that crew would be using bottom contact methods (i.e. pots) in Commonwealth water depths. =>Intensity and consequence minor because pelagic habitat structure e.g. mixed layer depth, considered to quickly return to pre-disturbed structure, and be undetectable. =>Confidence low, inadequate information on incidental behavior.
Direct impact without capture	Bait collection	0									

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
	Fishing	1	4	5	Water quality	Southern (Coastal) Pelagic Province	1.1	2	1	2	Direct impact without capture possible over whole spatial scale of fishing activity, in depths of 60-120m, and considered to have same effects as capture. Mechanical action of jigging considered to mix water column, and to disrupt column structure during duration of shot, which is not considered destructive for fluid habitat. =>Intensity minor, likely to be undetectable. =>Consequence negligible. Mixed layer depth likely to be minimally affected by this gear type, with rapid return to pre-disturbed structure. =>Confidence high given logical constraints, of benign pelagic gear.
	Incidental behaviour	1	4	5	Habitat structure and function	Southern (Coastal) Pelagic Province	5.1	1	1	1	Opportunity for incident associated with recreational fishing, occurs over the scale of effort (100-500nm), probably on a weekly basis, i.e. during crew downtime for ~6 months per year. Recreational fishing activities by crew considered to pose risk to pelagic habitat structure and function, with removal of pelagic species, incidental mixing of water column and additional turbulence from associated boat movements in the process of capture. Direct impact without capture considered to have same effects as capture. =>Intensity and consequence negligible because pelagic habitat structure e.g. mixed layer depth, considered to quickly return to pre-disturbed structure. =>Confidence low, inadequate information on incidental behavior.
	Gear loss	1	4	5	Habitat structure and function	Southern (Coastal) Pelagic Province	5.1	2	2	1	Opportunity for gear loss occurs over the spatial scale of the fishery. Gear loss considered to occur on a daily basis during the annual fishing season. Losses include loss of jig lines and jigs into the water column. =>Intensity minor. Amount of gear lost unspecified, but if considered to occur on a daily basis whilst fishing, could be expected to appear in both pelagic and coastal inshore/ shoreline habitat and on the benthos if sinks. Some (e.g. Jigs) likely to be ingested placing species at risk. =>Consequence minor, however amount of gear loss needs to be determined. Boats should prescribe to MARPOL regulations, and may need to address this. =>Confidence low, rates and volume of loss requires substantiation.

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
	Anchoring/ mooring	1	4	5	Habitat structure and function	Benthic: Inner and Outer shelf habitats	5.1	1	1	1	Anchoring/ mooring occur daily during the season in inshore waters throughout the range of the fishery. Considered to pose greatest risk to both the substratum quality (i.e. disturbance of sediments) and attached community during anchoring/ retrieval. =>Intensity and consequence negligible, area of disturbance likely to be small in a highly productive zone. High relief terrain (also supporting fragile fauna) is avoided by fishers to avoid snagging anchors. =>Confidence low because of a lack of verified data on anchoring/mooring activities and locations.
	Navigation/ steaming	1	4	5	Water quality	Southern (Coastal) Pelagic Province	1.1	1	1	2	Navigation/ steaming may occur daily during the fishing season. Considered to pose minimal risk to water quality in the Southern (coastal) Pelagic habitat. Turbulent mixing of the water column with vessels moving through the water. =>Intensity and consequence negligible due to the remote likelihood of detection at any spatial scale, and interactions that may be occurring are not detectable against natural variation. =>Confidence high given logical constraints.
Addition/ movement of biological material	Translocation of species	0									
	On board processing	0									
	Discarding catch	1	4	5	Water quality	Southern (Coastal) Pelagic Province	1.1	1	1	2	Discarding catch activity deemed to be low however not validated for this fishery. Assuming this activity was to occur throughout the range of operations, soft tissue discards are likely to be rapidly consumed by opportunistic scavengers, and unlikely to reach the benthos. =>Intensity and consequence negligible -any alteration in water quality or habitat function would be undetectable in minutes to hours. =>Confidence high given that bycatch is minimal and discarding is very low in the SSJF.
	Stock enhancement	0									
	Provisioning	0									
	Organic waste disposal	1	4	5	Water quality	Southern (Coastal) Pelagic Province	1.1	1	2	2	Organic waste such as food scraps and sewerage are deposited on a daily basis over the entire scale of the fishing effort. Boats subject to MARPOL. Water quality of pelagic habitats is considered to experience greatest impact of organic waste disposal, because volumes considered

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
											too small to reach the bottom. =>Intensity negligible, remote likelihood of detection in the short term as organic waste is rapidly taken up by pelagic scavengers. =>Consequence minor, addition of high nutrient material is expected to produce short term peaks in habitat disturbance/ productivity, with minimal detectibility within minutes to hours. =>Confidence high, logical constraints.
Addition of non-biological material	Debris	1	4	5	Water quality,	Southern (Coastal) Pelagic Province	1.1	2	2	1	Debris generation, possible over a spatial scale of 100-500nm, on a daily basis during the fishing season. Greatest activity in the Southern coastal pelagic habitat, therefore considered most likely to accumulate floating plastics, and inadvertent losses from fishing operations. All boats subject to MARPOL therefore losses should be unintentional. Debris considered to reduce water quality, and alter habitat structure with the addition of ingestible materials putting susceptible species at risk e.g. Seabirds, cetaceans, seals. =>Intensity and Consequence minor if adherence to MARPOL regulations means volumes small. =>Confidence low, volume of debris generated and species susceptibility within this fishery are unknown.
	Chemical pollution	0									
	Exhaust	1	4	5	Air quality	Southern (Coastal) Pelagic Province	2.1	1	1	2	Exhaust emissions from running engines may impact the air quality of the species within the Southern coastal Pelagic Province (e.g. Birds). =>Intensity and Consequence negligible. Exhaust likely to be rapidly dispersed by winds, and undetectable within short time frames. =>Confidence high, effects localized.
	Gear loss	1	4	5	Habitat types	Southern (Coastal) Pelagic Province	4.1	2	2	1	Addition of non-biological materials is occurring over the entire range of the fishery. Gear loss considered to occur on a daily basis during the annual fishing season. Losses include loss of jig lines and jigs into the water column. =>Intensity minor. Amount of gear lost unspecified, but if considered to occur on a daily basis whilst fishing, could be expected to appear in both pelagic and coastal inshore/ shoreline habitat and on the benthos if sinks. Some (e.g. Jigs) likely to be ingested placing species at risk. =>Consequence minor, however amount of gear loss needs to be determined. Boats should prescribe to MARPOL

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
											regulations, and may need to address this. =>Confidence low, rates and volume of loss requires substantiation.
	Navigation/ steaming	1	4	5	Water quality	Southern (Coastal) Pelagic Province	1.1	1	1	2	Navigation/ steaming may occur daily during the fishing season. Operation of the vessel will add noise and visual stimuli to surrounds which may be wider than the immediate area of the vessel. Considered to pose minimal risk to the pelagic air and water quality, and habitat function of this province, as is likely to be undetectable over these scales due to rapid dispersal of noise and visual 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 high given logical constraints.
	Activity/ presence on water	1	4	5	Water quality	Southern (Coastal) Pelagic Province	1.1	1	1	2	Operation of the vessel will add noise and visual stimuli (e.g. light) to surrounds which may have an impact wider than the immediate area of the vessel. Activity/presence on water occurs over a large spatial scale, and over 24 hours during fishing season. =>Intensity and Consequence negligible, remote likelihood of impact at any spatial or temporal scale. =>Confidence high because it was considered highly unlikely that vessel presence/activity would lead to habitat changes in its own right (logical constraints).
Disturb physical processes	Bait collection	0									
	Fishing	1	4	5	Habitat structure and function,	Southern (Coastal) Pelagic Province	5.1	2	2	1	This pelagic fishery is concentrated along on the continental shelf off the coast of Victoria, in waters 60-120m deep. Jig gear is not expected to interact with the benthos and if it does is considered inadvertent and inconsequential. Pelagic habitat processes are considered to be minimally impacted by squid gear specifically, any effect is predictably unmeasured. The most significant habitat impact is likely to be through the use of lights utilised in fishing operations for attracting target species. The degree of structural modification to pelagic habitat with the introduction of light attracted species is unknown, as are any associated changes to the habitat function which may persist for as long as fishing operations occur. =>Intensity and consequence minor because fishing

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
											considered to only impact physical processes over a small area in total, and minor with current level of effort. Disturbance of water column unlikely to be detectable for pelagic communities. =>Confidence low, requires validation of the effects of light use on pelagos as habitat.
	Boat launching	0									
	Anchoring/ mooring	1	4	5	Substrate quality	Coarse sediments, current rippled, mixed faunal community, inner shelf.	3.1	1	1	2	Anchoring/ mooring occur daily during the season in inshore waters throughout the range of the fishery. Considered to disturb substratum processes briefly over the period of anchoring/ retrieval. This effect would be highly localized and considered negligible. =>Intensity and consequence negligible, area of disturbance likely to be small in a highly productive zone. High relief terrain (also supporting fragile fauna) is avoided by fishers to avoid snagging anchors. =>Confidence high due to logic, although there is of a lack of verified data on anchoring/mooring activities and locations, and cumulative effects may be persistent in inshore locations frequently preferred by fishers.
	Navigation/steaming	1	4	5	Habitat structure	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.
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	2	2	1	Other Commonwealth fisheries operating within the SSJF boundary are the SET fisheries (Danish Seine and Otter Trawl methods), BSS, and the GHAT (Gillnet and hook methods primarily). SSJF is a pelagic fishery in contrast to these methods which target demersal/ benthic species, hence impact mainly benthic habitats of the SER. Overall spatial scale of overlap with other fisheries is approximately 1000nm. Temporal scale is daily. Spatial overlap exists with other fisheries, whose operational areas extend into the SSJF, although there is no overlap in

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
											effort currently (ETBF, SBT, SKJ, SPF). =>Intensity and consequence considered minor. =>confidence low - no data available to validate impact on habitat
	Aquaculture	0									
	Coastal development	0									
	Other extractive activities	1	6	6	Substrate quality	Coarse sediments, current rippled, mixed faunal community, inner shelf.	3.1	2	3	2	Production activity in the south east region occurs solely from the Gippsland Basin. Exploration activity is widespread throughout the Gippsland, Otway, Sorrel and Bass Basins. There is a substantial submarine petroleum pipeline network of 500 km conveying petroleum products from offshore production facilities within Bass Strait to the Longford gas plant in Sale (Victoria) for processing. Squid vessels in the SSJF are unlikely to come into contact with underwater cables and pipelines, due to the shallow nature of their jigging operations. Extractive activities considered to have greatest impact on the Habitat structure sub-component by creating artificial structures. =>Intensity considered minor in terms of pelagic habitat impacts. =>Consequence moderate, i.e. detectable change in habitat structure for benthos, less for pelagos. In the short term in shallower shelf waters, some disturbance of substratum and demersal water quality will occur. =>Confidence high given that artificial offshore structures are known to create new pelagic habitat.
	Other non-extractive activities	1	6	6	Habitat structure and function,	Coarse sediments, current rippled, mixed faunal community, inner shelf.	5.1	3	3	1	There is a substantial submarine petroleum pipeline network of 500 km conveying petroleum products from offshore production facilities within Bass Strait to the Longford gas plant in Sale (Victoria) for processing. Squid vessels in the SSJF are unlikely to come into contact with underwater cables and pipelines, due to the shallow nature of their jigging operations. Shipping activities occur on spatial scale >1000nm, temporal scale is daily. Shipping activities considered to have greatest impact on Water quality, e.g. exhaust emissions. =>Intensity and consequence moderate, i.e. severe but local impact on water quality, substrate quality and Benthic habitat structure or minor impact at broader scales. Detectable changes will exist in water quality, at small spatial scales time to recover on scale of days, at larger spatial scales

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
											recovery time on scale of hours to days. Pipeline activities are considered to have greatest impact on benthic habitat structure and function within the inner shelf zone, a temperate region considered to be reasonably productive at these depths, however recovery from disturbance may still require months to years for some components of the faunal community (slow growing species and habitat structural architecture. =>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, and age, growth and recolonisation rates of benthic habitats in these waters requires further investigation.
	Other anthropogenic activities	1	4	6	Habitat structure and function, Substrate quality, Habitat types	Coarse sediments, current rippled, mixed faunal community, inner shelf.	3.1, 4.1, 5.1	2	2	2	SSJF operators out of Lakes Entrance are most likely to interact with tourism operators, as it is the largest tourist port in the fishery. Boating and recreational fishing are popular inshore and may venture into Bass Strait but given the potentially hazardous nature of this stretch of water for small craft, interactions are probably minimal. =>intensity and consequence minor. =>confidence high - tourism activities documented

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 (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
Capture	Bait collection	0									
	Fishing	1	4	5	Functional group composition	Southern coastal	2.1	3	2	1	Fishing activity occurs at a spatial scale of 100-500nm. Temporal scale of fishery is daily but only for ~6 months per year. Fishing considered to pose greatest risk to Functional group composition as squid is an important predator and prey species =>Intensity considered moderate, i.e. moderate fishing impact at broader scales/ severe local effects. =>Consequence of squid fishing on functional group composition considered minor, i.e. Minor changes in relative abundance of community constituents up to 5%. =>Confidence considered low given a lack of formal arrow squid stock assessment.
	Incidental behaviour	1	4	5	Functional group composition	Southern coastal	2.1	1	1	2	Fishing activity, hence opportunity for incidental behaviour, occurs at a spatial scale of 100-500nm. Temporal scale of incidental behaviour considered weekly, i.e. during crew downtime for ~6 months per year. Incidental behaviour considered to pose greatest risk to Functional group composition as squid is an important predator and prey species =>Intensity considered negligible as incidental catch of squid considered rare at any spatial scale =>Consequence was also considered negligible. i.e. interactions which may affect the internal dynamics of communities leading to change in functional group composition but not detectable against natural variation =>Confidence of assessment is considered high because fishers aim to maximise commercial catch of target species and are therefore unlikely to engage in incidental behavioural activities leading to catch or damage of target species stocks.
Direct impact without	Bait collection	0									

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
capture	Fishing	1	4	5	Distribution of the community	Southern coastal	3.1	3	1	2	Fishing activity occurs at a spatial scale of 100-500nm. Temporal scale of fishery is daily but only for ~6 months per year. Fishing considered to pose greatest risk to the distribution of the southern coastal pelagic community due to powerful night lights that attract and repel species =>Intensity considered moderate, i.e. fishing lights considered to have moderate impacts at broader scales/ severe local effects =>Consequence of squid fishing lights on Community distribution was considered negligible, i.e. any impacts were thought to abate on the scale of hours to days =>Confidence considered high given strong directional responses of species to powerful night time lights which then quickly disappears when lights are turned off.
	Incidental behaviour	1	4	5	Functional group composition	Southern coastal	3.1	1	1	1	Fishing activity, hence opportunity for incidental behaviour, occurs at a spatial scale of 100-500nm. Temporal scale of incidental behaviour considered weekly, i.e. during crew downtime for ~6 months per year. Incidental behaviour considered to pose greatest risk to Functional group composition for example if Incidental behaviour involved the use of powerful fishing lights =>Intensity considered Negligible, if the use of powerful lights occurs (other than for primary reason of fishing) it was considered infrequent =>Consequence on Functional group composition was also considered Negligible, i.e. any impacts were thought to abate on the scale of hours to days => Confidence considered low given a lack of information on the incidental use of powerful lights.
	Gear loss	1	4	5	Functional group composition	Southern coastal	2.1	1	1	2	Fishing activity, hence opportunity for gear loss, occurs at a spatial scale of 100-500nm. Temporal scale for gear loss, i.e. jigs, considered to occur daily during ~6 month annual fishing season. Gear loss considered to pose greatest risk to Functional group composition in the southern coastal pelagic community, i.e. lost jigs were considered to snare/entangle visually acute predators, e.g. squid and barracouta =>Intensity was considered negligible because entanglement and significant gear loss thought to occur very rarely =>Consequence was also considered negligible =>Confidence was high given 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 (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
	Anchoring/ mooring	1	4	5	Distribution of the community	Southern inner shelf	3.1	1	1	2	Fishing activity, hence anchoring/ mooring occurs at a spatial scale of 100-500nm. Temporal scale for anchoring considered to be daily during ~6 month annual fishing season. Anchoring/ mooring considered to pose greatest risk to Distribution of the southern inner shelf community because anchoring could disturb benthic community species. =>Intensity considered negligible, i.e. activity and impacts considered rare =>Consequence also considered negligible because any impacts unlikely to be detected against the natural variability for the community =>Confidence in this assessment was high given logical constraints.
	Navigation/ steaming	1	4	5	Distribution of the community	Southern coastal	3.1	1	1	2	Navigation/ steaming activity occurs at a spatial scale of 100-500nm, i.e. over the breadth of the fishing grounds. Temporal scale for Navigation/ steaming is daily during ~6 month fishing season. Navigation/ steaming considered to pose greatest risk to Distribution of the southern coastal pelagic community, i.e. Navigation/ steaming considered to disturb species of the pelagic community =>Intensity negligible because any impacts considered extremely rare =>Consequence considered negligible, i.e. any interactions affecting the distribution of the pelagic community is very unlikely to be detected against natural variation =>Confidence was high given logical constraints.
Addition/ movement of biological material	Translocation of species	0									
	On board processing	0									
	Discarding catch	1	4	5	Species composition	Southern coastal	1.1	1	1	2	Discarding catch activity occurs at a spatial scale of 100-500nm, i.e. over the breadth of the fishing grounds. Temporal scale of Discarding catch was considered to be daily during ~6 month fishing season. Discarding catch considered to pose greatest risk to Species composition of southern coastal pelagic community because pelagic scavenger species expected to increase in abundance relative to other species =>Intensity considered negligible, i.e. remote likelihood of detection of impacts relating to the activity at any spatial/ temporal scale =>Consequence considered negligible , i.e. no detectable change

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
											above and beyond natural variation =>Confidence in this assessment was high given that discards are few in the SSJF.
	Stock enhancement	0									
	Provisioning	0									
	Organic waste disposal	1	4	5	Species composition	Southern coastal	1.1	1	1	2	Organic waste disposal activity occurs at a spatial scale of 100-500nm, i.e. over the breadth of the fishing grounds. Temporal scale of Organic waste disposal was considered to be daily during ~6 month fishing season. Organic waste disposal considered to pose greatest risk to Species composition of the southern coastal pelagic community because pelagic scavenger species expected to increase in abundance relative to other species =>Intensity considered negligible, i.e. remote likelihood of detection of impacts relating to the activity at any spatial/ temporal scale =>Consequence considered negligible , i.e. no detectable change above and beyond natural variation =>Confidence in this assessment was high given that discards are few in the SSJF.
Addition of non-biological material	Debris	1	4	5	Distribution of the community	Southern coastal	3.1	1	1	1	Fishing activity, hence Debris generation, possible over a spatial scale of 100-500nm. Temporal scale of fishery is daily but only for ~6 months per year, Debris considered to be generated less frequently, i.e. weekly. Debris considered to impact the Distribution of the southern coastal pelagic community, debris thought to attract/ aggregate some pelagic species =>Intensity was considered negligible as significant Debris considered rare, plus fishers have a code of conduct which aims to eliminate Debris =>Consequence was scored negligible at any spatial or temporal scale, time taken to recover to pre-disturbed state on the scale of hours =>Confidence of assessment was considered low given a lack of information of rates and types of Debris generated by the Southern Squid Jig Fishery.
	Chemical pollution	0									
	Exhaust	1	4	5	Distribution of the community	Southern coastal	3.1	1	1	2	Fishing activity, hence Exhaust emissions occur over a spatial scale of 100-500nm. Temporal scale of Exhaust emissions is daily during ~6 month fishing season. Exhaust considered to impact Distribution of the southern coastal pelagic community. =>Intensity was considered

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
											negligible as Exhaust considered very local. =>Consequence was scored negligible, i.e. no detectable change in community distribution, any change unlikely to be detectable against background variability for this community time taken to recover to pre-disturbed state on the scale of hours. =>Confidence of assessment was considered high given logical constraints.
	Gear loss	1	4	5	Distribution of the community	Southern coastal	3.1	1	1	2	Fishing activity, hence gear loss, occurs at a spatial scale of 100-500nm. Temporal scale of fishery is daily but only for ~6 months per year, however gear loss considered to occur less frequently, i.e. weekly. Gear loss considered to impact the Distribution of the southern coastal pelagic community, gear loss thought to attract/ aggregate some pelagic species. =>Intensity was considered negligible as significant gear loss considered rare. =>Consequence was scored negligible at any spatial or temporal scale, time taken to recover to pre-disturbed state on the scale of hours. =>Confidence of assessment was considered high given that fishers claim low levels of gear loss in the SSJF.
	Navigation/ steaming	1	4	5	Distribution of the community	Southern coastal	3.1	1	1	2	Navigation/ steaming activity occurs at a spatial scale of 100-500nm, i.e. over the breadth of the fishing grounds. Temporal scale for Navigation/ steaming is daily during ~6 month fishing season. Navigation/ steaming considered to pose greatest risk to Distribution of the southern coastal pelagic community, i.e. Navigation/ steaming considered to disturb species of the pelagic community =>Intensity negligible because any impacts considered extremely rare =>Consequence considered negligible, i.e. any interactions affecting the distribution of the pelagic community is very unlikely to be detected against natural variation =>Confidence was high given logical constraints.
	Activity/ presence on water	1	4	5	Distribution of the community	Southern coastal	3.1	3	2	2	Fishing activity, hence Activity/ presence of fishing vessels occurs at a spatial scale of 100-500nm. Temporal scale of Activity/ presence on water occurs daily but only for ~6 months per year. Activity/ presence considered to impact the Distribution of the southern coastal pelagic community by attraction of pelagic species toward the powerful lights

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
											used by squid fishing vessels =>Intensity was considered moderate, i.e. Moderate intensity at broader spatial scale, or severe but local changes in the distribution of the pelagic community =>Consequence was scored as minor, i.e. possible detectable change in distribution of the pelagic community but minimal impact on community dynamics, time to return to pre-disturbed distribution on the scale of days to weeks =>Confidence of assessment was high given that pelagic species are known to be strongly attracted toward squid vessel lights.
Disturb physical processes	Bait collection	0									
	Fishing	1	4	5	Distribution of the community	Southern coastal	3.1	3	2	2	Fishing activity occurs at a spatial scale of 100-500nm. Temporal scale of fishery is daily but only for ~6 months per year. Physical disturbance, by virtue of powerful lights caused by squid fishing was considered to pose greatest risk to Distribution of the southern coastal pelagic community =>Intensity was considered moderate, i.e. Moderate intensity at broader spatial scale, or severe but local changes in the distribution of the pelagic community =>Consequence was scored as minor, i.e. possible detectable change in distribution of the pelagic community but minimal impact on community dynamics, time to return to pre-disturbed distribution on the scale of days to weeks =>Confidence of assessment was high given that pelagic species are known to be strongly attracted toward squid vessel lights.
	Boat launching	0									
	Anchoring/ mooring	1	4	5	Distribution of community	Southern inner shelf	3.1	1	1	2	Fishing activity, hence anchoring/ mooring occurs at a spatial scale of 100-500nm. Temporal scale for anchoring considered to be daily during ~6 month annual fishing season. Anchoring/ mooring considered to pose greatest risk to Distribution of community =>Intensity considered negligible, i.e. activity and impacts considered rare =>Consequence also considered negligible because any impacts unlikely to be detected against the natural variability for the community =>Confidence in this assessment was high given 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 (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
	Navigation/steaming	1	4	5	Distribution of the community	Southern coastal	3.1	1	1	2	Navigation/ steaming activity occurs at a spatial scale of 100-500nm, i.e. over the breadth of the fishing grounds. Temporal scale for Navigation/ steaming is daily during ~6 month fishing season. Navigation/ steaming considered to pose greatest risk to Distribution of southern coastal pelagic community, i.e. Navigation/ steaming considered to disturb species of the pelagic community =>Intensity negligible because any impacts considered extremely rare =>Consequence considered negligible, i.e. any interactions affecting the distribution of the pelagic community is very unlikely to be detected against natural variation =>Confidence was high given logical constraints.
External Impacts (specify the particular example within each activity area)	Other fisheries	1	6	6	Functional group composition	Southern coastal	2.1	3	3	1	Other fishery activity occurs on spatial scale > 1000nm, temporal scale is daily. Other fisheries are considered to have greatest impact on Functional group composition of predators in southern coastal pelagic community =>Intensity considered moderate, severe local or moderate intensity of fishing over larger spatial scales =>Consequence scored as moderate, take of pelagic predators by other fisheries considered to result in changes to the relative abundance of community constituents, up to 10% chance of flipping to an alternate state/ trophic cascade =>Confidence of assessment was considered low given a lack of data however circumstantial evidence suggests that the majority of predator stocks display population declines and community level affects must be anticipated.
	Aquaculture	0									
	Coastal development	0									
	Other extractive activities	1	6	6	Distribution of the community	Southern coastal	3.1	2	2	2	Other extractive activities occur on spatial scale > 1000nm, temporal scale is daily. Extractive activities considered to have greatest impact on the Distribution of the community sub-component by creating artificial structures =>Intensity considered minor, i.e. minor extraction currently occurring, hence few structures currently deployed =>Consequence scored as minor, i.e. detectable change in community structure =>Confidence of assessment is high given that artificial

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
											offshore structures are known to create new pelagic habitat and thus allow establishment of new communities.
	Other non-extractive activities	1	6	6	Distribution of the community	Southern coastal	3.1	3	2	2	Shipping activities occur on spatial scale > 1000nm, temporal scale is daily. Shipping activities considered to have greatest impact on the distribution of the southern coastal pelagic community, e.g. noise, visual and exhaust pollution considered to repel members of the pelagic community away from the localized disturbance =>Intensity scored moderate, i.e. severe but local impact on community distribution or minor impact at broader scales =>Consequence scored as minor, detectable change in community distribution, at small spatial scales time to recover on scale of days, at larger spatial scales recovery time on scale of hours to days =>Confidence of assessment is high because shipping disturbance considered to have logical dispersal impacts (although short lived and at small spatial scales) for at least some members of the pelagic community.
	Other anthropogenic activities	1	4	6	Distribution of the community	Southern coastal	3.1	1	1	1	Fishing activity occurs at a spatial scale of 100-500nm, impact most likely on Distribution of the southern coastal pelagic community as a result of disturbance by tourism (whale watching) charter boats. =>Intensity considered negligible =>Consequence also considered negligible, i.e. any impacts not detectable against natural variation =>Confidence of assessment is considered low since difficult to score until better information available.

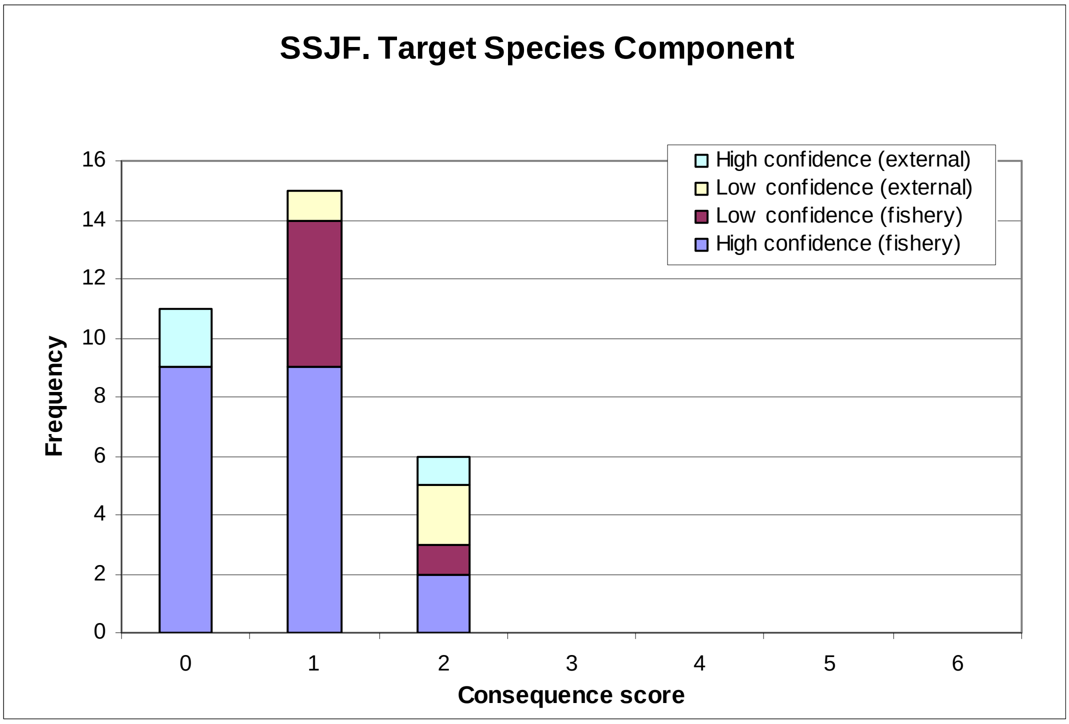
2.3.11 Summary of SICA results

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).

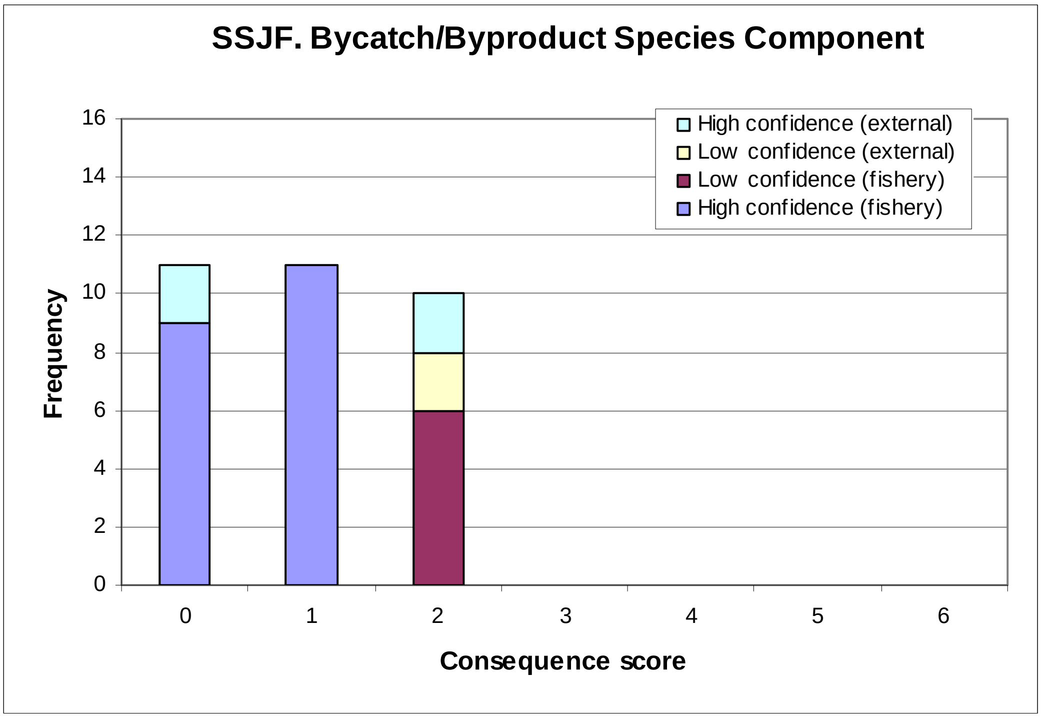
Level 1 (SICA) Document L1.6. Summary table of consequence scores for all activity/component combinations.

Direct impact	Activity	Target species	Byproduct and bycatch species	TEP species	Habitats	Communities
Capture	Bait collection					
	Fishing	2	2	**1**	**1**	2
	Incidental behaviour	**1**	2	**1**	2	**1**
Direct impact without capture	Bait collection					
	Fishing	**1**	2	**2**	**1**	**1**
	Incidental behaviour	**1**	2	**1**	1	1
	Gear loss	1	**1**	2	2	**1**
	Anchoring/ mooring	**1**	**1**	**1**	1	**1**
	Navigation/ steaming	**1**	**1**	2	**1**	**1**
Addition/ movement of biological material	Translocation of species					
	On board processing					
	Discarding catch	**1**	**1**	**2**	**1**	**1**
	Stock enhancement					
	Provisioning					
	Organic waste disposal	**1**	**1**	**2**	**2**	**1**
Addition of non-biological material	Debris	1	1	1	2	1
	Chemical pollution					
	Exhaust	**1**	**1**	**1**	**1**	**1**
	Gear loss	1	**1**	2	2	1
	Navigation/ steaming	1	**1**	2	**1**	**1**
	Activity/ presence on water	**2**	2	2	**1**	**2**
Disturb physical processes	Bait collection					
	Fishing	**2**	2	2	2	**2**
	Boat launching					
	Anchoring/ mooring	**1**	**1**	**1**	**1**	**1**
	Navigation/steaming	1	**1**	**1**	**1**	**1**
Note: external hazards are not considered at Level 2 in the PSA analysis						
External hazards	Other fisheries	2	2	**3**	2	3
	Aquaculture					
	Coastal development					
	Other extractive activities	**2**	**2**	2	**3**	**2**
	Other non extractive activities	2	2	2	3	**2**
	Other anthropogenic activities	1	**2**	2	**2**	1

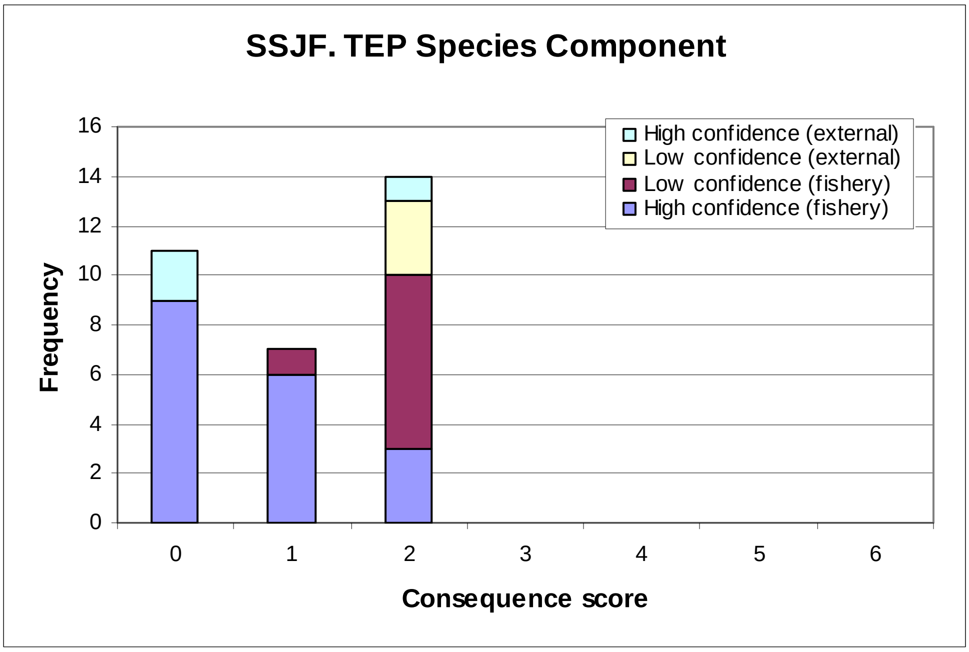
Target species: Frequency of consequence score differentiated between high and low confidence.



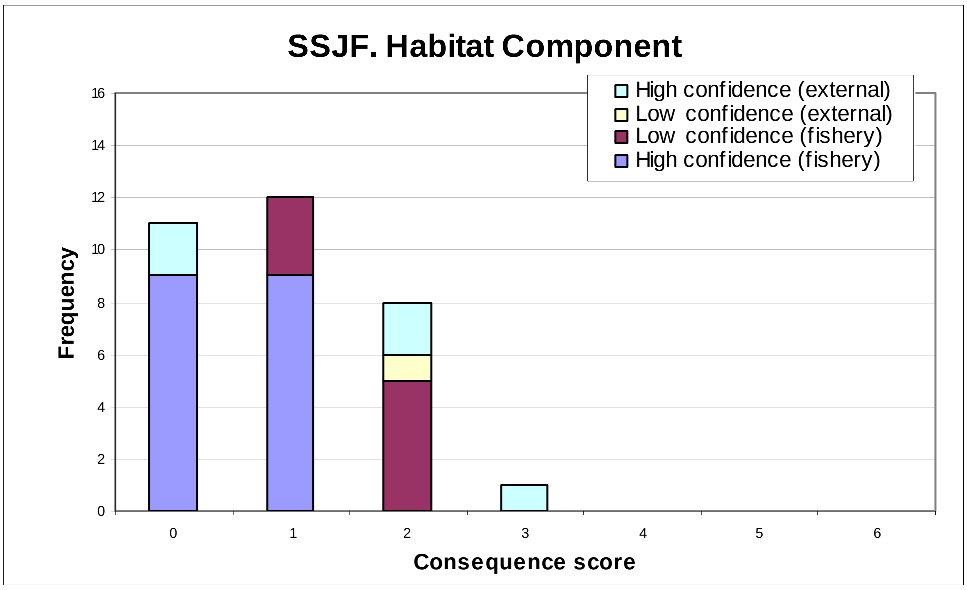
Byproduct and bycatch species. Frequency of consequence score differentiated between high and low confidence.



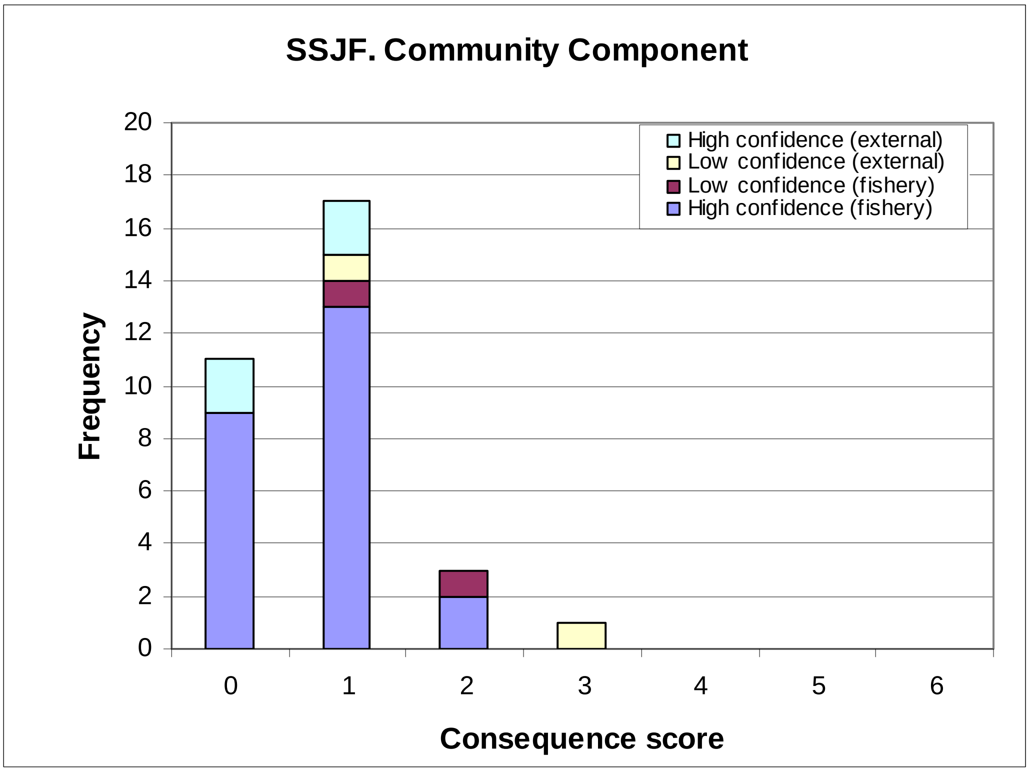
TEP species: Frequency of consequence score differentiated between high and low confidence (SICA excel workbook)



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

No internal fishing activities components assessed in the Level 1 analysis of the Southern Squid Jig Sub-fishery contained consequence scores of three or above. All internal hazards were assessed as minor or negligible risk.

The Southern Squid Jig Sub-fishery is a very selective fishery, with a single target species, *Nototodarus gouldi*. The fishing method, artificial jigging using baitless barbless hooks, is not attractive to other species and as such byproduct and, therefore, discarding is minimal. Although no reliable quantitative stock assessment has been carried out for the target species, the highly selective nature of this fishery, coupled with its low impact on habitat components, has resulted in predominantly high-confidence low-risk assessment scores.

TEP interactions were given close attention, with input from SquidFAG requested and Observer data collected to more confidently assess the particular hazard of seal interactions with the fishery. Data reports have shown this to be a low risk hazard, with no entanglement or capture noted, and the risk confidently noted as minor.

External hazards that were assessed with a risk score 3 (moderate) include:

- other fisheries in the region (TEP and Communities component);
- other extractive activities (Habitat component); and
- other non-extractive activities (Habitat component).

2.3.13 Components to be examined at Level 2

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

Due to the low risk scores associated with the fishing activities of the Southern Squid Jig Sub-fishery, analysis was not required at Level 2.

As such, further general documentation in this report is included only as a means of understanding the ERAEF process in full.

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 generally 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 to direct impacts of fishing only, which in all assessments to date has been the hazard with the greatest risks identified at Level 1. Future iterations of the methodology will include PSAs modified to measure the risk due to other activities, such as gear loss.

The PSA approach is based on the assumption that the risk to an ecological component will depend on two characteristics of the component units: (1) the extent of the impact due to the fishing activity, which will be determined by the susceptibility of the unit to the fishing activities (Susceptibility) and (2) the productivity of the unit (Productivity), which will determine the rate at which the unit can recover after potential depletion or damage by the fishing. It is important to note that the PSA analysis essentially measures potential for risk, hereafter denoted 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).

<u>Species</u>

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 sub-fishery 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			
	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**.

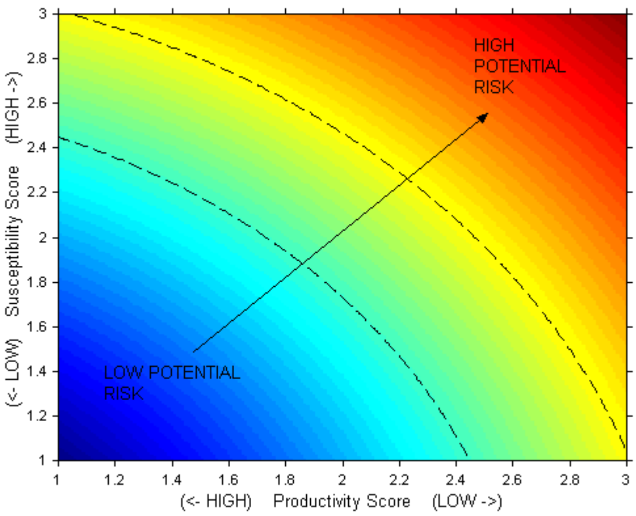


Figure 13. The axes on which risk of the ecological units is plotted. The *x*-axis includes attributes that influence the productivity of a unit, or its ability to recover after impact from fishing. The *y*-axis includes attributes that influence the susceptibility of the unit to impacts from fishing.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

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

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

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

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

ERA species ID	Taxa	Scientific name	CAAB code	Family name	Common name	Explanation for why taxa excluded

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

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 coverage is not required as a permit condition. Previous observer coverage has been for specific scientific studies only.

Summary of Species PSA results

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)].

ERA species ID	Taxa name	Scientific name	Common name	Role in fishery	Average logbook catch (kg) (2001-04)	Missing > 3 attributes (Y/N)	Missing productivity attributes (out of 7)	Missing susceptibility attributes (out of 4)	Productivity (additive) (1-low, 3-high)	Susceptibility (mult) (1- low, 3-high)	2D risk value (P&S) (low-high range=1.41-4.24)	Susceptibility override used?	2D P&S risk category	Comments

Summary of Habitat PSA results

A summary of the habitats considered at Level 2 is presented below, and is sorted by the overall risk score (high, medium, low); by sub-biome, and by SGF score (Habitat type).

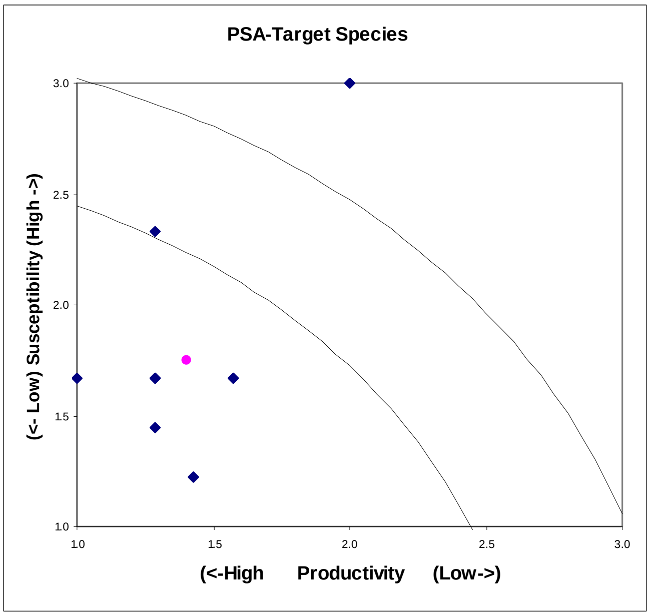
Record #	ERA habitat #	Sub-biome	Feature	Habitat Name	SGF Score	n missing attributes	Productivity score (Average)	Susceptibility score (Multiplicative)	Overall risk Value (P&Sm)	Overall risk Ranking (2D multiplicative)	Risk ranking override	Rationale

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 of the ecological unit. Units with a PSA score in the middle are at medium risk, while units in the lower third are at low risk of the ecological unit 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 of the ecological unit), 1/3rd will be between 3.18 and 2.64 (medium risk), and 1/3rd will be lower than 2.64 (low risk of the ecological unit).

Results of the PSA plot from PSA workbook ranking worksheet would follow the format of the example below:

PSA plot for target species



PSA plot for byproduct species
PSA plot for discards/bycatch species
PSA plot for TEP species
PSA plot for habitats
PSA plot for communities

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

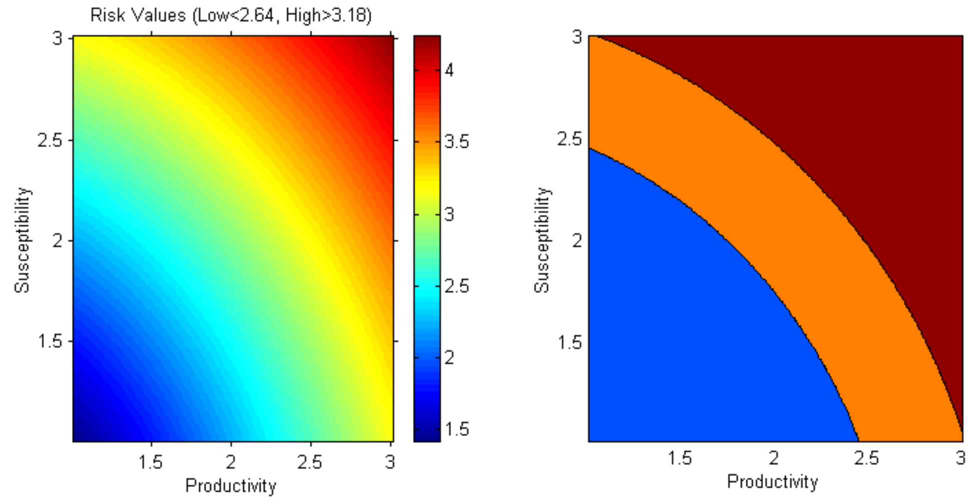


Figure 17. Overall risk values in the PSA plot. Left panel. Colour map of the distribution of the euclidean overall risk values. Right panel. The PSA plot contoured to show the low risk of the ecological unit (blue), medium risk (orange) and high risk of the ecological unit (red) values.

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 of the ecological unit to fishing activities. This prioritization means units with the lowest inherent productivity or highest susceptibility, which can only sustain the lowest level of impact, can be examined in detail. The overall risk to an individual unit will depend on the level of impact as well its productivity and susceptibility.

2.4.5 Uncertainty analysis ranking of overall risk (Step 5)

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

A second measure of uncertainty is due to the selection of the attributes. The influence of particular attributes on the final result for a unit of analysis (e.g. a habitat unit) can be quantified with an uncertainty analysis, using a Monte Carlo resampling technique. A set of productivity and susceptibility scores for each unit is calculated by removing one of the productivity or susceptibility attributes at a time, until all attribute combinations have been used. The variation (standard deviation) in the productivity and susceptibility scores is a measure of the uncertainty in the overall PSA score. If the uncertainty analysis shows that the unit would be treated differently with regard to risk, it should be the subject of more study.

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

Availability of information

The ability to score each species based on information on each attribute [varied/did not vary] between the attributes (as per summary below). With regard to the productivity attributes, [least known productivity attribute] was missing in [X]% of [units], and so the most conservative score was used, while information on [best known productivity attribute] could be found or calculated for [Y% of units]. 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.

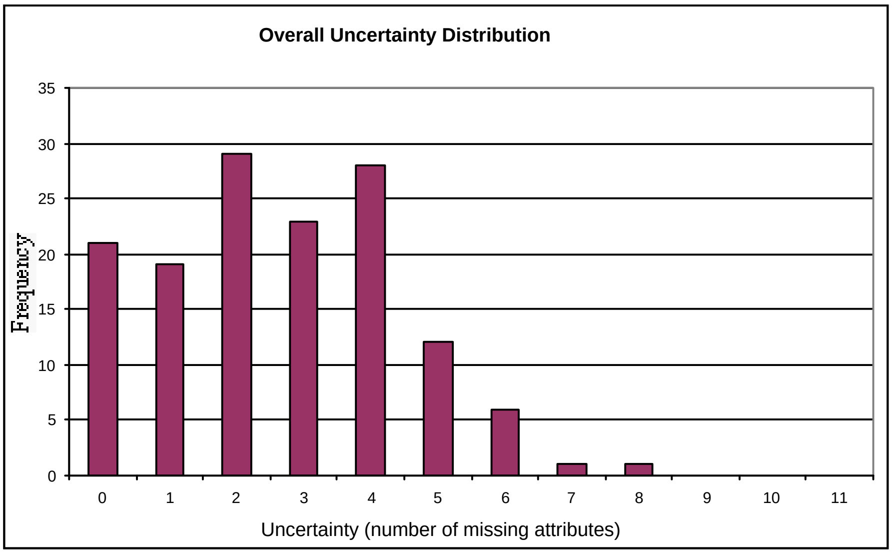
Results from PSA workbook ranking worksheet (species only).

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							
n species scores with attribute unknown, (conservative score used)							
% unknown information							
Susceptibility Attributes	Availability	Encounter ability		Selectivity	PCM		
		Bathymetry overlap	Habitat				
Total species scores for attribute							
n species scores with attribute unknown, (conservative score used)							
% unknown information							

Each species considered in the analysis had information for an average of [A, (B%)] productivity attributes and [C (D%)] susceptibility attributes. This meant that, on average, conservative scores were used for less than [E%] of the attributes for a single species. [Units] had missing information for between [F and G] of the combined [H] productivity and susceptibility attributes.

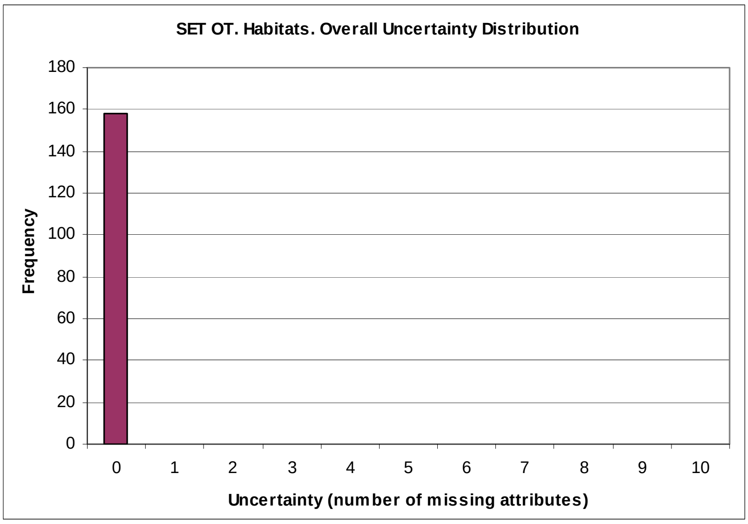
Results: Overall uncertainty distribution in PSA workbook ranking graphs worksheet

Species uncertainty distribution histogram would follow the format of the example below:



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

Habitats: Twenty-one attributes are used in the habitat PSA. All attributes are scored according to Habitat attribute tables 9-27. Only attributes that could be ranked are utilized and therefore there are no missing attributes. [example below]



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

Correlation between attributes

Species component:

The attributes selected for productivity were often strongly correlated (as per correlation matrix below for productivity). The strongest productivity attribute correlation was between fecundity and reproductive strategy. This is why the attributes for productivity are averaged, as they are all in turn correlated with the intrinsic rate of increase (see

ERAEF: Methodology document for more details). In contrast the susceptibility attributes were less correlated, which is to be expected as they measure independent aspects of this dimension, and are multiplied to obtain the overall susceptibility score. The strongest susceptibility correlation was between encounterability and selectivity, while the rest 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		X					
Fecundity			X				
Max size				X			
Min size at maturity					X		
Reproductive strategy						X	
Trophic level							X

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

	Availability	Encounterability	Selectivity	Post-capture mortality
Availability	X			
Encounterability		X		
Selectivity			X	
Post-capture mortality				X

Habitat Component:

The attributes selected for productivity and susceptibility [were/not] strongly correlated (as per correlation matrix below for productivity and susceptibility). There was [X] correlation between the productivity attributes Regeneration of Fauna and Natural disturbance (r = [x]). The susceptibility correlation could not be calculated between the Availability and any other aspect, because there was no variation in the Availability score. There [was/X] correlation between the attributes used to calculate Encounterability and Selectivity. All attributes were suitable for inclusion in the PSA.

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

Productivity Correlation Matrix	Regeneration of fauna	Natural disturbance
Regeneration of fauna	X	
Natural disturbance	X	X

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

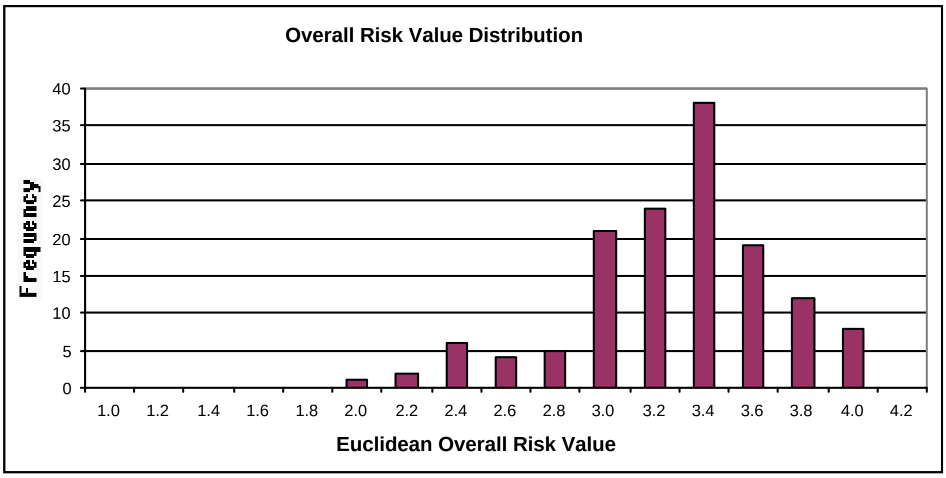
Susceptibility Correlation Matrix	Availability score	Encounterability score (average)	Selectivity score (average)
Availability score	X		
Encounterability score (average)	X	X	
Selectivity score (average)	X	X	X

Productivity and susceptibility values for Species
The average productivity score for all [units] was [X ± Y] (mean ± SD of scores calculated using n-1 attributes) and the mean susceptibility score was [X ± Y] (as per summary of average productivity and susceptibility scores as below). Individual scores are shown in Section 2.4.2 and 2.4.3: Summary of PSA results. The [small/large] variation in the average of the boot-strapped values (using n-1 attributes), indicates the productivity and susceptibility scores [are/are not] robust to elimination of a single attribute. Information for a single attribute [does not/does] has a disproportionately large effect on the productivity and susceptibility scores. Information was missing for an average of [Z] attributes out of [Y] possible for each [unit].

Productivity and susceptibility values for habitat units.
The average productivity score for all habitats was [X ± Y] (mean ± SD of scores calculated using n-1 attributes) and the mean susceptibility score was [X ± Y] (as per summary of average productivity and susceptibility scores as below). Individual scores are shown in Section 2.4.2 and 2.4.3: Summary of PSA results. The small/large variation in the average of the boot-strapped values (using n-1 attributes), indicates the productivity and susceptibility scores are robust to elimination of a single attribute. Information for a single attribute [does not/does] has a disproportionately large effect on the productivity and susceptibility scores. Information was missing for an average of [Z] attributes out of [Y] possible for each [unit].

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 [X], with a range of [Y – Z]**.**
The actual values for each species are shown in Section 2.4.2 and 2.4.3: Summary of PSA results. A total of [A units, (B%)] were classed as high risk of the ecological unit, [B (C%)] were in the medium risk category, and [D (E%)] as low risk of the ecological unit**.**

Results: Frequency distribution of the overall PSA risk values.
Evaluation example only

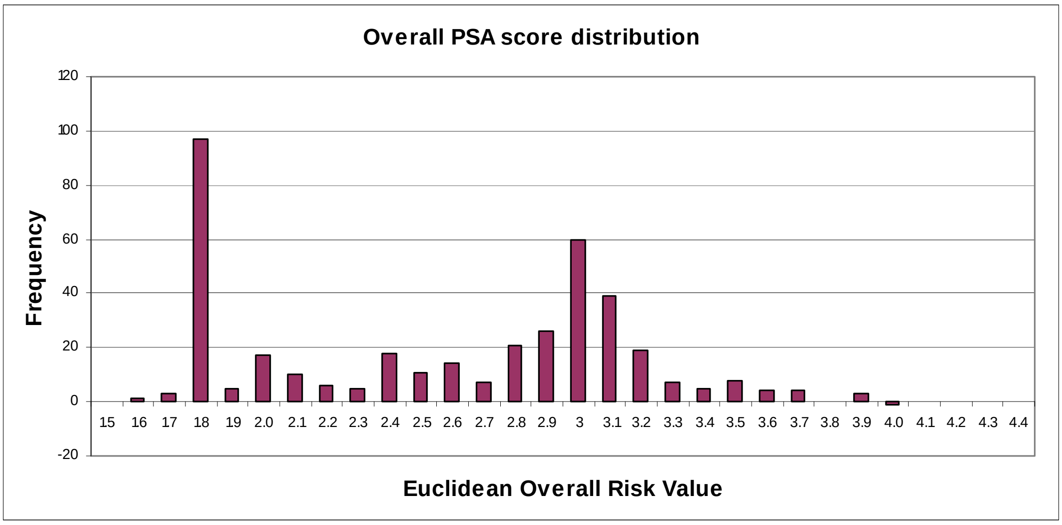


Frequency distribution of the overall risk values generated for the [X units] in the [fishery sub-fishery] PSA.

Overall Risk Values for Habitats

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 XX, with a range of XX- XX**.**

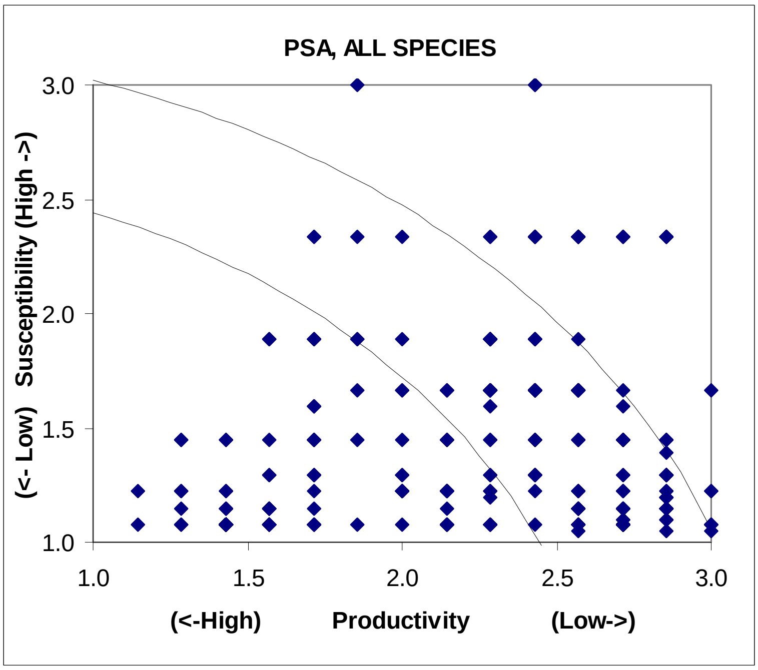
The actual values for each species are shown in Section 2.4.2 and 2.4.3: Summary of PSA results. A total of XX units, (X%) were classed as high risk of the ecological unit, XX units, (XX%) were in the medium risk category, and XX (XX%) as low risk of the ecological unit**.**



Frequency distribution of the overall risk values generated for the [X] habitat types in the [fishery 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 [all/lower left/upper right] parts of the plot, indicating that [both high and low risk of the ecological unit units] are potentially impacted in the [fishery sub-fishery].

Results Plot for all species in the sub-fishery PSA risk values.
Evaluation example only



PSA plot for all [units] in the [fishery sub-fishery]. Species in the upper right of the plot are at highest risk of the ecological unit.

The number of attributes with missing information is of particular interest, because the conservative scoring means these units may be scored at higher risk of the ecological unit 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.

2.4.6 Evaluation of the PSA results (Step 6)

Due to the low risk scores associated with the Southern Squid Jig Sub-fishery, analysis did not extend to Level 2. Information regarding PSA analysis is included to provide a full understanding of the ERAEF process. No PSA assessment was required for this sub-fishery.

Species components:
<u>Overall</u>

<u>Results</u>

<u>Discussion</u>

Habitat components:
Overall

Results:

Summary of the average productivity, susceptibility and overall risk scores.

Component	Measure	
All habitats	Number of habitats	X
	Average of productivity total	X
	Average of susceptibility total	X
	Average of overall risk value (2D)	X
	Average number of missing attributes	0

PSA (productivity and susceptibility) risk categories for the habitat component**.**

Risk Category	High	Medium	Low	Total
Total Habitats	X	X	X	X

PSA (productivity and susceptibility) risk categories for sub-biome (depth zone) fished (before override adjustment).

2D Risk Score	Inner-shelf	Outer-shelf	Upper-slope	Mid-slope	Total habitats
High	X	X	X	X	X
Medium	X	X	X	X	X
Low	X	X	X	X	X
Total	X	X	X	X	X

PSA (productivity and susceptibility) risk categories for sub-biome fished after Risk Ranking adjustment (stakeholder/expert override).

2D Risk Score	Inner-shelf	Outer-shelf	Upper-slope	Mid-slope	Total habitats
High	X	X	X	X	X
Medium	X	X	X	X	X
Low	X	X	X	X	X
Total	X	X	X	X	X

[No] inner shelf habitats are classified as high risk of the ecological unit, [X] as medium risk, and [X] as low risk of the ecological unit. [X] outer shelf habitats produce high risk scores, [X] medium and [X] are at low risk of the ecological unit. Of the upper slope [X] are classified as high risk of the ecological unit,[X] at medium and [no] upper slope habitats appear at low risk of the ecological unit. Habitats at mid-slope depths are either at high risk of the ecological unit (X) or at medium risk (X); XX are considered low risk of the ecological unit.

Discussion

****

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

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

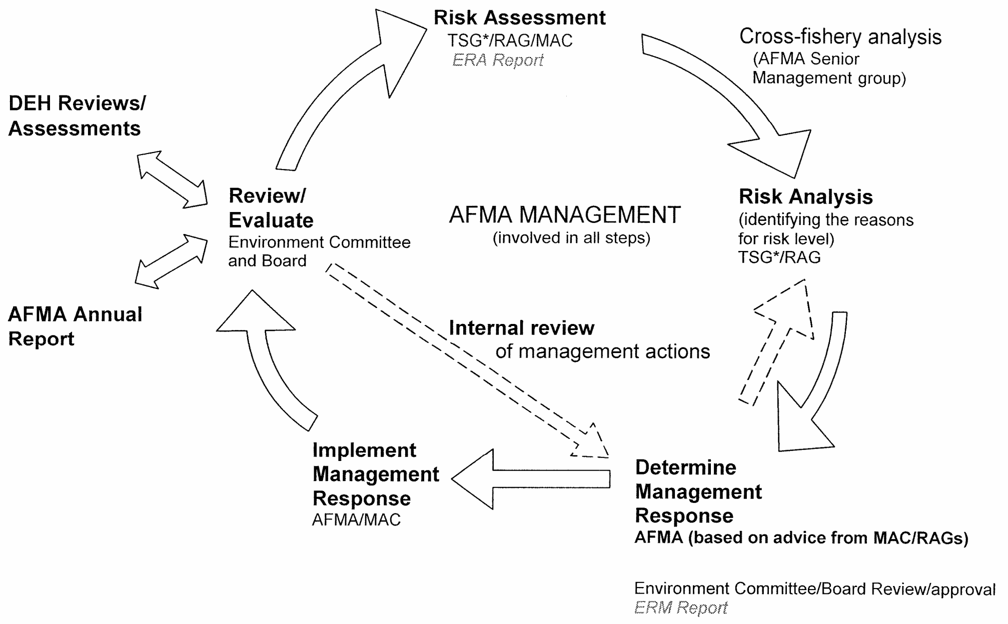
For example, if in a Level 2 analysis of habitat types, two of seven habitat types were determined to have risk from the sub-fishery, only those two habitat types would be considered at Level 3.

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

- The risk of 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 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 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 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 the conclusion of the 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.

2.5 Level 3

No Level 3 analyses have been undertaken for species, habitats or communities associated with the SSJF.

3. General discussion and research implications

The Southern Squid Fishery comprises a single jig sub-fishery. Concessions are granted annually, and are capped at a maximum of 84, although much of this is latent effort. The main fishery grounds are between Queenscliff and Portland in Victoria, with growing effort south of Kangaroo Island, South Australian, although the fishery area itself covers Commonwealth waters from Queensland (Sandy Cape on Fraser Island) to the South Australian/ Western Australian border and includes all Commonwealth waters around Tasmania.

Squid jig fishing is typically night fishing and relies on strong light to attract squid aggregations to the hooks. The fishery generally uses automatic jigging machines and lines with baitless barbless hooks, although some use of hand-held jig lines may also be used. Depths fished are generally 50-100 m. Sinkers are used at the bottom of lines, but do not reach the benthos. As such there is minimal benthic habitat impact.

The squid jig fishing method is very selective, targeting a single species (*Nototodarus gouldi* arrow/Goulds squid) with minimal bycatch or discard associated. The use of strong night light to attract squid may also attract and disorientate seabirds, but the interactions with other wildlife in general, or TEP species specifically, is considered minimal, with no significant issues noted in Observer reports.

A formal management plan was established in 2005. This is in part due to recognition that the fishery may not be fully utilized, and that further development may occur in the future.

3.1 Level 1

Funding ongoing research in arrow squid biology and stock assessment is a high priority for SquidMAC. There is currently insufficient information available to develop quantitative stock assessments for squid species, and thus TAC and quota rights, as used in other fisheries, have not been set for the Southern Squid Jig Sub-fishery. Alternatively, recent management changes have established gear Statutory Fishing Rights (SFR) with a specified number of standard jigging machines allocated to permit holders and nominated boats. This SFR is determined annually in conjunction with Total Allowable Effort (TAE), and CPUE data will be reviewed to ensure that precautionary catch triggers are appropriate. SquidFAG will be asked to review the stock status of the arrow squid in the event that catch triggers are met, but in the absence of sufficient data, these management steps have been taken as a precautionary measure to ensure ecological sustainability.

3.2 Level 2

Level 2 assessment was not required for any component in the southern squid jig fishery.

3.2.1 Species at risk

n/a

3.2.2 Habitats at risk

n/a

3.2.3 Communities at risk

n/a

3.3. Key Uncertainties / Recommendations for Research and Monitoring

At this stage, there are no pressing issues for the SSJF identified in the ERAEF assessment.

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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 Chondricythian 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 foodweb.
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 (added October 2006)

Date	Format received	Comment from stakeholder	Action/explanation
Oct 2006	Written comments on earlier version of fishery report collated by AFMA	Variety of clarification and word choice comments.	Clarified throughout the report.
Oct 2006	CSIRO internal review (EG)	Variety of clarification and word choice comments.	Clarified throughout the report.
Oct 2006	Comments received from AFMA Sept 2006	Need to clarify 2.1 Stakeholder Engagement table to reflect that a meeting was held in October 2005 with the RAG to discuss revised assessment that resulted in a Level 2 assessment not being undertaken any further. The stakeholder engagement table also should reflect that new data was obtained whilst the initial Level 2 was being undertaken. Due to the availability of new verified information (observer coverage) it was CSIRO determined the risks to be negligible and assessment ceased	Detail added to stakeholder engangement table, this meeting was listed in the Table, so clarification was added about a preliminary Level 2, that was not ultimately needed.

Appendix B: PSA results summary of stakeholder discussions

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

<u>Level 2 was not required for the SSJF.</u>

The following species were discussed at the INSERT FISHERY GROUP NAME meeting on INSERT DATE and LOCATION. ALL or 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
					e.g. Distribution queried- core depth is mostly shallower than fishery	*Changed depth distribution*	*Reduced risk from high to medium*	
					e.g. extra size information provided by fishers	*Max size added*	*Reduced risk from high to medium*	
					e.g. Confusion re species identification	*none*	*none*	*Improve species identification*
					E.g. more common on outer shelf. Does occur in range of fishery according to literature.	*none*	*none*	*Check depths at which caught in adjacent fishery*

Appendix C: SICA consequence scores for ecological components

Table 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**. State of reduction on the rate of increase is 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 population size or	**3. Genetic structure** Moderate 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 25%.

Sub-component	Score/level					
	1 Negligible	2 Minor	3 Moderate	4 Major	5 Severe	6 Intolerable
			number of spawning units up to 5%.			
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 behaviour/ movement	**6. Behaviour/ movement** Possible detectable change in behaviour/ movement but minimal impact on population dynamics.	**6. Behaviour/ movement** Detectable change in behaviour/ movement with the potential for some impact on population dynamics.	**6. Behaviour/ movement** Change in behaviour/ movement, impact adversely affecting population dynamics. Time to return to	**6. Behaviour/ movement** Change in behaviour/ movement. Impact adversely affecting population dynamics. Time to return to

Sub-component	Score/level					
	1 Negligible	2 Minor	3 Moderate	4 Major	5 Severe	6 Intolerable
		on the scale of hours.	Time to return to original behaviour/ movement on the scale of days to weeks	Time to return to original behaviour/ movement on the scale of weeks to months	original behaviour/ movement on the scale of months to years.	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

Sub-component	Score/level					
	1 Negligible	2 Minor	3 Moderate	4 Major	5 Severe	6 Intolerable
	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/increasing 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/increasing outside of historical range and/or allowed/facilitated new species to appear. Recovery period measured in years to decades.	4. Trophic/size structure Changes in mean trophic level. Ecosystem function severely altered and some function or components are missing and new groups present. Recovery period measured in years to decades.	4. Trophic/size structure Ecosystem function catastrophically altered as a result of changes in mean trophic level, total collapse of ecosystem processes. Recovery period measured in decades to centuries.
Bio-geochemical 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

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