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Ecological Risk Assessment for Effects of Fishing

REPORT FOR THE NORTH WEST SLOPE TRAWL FISHERY

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Helping Communities Helping Australia
An Australian Government Initiative

This fishery ERA report should be cited as

Wayte, S., J. Dowdney, A.Williams, C.Bulman, M.Sporcic, M.Fuller, and A.Hobday (2007) Ecological Risk Assessment for the Effects of Fishing: Report for the North West Slope Trawl Fishery. Report for the Australian Fisheries Management Authority, Canberra.

Notes to this document:

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

> (Hobday, A. J., A. Smith, H. Webb, R. Daley, S. Wayte, C. Bulman, J. Dowdney, A. Williams, M. Sporcic, J. Dambacher, M. Fuller, T. Walker. (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 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 North West Slope Trawl fishery was undertaken using the ERAEF method version 9.2. ERAEF stands for “Ecological Risk Assessment for Effect of Fishing”, and was developed jointly by CSIRO Marine and Atmospheric Research, and the Australian Fisheries Management Authority. ERAEF provides a hierarchical framework for a comprehensive assessment of the ecological risks arising from fishing, with impacts assessed against five ecological components – target species; by-product and by-catch species; threatened, endangered and protected (TEP) species; habitats; and (ecological) communities.

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

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

This assessment of the North West Slope Trawl fishery (NWSTF) includes the following:

- Scoping
- Level 1 results for all components
- Level 2 results for target species and habitats

Fishery Description

Gear:	Prawn trawl (minimum 50mm cod-end)
Area:	North West coast of Western Australia
Depth range:	200 to 600 m
Fleet size:	7 fishing permits
Effort:	Approximately 1,000 shots per year
Landings:	Approximately 70 t per year
Discard rate:	Unknown
Main target species:	3 species of scampi
Management:	7 transferable fishing permits
Observer program:	AFMA observers on 2 trips

Ecological Units Assessed

Target species:	7
Byproduct species:	16
Discard Species:	13
TEP species:	121
Habitats:	77 (76 benthic, 1 pelagic)
Communities:	11 (9 demersal, 2 pelagic)

Level 1 Results

The byproduct/bycatch and TEP species components were eliminated at Level 1. There was at least one risk score of 3 – moderate – or above for each of the other components.

Most hazards (fishing activities) were eliminated at Level 1 (risk scores 1 or 2). The hazards remaining were:

- capture by fishing (impact on target species, habitats and communities);
- indirect impact of fishing on habitats; and
- disturbance of physical processes by fishing (impact on target species, habitats and communities).

The only significant external hazard was other extractive activities (oil and gas exploration and extraction).

Risks rated as major or above (risk scores 4) were all related to direct or indirect impacts on habitats from primary fishing operations. No severe impacts (risk score 5) were identified in the analysis.

Impacts from fishing on target species and on habitats were assessed in more detail at Level 2.

Level 2 Results

Species

The seven target species were assessed at Level 2 using the PSA analysis. No expert over rides were used, and no species had more than three missing attributes. Scarlet prawn is the only species assessed to be at high risk in the NWSTF. It is the largest commercial crustacean targeted, and thus has the highest selectivity score, leading to a high susceptibility score. However current catches of scarlet prawn are very low in the NWSTF (<100 kg per year), so it is unlikely to be at risk from the fishery at present. It would be commercially attractive if found in larger quantities. Worldwide, this species has been recorded in depths to 1800m, so it is conceivable that further resources may be discovered if the deeper waters of the North West slope are explored (Wadley, 1992).

Australian scampi, Boschmai scampi and velvet scampi are currently the main target species in the NWSTF. They are assessed at medium risk in the PSA analysis. These species have been assessed in more detail in other analyses (Lynch and Garvey, 2005). Although catch rates have declined, they are not considered to be over-exploited at current catch levels

There is no information available for any of the target species on the overlap of their range with effort in the fishery. Fishing for scampi in the NWSTF has been confined to relatively small areas, and there is no evidence of serial depletion of scampi in the fishery (Lynch and Garvey, 2005).

Habitats

The poor knowledge and lack of data availability of seabed habitats in this large fishery area required a list of habitats to be generated based on Scoping Method 2 which incorporates (1) the presence of known coarse-scale habitat types (geomorphic features) and (2) the presence of fine-scale habitats inferred from better known adjacent or similar fishery areas. As effort in this fishery occurs between 200-700m, only upper shelf habitats are considered in the PSA. A precautionary approach is taken, in which all upper slope habitats of geomorphic features were included: canyons, trenches, troughs, seamounts, pinnacles, plateaus and terrace (Geoscience Australia, National Bioregionalization). In addition, seabed habitat data from a recent (late-2005) CSIRO survey of deep benthic biodiversity off the western WA coast were also considered. Rankings are consistent with the same habitat types from other Commonwealth fisheries utilizing similar gear in upper slope depths (i.e. SET OT, WDWT, GABT).

This alternative scoping method generated a conservatively large list of potentially encounterable upper slope habitats, 76 of which were assessed at Level 2 using the habitat PSA analysis, and included many habitat types in each risk category. However, these detailed habitat types can be readily aggregated into a smaller number of general categories for interpretation. This is because many types are similar, differing in only one respect of substratum or geomorphology or dominant fauna, and therefore attracting similar PSA scores and the same risk rankings. For example, one general type will group together the habitats of a depth zone characterized by similar substratum and geomorphology but different large fauna (sponges, crinoids, octocorals or mixed communities).

Of the 76 habitat types, 22 were assessed to be at high risk, 20 medium, and 34 low.

High risk habitats on the upper slope include several hard bottom types, in this case dominated by large sponges not seen on the mid slope. There are also several soft bottom habitats based on bryozoan communities which are restricted to a narrow zone near the shelf break. Habitats of canyon features also occur at this depth zone.

Communities

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

Summary

Both target species and benthic habitats were identified as potentially at risk in the North West Slope Fishery. However the single high risk target species is rarely caught at present, and although trawling is likely to impact a variety of benthic habitats, the current scale of the fishery relative to its overall area suggests that habitats are not currently at high actual risk.

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.

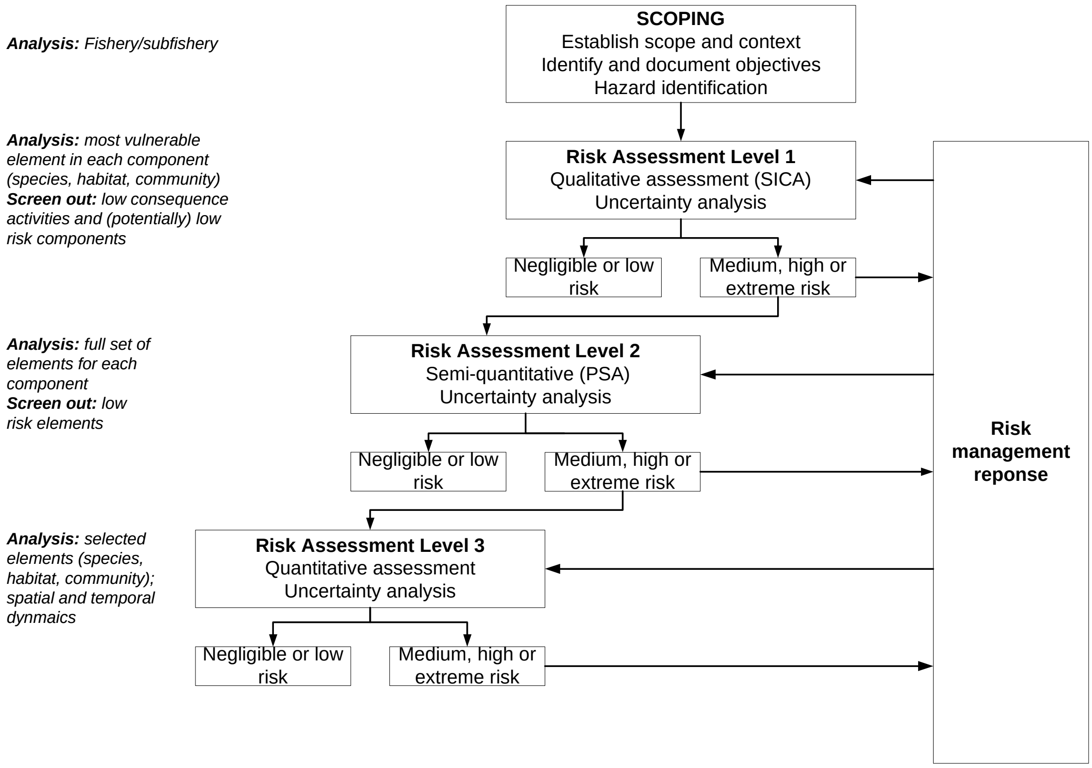


Figure 1. Overview of ERAEF showing focus of analysis for each level at the left in italics.

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.

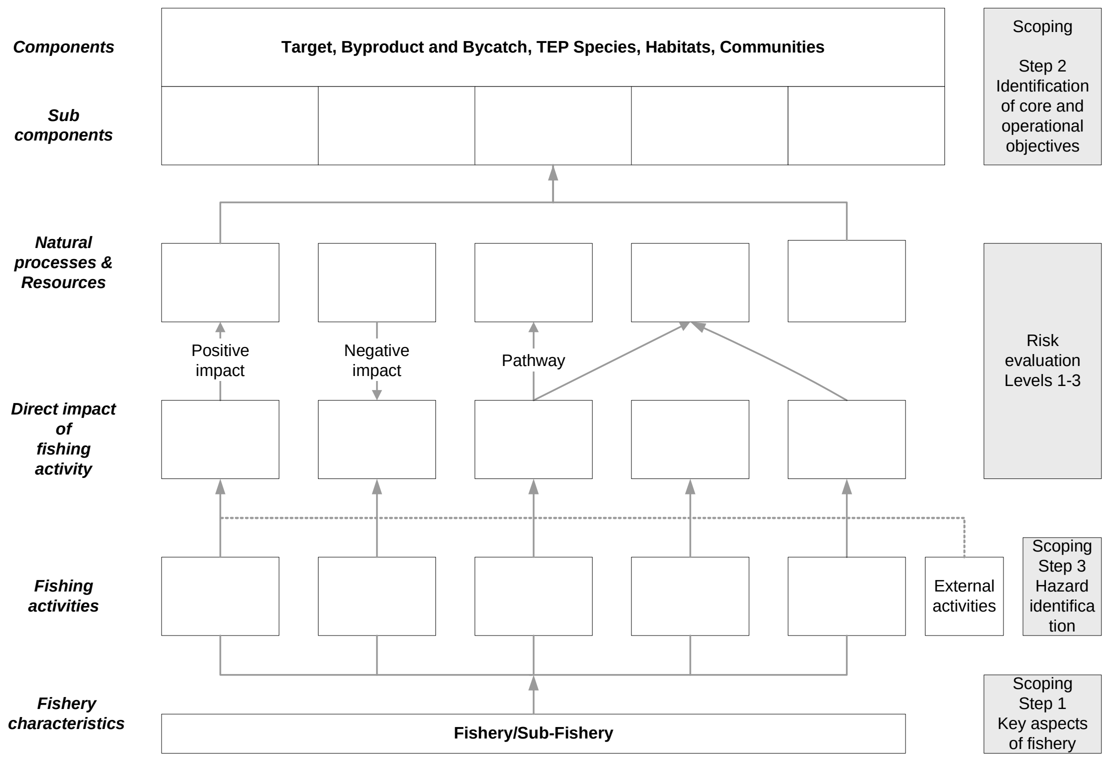


Figure 2. Generic conceptual model used in ERAEF.

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

included in this checklist (and would feed back into the original checklist). The background information and consultation with the stakeholders is used to finalise 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 ERA report author and debated at the stakeholder meeting. Because of the number of activities (up to 24) in each of five components (resulting in up to 120 SICA elements), preparation before involving the full set of stakeholders may allow time and attention to be focused on the uncertain or controversial or high risk elements. The rationale for each SICA element must be documented and this may represent a challenge in the workshop situation. Documenting the rationale ahead of time for the straw-man scenarios is crucial to allow the workshop debate to focus on the right portions of the logical progression that resulted in the consequence score.

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

Level 2. PSA (Productivity Susceptibility Analysis)

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

Susceptibility attribute estimates, such as “fraction alive when landed”, can also be made based on input from experts such as scientific observers. The final PSA is completed by scientists because access to computing resources, databases, and programming skills is required. Feedback to stakeholders regarding comments received during the preliminary PSA consultations is considered crucial. The final results are then presented to the stakeholder group before decisions regarding Level 3 are made. The stakeholder group may also decide on priorities for analysis at Level 3.

Level 3

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

Conclusion and final risk assessment report

The conclusion of the stakeholder consultation process will result in a final risk assessment report for the individual fishery according to the ERAEF methods. It is envisaged that the completed assessment will be adopted by the fishery management group and used by AFMA for a range of management purposes, including to address 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, is specific to a particular sub-fishery. The fishery is a group of people carrying out certain activities as defined under a management plan. Depending on the jurisdiction, the fishery/sub-fishery may include any combination of commercial, recreational, and/or indigenous fishers.

The results presented below are for the North West Slope Trawl Fishery.

2.1 Stakeholder Engagement

2.1 Summary Document SD1. Summary of stakeholder involvement for *North West Slope Trawl 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	03.02.04	Ross Gould, Supervising Fishery Manager, Department of Fisheries, Government of Western Australia	Request for information concerning interactions with State Fisheries.
		09.02.04	David Guillot, WESTMAC industry representative. WDWTF operator.	Clarification of catching trends, major issues with fishery.
		17.02.04	Greg Nelson, NWSTF Fleet Manager	Clarification of discarding practices, incidental behaviour, waste management
		17.02.04	Michael Obrien, WESTMAC industry representative. WDWTF operator.	Clarification of discarding practices, incidental behaviour, waste management
	Verbal, face to face; Consultation within AFMA	Continual, March to May 2004	Data management Section, relevant managers.	Consolidate fisheries data clarify fishery overview details
	Email: Document distributed to stakeholders for comment (Wade Whitlaw letter)	2 April 2004	WESTMAC Members, File Reference: F2004/0269	Response from Victoria Wilkinson Assistant Director Sustainable Fisheries Section, *DEH* (14 April 2004). Clarified and edited inconsistencies in

ERA report stage	Type of stakeholder interaction	Date of stakeholder interaction	Composition of stakeholder group (names or roles)	Summary of outcome
				draft
	Meeting/Workshop	May 27, 2004, to AFMA manager	Document distributed to WESTMAC members ahead of meeting. To be discussed at meeting.	
	Review by fishers		*e.g. Executive Officer of fishery distributed to fishers*	*e.g. April 24, feedback on preferred objectives was provided* *Hazards agreed on.*
Level 1 (SICA)	Phone discussion	10 October 2005	John Garvey, AFMA	Provided general information as well as answers to specific questions about the fishery
	Phone discussion	11 October 2005	Adrianne Burke, AFMA	Discussion of Level 1 analysis
	Workshop	18 October 2005	WESTMAC members Ron Edwards (chair), Wade Whitelaw (AFMA), Justine Johnston (AFMA), Richard Elvin (industry), Greg Ferguson (industry), David Guillot (industry), Michael O'Brien (Industry), Tony Koslow (CSIRO), Ross Gould (WA State Fisheries), Clinton Chambers (DEH), Tim Smith (AFMA)	Review species lists and Level 1 analysis.
	Email	September 2005	WESTMAC members as above	Revised copy of ERA report sent to all meeting participants for comment
Level 2 (PSA)	Meeting	7 March 2006	WESTMAC members Ron Edwards (chair), Wade Whitelaw (AFMA), Justine Johnston (AFMA), Richard Elvin (industry), Greg Ferguson (industry), David Guillot (industry), Michael O'Brien (Industry), Tony Koslow (CSIRO), Ross Gould (WA State Fisheries), Andrew Prendergast (industry), Clayton Neilson (industry), Ross Wood (industry), Tim Smith (AFMA)	Presented Level 2 results

2.2 Scoping

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

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

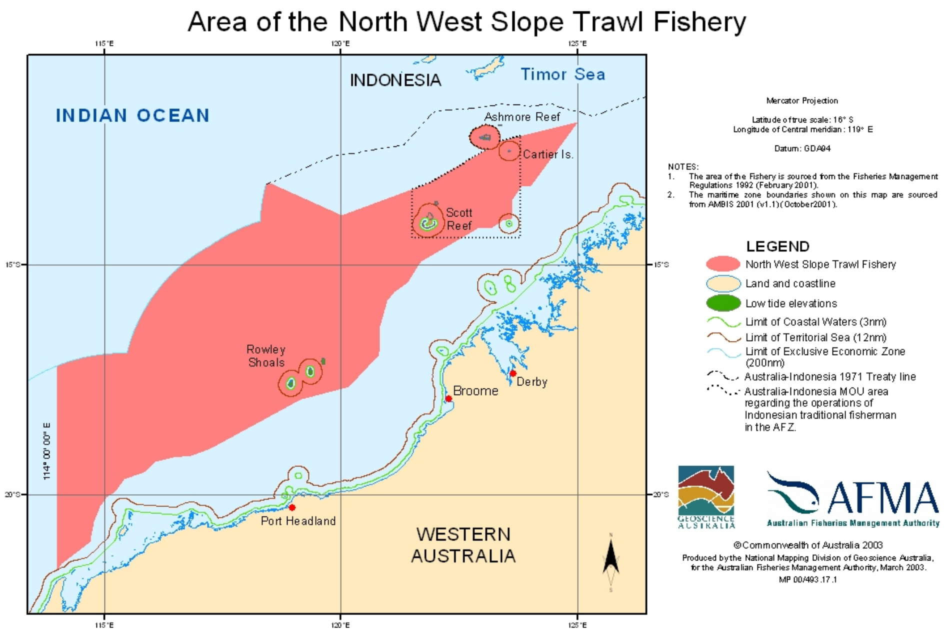
2.2.1 General Fishery Characteristics (Step 1).

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

Scoping Document S1 General Fishery Characteristics

<u>Fishery Name</u>: North West Slope Trawl Fishery
<u>Date of assessment</u>: October 2005
<u>Assessor</u>: Sally Wayte

General Fishery Characteristics	
Fishery Name	North West Slope Trawl Fishery (NWSTF)
Sub-fisheries	*Identify sub-fisheries on the basis of fishing method/area.* none
Sub-fisheries assessed	*The sub-fisheries to be assessed on the basis of fishing method/area in this report.* The whole fishery
Start date/history	*Provide an indication of the length of time the fishery has been operating.* The NWSTF was brought under the management of the Australian Fisheries Service (now AFMA) on 15 March 1985. Commercial interest in the area began following the confirmation of promising scampi and deepwater prawn stocks by research cruises conducted in 1978, 1982 and 1984 and by an independent industry survey in 1983 (Jernakoff 1988).
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 North West Slope Trawl Fishery (NWSTF) is located in deepwater off north-western coast of Western Australia and operates seaward from a management boundary approximating the 200m isobath to the edge of the Australian Fishing Zone (AFZ) (Figure 1). The fishery's western boundary adjoins the Western Deepwater Trawl Fishery at longitude 114°E. The eastern boundary forms at roughly 125°E but does not extend to the outer limit of the AFZ due to arranged Australian-Indonesian maritime boundaries in the Timor Sea.

	 **Figure 1** Waters of the North West Slope Trawl Fishery.
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 NWSTF is not managed through spatial zones or regions.
Fishing season	*What time of year does fishing in each sub-fishery occur?* Temporal closures are not enforced in the NWSTF. Permit holders generally access the fisheries on a part time or opportunistic basis as an adjunct to other Commonwealth fisheries. Fishing effort in the NWSTF is generally minimal during the months of April, September and October while vessels operate in the Northern Prawn Fishery.
Target species and stock status	*Species targeted and where known stock status.* The NWSTF is based on commercial stocks of deepwater crustaceans, principally scampi and prawns. There are three main commercially important species of scampi (*M. velutinus*, *M. australiensis*, and *M. boschmai*) which are taken from different depth distributions between 260 to 500 metres (Wallner & Phillips, 1995). More recently the fishery is increasingly taking a combination of other scampi species that are marketed as mixed scampi tails (Wallner & Phillips, 1995). In the NWSTF four penaeid species (*Aristaeomorpha foliacea*, *Haliporoides sibogae*, *Aristeus virilis* and *Aristaeopsis edwardsiana*) compose a high percentage (70%) of the fishery's prawn catch. Numerous other prawn species comprise the remainder of the prawn catch with up to 41 commercial or potentially commercial crustacean species featuring in the catch of the NWSTF (Wadley, 1992). While the deepwater prawns have previously been the primary target species of the fishery, they are currently only taken as a byproduct whilst targeting scampi.
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 collection.
Current entitlements	*The number of current entitlements in the fishery. Note latent entitlements. Licences/permits/boats and number active.* The NWSTF has limited entry with only 7 fishing permits allocated. These permits enable only one vessel to operate under each at any one time but are fully transferable between vessels. Permit conditions impose cod end mesh-size restrictions. 10 vessels operated in the fishery in 2001 and 2002, 6 vessels in 2003 and 8 vessels in 2004.

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 TACs

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

Year (financial)	active vessels	Effort (hours)
2000-01	10	7,480
2001-02	10	8,147
2002-03	5	4,936
2003-04	8	5,379

Figure 2 illustrates annual fishing effort for the NWSTF and WDWTF. In both sub-fisheries not all permit endorsements are annually active. In 2002 for example only 6 permits were active in both sub-fisheries.

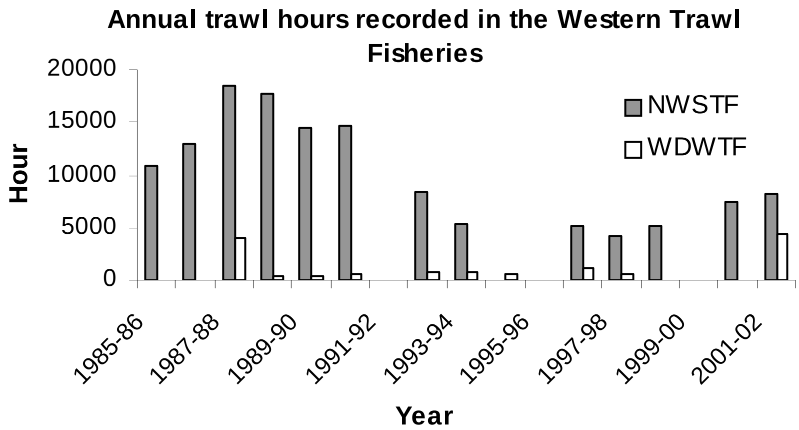


Figure 2. Total trawl hours recorded in the North West Slope Trawl (NWSTF) and Western Deepwater Trawl Fisheries (WDWTF). Zero trawl hours are due to confidentiality of data when fewer than five vessels have operated except prior to 1987 in the WDWTF when the fishery was not in existence.

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

Year	Total Catch (t)	Prawn catch (t)	Scampi catch (t)
2000-01	114	6	103
2001-02	103	17	82
2002-03	63	16	45
2003-04	60	0.8	57

Since the start of the fishery in 1985, catch composition of the NWSTF has changed from being dominated by deepwater prawn to scampi. Changes in relative catch composition can be attributed to; i) seasonal variations in species abundance, ii) variation in the number of vessels actively fishing between years, iii) market demands and iii) a real decrease in abundance as exploitation has reduced surplus standing stocks (Wallner & Phillips, 1995).

<table>
<tr>
<td>Current and recent value of fishery ($)</td>
<td>Note current and recent value trends by sub-fishery. In table form
<table>
<tr><th>Year</th><th>Value ($million)</th></tr>
<tr><td>2000-01</td><td>1.3</td></tr>
<tr><td>2001-02</td><td>1.1</td></tr>
<tr><td>2002-03</td><td>unavailable</td></tr>
<tr><td>2003-04</td><td>1.1</td></tr>
</table>
Between 1997/98 to 2001/02 the average GVP was $ 1 077 000</td>
</tr>
<tr>
<td>Relationship with other fisheries</td>
<td>Commercial and recreational, state, national and international fisheries List other fisheries operating in the same region any interactions

Commonwealth Fisheries

a) Western Tuna and Billfish Fisheries (WTBF)

The Western Tuna and Billfish Fishery (142^{o} 30’E to 34^{o} 00’S) operates in the same region as the NWSTF. The WTBF targets pelagic species using longlines, purse seines and minor lines (hand line, rod and reel, troll, and polling). The NWSTF in contrast, targets demersal resources. Direct interaction with the WTBF is negligible.

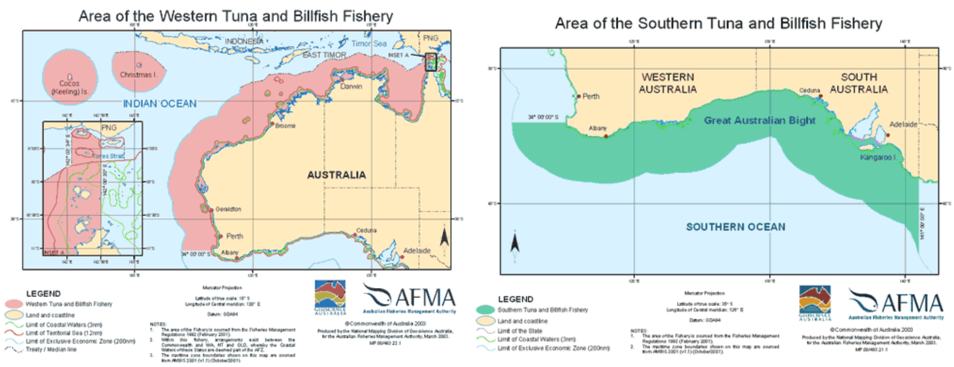


Figure 3. Waters of the Southern and Western Tuna and Billfish Fisheries

b) Western Deepwater Trawl Fishery

The WDWTF is located in deepwater off Western Australia operating from a management line approximating the 200m isobath outwards to the edge of the AFZ (Figure 4). The fishery’s northern most point is formed by the boundary of the AFZ to longitude 114°E where it runs adjacent to the waters of the NWSTF. The southern extremity lies on the boundary of the AFZ with longitude 115°08’E where the fishery runs adjacent to the Great Australian Bight Trawl Fishery. The WDWTF does catch some scampi, otherwise there is little species overlap between the 2 fisheries.</td>
</tr>
</table>

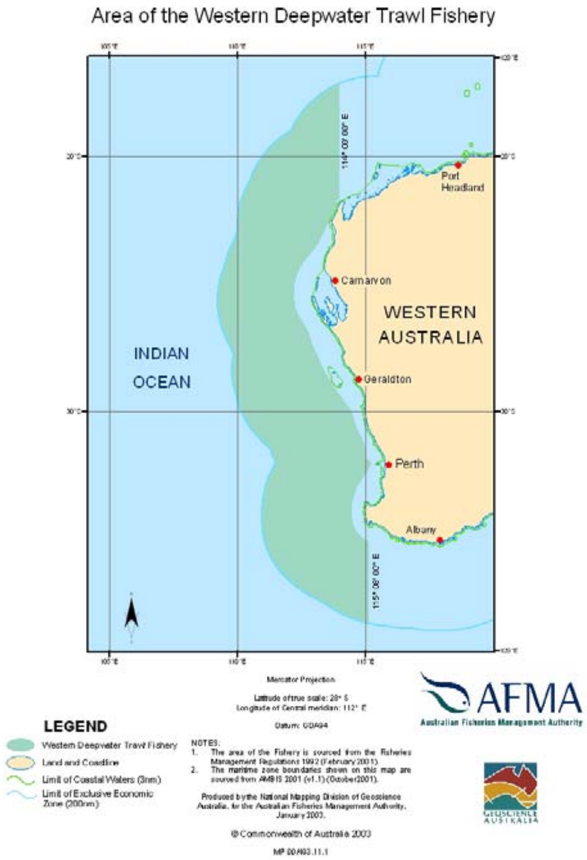


Figure 4 Waters of the Western Deepwater Trawl Fishery

Western Australian State Fisheries

Under a negotiated Offshore Constitutional Settlement (OCS) agreement the Western Australian government has management responsibility for all species taken by fishing methods other than trawling, excluding tuna, to 200 nm limit of the AFZ.

a) West Coast Deep-Sea Crab Fishery (WCDSCF)

The NWSTF shares waters of operation with the WCDSCF. The WCDSCF includes waters between Cape Leeuwin and the Northern Territory border seaward to the AFZ boundary (Figure 5). Principal target species of the WCDSCF are giant king crabs (*Pseudocarcinus gigas*), snow crabs (*Chaceon bicolor*) and champagne crabs (*Hypthalassia acerba*). Vessels are only permitted to fish outside the 150m isobath using pots (Penn 2002). Seven licences are issued in the fishery. Operators deploy up to 700 pots each (Penn 2002).

Interactions between the NSWTF and WCDSCF exist as both operate demersally in the same waters. Two levels of interactions are identified. The first is through direct resource sharing, and the second through indirect resource impacts. Trawling gear may cause deleterious effects on benthic habitats and thus on WCDSCF productivity. In particular, trawling could damage bryozoan rich substrates which appear from 120 meters and progressively dissipate until 300m (Levings *et al* 2001). Higher relative densities of female giant crabs (*Puesdocarcinus gigas*) have been found in areas with bryozoan rich substrates (Levings *et al* 2001). There is a need to gain empirical evidence that quantifies these assumptions.

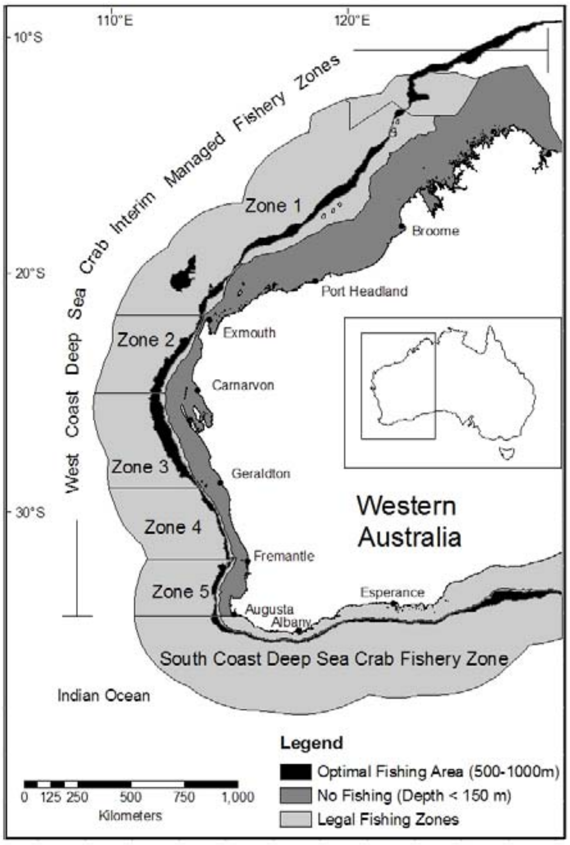


Figure 5 Waters of the West Coast Deep-Sea Crab Fishery (Source: Department of Fisheries, Government of Western Australia).

b) Northern Demersal Scalefish Fishery (NDSF)

Waters of the NDSF include all Western Australian waters east of longitude 120^{o} 00'E extending seaward to the AFZ 200nm boundary (S1.1 Figure 6). A demarcated offshore zone (Area 2) includes all waters from the 200m isobath to 200nm and subsequently overlaps with the NWSTF. Access to Area 2 is limited to 11 licenses that are issued under an agreed research framework. Catch rates in Area 2 have been relatively low and therefore have not encouraged concerted fishing efforts (Penn 2002).

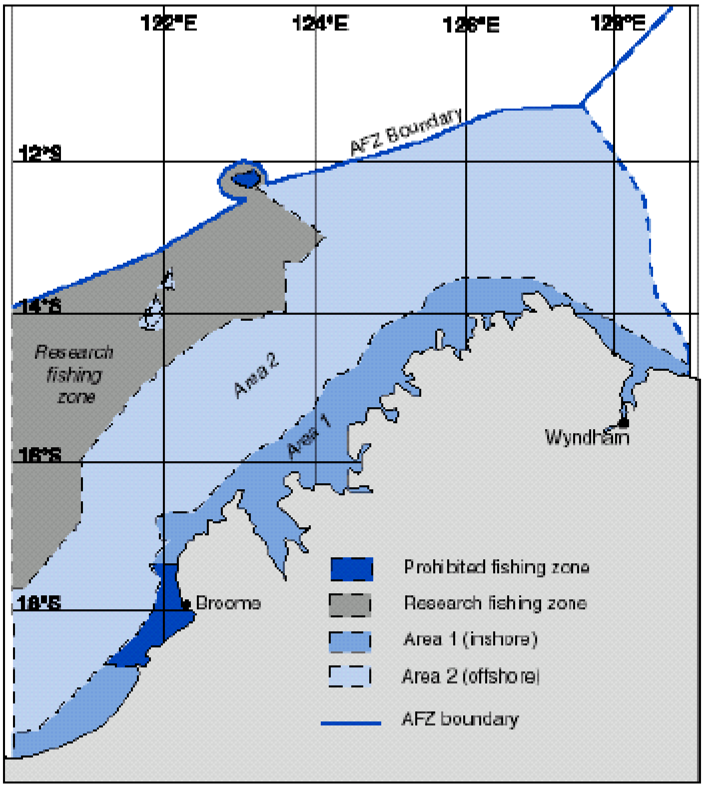


Figure 6 Waters of the Northern Demersal Scalefish Fishery (Adapted from Penn 2002).

Principal target species of the NDSF include red emperor and goldband snapper. Numerous snappers, emperors and cods constitute the majority of by-product species. Both red emperor and goldband snapper stocks are considered fully exploited. Fish traps and limited line fishing gears are used.

Resource sharing is largely incidental as the NWSTF actively targets crustaceans. The level of interaction however may change over time if commercially viable finfish stocks are exploited by the NWSTF. Limited expansion in the NDSF and failure of exploratory studies to find commercially viable stocks in the region (Newman and Evans 2002; Newman *et al* 2000) currently provides low incentive for NWSTF operators to target finfish.

c) Pilbara Demersal Finfish Fishery (PDFF)

The PDFF adjoins the NWSTF covering waters landward of the 200m isobath, north of 21^{o} 44'S and between latitudes 114^{o} 09'36"E and 120^{o} 00'E (S1.1 Figure 7). Snappers, emperors and other assorted finfish are targeted using trawl and to a limited extent fish trap and line methods. Stock sharing may occur if targeting within the NWSTF shifts to include straddling finfish stocks.

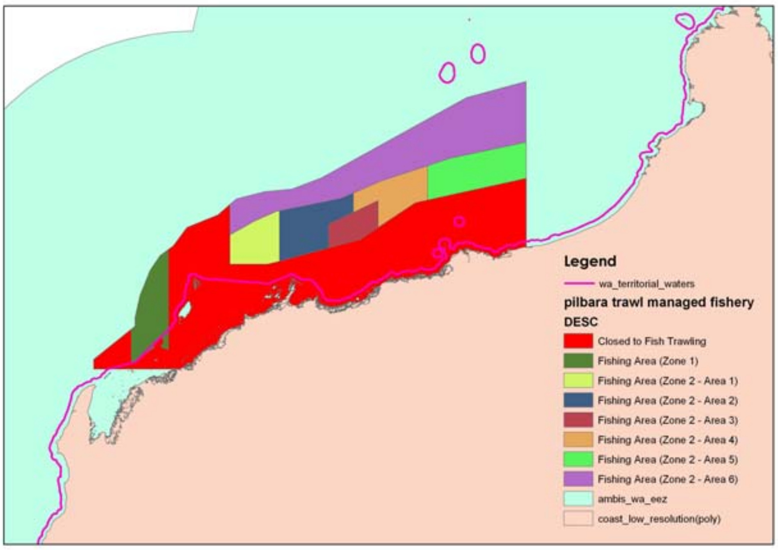


Figure 7 Waters of the Pilbara Demersal Finfish Fishery (Source: Department of Fisheries, Government of Western Australia).

d) WA North Coast Shark Fishery

The WANCSF extends from 114°06´E (North West Cape) to 123°45´E (Koolan Island) and comprises shark long-lining vessels targeting a variety of species including blacktip, sandbar and lemon sharks. There is no interaction with the NWSTF.

International Fisheries

In recognition of traditional Indonesian fishing activities, Australia and Indonesia signed a Memorandum of Understanding (MoU) in 1974 permitting subsistence fishing by traditional Indonesian fishers within the then 12 nautical mile territorial waters of Ashmore Reef, Cartier Island, Seringapatam Reef, Scott Reef, Browse Island and Adele Island (Wallner and McLoughlin, 1995). The majority of these reefs and islands fall within the waters of the NWSTF, although some have since been declared as nature reserves or marine parks.

In 1979, Australia declared the Australian Fishing Zone (AFZ), incorporating offshore reefs and islands in the Timor Sea. Under Australian and international law the AFZ effectively outlawed the fishing of reefs named in the MoU by Indonesian vessels. Australia subsequently adopted a policy of permitting such fishing and after discussions with Indonesia in 1989 agreed to define the area accessible to traditional Indonesian fishing as that contained within the MoU box (**Figure 1**).

While the MoU box overlaps the waters of the NWSTF there is no competition for resources between the NWSTF and traditional Indonesian fishers. Interaction between the fisheries does not exist as the traditional Indonesians focus their effort around the shallow waters neighboring the shoals and islands within the area. The Indonesians primarily target four taxa groups within the MoU box: sharks, trochus shell, trepang and demersal finfish.

Recreational Fisheries

Recreational fishing effort has not been investigated for the entire expanse of the Western Trawl Fisheries. Limited recreational effort in the Shark Bay Snapper Fishery and the offshore zone of the Northern Demersal Scalefish Fishery have been reported (Penn 2002). Environmental conditions and gear requirements are likely to preclude many recreational fishers from targeting offshore, deepwater demersal resources.

Gear	
Fishing gear and methods	*Description of the methods and gear in the fishery, average number days at sea per trip.* Vessels operating in the NWSTF are composed of all-steel construction 20–25m prawn trawlers modified for deepwater trawling. Modification of demersal prawn trawling gear for deepwater trawling includes large capacity winches, stern-towed twin or triple nets and product handling equipment (hoppers) capable of rapidly processing large volumes of fragile deepwater species (Evans 1992). All vessels operating in the NWSTF freeze catch on board and typically have the capacity to store 30 – 50 tonnes of product. Fishing duration is usually four to five weeks and is limited by freezer space, fuel and freshwater reserves (Evans 1992). No restriction on net headrope length exists in the NWSTF however a maximum mesh size (50mm) does apply in order to discourage any targeting of demersal finfish. Generally 'Florida flyer' type nets are standard for both scampi and deepwater prawn fishing (Evans 1992). These nets are based on NPF banana prawn nets with extended wing panels and slightly different seaming (Evans 1992). Vessels tow nets in either dual or triple arrays giving a total headrope length of between 47 and 75 metres depending on vessel power (Evans 1992). Wing mesh size is typically 60mm for prawns and 90mm for scampi with codends generally a heavier gauge 45mm mesh regardless of the target species (Evans 1992). Footropes are wire cored 'combination rope' preceded by chain link for the ground gear. Drop chains connect the two, with their lengths affecting the amount of bite into the substrate. Tickler chains are also often used to stimulate crustaceans off the sea floor. The chains are strung between the trawl wing corners and lead the whole assembly.
Fishing gear restrictions	*Any restrictions on gear* Cod-end mesh size may not exceed 50 mm.
Selectivity of gear and fishing methods	*Description of the selectivity of the sub-fishery methods* In comparison with other fishing gears trawling is non-selective. In this fishery mesh size is the only regulated part of the trawl gear. No other design and use specifications exist.
Spatial gear zone set	*Description where gear set i.e. continental shelf, shelf break, continental slope (range nautical miles from shore)* The NWSTF is located in deepwater off north-western coast of Western Australia and operates seaward from a management boundary approximating the 200m isobath to the edge of the Australian Fishing Zone (AFZ).
Depth range gear set	*Depth range gear set at in metres* 200m to 600m
How gear set	*Description how set, pelagic in water column, benthic set (weighted) on seabed* The nets are typically towed at 3 knots along relatively flat mud or silt substrates. Hard bottom areas or rocky outcrops are avoided as these areas are not ideal scampi habitat and also lead to snaring and damage of nets. Shot duration is typically 3-5 hours with a combined shoot-away and haul-up time of around one hour at 500 metres (Evans 1992). In order to minimise product damage, shot duration is reduced when targeting deepwater prawns due to their more fragile nature (Evans 1992). Trawling usually occurs around the clock.
Area of gear impact per set or shot	*Description of area impacted by gear per set (square metres)* Not estimated
Capacity of gear	*Description number hooks per set, net size weight per trawl shot* Not available
Effort per annum all boats	*Description effort per annum of all boats in fishery by shots or sets and hooks, for all boats* See above
Lost gear and ghost fishing	*Description of how gear is lost, whether lost gear is retrieved, and what happens to gear that is not retrieve, and impacts of ghost fishing* See SICA analysis

Issues	
Target species issues	*List any issues, including biological information such as spawning season and spawning location, major uncertainties about biology* ***NWSTF*** **Scampi** Three species account for the majority of scampi (metanephropid) catch taken in the NWSTF (*Metanephrops australiensis, M. velutinus and M. boschmai*). Life history traits of Australian scampi are characterised by low fecundity, a prolonged incubation period, abbreviated larval development and take 3-5 years to mature and recruit to the fishery (Wallner and Phillips 1995). These attributes are indicative of a low carry capacity or resilience to exploitation. Declines in relative stock abundance have been reported (Lynch and Garvey 2005). Analysis of CPUE between 1985-2003 indicated that CPUE values for the last few years are the lowest ever recorded if increases in fishing power are taken into account. Fishery independent surveys would improve the robustness of the assessment. Scampi abundance is closely linked to depth and sediment type (Wallner and Phillips 1995; McLoughlin *et al* 1988; Carter *et al* 1983). Distinct areas of high productivity interspersed by areas of low catch rates in the NWSTF have been recorded (Wadley 1992). Scampi composition has also shown variation between major fishing grounds (Wallner and Phillips 1995). Patchy distributions driven by habitat availability may increase risk to localised depletion. Detailed analysis of scampi distributions (including areas lightly or non-fished areas), biology and habitat affiliations may provide a sound basis to assess the viability of spatial closures to alleviate depletion risks. Pre-recruits may co-exist with fishery recruited individuals due to having an abbreviated pelagic phase (Wallner and Phillips 1995). Trawling could indirectly affect pre-recruit survivorship through habitat disturbance (i.e. burrows) and food supply (Wassenberg and Hill 1989). Trawling induced changes in benthic composition and topography are yet to be quantified for the NWSTF. Qualitative and quantitative evidence of benthic impacts are listed in below section '*Habitat issues'*. To date pre-recruit scampi stocks have not been surveyed thus potential fishery impacts are unknown. In the case of *M. velutinus* susceptibility to overexploitation may be further augmented by significantly higher relative catch rates of females during periods of increased prevalence of berried females. In October 1987 up to 72% of the total *M. velutinus* catch consisted of berried females (Wallner and Phillips 1995). A higher propensity for berried *M. velutins* females to emerge from their burrows could occur, thus increasing catchability. Emergence from burrows may aid in oxygenating broods or to provide opportunities to forage and build depleted energy reserves after spawning (Wallner and Phillips 1995). Significant departures from equal sex ratios in *M. australiensis* and *M. velutins* catches were not detected (Wallner and Phillips 1995). In an earlier study however, 28.3% of 573 females caught during the month of September were berried (Carter *et al* 1983). It is thought that female metanephropids are reproductively active throughout the year, although the timing and patterns of recruitment are not yet defined, making management responses difficult to construct. **Deep water prawns** Biological characteristics of deepwater prawns caught in NWSTF are largely unknown. Distribution trends do indicate a susceptibility to localised depletion through efficient targeting. When targeted, specific prawn grounds have been fished. Over 90% of total red prawn (A*ristaemorpha foliacea)* catches between 1985-90 were taken from fishing grounds south of the Rowley Shoals (Wadley 1992). *A. foliacea* possess a highly aggregated distribution and substrate preference (soft mud and muddy sandy) within the NWSTF

<table>
<tr><td></td><td>(Wadley 1992). Disparity in depth preference between species has also been found (Wadley 1992).</td></tr>
<tr><td>Byproduct and bycatch issues and interactions</td><td>List any issues, as for the target species above
NWSTF byproduct has regularly included squid along with intermittent catches of deep sea bugs (slipper lobsters), whip and spear lobsters, fish such as ling and silver dory and precious shells (Evans, 1992). Cephalopods (squid) form the most important byproduct in the NWSTF in terms of both tonnage and value (Phillips, 1992). At least four species of squid are taken in the fishery with Nototodarus hawaiiensis dominating the squid catches.

Given that the fleet targets crustaceans and has avoided exploratory fishing away from the prawn grounds, there has been little occurrence of commercial fish catches being reported. This is compounded by the fact that the fleet is using prawn nets which are not designed to target fish (Jernakoff, 1988). Fish that are captured are seldom kept as byproduct as they are generally unmarketable, unpalatable or too small (Evans, 1992).

There is a lack of knowledge surrounding the composition and volume of bycatch in the NWSTF. The diversity of bycatch is reputedly high but also variable. Similarly the volume of the bycatch is also noted to be highly variable (pers. com. John Garvey). Although the NWSTF utilises non-selective trawling techniques the bycatch volume and composition is significantly reduced in comparison to other tropical trawl fisheries due to the depth range at which the fishery operates.

According to logbook data for 2001-04, between a third and a half of the total catch is discarded (see table below). In recent years most of the discarded catch has not been identified.
<table>
<tr><th>year</th><th>Total kept (t)</th><th>Total discarded (t)</th><th>Discarded unidentified (t)</th><th>% catch discarded</th><th>% discards unidentified</th></tr>
<tr><td>2001</td><td>116</td><td>42</td><td>12</td><td>27</td><td>29</td></tr>
<tr><td>2002</td><td>64</td><td>58</td><td>39</td><td>48</td><td>67</td></tr>
<tr><td>2003</td><td>67</td><td>52</td><td>33</td><td>44</td><td>63</td></tr>
<tr><td>2004</td><td>42</td><td>20</td><td>20</td><td>32</td><td>100</td></tr>
</table></td></tr>
<tr><td>TEP issues and interactions</td><td>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.
The recording of interactions with protected wildlife was introduced into NWSTF logbooks on the 27th April 2001. Since the introduction of this mechanism, no interactions with listed wildlife has been recorded within the fishery.

A need exists in this fishery to better record interactions with TEP species. Bycatch mitigation measures, observers and crew training could all contribute to recording and minimising such interactions.

Dogfish (Family: Squalidae) have been identified as a high conservation concern due to documented declines off south-eastern Australia (Pogonoski et al 2002). Two species of dogfish considered to be of high conservation concern are known to occur within the NWSTF region (gulper shark, Centrophorus granulosus; black shark; Dalatias licha) (Williams et al 1996). Occasional catches of dogfish can be expected in the NWSTF, although none have been recorded to date.</td></tr>
<tr><td>Habitat issues and interactions</td><td>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
Detailed studies of fishing induced habitat impacts have not been conducted for the Western Trawl Fisheries. Limited qualitative and quantitative data provides some insight into potential effects of trawling on the benthos. Major results are as follows:</td></tr>
</table>

	• Benthic taxa were the dominant (23.1%) bycatch category by weight of exploratory trawls conducted in the NWSTF in 1998-00 (Newman & Evans 2002) • Concern has been raised regarding trawling impacts on bryozoan rich substrates which appear from 120 meters and progressively dissipate until 300m (Levings *et al* 2001). Distribution patterns of female giant crabs (*Pseudocarcinus gigas*) may be correlated with bryozoan rich substrates. Giant crabs form a major part of catches taken in the West Coast Deep-Sea Crab Fishery (Penn 2002). • Reduced observations of hexactinellid sponges have been made from heavily trawled areas in the NWSTF (Wallner and Phillips 1995) 10% of sessile fauna is reportedly detached annually from the Pilbara Demersal Finfish Fishery (Penn 2002)
Community issues and interactions	*List any issues for any of the community units identified in* ***Scoping Document S1.2****.* No community issues have been identified
Discarding	*Summary of discarding practices by sub-fishery, including bycatch, juveniles of target species, high-grading, processing at sea.* There is a lack of knowledge surrounding the composition and volume of bycatch in the NWSTF. The diversity of bycatch is reputedly high but also variable. Similarly the volume of the bycatch is also noted to be highly variable (pers. com. John Garvey). High bycatch variability arises as a result of the composition and volume altering dependent on the catch species being targeted and their associated depth distributions. When targeting red prawns catch can be relatively clean with low volumes of bycatch. Alternatively, when targeting *M. boschmai*, the scampi with the shallowest depth distribution, bycatch increases and can include tropical snappers (pers. com. John Garvey). In addition to bycatch composition varying with depth profile, the broad expanse of the fishery can result in bycatch gradients associated with latitude and longitude. Fish that are captured are usually discarded as they are generally unmarketable, unpalatable or too small (Evans, 1992).
Management: planned and those implemented	
Management Objectives	*The management objectives from the most recent management plan* A Management Plan is yet to be formalised for the NWSTF. A limited entry policy is currently implemented. A statement of management arrangements is being developed to articulate AFMA's management strategy. AFMA's fisheries management approach is guided by the following objectives: a) implementing efficient and cost-effective management on behalf of the commonwealth; and b) ensuring that the exploitation of fisheries resources and the carrying on of any related activities are conducted in a manner consistent with the principles of ecologically sustainable development and the exercise of the precautionary principle, in particular the need to have regard to the impact of fishing activities on non-target species and the long term sustainability of the marine environment; and c) maximising economic efficiency in the exploitation of fisheries resources; and d) ensuring accountability to the fishing industry and the Australian community in the Authority's management of fisheries resources; and e) achieving Government targets in relation to the recovery of the costs of the Authority. f) ensuring, through proper conservation and management measures, that the living resources of the Australian Fishing Zone (AFZ) are not endangered by over-exploitation; and

	• achieving the optimum utilisation of the living resources of the AFZ.
Fishery management plan	*Is there a fisheries management plan is it in the planning stage or implemented what are the key features* The NWSTF does not have a statutory management plan. Instead it has a Statement of Management Arrangements, describing the arrangements in place for the fishery. The NWSTF is currently managed by limited entry input.
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.* 1. Limited entry. A total of 7 fishing permits are currently allocated to the NWSTF. 2. Gear restriction. Codend mesh size may not exceed 50 millimetres for trawl gear used in the NWSTF. This measure was implemented to discourage the targeting of demersal finfish.
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.* none
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.* Codend mesh size may not exceed 50 millimetres for trawl gear used in the NWSTF. This measure was implemented to discourage the targeting of demersal finfish.
Regulations	*Regulations regarding species (bycatch and byproduct, TEP), habitat, and communities; Marpol and pollution; rules regarding activities at sea such as discarding offal and/or processing at sea.* **1. Species (bycatch, byproduct and TEP):** Mesh size regulations enforced in the NWSTF are designed to limit the catch of non-target, demersal finfish. Due to low catch frequency of TEP species, specific regulations have not been implemented to preclude their capture. A ‘Code of fishing ethics: The capture of sea turtles’ is attached to NWSTF logbooks and provides ‘Turtle Recovery Procedures’ and identification guide as a precautionary measure, acknowledging that the likelihood of turtle capture is minimal in any case. **2. Habitat and communities** Disturbance to habitats and communities is minimised through restricted access
Initiatives and strategies	*BAPs; TEDs; industry codes of conduct, MPAs, Reserves* The following marine protected areas occur within the area of operation of the NWSTF. Commercial fishing is prohibited in these zones. ▪ Cartier Island Marine Reserve, ▪ Ashmore Reef Marine National Nature Reserve and. ▪ Mermaid Reef Marine National Park
Enabling processes	*Monitoring (logbooks, observer data, scientific surveys); assessment (stock assessments); performance indicators (decision rules, processes, compliance; education; consultation process* A shot by shot catch and effort logbook was introduced at the beginning of the fishery. The Western Trawl Fisheries Management Advisory Committee (WESTMAC) is the principal forum where issues relating to the WDWTF are discussed, problems identified and possible solutions developed. It also provides an avenue for consultation between industry, managers, researchers, environment/ conservation and State government officers. WESTMAC holds an annual public meeting and a committee meeting each year in Perth.

Other initiatives or agreements	*State, national or international conventions or agreements that impact on the management of the fishery/sub-fishery being evaluated.* **Offshore Constitutional Settlement** A current Offshore Constitutional Settlement (OCS) was negotiated between the Commonwealth and Western Australian Governments for the management of the WTF. The OCS arrangement was dated 19th December 1994 (Commonwealth of Australia Gazette No. GN 4. 1 Feb 1995). Under this arrangement AFMA has management responsibilities for all species taken by trawl in waters between the 200 m isobath and the 200 nm Australian Fishing Zone limit. The Western Australian Government has management responsibility for all other species taken by non-trawl methods, excluding tuna's, to the seaward boundary of the AFZ. Other key documents that have impacted on management include UNCLOS, Convention on Biodiversity, Straddling Stocks Agreement, FAO (various), MARPOL, National Bycatch Policy and Turtle Recovery Plan.
Data	
Logbook data	*Verified logbook data; data summaries describe programme* A shot by shot catch and effort logbook was introduced at the beginning of the fishery
Observer data	*Observer programme describe parameters as below* Purpose: 1. Keep records of all hauls, commercial catch, bycatch and discarded catch. 2. Collect information on the vessel's details and its fishing gear. 3. Record all interactions and sightings of marine mammals, cetaceans and seabirds. 4. Collect biological data for commercially important species such as Mirror Dory, *Zenopsis nebulosis* and Pink Ling, *Genypterus blacodes.* Data collection: AFMA observers have taken part in 2 trips on the NWSTF – in June 2004 and June 2005. Data collation: Data is stored at AFMA. Data communication: A (confidential) report has been produced for each observer cruise. Data checking:
Other data	*Studies, surveys* In 1988 CSIRO undertook a research project to investigate the population biology of the deepwater crustacea caught in the NWSTF. The results of the studies carried out under the project are reported in the FRDC Project 1988/74: *The fisheries biology of deepwater crustacea and finfish on the continental slope of Western Australia*. *NWSTF* – A FRDC funded commercial survey of the finfish resources within the grounds of the NWSTF was endorsed for three years from 1998 (FRDC 1998/152). The project was designed to establish an understanding of the finfish resources inhabiting the grounds and to provide an information base from which a sustainable finfish fishery could be established. For the purposes of the project previously unendorsed operators were given access to the finfish trawl fishery by means of a scientific permit. However no operators fished in excess of one week and the project concluded a year earlier than initially expected due to the lack of interest caused by the high economic costs and poor catch returns.

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
7	16	12	121	77	11

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

ERA species number	Taxa	Family name	Scientific name	Common name	CAAB code	Reference
15	Invertebrate	Aristaeidae	*Aristaeomorpha foliacea*	Giant red prawn	28712001	From AFMA logbook data
16	Invertebrate	Aristaeidae	*Aristaeopsis edwardsiana*	Scarlet Prawn	28712008	
17	Invertebrate	Solenoceridae	*Haliporoides sibogae*	Royal Red Prawn	28714005	
1326	Invertebrate	Aristaeidae	*Aristeus virilis*	Pink striped prawn	28712003	
1332	Invertebrate	Nephropidae	*Metanephrops australiensis*	Australiensis scampi	28786001	
1333	Invertebrate	Nephropidae	*Metanephrops boschmai*	Boschmai scampi	28786002	
1335	Invertebrate	Nephropidae	*Metanephrops velutinus*	Velvet scampi	28786005	

<u>Byproduct species *North West Slope Trawl Fishery*</u>

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

ERA species number	Taxa	Family name	Scientific name	Common name	CAAB code	Reference
1331	Invertebrate	Pandalidae	*Heterocarpus woodmasoni*	Red carid	28770007	From AFMA logbook data
1334	Invertebrate	Nephropidae	*Metanephrops neptunus*	Neptune scampi	28786003	
2212	Invertebrate	Nephropidae	*Metanephrops sibogae*	Siboga scampi	28786004	
2287	Invertebrate	Nephropidae	*Nephrosis serrata*	Deep-sea scampi	28786007	
2288	Invertebrate	Nephropidae	*Nephrosis stewarti*	Stewart's scampi	28786008	
1998	Invertebrate	Order Teuthoidea	*Order Teuthoidea - undifferentiated*	squid	23615000	
2022	Invertebrate	Palinuridae	*Palinuridae - undifferentiated*	spiny lobsters	28820000	
24	Invertebrate	Scyllaridae	*Thenus orientalis*	BUG	28821008	
600	Teleost	Lutjanidae	*Etelis carbunculus*	Ruby snapper; Northwest Ruby Fish	37346014	
933	Teleost	Ophidiidae	*Genypterus blacodes*	Ling	37228002	
888	Teleost	Trachichthyidae	*Gephyroberyx darwinii*	darwin's roughy	37255004	
683	Teleost	Lutjanidae	*Lutjanus erythropterus*	Saddle-tailed Sea Perch	37346005	
684	Teleost	Lutjanidae	*Lutjanus malabaricus*	Scarlet Sea Perch / Large Mouth Nannygai	37346007	
158	Teleost	Sparidae	*Pagrus auratus*	Snapper/Squirefish	37353001	
1088	Teleost	Carangidae	*Trachurus declivis*	Jack Mackerel	37337002	
1097	Teleost	Zeidae	*Zenopsis nebulosus*	Mirror Dory	37264003	

<u>Discard species *North West Slope Trawl Fishery*</u>

List the discard (bycatch) species (excluding TEP species) of the 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. The list of bycatch species is obtained by reviewing all available fishery literature, including logbooks, observer reports and discussions with stakeholders.

ERA species number	Taxa	Family name	Scientific name	Common name	CAAB code	Reference
286	Chondrichthyan	Callorhinchidae	*Callorhinchus milii*	Elephantfish	37043001	From AFMA logbook data
534	Chondrichthyan	Chimaeridae	*Chimaera sp. E*	Marbled Ghostshark	37042009	
2046	Chondrichthyan	Dasyatidae	*Dasyatidae - undifferentiated*	stingrays	37035000	
956	Chondrichthyan	Chimaeridae	*Hydrolagus ogilbyi*	Ogilbys Ghost Shark	37042001	
2042	Chondrichthyan	Squalidae	*Squalidae - undifferentiated*	dogfishes	37020000	
2026	Invertebrate	infraorder Brachyura	*Brachyura - undifferentiated*	crabs	28850000	
2010	Invertebrate	Class Asteroidea	*Class Asteroidea - undifferentiated*	starfish	25102000	
1330	Invertebrate	Pandalidae	*Heterocarpus sibogae*	White carid	28770005	
1981	Invertebrate		*Porifera - undifferentiated*	sponges	10000000	
1983	Invertebrate	Class Scyphozoa	*Scyphozoa spp - undifferentiated*	jellyfish	11120000	
332	Teleost	Berycidae	*Centroberyx affinis*	Redfish	37258003	
195	Teleost	Uranoscopidae	*Pleuroscopus pseudodorsalis*	blue stargazer	37400005	
86	Teleost	Trachipteridae	*Trachipterus arawatae*	Ribbon or Dealfish	37271001	

<u>TEP species *North West Slope Trawl Fishery*</u>
List the TEP species that occur in the area of the sub-fishery. Highlight species that are known to interact directly with the fishery. TEP species are those species listed as Threatened, Endangered or Protected under the EPBC Act.

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

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

ERA species number	Taxa	Family name	Scientific name	Common name	CAAB code
313	Chondrichthyan	Odontaspididae	*Carcharias taurus*	grey nurse shark	37008001
315	Chondrichthyan	Lamnidae	*Carcharodon carcharias*	white shark	37010003
1067	Chondrichthyan	Rhincodontidae	*Rhincodon typus*	whale shark	37014001
1438	Marine bird	Laridae	*Anous minutus*	Black Noddy	40128001
203	Marine bird	Laridae	*Anous stolidus*	Common noddy	40128002
67	Marine bird	Laridae	*Anous tenuirostris*	Lesser noddy	40128003
2272	Marine bird	Laridae	*Anous tenuirostris melanops*	Australian Lesser Noddy	
1580	Marine bird	Procellariidae	*Calonectris leucomelas*	streaked shearwater	40041002
829	Marine bird	Fregatidae	*Fregata ariel*	Lesser frigatebird	40050002
1435	Marine bird	Fregatidae	*Fregata minor*	Great Frigatebird	40050003
974	Marine bird	Laridae	*Larus novaehollandiae*	Silver Gull	40128013
73	Marine bird	Procellariidae	*Macronectes giganteus*	Southern Giant-Petrel	40041007
1431	Marine bird	Laridae	*Phaethon lepturus*	White-tailed Tropicbird	40045001
1432	Marine bird	Phaethontidae	*Phaethon rubricauda*	Red-tailed Tropicbird	40045002
1048	Marine bird	Procellariidae	*Pterodroma mollis*	Soft-plumaged Petrel	40041032
1059	Marine bird	Procellariidae	*Puffinus pacificus*	Wedge-tailed Shearwater	40041045
1015	Marine bird	Laridae	*Sterna anaethetus*	Bridled Tern	40128023

ERA species number	Taxa	Family name	Scientific name	Common name	CAAB code
1017	Marine bird	Laridae	*Sterna bergii*	Crested Tern	40128025
1018	Marine bird	Laridae	*Sterna caspia*	Caspian Tern	40128026
1019	Marine bird	Laridae	*Sterna dougallii*	Roseate tern	40128027
1020	Marine bird	Laridae	*Sterna fuscata*	Sooty tern	40128028
1433	Marine bird	Sulidae	*Sula dactylatra*	Masked Booby	40047004
881	Marine bird	Sulidae	*Sula leucogaster*	Brown boobies	40047005
1434	Marine bird	Sulidae	*Sula sula*	Red-footed Booby	40047006
256	Marine mammal	Balaenopteridae	*Balaenoptera acutorostrata*	Minke Whale	41112001
1439	Marine mammal	Balaenidae	*Balaenoptera bonaerensis*	Antarctic Minke Whale	41112007
261	Marine mammal	Balaenopteridae	*Balaenoptera borealis*	Sei Whale	41112002
262	Marine mammal	Balaenopteridae	*Balaenoptera edeni*	Bryde's Whale	41112003
265	Marine mammal	Balaenopteridae	*Balaenoptera musculus*	Blue Whale	41112004
612	Marine mammal	Delphinidae	*Delphinus delphis*	Common Dolphin	41116001
813	Marine mammal	Dugongidae	*Dugong dugon*	Dugong	41206001
902	Marine mammal	Delphinidae	*Feresa attenuata*	Pygmy Killer Whale	41116002
934	Marine mammal	Delphinidae	*Globicephala macrorhynchus*	Short-finned Pilot Whale	41116003
937	Marine mammal	Delphinidae	*Grampus griseus*	Risso's Dolphin	41116005
1440	Marine mammal	Ziphiidae	*Indopacetus pacificus*	Longman's Beaked Whale	41120003
968	Marine mammal	Physeteridae	*Kogia breviceps*	Pygmy Sperm Whale	41119001
969	Marine mammal	Physeteridae	*Kogia simus*	Dwarf Sperm Whale	41119002
970	Marine mammal	Delphinidae	*Lagenodelphis hosei*	Fraser's Dolphin	41116006
984	Marine mammal	Balaenopteridae	*Megaptera novaeangliae*	Humpback Whale	41112006
986	Marine mammal	Ziphiidae	*Mesoplodon densirostris*	Blainville's Beaked Whale	41120005
987	Marine mammal	Ziphiidae	*Mesoplodon gingkodens*	Gingko Beaked Whale	41120006
860	Marine mammal	Delphinidae	*Orcaella brevirostris*	Irrawaddy dolphin	41116010
1002	Marine mammal	Delphinidae	*Orcinus orca*	Killer Whale	41116011
1007	Marine mammal	Delphinidae	*Peponocephala electra*	Melon-headed Whale	41116012
1036	Marine mammal	Physeteridae	*Physeter catodon*	Sperm Whale	41119003
1044	Marine mammal	Delphinidae	*Pseudorca crassidens*	False Killer Whale	41116013
1076	Marine mammal	Delphinidae	*Sousa chinensis*	Indo-Pacific Humpback Dolphin	41116014

ERA species number	Taxa	Family name	Scientific name	Common name	CAAB code
1080	Marine mammal	Delphinidae	*Stenella attenuata*	Spotted Dolphin	41116015
1081	Marine mammal	Delphinidae	*Stenella coeruleoalba*	Striped Dolphin	41116016
1082	Marine mammal	Delphinidae	*Stenella longirostris*	Long-snouted Spinner Dolphin	41116017
1083	Marine mammal	Delphinidae	*Steno bredanensis*	Rough-toothed Dolphin	41116018
1494	Marine mammal	Delphinidae	*Tursiops aduncus*	Indian Ocean bottlenose dolphin	41116020
1091	Marine mammal	Delphinidae	*Tursiops truncatus*	Bottlenose Dolphin	41116019
1098	Marine mammal	Ziphiidae	*Ziphius cavirostris*	Cuvier's Beaked Whale	41120012
1408	Marine reptile	Hydrophiidae	*Acalyptophis peronii*	Horned Seasnake	39125001
1409	Marine reptile	Hydrophiidae	*Aipysurus apraefrontalis*	Short-nosed Seasnake	39125002
1410	Marine reptile	Hydrophiidae	*Aipysurus duboisii*	Dubois' Seasnake	39125003
1411	Marine reptile	Hydrophiidae	*Aipysurus eydouxii*	Spine-tailed Seasnake	39125004
1412	Marine reptile	Hydrophiidae	*Aipysurus foliosquama*	Leaf-scaled Seasnake	39125005
1413	Marine reptile	Hydrophiidae	*Aipysurus fuscus*	Dusky Seasnake	39125006
1414	Marine reptile	Hydrophiidae	*Aipysurus laevis*	Olive Seasnake, Golden Seasnake	39125007
1415	Marine reptile	Hydrophiidae	*Aipysurus tenuis*	Brown-lined Seasnake	39125008
254	Marine reptile	Hydrophiidae	*Astrotia stokesii*	Stokes' seasnake	39125009
324	Marine reptile	Cheloniidae	*Caretta caretta*	Loggerhead	39020001
541	Marine reptile	Cheloniidae	*Chelonia mydas*	Green turtle	39020002
613	Marine reptile	Dermochelyidae	*Dermochelys coriacea*	Leathery turtle	39021001
1530	Marine reptile	Hydrophiidae	*Disteira kingii*	spectacled seasnake	39125010
1416	Marine reptile	Hydrophiidae	*Disteira major*	Olive-headed Seasnake	39125011
1417	Marine reptile	Hydrophiidae	*Emydocephalus annulatus*	Turtle-headed Seasnake	39125012
1418	Marine reptile	Hydrophiidae	*Enhydrina schistosa*	Beaked Seasnake	39125013
1419	Marine reptile	Hydrophiidae	*Ephalophis greyi*	North-western Mangrove Seasnake	39125014
822	Marine reptile	Cheloniidae	*Eretmochelys imbricata*	Hawksbill turtle	39020003
1420	Marine reptile	Hydrophiidae	*Hydrelaps darwiniensis*	Black-ringed Seasnake	39125015
1421	Marine reptile	Hydrophiidae	*Hydrophis coggeri*	Slender-necked Seasnake	39125019
1531	Marine reptile	Hydrophiidae	*Hydrophis czeblukovi*	fine-spined seasnake	39125020
957	Marine reptile	Hydrophiidae	*Hydrophis elegans*	Elegant seasnake	39125021
1422	Marine reptile	Hydrophiidae	*Hydrophis mcdowelli*	seasnake	39125025

ERA species number	Taxa	Family name	Scientific name	Common name	CAAB code
1423	Marine reptile	Hydrophiidae	*Hydrophis ornatus*	seasnake	39125028
1424	Marine reptile	Hydrophiidae	*Lapemis hardwickii*	Spine-bellied Seasnake	39125031
857	Marine reptile	Cheloniidae	*Natator depressus*	Flatback turtle	39020005
1005	Marine reptile	Hydrophiidae	*Pelamis platurus*	yellow-bellied seasnake	39125033
319	Teleost	Syngnathidae	*Acentronura larsonae*	Helen's Pygmy Pipehorse	37282036
56	Teleost	Syngnathidae	*Bhanotia fasciolata*	Corrugated Pipefish, Barbed Pipefish	37282104
53	Teleost	Syngnathidae	*Bulbonaricus brauni*	Braun's Pughead Pipefish, Pug-headed Pipefish	37282037
546	Teleost	Syngnathidae	*Campichthys tricarinatus*	Three-keel Pipefish	37282040
388	Teleost	Syngnathidae	*Choeroichthys brachysoma*	Pacific Short-bodied Pipefish, Short-bodied pipefish	37282042
387	Teleost	Syngnathidae	*Choeroichthys latispinosus*	Muiron Island Pipefish	37282044
389	Teleost	Syngnathidae	*Choeroichthys suillus*	Pig-snouted Pipefish	37282046
563	Teleost	Syngnathidae	*Corythoichthys amplexus*	Fijian Banded Pipefish, Brown-banded Pipefish	37282047
566	Teleost	Syngnathidae	*Corythoichthys conspicillatus*	Yellow-banded Pipefish, Network Pipefish	37282032
52	Teleost	Syngnathidae	*Corythoichthys intestinalis*	Australian Messmate Pipefish, Banded Pipefish	37282049
452	Teleost	Syngnathidae	*Corythoichthys schultzi*	Schultz's Pipefish	37282052
401	Teleost	Syngnathidae	*Cosmocampus banneri*	Roughridge Pipefish	37282053
55	Teleost	Syngnathidae	*Doryrhamphus janssi*	Cleaner Pipefish, Janss' Pipefish	37282059
568	Teleost	Syngnathidae	*Doryrhamphus malus*	Flagtail Pipefish, Negros Pipefish	37282060
569	Teleost	Syngnathidae	*Doryrhamphus melanopleura*	Bluestripe Pipefish	37282058
361	Teleost	Syngnathidae	*Dunckerocampus dactyliophorus*	Ringed Pipefish	37282057
386	Teleost	Syngnathidae	*Dunckerocampus pessuliferus*	Many-banded Pipefish	37282108
321	Teleost	Syngnathidae	*Festucalex scalaris*	Ladder Pipefish	37282063
914	Teleost	Syngnathidae	*Filicampus tigris*	Tiger Pipefish	37282064
54	Teleost	Syngnathidae	*Halicampus brocki*	Brock's Pipefish	37282065

ERA species number	Taxa	Family name	Scientific name	Common name	CAAB code
359	Teleost	Syngnathidae	*Halicampus dunckeri*	Red-hair Pipefish, Duncker's Pipefish	37282066
938	Teleost	Syngnathidae	*Halicampus grayi*	Mud Pipefish, Gray's Pipefish	37282030
57	Teleost	Syngnathidae	*Halicampus nitidus*	Glittering Pipefish	37282069
454	Teleost	Syngnathidae	*Halicampus spinirostris*	Spiny-snout Pipefish	37282070
360	Teleost	Syngnathidae	*Haliichthys taeniophorus*	Ribboned Seadragon, Ribboned Pipefish	37282007
945	Teleost	Syngnathidae	*Hippichthys penicillus*	Beady Pipefish, Steep-nosed Pipefish	37282075
549	Teleost	Syngnathidae	*Hippocampus angustus*	Western Spiny Seahorse	37282005
453	Teleost	Syngnathidae	*Hippocampus jugumus*	Spiny Seahorse	37282112
951	Teleost	Syngnathidae	*Hippocampus planifrons*	Flat-face Seahorse	37282078
318	Teleost	Syngnathidae	*Hippocampus spinosissimus*	Hedgehog Seahorse	
949	Teleost	Syngnathidae	*Hippocampus taeniopterus*	Spotted Seahorse, Yellow Seahorse	37282033
547	Teleost	Syngnathidae	*Micrognathus micronotopterus*	Tidepool Pipefish	37282088
32	Teleost	Eleotridae	*Milyeringa veritas*	Blind Gudgeon	37429032
362	Teleost	Syngnathidae	*Phoxocampus belcheri*	Rock Pipefish	37282109
320	Teleost	Syngnathidae	*Solegnathus guentheri*	Indonesian Pipefish, Gunther's Pipehorse	37282003
1071	Teleost	Syngnathidae	*Solegnathus sp. 1 [in Kuiter, 2000]*	Pipehorse	37282099
1074	Teleost	Solenostomidae	*Solenostomus cyanopterus*	Blue-finned Ghost Pipefish, Robust Ghost	37281001
1029	Teleost	Syngnathidae	*Syngnathoides biaculeatus*	Double-ended Pipehorse, Alligator Pipefish	37282100
1089	Teleost	Syngnathidae	*Trachyrhamphus bicoarctatus*	Bend Stick Pipefish, Short-tailed Pipefish	37282006
322	Teleost	Syngnathidae	*Trachyrhamphus longirostris*	Long-nosed Pipefish, Straight Stick Pipefish	37282101

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 derived list of Benthic habitats for the North West Slope Trawl Fishery. Due to the lack of habitat image data for this region, this list of habitats is inferred using the Habitat Scoping Method 2. Scoping Steps involved:

- inclusion of existing WDWTF habitat data. Ideally the data from the adjacent fisheries would inform the bulk of this list, however data was accessible for only the WDWTF on the Southern most NWSTF boundary. A benthic habitat list for the NPF which adjoins the Northeastern edge of the NWSTF was not yet completed.
- mapping the Geomorphic Units (GU), or features occurring within the jurisdictional boundary of the fishery. Some subsequent rationalization of all Geomorphic Units identified, was done to provide consistency with particular features previously identified by survey, recorded in the ERAEF database of Commonwealth Fishery habitats. In line with a precautionary approach, all ERAEF habitats associated with specific upper slope (200-700m) features were added. These included, Canyons (which included upper slope GU areas identified as canyons, trenches, and troughs), Seamounts (considered representative of types that may occur on the NWS GU features identified as pinnacles and plateaus), shelf break (the section extending into the upper edge of the upper slope), terraces, and the slope, and four types considered likely to occur (# 1-4).
- Inclusion of all soft sediment habitats, as this fishery targets these types of terrain. Effort does not occur in <200m, or rarely, > 700m, therefore is considered only for the upper slope of the NWS.

Inevitably, this alternative scoping method generates a conservatively large list of potentially encounterable habitats, many of which are similar to each other, varying in only one aspect of substratum, geomorphology or fauna. Shading denotes habitats occurring within the jurisdictional boundary of the fishery that are not subject to effort from crustacean trawling.

	ERA Habitat #	Sub-biome	Feature	ERA Habitat type	SGF Score	Depth (m)	Image available	Reference image location
3683	202	upper slope	Terrace, Slope	mud, unrippled, no fauna	000	200- 700	Y	Habitat Image Collection
3663	143	upper slope	slope	mud, unrippled, large sponges	001	200- 700	N	TBC
3662	142	upper slope	slope	mud, unrippled, encrustors	006	200- 700	Y	Habitat Image Collection
3664	144	upper slope	Canyon, Slope	Mud, Unrippled, Sedentary	007	200-700	Y	Habitat Image Collection
3661	141	upper slope	Slope	mud, unrippled, bioturbators	009	200- 700	Y	Habitat Image Collection
3660	140	upper slope	slope	mud, irregular, bioturbators	039	200- 700	Y	Habitat Image Collection
3620	046	upper slope	slope	fine sediments, unrippled, no fauna	100	200- 700	Y	Habitat Image Collection
3697	227	upper slope	Slope	Fine sediments, unrippled, large sponges	101	200- 700	Y	Habitat Image Collection
3657	137	upper slope	slope	fine sediments, unrippled, small sponges	102	200- 700	Y	Habitat Image Collection
3656	136	upper slope	slope	fine sediments, unrippled, encrustors	106	200- 700	Y	Habitat Image Collection
3644	078	upper slope	Canyon, Terrace, Slope	Fine sediments, unrippled, Solitary epifauna	107	200- 700	2	Habitat Image Collection
3618	044	upper slope	slope, canyon, terrace	fine sediments, unrippled, bioturbators	109	200- 700	Y	Habitat Image Collection
3654	133	upper slope	Slope	Fine sediments, current rippled, no fauna	110	200- 700	Y	Habitat Image Collection
3641	073	upper slope	Canyon, Terrace	Fine sediments, irregular, Small encrustors / erect forms (including bryozoans)	136	200-700	Y	Habitat Image Collection
3700	231	upper slope	Slope	Fine sediments, irregular, glass sponge (stalked)	137	200- 700	Y	Habitat Image Collection
3616	041	upper slope	Slope	Fine sediments, irregular, bioturbators	139	200- 700	3	Habitat Image Collection
3655	134	upper slope	slope	fine sediments, subcrop, large sponges	151	200- 700	N	TBC
3643	077	upper slope	canyon, slope	fine sediments, subcrop, small sponges	152	200- 700	Y	Habitat Image Collection
3615	040	upper slope	slope	fine sediments, subcrop, sedentary	157	200- 700	Y	Habitat Image Collection
3728	284	upper slope	slope	Coarse sediments, unrippled, large sponges	201	200- 700	Y	Habitat Image Collection
3729	285	upper slope	slope	Coarse sediments, unrippled, octocorals	205	200- 700	Y	Habitat Image Collection
3617	043	upper slope	slope	coarse sediments, unrippled, low mixed encrustors	206	200- 700	Y	Habitat Image Collection
3619	045	upper slope	slope	coarse sediments, unrippled, sedentary	207	200- 700	Y	Habitat Image Collection
3702	235	upper slope	Slope	Coarse sediments, rippled, no fauna	210	200- 700	Y	Habitat Image Collection
3703	236	upper slope	Slope	Coarse sediments, rippled, solitary epifauna	217	200- 700	Y	Habitat Image Collection
3704	237	upper slope	Slope	Coarse sediments, wave rippled, bryozoan turf	226	200- 700	Y	Habitat Image Collection
3705	238	upper slope	Slope	Coarse sediments, irregular, octocorals (matrix of solsomalia)	235	200- 700	Y	Habitat Image Collection
3642	076	upper slope	canyon, slope	coarse sediments, irregular, low mixed encrustors	236	200- 700	Y	Habitat Image Collection

	ERA Habitat #	Sub-biome	Feature	ERA Habitat type	SGF Score	Depth (m)	Image available	Reference image location
3640	072	upper slope	Slope	Coarse sediments, rippled, bioturbators	239	200- 700	Y	Habitat Image Collection
3706	239	upper slope	Slope	Coarse sediments, subcrop, large sponges	251	200- 700	Y	Habitat Image Collection
3707	240	upper slope	Slope	Sedimentary rock, subcrop, octocorals	655	200- 700	Y	Habitat Image Collection
3708	241	upper slope	Slope	Coarse sediments, subcrop, low encrusting community	256	200- 700	Y	Habitat Image Collection
3658	138	upper slope	slope	gravel, debris flow, encrustors	346	200- 700	Y	Habitat Image Collection
3651	130	upper slope	slope	cobble, debris flow, no fauna	440	200- 700	Y	Habitat Image Collection
3653	132	upper slope	slope	cobble, debris flow, small sponges	442	200- 700	Y	Habitat Image Collection
3652	131	upper slope	slope	cobble, debris flow, octocorals	445	200- 700	N	Habitat Image Collection
3650	129	upper slope	slope	cobble, debris flow, encrustors	446	200- 700	Y	Habitat Image Collection
3730	286	upper slope	slope	Cobble/ boulder, debris, sedentary	447	200- 700	Y	Habitat Image Collection
3637	069	upper slope	canyon	cobble, low outcrop, crinoids	464	200- 700	Y	Habitat Image Collection
3712	247	upper slope	Slope	boulders, low outcrop, no fauna	470	200- 700	Y	Habitat Image Collection
3731	287	upper slope	slope	slabs and boulders, low outcrop, octocorals	475	200- 700	Y	Habitat Image Collection
3732	288	upper slope	slope	Igneous Rock (?), low outcrop, octocorals	565	200- 700	Y	Habitat Image Collection
3733	289	upper slope	slope	Igneous Rock (?), low outcrop, mixed faunal community	573	200- 700	Y	Habitat Image Collection
3734	290	upper slope	slope	Igneous Rock (?), high outcrop, no fauna	590	200- 700	Y	Habitat Image Collection
3735	291	upper slope	slope	Igneous Rock (?), high outcrop, mixed faunal community	593	200- 700	Y	Habitat Image Collection
3716	251	upper slope	Slope	Sedimentary rock, subcrop, no fauna	650	200- 700	Y	Habitat Image Collection
3636	067	upper slope	canyon, slope	Sedimentary rock, subcrop, large sponges	651	200- 700	Y	Habitat Image Collection
3638	070	upper slope	canyon	Sedimentary rock, subcrop, small sponges	652	200- 700	Y	Habitat Image Collection
3610	033	upper slope	slope	Sedimentary rock, subcrop, mixed faunal community	653	200- 700	Y	Habitat Image Collection
3667	148	upper slope	Terrace, Slope	Sedimentary rock, Subcrop, Octocorals (gold corals / seawhips)	655	200-700	Y	Habitat Image Collection
3613	036	upper slope	Slope	Sedimentary rock, subcrop, small encrustors	656	200- 700	Y	Habitat Image Collection
3736	292	upper slope	slope	Sedimentary Rock (?), subcrop, sedentary	657	200- 700	Y	Habitat Image Collection
3719	256	upper slope	Slope	Sedimentary rock, low outcrop, octocorals	665	200- 700	Y	Habitat Image Collection
3612	035	upper slope	Slope	Sedimentary rock, low outcrop, small encrustors	666	200- 700	Y	Habitat Image Collection
3720	257	upper slope	Shelf break	Sedimentary rock, low outcrop, no fauna	670	200- 700	3	Habitat Image Collection
3665	145	upper slope	Canyon	Sedimentary rock, low outcrop, large sponges	671	200- 700	2	Habitat Image Collection

	ERA Habitat #	Sub-biome	Feature	ERA Habitat type	SGF Score	Depth (m)	Image available	Reference image location
3666	146	upper slope	slope	Sedimentary rock, low outcrop, small sponges	672	200- 700	Y	Habitat Image Collection
3692	216	upper slope	Canyon	Sedimentary rock, low outcrop, Octocorals (gold corals / seawhips)	675	200-700	Y	Habitat Image Collection
3639	071	upper slope	Shelf break	Sedimentary rock, low outcrop, small encrustors	676	200- 700	3	Habitat Image Collection
3721	261	upper slope	Slope	Sedimentary rock, low outcrop, sedentary	677	200- 700	Y	Habitat Image Collection
3723	264	upper slope	Slope	Sedimentary rock, high outcrop, octocorals	683	200- 700	Y	Habitat Image Collection
3614	039	upper slope	slope	Sedimentary rock, high outcrop, crinoids	684	200- 700	Y	Habitat Image Collection
3693	217	upper slope	Canyon	Sedimentary rock, High Outcrop, Small encrustors / erect forms	686	200-700	Y	Habitat Image Collection
3694	218	upper slope	Canyon	Sedimentary rock, High Outcrop, Sedentary: e.g. seapens	687	200-700	Y	Habitat Image Collection
3724	265	upper slope	Slope	Sedimentary rock, high outcrop, no fauna	690	200- 700	3	Habitat Image Collection
3725	267	upper slope	Slope	Sedimentary rock, high outcrop, small sponges	692	200- 700	Y	Habitat Image Collection
3635	066	upper slope	canyon	Sedimentary rock, high outcrop, crinoids	694	200- 700	Y	Habitat Image Collection
3726	269	upper slope	Slope	Sedimentary, high outcrop, octocorals	695	200- 700	Y	Habitat Image Collection
3611	034	upper slope	slope	Sedimentary rock, high outcrop, encrustors	696	200- 700	Y	Habitat Image Collection
3727	270	upper slope	Slope	Sedimentary, high outcrop, solitary epifauna	697	200- 700	Y	Habitat Image Collection
3737	293	upper slope	slope	Rock/ biogenic matrix, low outcrop, mixed faunal community	763	200- 700	Y	Habitat Image Collection
3649	128	upper slope	slope	Bryozoan based communities	XX6	200- 700	Y	Habitat Image Collection
#1	TBC	upper slope	slope	Likely: fine seds, subcrop, mixed faunal community (corals)	153	200- 700	N	TBC
#2	TBC	upper slope	slope	Likely: fine seds, low outcrop, mixed faunal community (corals)	173	200- 700	N	TBC
#3	TBC	upper slope	slope	Likely: coarse seds, subcrop, mixed faunal community (corals)	253	200- 700	N	TBC
#4	TBC	upper slope	slope	Likely: coarse seds, low outcrop, mixed faunal community (corals)	273	200- 700	N	TBC
3621	049	mid-slope	slope	Igneous rock, high outcrop, crinoids	594	700- 1500	Y	Habitat Image Collection
3622	050	mid-slope	slope	cobble, debris flow, encrustors	446	700- 1500	Y	Habitat Image Collection
3623	051	mid-slope	slope	cobble, outcrop, no fauna	460	700- 1500	Y	Habitat Image Collection
3624	052	mid-slope	slope	Sedimentary rock, outcrop, octocorals	675	700- 1500	Y	Habitat Image Collection
3625	053	mid-slope	slope	Igneous rock, low outcrop, sedentary	567	700- 1500	Y	Habitat Image Collection
3626	054	mid-slope	slope	Sedimentary rock, outcrop, crinoids	694	700- 1500	Y	Habitat Image Collection
3627	056	mid-slope	slope, canyons, seamounts	Sedimentary rock, outcrop, mixed faunal community	673	700- 1500	Y	Habitat Image Collection
3628	057	mid-slope	slope	fine sediments, subcrop, bioturbators	150	700- 1500	Y	Habitat Image Collection

	ERA Habitat #	Sub-biome	Feature	ERA Habitat type	SGF Score	Depth (m)	Image available	Reference image location
3629	058	mid-slope	slope	cobble, unrippled, small sponges	402	700- 1500	Y	Habitat Image Collection
3630	059	mid-slope	Seamount	Coarse sediments, Highly irregular, Small encrustors / erect forms (including bryozoans)	236	700-1500	Y	Habitat Image Collection
3631	061	mid-slope	slope	fine sediments, irregular, bioturbators	139	700- 1500	Y	Habitat Image Collection
3632	062	mid-slope	slope	coarse sediments, unrippled, octocorals	205	700- 1500	Y	Habitat Image Collection
3633	063	mid-slope	slope	fine sediments, unrippled, octocorals	105	700- 1500	Y	Habitat Image Collection
3634	064	mid-slope	slope	Sedimentary slab and mud boulders, outcrop, crinoids	464	700- 1500	Y	Habitat Image Collection
3645	080	mid-slope	Terrace, Seamount	Sedimentary rock, Low Outcrop, Small encrustors	676	700-1500	Y	Habitat Image Collection
3646	081	mid-slope	seamount	Sedimentary rock, unrippled, no fauna	600	700- 1500	Y	Habitat Image Collection
3647	084	mid-slope	Canyon, Seamount	Sedimentary rock, Low Outcrop, Sedentary: e.g. seapens	677	700-1500	Y	Habitat Image Collection
3648	085	mid-slope	seamount	Sedimentary rock, unrippled, encrustors	606	700- 1500	Y	Habitat Image Collection
3668	150	mid-slope	slope	coarse sediments, current rippled, no fauna	210	700- 1500	N	Habitat Image Collection
3669	151	mid-slope	slope	coarse sediments, current rippled, octocorals	215	700- 1500	N	Habitat Image Collection
3670	152	mid-slope	slope	Coarse sediments, current rippled, sedentary	217	700- 1500	Y	Habitat Image Collection
3671	153	mid-slope	slope	coarse sediments, unrippled, no fauna	200	700- 1500	N	Habitat Image Collection
3672	154	mid-slope	slope	cobble, debris flow, crinoids	444	700- 1500	N	Habitat Image Collection
3673	155	mid-slope	slope	slabs/ boulders, debris flow, octocorals	445	700- 1500	Y	Habitat Image Collection
3674	156	mid-slope	Terrace, Slope	Fine sediments, Unrippled, No fauna	100	700-1500	Y	Habitat Image Collection
3675	157	mid-slope	Slope	Igneous rock, high outcrop, octocoral	595	700-1500	Y	Habitat Image Collection
3676	158	mid-slope	slope	mud, current rippled, bioturbators	019	700- 1500	N	Habitat Image Collection
3677	159	mid-slope	Slope	Mud, irregular, bioturbators	039	700-1500	Y	Habitat Image Collection
3678	160	mid-slope	slope	mud, irregular, sedentary	037	700- 1500	N	Habitat Image Collection
3679	161	mid-slope	slope	mud, unrippled, small sponges	002	700- 1500	N	Habitat Image Collection
3680	163	mid-slope	Terrace, Slope	Sedimentary rock, High Outcrop, Octocorals (gold corals / seawhips)	695	700-1500	Y	Habitat Image Collection
3681	164	mid-slope	slope	Sedimentary rock, subcrop, crinoids	654	700- 1500	Y	Habitat Image Collection
3682	165	mid-slope	Slope	Sedimentary, subcrop, octocoral	655	700-1500	Y	Habitat Image Collection
3684	207	mid-slope	Terrace	Coarse sediments, Current rippled / directed scour, Small encrustors / erect forms (including bryozoans)	216	700-1500	Y	Habitat Image Collection
3685	208	mid-slope	Seamount	Coarse sediments, Highly irregular, Mixed faunal community (sponges, seawhips, ascidians)	233	700-1500	Y	Habitat Image Collection

´	ERA Habitat #	Sub-biome	Feature	ERA Habitat type	SGF Score	Depth (m)	Image available	Reference image location
3686	210	mid-slope	Seamount	Cobble/ boulder, Debris flow / rubble banks, Sedentary: e.g. seapens	447	700-1500	Y	Habitat Image Collection
3687	211	mid-slope	Seamount	Igneous / metamorphic rock, Subcrop, Small encrustors	556	700-1500	Y	Habitat Image Collection
3688	212	mid-slope	Seamount	Igneous / metamorphic rock, Subcrop, Sedentary: e.g. seapens	557	700-1500	Y	Habitat Image Collection
3689	213	mid-slope	Seamount	Igneous rock (?), outcrop, octocoral	575	700-1500	Y	Habitat Image Collection
3690	214	mid-slope	Seamount	Igneous / metamorphic rock, Low Outcrop, Small encrustors	576	700-1500	Y	Habitat Image Collection
3691	215	mid-slope	Seamount	Igneous / metamorphic rock, Low Outcrop, Sedentary: e.g. seapens	577	700-1500	Y	Habitat Image Collection
3695	221	mid-slope	Slope	Mud, irregular (bioturbators), crinoids/ featherstars on whip	005	700-1500	Y	Habitat Image Collection
3696	222	mid-slope	Slope	Mud, flat, solitary	007	700-1500	Y	Habitat Image Collection
3698	228	mid-slope	Slope	Fine, unrippled, solitary	107	700-1500	Y	Habitat Image Collection
3699	230	mid-slope	Slope	fine sediments, irregular, no fauna	130	700-1500	Y	Habitat Image Collection
3701	232	mid-slope	Slope	Fine sediments, subcrop, octocorals	155	700-1500	Y	Habitat Image Collection
3709	243	mid-slope	Slope	Gravel, irregular, low encrustings	336	700-1500	2	Habitat Image Collection
3710	244	mid-slope	Slope	Igneous rock/boulder, rubble bank, none	440	700-1500	Y	Habitat Image Collection
3711	245	mid-slope	Slope	boulders and slabs, subcropping, octocorals	455	700-1500	Y	Habitat Image Collection
3713	248	mid-slope	Slope	Igneous rock, rubble bank, no fauna	540	700-1500	Y	Habitat Image Collection
3714	249	mid-slope	Seamount	Igneous rock, rubble bank, octocorals	545	700-1500	Y	Habitat Image Collection
3715	250	mid-slope	Seamount	Igneous rock, low outcrop, no fauna	570	700-1500	Y	Habitat Image Collection
3717	252	mid-slope	Slope	Sedimentary, subcrop, small encrustors	656	700-1500	2	Habitat Image Collection
3718	253	mid-slope	Slope	rock (conglomerate/sedimentary), subcrop, bioturbators	659	700-1500	Y	Habitat Image Collection
3722	262	mid-slope	Slope	sedimentary/mudstone, high outcrop, no fauna	680	700-1500	Y	Habitat Image Collection
3738	294	mid-slope	slope	Fine sediments, unrippled, bioturbators	109	700- 1500	Y	Habitat Image Collection
3739	295	mid-slope	slope	Fine sediments, subcrop, encrustors	156	700- 1500	Y	Habitat Image Collection
3740	296	mid-slope	slope	Coarse sediments, irregular, no fauna	230	700- 1500	Y	Habitat Image Collection
3741	297	mid-slope	slope	Coarse sediments, subcrop, no fauna	250	700- 1500	Y	Habitat Image Collection
3742	298	mid-slope	slope	Coarse sediments, low outcrop, no fauna	260	700- 1500	Y	Habitat Image Collection

Scoping Document S2B2. Pelagic Habitats

A list of the pelagic habitats for the North West Slope Trawl Fishery.

ERAEF Habitat Number	Pelagic Habitat type	Depth (m)	Comments	Reference
P6	North Western Pelagic Province - Oceanic	0 – > 800	this is a compilation of the range covered by Oceanic Community (1) and (2)	dow167A1, A2, A4

Scoping Document S2C1. Demersal communities

In ERAEF, communities are defined as the set of species assemblages that occupy the large scale provinces and biomes identified from national bioregionalisation studies. The biota includes mobile fauna, both vertebrate and invertebrate, but excludes sessile organisms such as corals that are largely structural and are used to identify benthic habitats. The same community lists are used for all fisheries, with those selected as relevant for a particular fishery being identified on the basis of spatial overlap with effort in the fishery. The spatial boundaries for demersal communities are based on IMCRA boundaries for the shelf, and on slope 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 in which fishing activity occurs in the North West Slope trawl subfishery (x). Shaded cells indicate all communities within the province.

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

Scoping Document S2C2. Pelagic communities

Pelagic communities that overlie the demersal communities in which fishing activity occurs in the North West Slope trawl subfishery (x). Shaded cells indicate all communities that exist in the province.

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

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

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

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

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

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

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

Scoping Document S3 Components and Sub-components Identification of Objectives

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

Component	Core Objective	Sub-component	Example Operational Objectives	Example Indicators	Rationale
	"What is the general goal?"	*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 add in rationale for each objective 1.2 1.3 1.4
		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
		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

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
		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 5.2
		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
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 1.2 1.3 1.4

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

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

Component	Core Objective	Sub-component	Example Operational Objectives	Example Indicators	Rationale
		5. Reproductive Capacity	5.1 Fecundity of the population does not change outside acceptable bounds (e.g. more than X% of reference population fecundity) Recruitment to the population does not change outside acceptable bounds	Egg production of population Abundance of recruits	5.1
		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
		7. Interactions with fishery	7.1 Survival after interactions is maximised 7.2 Interactions do not affect the viability of the population or its ability to recover	Survival rate of species after interactions Number of interactions, biomass or numbers in population	7.1 7.2
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
		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

Component	Core Objective	Sub-component	Example Operational Objectives	Example Indicators	Rationale
		3. Substrate quality	3.1 Sediment quality does not change outside acceptable bounds	Sediment chemistry, stability, particle size, debris, pollutant concentrations	3.1
		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
		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
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
		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
		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
		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
		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

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: North West Slope Trawl Fishery
Sub-fishery Name:
Date: October 2005

Direct impact of Fishing	Fishing Activity	Score (0/1)	Documentation of Rationale
Capture	Bait collection	0	Bait collection is not required for methods used
	Fishing	1	Industry is based on the capture of marine animals.
	Incidental behaviour	1	Recreational fishing such as trolling may occur.
Direct impact without capture	Bait collection	0	Bait collection is not required for methods used
	Fishing	1	Organisms may be damaged or destroyed directly by contact with trawling gear or indirectly through ecosystem alteration.
	Incidental behaviour	1	Recreational fishing such as trolling may occur, some animals may escape without being landed, and later die.
	Gear loss	1	Fragments of trawl mesh damaged by certain substrates may cause damage or destroy marine organisms through direct contact, possible digestion and incidental capture (ghost fishing).
	Anchoring/ mooring	0	Vessels operating in the fishery do not anchor or moor in the fishing grounds.
	Navigation/steaming	1	Direct impacts, without capture on organisms may occur while navigating/steaming.
Addition/ movement of biological material	Translocation of species (boat launching, reballasting)	1	Hull fouling may translocate organisms within sub-habitats of the NWSTF and between fisheries by vessels with permits in multiple fisheries (e.g. Northern Prawn Fishery).
	On board processing	1	Discards are returned to the ocean and may result in the movement of biological material.
	Discarding catch	1	Unwanted catch is discarded at sea.
	Stock enhancement	0	The fishery depends solely on natural stock levels.
	Provisioning	0	Bait or burley is not used in the fishery.
	Organic waste disposal	1	Organic wastes such as food scraps and sewage are disposed of at sea.
Addition of non-biological material	Debris	1	Incidental discarding of material (cardboard, plastic, rope) may occur.
	Chemical pollution	1	Chemicals may be introduced to the water during vessel maintenance at sea. Emissions may also occur during the operation of the vessel.
	Exhaust	1	Exhaust may by introduced to the atmosphere and water during vessel operation.
	Gear loss	1	Trawl mesh may be introduced to the water if damaged by rough substrates.

Direct impact of Fishing	Fishing Activity	Score (0/1)	Documentation of Rationale
	Navigation/ steaming	1	Operation of a vessel will add noise and visual stimuli (e.g. light) to the surrounds. Echo-sounders used to locate suitable fishing grounds may also disrupt other species such as whales. Potential boat collisions may result in the sinking of vessels.
	Activity/ presence on water	1	The operation and presence of a vessel will add noise and visual stimuli (e.g. light) to the environment.
Disturb physical processes	Bait collection	0	Bait collection is not required for methods used
	Fishing	1	In operation, trawl gear may disturb water flow patterns and sediments when nets are dragged the along the seafloor.
	Boat launching	0	Vessels entering the fishery are from established ports.
	Anchoring/ mooring	0	Vessels operating in the fishery do not anchor or moor in the fishing grounds.
	Navigation/ steaming	1	Navigation/steaming may affect physical processes in the pelagic zone by generating turbulence and wash.
External Hazards (specify the particular example within each activity area)	Other capture fishery methods	1	Other Commonwealth fisheries and Western Australian State fisheries fish in overlapping areas. These are listed in the Scoping Document.
	Aquaculture	0	No aquaculture activities occur within the waters of NWSTF.
	Coastal development	0	The NWSTF extends from the 200 m isobath out to the edge of the AFZ. The distance from the coast means that coastal developments (e.g. runoff) would have little impact on the fishery.
	Other extractive activities	1	According to a Geoscience report as of March 2003, 59 exploration permits, 9 retention leases and 1 production license overlapped with the NWSTF
	Other non-extractive activities	1	Major ports in Western Australian service shipping channels throughout the Indian ocean. The main ports include: • The Pilbara ports of Dampier, Port Hedland and Cape Lambert are import mineral and gas exports. • Bunbury, Esperance and Geraldton also handle mineral exports in addition to grain and manufactured goods • Fremantle is the State’s main general cargo and container port
	Other anthropogenic activities	1	Offshore reefs in the NWSTF are used for recreational activities such as fishing diving. Impacts may occur by boats in transit to the reefs.

Table 4. Examples of fishing activities.

(Modified from Fletcher *et al*. 2002)

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

Direct Impact of Fishing	Fishing Activity	Examples of Activities Include
	movements, reballasting)	the fishery.
	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 burley 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

Direct Impact of Fishing	Fishing Activity	Examples of Activities Include
		flow patterns.
	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:

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

Other publications that may provided information include

- BRS Fishery Status Reports
- Strategic Plans

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

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

In this case, 18 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 22 activity-component scenarios will be considered at Level 1. This results in 110 total scenarios (of 160 possible) to be developed and evaluated using the unit lists (species, habitats, communities).

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

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

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

- Step1: Record the hazard identification score (absence (0) presence (1) scores) identified at step 3 at the scoping level (Scoping Document S3) onto the SICA table
- Step 2: Score spatial scale of the activity
- Step 3: Score temporal scale of the activity
- Step 4: Choose the sub-component most likely to be affected by activity
- Step 5: Choose the most vulnerable unit of analysis for the component e.g. species, habitat type or community assemblage
- Step 6: Select the most appropriate operational objective
- Step 7: Score the intensity of the activity for that sub-component
- Step 8: Score the consequence resulting from the intensity for that sub component
- Step 9: Record confidence/uncertainty for the consequence scores
- Step 10. Document rationale for each of the above steps
- Step 11. Summary of SICA results
- Step 12. Evaluation/discussion of Level 1
- Step 13. Components to be examined at Level 2

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

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

2.3.2 Score spatial scale of activity (Step 2)

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

Spatial scale score of activity

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

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

2.3.3 Score temporal scale of activity (Step 3)

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

Temporal scale score of activity

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

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

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

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

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

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

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

2.3.6 Select the most appropriate operational objective (Step 6)

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

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

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

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

Level	Score	Description
Negligible	1	remote likelihood of detection at any spatial or temporal scale
Minor	2	occurs rarely or in few restricted locations and detectability even at these scales is rare
Moderate	3	moderate at broader spatial scale, or severe but local
Major	4	severe and occurs reasonably often at broad spatial scale
Severe	5	occasional but very severe and localized or less severe but widespread and frequent
Catastrophic	6	local to regional severity or continual and widespread

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

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

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

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

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

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

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

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

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

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

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

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

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

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)

Direct impact of Fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (from S2.1)	Intensity Score (1-6)	**Consequence Score (1-6)**	Confidence score (1-2)	Rationale
Capture	Bait collection	0									
	Fishing	1	5	4	Population size	velvet scampi	1.1	3	**3**	1	Fishery spans 11 degrees of latitude - spatial scale is 660 nm => Fishing occurs between 100-200 days per year =>Scampi are long-living and slow-growing with low fecundity, and do not disperse widely. Velvet scampi is the main target species, and catch rates have declined (Lynch and Garvey 2005) => intensity moderate as fishing grounds are thought to be fully exploited => consequence moderate as stocks likely to be at full exploitation rate => confidence low as no fishery independent surveys to confirm trends
	Incidental behaviour	1	5	3	Population size	none		1	**1**	2	Recreational trolling is unlikely to affect deepwater target species
Direct impact without capture	Bait collection	0									
	Fishing	1	5	4	Population size	giant red prawn	1.1	2	**2**	1	Juvenile prawns may be too small to be captured but damaged by passing through the net, as they are fragile => intensity minor as little targeting of prawns has occurred in recent years => consequence minor as not likely to have impact on population size=> confidence low due to lack of information
	Incidental behaviour	1	5	4		none		1	**1**	2	Recreational trolling is unlikely to affect deepwater target species
	Gear loss	1	5	3	Behaviour/movement	velvet scampi	6.1	1	**1**	2	Lost nets may form a movement barrier to bottom-dwelling scampi - scampi more likely to be affected than more mobile prawns => intensity negligible => consequence negligible as any impact is unlikely to be detectable => confidence high by logic.
	Anchoring/ mooring	0									

Direct impact of Fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (from S2.1)	Intensity Score (1-6)	**Consequence Score (1-6)**	Confidence score (1-2)	Rationale
	Navigation/ steaming	1	5	4	Behaviour/movement	giant red prawn	6.1	1	**1**	2	Prawns more likely to be affected by vessel navigation/steaming than bottom-dwelling scampi, as they rise to mid-water at night => intensity negligible as few vessels currently operating in the fishery => consequence negligible as prawns migrate to mid-water at night, not surface, so unlikely to suffer direct impact => confidence high due to logic
Addition/ movement of biological material	Translocation of species	1	5	4	Reproductive capacity	giant red prawn	5.1	2	**2**	1	Hull fouling may translocate organisms within sub-habitats of the WTF and between fisheries by vessels with permits in multiple fisheries (e.g. Northern Prawn Fishery) => intensity minor as potential pests from Northern Prawn Fishery unlikely to survive during long steaming time between fisheries=> consequence minor => confidence low due to lack of information
	On board processing	1	5	4	Behaviour/movement	velvet scampi	6.1	2	**1**	1	Small scampi are tailed onboard. Discarded organic matter sinking to the benthos may alter the abundance of detrital food available to crustaceans. This may result in increased movement of deepwater scampi and other crustaceans into the area => intensity minor as detectability rare => consequence negligible as impact unlikely to be detectable => confidence low due to lack of data
	Discarding catch	1	5	4	Behaviour/movement	velvet scampi	6.1	2	**1**	1	Discards sinking to the benthos may alter the abundance of detrital food available to crustaceans. This may result in increased movement of deepwater scampi into the area => intensity minor as detectability rare => consequence negligible as impact unlikely to be detectable => confidence low due to lack of data
	Stock enhancement	0									
	Provisioning	0									
	Organic waste disposal	1	5	4	Behaviour/movement	velvet scampi	6.1	1	**1**	2	Discards sinking to the benthos may alter the abundance of detrital food available to crustaceans. This may result in increased movement of deepwater scampi into the area => intensity negligible as few vessels in the fishery => consequence negligible as impact unlikely to be detectable => confidence high due to logic
Addition of non-biological material	Debris	1	5	4	Behaviour/movement	velvet scampi	6.1	1	**1**	2	Debris may form a movement barrier to bottom-dwelling scampi - scampi more likely to be affected than more mobile prawns => intensity negligible as debris is negligible => consequence negligible => confidence high by logic

Direct impact of Fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (from S2.1)	Intensity Score (1-6)	**Consequence Score (1-6)**	Confidence score (1-2)	Rationale
	Chemical pollution	1	5	4	Reproductive capacity	velvet scampi	5.2	1	**1**	2	Scampi may consume contaminated detritus. Chemical pollutants that filter down to the benthos are likely to enter this trophic level as a first impact => intensity negligible as chemical pollutants introduced by fishery are negligible => consequence is negligible => confidence high due to logic.
	Exhaust	1	5	4	Population size	giant red prawn	1.1	1	**1**	2	Most exhaust enters the atmosphere, or immediately below the water from engines. Dissolved gases and particulates not believed to be of consequence to benthic/mid-water target species. Confidence high due to logical consideration
	Gear loss	1	5	3	Behaviour/movement	velvet scampi	6.1	1	**1**	2	Lost nets may form a movement barrier to bottom-dwelling scampi - scampi more likely to be affected than more mobile prawns => intensity negligible as little gear is lost=> consequence negligible as any impact is unlikely to be detectable => confidence high by logic.
	Navigation/ steaming	1	5	4	Behaviour/movement	giant red prawn	6.1	1	**1**	2	Prawns more likely to be affected by noise from vessel navigation/steaming than bottom-dwelling scampi, as they rise to mid-water at night => intensity negligible as few vessels currently operating in the fishery => consequence negligible as prawns migrate to mid-water at night, not surface, so unlikely be disturbed by vessel noise => confidence high due to logic
	Activity/ presence on water	1	5	4	Behaviour/movement	giant red prawn	6.1	1	**1**	2	Prawns more likely to be affected vessel activity than bottom-dwelling scampi, as they rise to mid-water at night => intensity negligible as few vessels currently operating in the fishery => consequence negligible as prawns migrate to mid-water at night, not surface, so unlikely be disturbed by vessel activity => confidence high due to logic
Disturb physical processes	Bait collection	0									
	Fishing	1	5	4	Population size	velvet scampi	1.1	3	**3**	1	Juvenile scampi are likely to inhabit the same grounds as adult stocks. They are not caught by trawling but destruction of burrows and disturbance of sediment by trawling may result in a significant mortality of pre-recruit age classes (Phillips 1992)=> intensity moderate as fishing has been confined to relatively small areas within the NWS => consequence moderate as stocks likely to be at full exploitation => confidence low due to lack of information
	Boat launching	0									
	Anchoring/ mooring	0									

Direct impact of Fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (from S2.1)	Intensity Score (1-6)	**Consequence Score (1-6)**	Confidence score (1-2)	Rationale
	Navigation/steaming	1	5	4	Behaviour/movement	giant red prawn	6.1	1	**1**	2	Prawns more likely to be affected by disturbance of physical processes from vessel navigation/steaming than bottom-dwelling scampi, as they rise to mid-water at night => intensity negligible as few vessels currently operating in the fishery => consequence negligible as prawns migrate to mid-water at night, not surface, so unlikely be disturbed => confidence high due to logic
External hazards (specify the particular example within each activity area)	Other fisheries	1	5	4	Population size	scampi	1.1	2	**2**	1	The WDWTF also catches scampi, but species are not identified, and it is is not known if they are the same stocks as those exploited in the NWSTF.
	Aquaculture	0									
	Coastal development	0									
	Other extractive activities	1	3	4	Population size	scampi	1.1	3	**2**	1	Oil drilling will dramatically impact on the benthos and may result in deleterious effects to localised grounds. => intensity moderate as impact is occasional but severe and localised => consequence minor as local populations unlikely to be severely affected => confidence low due to lack of information
	Other non extractive activities	1	3	3	Population size	scampi	1.1	2	**2**	1	Seismic activity has the potential to affect local populations of scampi => intensity minor as occurs in restricted locations => consequence minor as effect is not expected to be long-lasting => confidence low due to lack of information
	Other anthropogenic activities	1	5	4	Population size	scampi	1.1	1	**1**	2	There are few other anthropogenic activities in the area that have the potential to affect target species

2.3.1 Level 1 (SICA) Documents L1.2 - Byproduct and Bycatch Component

Direct impact of Fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (from S2.1)	Intensity Score (1-6)	**Consequence Score (1-6)**	Confidence score (1-2)	Rationale
Capture	Bait collection	0									
	Fishing	1	5	4	Population size	squid	1.1	2	**2**	1	Squid are the most important byproduct in the NWSTF in terms of tonnage and value. => intensity minor as squid is taken intermittently in small and variable volumes => consequence minor as small catch is unlikely to impact stock which is productive => confidence low as no formal assessments, and species are not identified in logbooks
	Incidental behaviour	1	5	3	Population size	sea perch	1.1	1	**1**	2	Crew may handline for fish when sheltering from bad weather => intensity negligible as occurs rarely => consequence negligible as catch would be very low => confidence high due to logic
Direct impact without capture	Bait collection	0									
	Fishing	1	5	4	Population size	spiny lobsters	1.1	1	**1**	2	Spiny lobsters may be damaged by impact with net => intensity negligible as remote likelihood of detection => consequence negligible => confidence high due to logic
	Incidental behaviour	1	5	4	Population size	sea perch	1.1	1	**1**	2	Crew may handline for fish when sheltering from bad weather => intensity negligible as occurs rarely => consequence negligible as catch would be very low => confidence high due to logic
	Gear loss	1	5	3	Behaviour/movement	bugs	6.1	1	**1**	2	Lost nets may form a movement barrier to bottom-dwelling bugs => intensity negligible as little gear is lost=> consequence negligible as any impact is unlikely to be detectable => confidence high by logic.
	Anchoring/ mooring	0									
	Navigation/ steaming	1	5	4	Behaviour/movement	sharks	6.1	1	**1**	2	Direct impact from navigation/steaming unlikely to affect any byproduct/bycatch species
Addition/ movement of biological material	Translocation of species	1	5	4	Reproductive capacity	red carid	5.1	1	**1**	1	Hull fouling may translocate organisms within sub-habitats of the WTF and between fisheries by vessels with permits in multiple fisheries (e.g. Northern Prawn Fishery) => intensity negligible as potential pests from Northern Prawn Fishery unlikely to survive during long steaming time between fisheries=> consequence negligible => confidence low due to lack of information
	On board processing	1	5	4	Behaviour/movement	Sharks	6.1	1	**1**	1	Some scampi are tailed. If tails thrown overboard this could attract scavenging species, however consequences are considered negligible. Confidence high due to small amount of material thrown overboard.

Direct impact of Fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (from S2.1)	Intensity Score (1-6)	**Consequence Score (1-6)**	Confidence score (1-2)	Rationale
	Discarding catch	1	5	4	Behaviour/movement	Sharks	6.1	2	**2**	1	Discarding of catch could attract scavenging species, however consequences are considered minor as time to return to original behaviour is on scale of days to weeks. Confidence low due to lack of information on scavenging behaviour.
	Stock enhancement	0									
	Provisioning	0									
	Organic waste disposal	1	5	4	Behaviour/movement	Sharks	6.1	1	**1**	2	Organic waste disposal can attract species, however the limited volume of food from such sources and the area over which such an event occurs is negligible. Consequence also negligible. Confidence high due to logic.
Addition of non-biological material	Debris	1	5	4	Population size	Sharks	1.1	1	**1**	2	Debris lost from boats is considered to be of negligible intensity. If ingested by animals, could lead to death; however death by such events considered to have negligible consequences for population sizes. Confidence high due to logical consideration.
	Chemical pollution	1	5	4	Reproductive capacity	Sharks	5.1	1	**1**	2	Heavy metals from antifouling bioaccumulates higher up the trophic chain. Consequently sharks can be expected to accumulate the highest levels. Dilution is considered to quickly reduce the impact of any chemicals entering the sea. Consequence considered negligible. Confidence high due to logic.
	Exhaust	1	5	4	Reproductive capacity	Sharks	5.1	1	**1**	2	Most exhaust enters the atmosphere, or immediately below the water from engines. Dissolved gases and particulates not believed to be of consequence to benthic species. Confidence high due to logical consideration
	Gear loss	1	5	3	Behaviour/movement	bugs	6.1	1	**1**	2	Lost nets may form a movement barrier to bottom-dwelling bugs => intensity negligible as little gear is lost=> consequence negligible as any impact is unlikely to be detectable => confidence high by logic.
	Navigation/ steaming	1	5	4	Behaviour/movement	Sharks	6.1	1	**1**	2	The addition of noise from navigation/steaming unlikely to affect byproduct/bycatch species as few vessels operate in this fishery => consequence negligible => Confidence high due to logic
	Activity/ presence on water	1	5	4	Behaviour/movement	Sharks	6.1	1	**1**	2	Simple presence of vessels on water might change the behaviour of sharks by acting as a fish aggregation device particular during and after fishing. Hard to envisage any impact for the shark species. High confidence by consensus and lack of scenarios.
Disturb	Bait collection	0									

Direct impact of Fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (from S2.1)	Intensity Score (1-6)	**Consequence Score (1-6)**	Confidence score (1-2)	Rationale
physical processes	Fishing	1	5	4	Population size	bugs	1.1	3	**2**	1	Bugs burrow and the potential exists that demersal trawls can destroy their habitat where their presence may overlap with other targeted crustaceans. Intensity moderate as local effects may be severe => consequence minor as not likely to have a long-term effect on population size => confidence low as little information is available
	Boat launching	0									
	Anchoring/ mooring	0									
	Navigation/steaming	1	5	4	Behaviour/movement	sharks	6.1	1	**1**	2	Disturbance of physical processes by navigation/steaming is unlikely to affect demersal species
External hazards (specify the particular example within each activity area)	Other fisheries	1	5	4	Population size	bugs	1.1	2	**2**	1	Bugs are now the main target of the adjoining Western Deepwater Trawl Fishery => intensity minor as catches are still relatively low => consequence minor => confidence low as no stock assessments have been done
	Aquaculture	0									
	Coastal development	0	0	0							
	Other extractive activities	1	3	4	Population size	Deepwater bugs	1.1	2	**2**	1	Oil drilling has the potential to affect local populations of deepwater bugs => intensity minor as occurs in restricted locations => consequence minor as effect is not expected to be long-lasting => confidence low due to lack of information
	Other non extractive activities	1	3	3	Population size	Deepwater bugs	1.1	2	**2**	1	Seismic activity has the potential to affect local populations of deepwater bugs => intensity minor as occurs in restricted locations => consequence minor as effect is not expected to be long-lasting => confidence low due to lack of information
	Other anthropogenic activities	1	5	4	Behaviour/movement	sharks	6.1	1	**1**	2	There are few other anthropogenic activities in the area that have the potential to affect target species

2.3.1 Level 1 (SICA) Documents L1.3 - TEP Species Component;

Direct impact of Fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (from S2.1)	Intensity Score (1-6)	**Consequence Score (1-6)**	Confidence score (1-2)	Rationale
Capture	Bait collection	0									
	Fishing	1	5	4	Population size	none	1.1	1	**1**	2	No TEP species have been observed to be caught in this fishery
	Incidental behaviour	1				none		1	**1**	2	No known incidental behaviour that could affect TEP species.
Direct impact without capture	Bait collection	0									
	Fishing	1	5	4	Behaviour/movement	Frigate bird	6.1	2	**2**	2	Frigate birds have been observed to hover around vessels => intensity minor as vessels are few => consequence minor as time to return to original behaviour likely to be on scale of hours => confidence high as AFMA observer information is available
	Incidental behaviour	1	5	4		none		1	**1**	2	No known incidental behaviour that could affect TEP species.
	Gear loss	1	5	3	Population size	common dolphin	1.1	1	**1**	2	TEP species could become entangled in lost gear => Intensity negligible as little gear is lost => consequence negligible as expected to have no impact on TEP stocks => confidence high due to logic
	Anchoring/ mooring	0									
	Navigation/ steaming	1	5	4	Behaviour/movement	Turtles, Leatherback and loggerheads	6.1	1	**1**	2	Intensity: negligible because it is unlikely to have measurable/detectable impact e.g. through collisions. Consequence: negligible because interactions remote, and impact on population size or behaviour and movement of TEP species unlikely. Confidence: high because it was considered unlikely for there to be strong interactions between Navigation/steaming and TEP species.
Addition/ movement of biological material	Translocation of species	1	5	4		none		1	**1**	2	Can't think of any scenario where translocation of species could affect TEP species.
	On board processing	1	5	4	Behaviour/movement	Frigate bird	6.1	2	**2**	2	Frigate birds have been observed to hover around vessels, possibly attracted by waste => intensity minor as vessels are few => consequence minor as time to return to original behaviour likely to be on scale of hours => confidence high as AFMA observer information is available

Direct impact of Fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (from S2.1)	Intensity Score (1-6)	**Consequence Score (1-6)**	Confidence score (1-2)	Rationale
	Discarding catch	1	5	4	Behaviour/movement	Frigate bird	6.1	2	**2**	1	Frigate birds have been observed to hover around vessels, possibly attracted by waste => intensity minor as vessels are few => consequence minor as time to return to original behaviour likely to be on scale of hours => confidence low due to lack of information
	Stock enhancement	0									
	Provisioning	0									
	Organic waste disposal	1	5	4	Behaviour/movement	Frigate bird	6.1	2	**2**	2	Frigate birds have been observed to hover around vessels, possibly attracted by waste => intensity minor as vessels are few => consequence minor as time to return to original behaviour likely to be on scale of hours => confidence high as AFMA observer information is available
Addition of non-biological material	Debris	1	5	4	Population size	Turtles	1.1	1	**2**	2	Plastics may be an issue, entanglement, ingestion. Boats subject to MARPOL rules . Intensity: negligible if MARPOL rules followed. Consequence: minor because debris by this fishery expected to be accidental not routine . Confidence Limited domestic observer data indicated crews diligent re waste therefore high confidence
	Chemical pollution	1	5	4	Population size	white shark	1.1	2	**2**	2	White shark considered species most vulnerable as they are long-lived top-order predators, so may accumulate high levels of chemicals in tissues => Intensity was scored as minor as most deleterious chemicals probably not from fishing vessels => Consequence was also considered minor as it is not likely that fishing vessels are a major source of pollution=> Confidence high due to logic
	Exhaust	1	5	4	Behaviour and movement	frigate bird	6.1	1	**1**	2	Intensity: negligible because exhaust considered low impact to TEP species =>Consequence: considered negligible because species unlikely to avoid fumes so unlikely to affect behaviour and movement of target species. =>Confidence: considered high due to logical consideration.
	Gear loss	1	5	3	Population size	common dolphin	1.1	1	**1**	2	TEP species could become entangled in lost gear => Intensity negligible as little gear is lost => consequence negligible as expected to have no impact on TEP stocks => confidence high due to logic

Direct impact of Fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (from S2.1)	Intensity Score (1-6)	**Consequence Score (1-6)**	Confidence score (1-2)	Rationale
	Navigation/ steaming	1	5	4	Behaviour / movement	Humpback whale	6.1	2	**2**	2	The humpback whale was chosen for analysis because noise and visual stimuli from fishing operations may disrupt calving => Navigation/ steaming is a large component of the NWSTF operations, however, it was considered that any impact would be rare => Consequence was considered minor for humpback whale populations => Confidence high due to low number of vessels operating in the NWSTF
	Activity/ presence on water	1	5	4	Behaviour / movement	Humpback whale	6.1	2	**2**	2	Humpback whale chosen because the presence of fishing vessels introduces sound waves that may impact on whale behaviour=> intensity and Consequence considered minor, any effects of vessel presence unlikely to be measurable for humpback whales in the NWSTF => Confidence high because of low number vessels operating in the NWSTF unlikely to have effect
Disturb physical processes	Bait collection	0									
	Fishing	1	5	4	Behaviour / movement	Humpback whale	6.1	1	**1**	2	Disturbance of physical processes by trawling may cause momentary disruption to feeding and/or movement=> intensity and Consequence considered negligible, any effects of vessel presence unlikely to be measurable for humpback whales in the NWSTF => Confidence high because of low number vessels operating in the NWSTF unlikely to have effect
	Boat launching	0									
	Anchoring/ mooring	0									
	Navigation/steaming	1	5	4	Behaviour / movement	white shark	6.1	1	**1**	2	Disturbance of physical processes by navigation/steaming may cause momentary disruption to feeding and/or movement=> intensity and Consequence considered negligible, any effects of vessel presence unlikely to be measurable for white shark in the NWSTF => Confidence high because of low number vessels operating in the NWSTF unlikely to have effect
External hazards (specify the particular example within each activity area)	Other fisheries	1	5	4	Population size	Turtles	1.1	2	**2**	1	Turtles occasionally caught in the Western Tuna and Billfish Fishery which overlaps the NWSTF. Consequence: minor because reports of interactions low and turtles able to swim to surface for air and can be released alive (SWTBF ERA report)
	Aquaculture	0									
	Coastal development	0	0	0							

Direct impact of Fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (from S2.1)	Intensity Score (1-6)	**Consequence Score (1-6)**	Confidence score (1-2)	Rationale
	Other extractive activities	1	3	4	Population size, Behaviour and movement	Seabirds	1.1, 6.1	2	**2**	2	Oil and gas industry. May be pollution from petrochemical industry in both shallow and deep water Noise and visual stimuli. re operations. Intensity: assumed to have minor impact both direct and indirect on TEP species, but linkages need to be better understood. Consequence: cumulative effects expected to be minor and not affect population size or behaviour or movement of TEP species . Confidence: high as oil and gas exploration only in limited area of the NWSTF
	Other non extractive activities	1	3	3	Behaviour / movement	Humpback whale	6.1	2	**2**	2	Shipping introduces sound waves that may impact on humpback whale behaviour=> intensity and consequence considered minor, any effects of vessel presence unlikely to be measurable for humpback whales in the NWSTF => Confidence high due to logic
	Other anthropogenic activities	1	5	4	Population size	Turtles	1.1	1	**1**	2	The turtles that occur/live/pass through the region of the fishery are extensively harvested (eggs and adults) throughout the world and killed through many anthropogenic events (pollution, boat strike, recreational fishing gear, beach use etc). Some species are in critical danger of extinction and all are endangered to some extent. Intensity and consequence scored low because most of these hazards not occurring in the area of this fishery.

2.3.1 Level 1 (SICA) Documents L1.4. - Habitat Component.

Direct impact of Fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (from S2.1)	Intensity Score (1-6)	**Consequence Score (1-6)**	Confidence score (1-2)	Rationale
Capture	Bait collection	0									
	Fishing	1	5	4	Habitat structure and Function	Fine sediments, unrippled, large sponges, upper slope	5.1	3	**4**	1	Fishing activity in the North West Slope Trawl Fishery occurs over 5-11º in extent on the continental slope off North Western Australia. Operations average between 100-200 days annually over the last 3 years with trawling occurring over 24 hours. Fishery primarily targets deepwater scampi and prawns at upper slope depths of 200-600m on open sediment areas, no fishing < 200m. Active disturbance of the substratum is designed to stimulate sheltering crustaceans into gear, using modified demersal prawn trawling gear, stern towed twin or triple nets, + tickler chains. Trawl shot times depend on the target species but average between 2-4 hours. Fishery may have intensely localised benthic impacts as target species form aggregations which are targeted. The most vulnerable habitats are those with large, erect, or fragile faunas, and serve as crustacean habitat. Habitat structure and function is at risk if substratum and epifauna are removed/ killed or relocated by the gear. Burrowing fauna (infauna) will be impacted in areas of semi-consolidated sediments that are repeatedly trawled. Intensity: low to moderate over the area of the fishery, may be localised in frequently targeted features. Consequence: Mostly minor to moderate, but may be major when deep faunas with low productivity (resilience) are removed. Regeneration times significantly increase with depth in a number of deep water invertebrate species, upper slope habitat recovery may take > decades (if at all), depending on the degree of modification and connectivity to recruitment sources. Confidence: low, few data exist for habitats in this region at these depths.
	Incidental behaviour	1	5	4	Habitat structure and Function	North Western Oceanic Pelagic Province	5.1	1	**1**	2	Recreational fishing such as trolling may occur on the way to and from fishing grounds. This seems an unlikely activity to occur during the normal course of fishing operations as attention would be required elsewhere. Intensity and Consequence: negligible impact on pelagic environment. Confidence: high, constrained by logic.
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 (from S2.1)	Intensity Score (1-6)	**Consequence Score (1-6)**	Confidence score (1-2)	Rationale
capture	Fishing	1	5	4	Habitat structure and Function	Fine sediments, unrippled, large sponges, upper slope	5.1	3	**4**	1	Habitat likely to be damaged by contact with gear. Some epifaunal types that are flexible, low or encrusting, or burrowing infauna, may survive gear passing, however actual post encounter mortality for habitats is unquantified, but could predictably be high. Intensity: moderate over the area of the fishery, but locally concentrated around targeted features. Consequence: Moderate to major where habitat modification in depths characterised by lower productivity may lead to extended recovery times. Habitats are susceptible, regardless of catch rates. If regeneration rates are slow, the effects of historical intensity may remain apparent at these depths for many decades, depending on the degree of modification and connectivity to recruitment sources. Confidence: low, data required as uncertainty for recovery rates of deep fauna in this region.
	Incidental behaviour	1	5	4	Habitat structure and Function	North Western Oceanic Pelagic Province	5.1	1	**1**	2	Recreational fishing such as trolling may occur on the way to and from fishing grounds. This seems an unlikely activity to occur during the normal course of fishing operations as attention would be required elsewhere. Intensity and Consequence: negligible impact on pelagic environment. Confidence: high, constrained by logic.
	Gear loss	1	5	3	Habitat structure and Function	Sedimentary rock, high outcrop, octocorals, upper slope	5.1	2	**2**	1	Gear loss possible over entire range of the subfishery, but more likely to occur in the area of greatest fishing effort. Gear loss considered to occur a few times a year during the calendar fishing year. Lost gear likely to be irretrievable in deeper waters, may damage higher relief habitat in the process of snagging and attempted/ actual retrieval, eventually becoming habitat if remains as part of benthos. Intensity: minor, considered a rare event. Consequence: minor habitat modification (locally severe); likely to take significant time to recover at upper slope-mid slope depths, although fishers report that gear loss is negligible, due to lack of reefs on which gear gets hooked Confidence: high as little gear loss occurs
	Anchoring/ mooring	0									

Direct impact of Fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (from S2.1)	Intensity Score (1-6)	**Consequence Score (1-6)**	Confidence score (1-2)	Rationale
	Navigation/ steaming	1	5	4	Habitat structure and Function	North Western Oceanic Pelagic Province	5.1	1	**1**	2	Navigation/ steaming may occur daily during fishing season. The water quality of the North Western Oceanic Pelagic habitat may change with increased turbulence and changes in water mixing that could occur from movement of vessels through water. Intensity and Consequence: negligible due to remote likelihood of detection at any spatial or temporal scale and interactions that may be occurring are not detectable against natural variation. Confidence scored high because of logical constraints.
Addition/ movement of biological material	Translocation of species	1	5	4	Water quality	North Western Oceanic Pelagic Province	1.1	1	**1**	2	Translocation of species occurs when species are transported by vessels (e.g. black striped mussel), gear, ships ballast water (e.g. algal cysts, *Carcinus maenas*- European Green Crab eggs) (WA 0605). Risks are greater for interstate/ OS vessels fishing in the NWSTF. Translocation could occur over the entire range of the fishery, but is likely to have the greatest impact on shoreline or coastal habitat rather than offshore waters. Intensity and Consequence: negligible in offshore waters but potentially severe inshore, many shallow water examples have been shown to impact benthic habitat stability. Confidence: High, mechanism well documented however unvalidated record of frequency of this occurrence within waters linked to activities by this fishery.
	On board processing	1	5	4	Water quality	North Western Oceanic Pelagic Province	1.1	1	**1**	1	Most processing involves freezing catch at sea. Trip durations can be 4-5 weeks. Intensity and Consequence: negligible, detection improbable. Discards can be expected to be rapidly taken up by pelagic scavengers and unlikely to reach the bottom in theses depths. Confidence: low, little information available about degree of processing involving wastes into sea.

Direct impact of Fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (from S2.1)	Intensity Score (1-6)	**Consequence Score (1-6)**	Confidence score (1-2)	Rationale
	Discarding catch	1	5	4	Substrate quality	mud, unrippled, bioturbators, upper slope	3.1	2	**2**	1	Some potential for live discarding of berried female crustaceans (WESTMAC 10, 2004), otherwise discarding depends on target species. Some tailing of Pink Prawns at Sea. Discarding of Pink prawn, and White carid prawn common and can be substantial. Post capture survival unquantified. Dead discards can be expected to be taken up opportunistically by pelagic scavengers, although potentially crustacean parts will take longer to break down, and may sink to bottom. If discard densities large enough some localized accumulation on benthos may occur, creating anoxic conditions. Volumes may be enough to damage erect, inflexible faunal communities, but unlikely due to random and dispersed dumping and water depth. Intensity and Consequence: considered minor, may be detectable but insignificant across the scale of the fishery. Confidence low: because of a lack of insufficient knowledge on benthic trophodynamics associated with discards.
	Stock enhancement	0									
	Provisioning	0									
	Organic waste disposal	1	5	4	Water quality	North Western Oceanic Pelagic Province	1.1	1	**2**	2	Organic wastes such as food scraps and sewerage are deposited on a daily basis over the entire scale of fishing effort. Boats subject to MARPOL. Water quality of pelagic habitats is considered to experience greatest impact of organic waste disposal. Intensity: negligible. Discarded waste could be expected to be taken up rapidly by pelagic scavengers, and as overall volume of waste is likely to be small, it is unlikely to reach the benthos, or accumulate even if it does. Consequence: Minor, addition of high nutrient material is realistically expected to cause short term peaks in productivity or scavenging species interactions, with minimal detectability within minutes to hours. Confidence: high, logical constraints.

Direct impact of Fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (from S2.1)	Intensity Score (1-6)	**Consequence Score (1-6)**	Confidence score (1-2)	Rationale
Addition of non-biological material	Debris	1	5	4	Habitat structure and Function	North Western Oceanic Pelagic Province	5.1	2	**2**	1	Fishing activity occurs over a large spatial scale. Generation of debris possible over this scale, and may occur on a daily basis during fishing season. Greatest effort within the North Western Oceanic pelagos, therefore considered the most likely habitat to accumulate floating plastics, and inadvertent losses from fishing operations. All boats subject to MARPOL, which means losses should be unintentional, and retrieved if possible. Debris considered to reduce water quality, and alter habitat structure with the addition of ingestible materials putting susceptible species at risk e.g. seabirds, dolphins or seals. Intensity: minor if adherence to MARPOL regulations. Consequence: minor to habitat as dispersal and small volumes likely. Confidence: low because the volume of debris generated and species susceptibility are unknown.
	Chemical pollution	1	5	3	Water quality	North Western Oceanic Pelagic Province	1.1	2	**2**	1	Chemicals may be introduced to pelagic habitats during vessel maintenance at sea. Chemical spill considered annual but is possible every time fishing occurs. The North Western Oceanic Pelagic habitat would be most at risk from chemical pollution. Residence time of small volume of contaminants likely to be short term in the offshore environment as weather and oceanographics disperse substances quickly. Intensity: minor because the activity (chemical spill) is thought to occur rarely. Consequence: minor, possible detectable change in water quality, but time to return to prior state on the scale of hours to days (note that chemical pollution likely to have measurable consequences if large-scale event occurs in a sensitive area, the scale of an event will be limited by the amount of chemicals carried by the fishing vessels). Confidence: low with out data on the volume of pollution.
	Exhaust	1	5	4	Air quality	North Western Oceanic Pelagic Province	2.1	1	**1**	2	Exhaust from running engines may impact the air quality of the species within Western Oceanic Pelagic habitat (e.g. birds). Intensity and Consequence: negligible due to rapid dispersal of pollutants in winds, and likely to be physically undetectable over very short time frames. Confidence in assessment: high because effect of exhaust was considered to be localised. Logical consideration.

Direct impact of Fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (from S2.1)	Intensity Score (1-6)	**Consequence Score (1-6)**	Confidence score (1-2)	Rationale
	Gear loss	1	5	3	Habitat structure and Function	Sedimentary rock, high outcrop, octocorals, upper slope	5.1	2	**1**	1	Gear loss possible over entire range of the subfishery. Gear loss infrequent and tends to be associated with trawling 'hard' terrains, i.e. snagging on high relief reef or rugose surface structures. Tears to nets are more likely than loss of whole nets, trawl doors and accessory gear. In the rare occurrence of loss of whole nets, retrieval is unlikely to be affected in deeper waters. Lost gear known to ball up if not retrieved, potentially damaging habitat in the vicinity, eventually becoming habitat. Intensity: minor, impact considered detectible but overall footprint of lost gear extremely small. Consequence: negligible, habitat modification likely to be undetectable. Confidence: high, though effects not visually documented for this fishery, and there is a lack of verified data on rates and types of gear loss.
	Navigation/ steaming	1	5	5	Water quality	North Western Oceanic Pelagic Province	1.1	1	**1**	2	Navigation/ steaming may occur daily during 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. Changes to the pelagic air and water quality, and habitat function of the oceanic habitat are 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 scored high because of logical constraints.
	Activity/ presence on water	1	5	5	Water quality	North Western Oceanic 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 in consequence score: high because it was considered highly unlikely that vessel presence/activity would lead to community level changes in its own right (logical constraints).
Disturb	Bait collection	0									

Direct impact of Fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (from S2.1)	Intensity Score (1-6)	**Consequence Score (1-6)**	Confidence score (1-2)	Rationale
physical processes	Fishing	1	5	5	Substrate quality	mud, unrippled, bioturbators, upper slope	3.1	3	**3**	1	Benthic processes will be most disturbed along the upper slope of North Western Australia where fishing activity currently concentrates on deep water crustaceans. This zone is characterised by gently sloping plains of muddy and sandy sediments grading into narrow mud terraces and escarpments. Targeted soft ground is likely to be interspersed with hard patches/ biogenic reef which support diverse faunal communities, dominated by suspension and filter feeding animals. Intensity: minor to major, because gear contact with bottom causes sediment resuspension which potentially smothers animals dependent on nonturbid conditions. Consequence: moderate, Shallow infaunal bioturbators may be dislodged leading to damage, mortality or relocation. Sheltering habitat of crustaceans destroyed in process of trawl passing, known to be locally intense in some locations. Recovery capacity of habitat modified by the net is unknown however seems to favor rapidly colonizing, predatory species altering habitat processes. Disturbance to physical processes most likely to be short term – permanent change to habitat structure and function possible if frequency of interaction precludes complete recovery. Confidence: low inadequate knowledge on the impact of crustacean trawling on long term substratum processes.
	Boat launching	0									
	Anchoring/ mooring	0									
	Navigation/steaming	1	5	5	Habitat structure and Function	North Western Oceanic Pelagic Province	5.1	1	**1**	2	Navigation/ steaming may increase water mixing and turbulence influencing habitat structure, function daily during fishing season. Intensity and Consequence: negligible. Alteration of physical processes in the pelagos during operation of the vessel are likely to be undetectable at any spatial or temporal scale, due to the shallow nature of the interaction when compared with mixed layer depths normally present in these waters. Confidence scored high because of logical constraints.

Direct impact of Fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (from S2.1)	Intensity Score (1-6)	**Consequence Score (1-6)**	Confidence score (1-2)	Rationale
External hazards (specify the particular example within each activity area)	Other fisheries	1	6	6	Habitat structure and function	Fine sediments, unrippled, large sponges, upper slope	5.1	2	**2**	1	The only Commonwealth fishery operating within the same operational area of the NWSTF is the WTBF. The WTBF targets pelagic species using pelagic longlines, therefore direct interaction is likely to be pelagic in nature and minimal. Benthic habitats not considered to be at threat. Western Australian State Fisheries also operating in the region under a negotiated OCS include; Northern Demersal Scalefish Fishery, and the Pilbara Trap and Line Fisheries. Interaction of trap and trawl methods is possible although effort by State operators outside 200m isoline is minimal. The West Coast Deep-Sea Crab Fishery (WCDSCF), a state managed crustacean fishery that primarily targets *Chaceon bicolor*, *Hypthalass*i*a acerba*, and *Pseudocarcinus gigas*, in waters 600- 1200m deep. The footprint of other gears must include dragging during retrieval, and although small in comparison with trawl gears, may leave detectable impacts at depth. Fragile epifauna, and habitats of surface layers of the substratum (small pits, holes, burrows) are likely to be crushed in the process. Intensity: minor, over area of fishery. Consequence: minor, low overlap of efforts. Confidence: low because of insufficient knowledge of habitat dynamics, and ecosystem connectivity in this region. This may alter with further assessment of cumulative impacts.
	Aquaculture	0									
	Coastal development	0									
	Other extractive activities	1	3	6	Habitat structure and function	Rock/ biogenic matrix, subcrop, large sponges, outer shelf	5.1	3	**4**	1	The North West Slope is of prime interest to Oil and Gas stakeholders. Oil and gas exploration, including seismic activity and exploratory well drilling occurs regularly within the NWSTF to depths of up to >1500m, with the main focus in waters of ~200m. As of 2003, 1 Production licence, 48 exploration permits, and 8 retention leases overlap with the NWSTF. Activity is concentrated on the shelf, although there may be pollution and associated stimuli from the petrochemical industry in both shallow and deep water. Intensity: moderate as activity in this fishery may have locally intense effects on the benthos. Consequence: Cumulative impacts may exist with trawl fisheries, but considered major in their own right. Confidence: low, due to limited information available.

Direct impact of Fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (from S2.1)	Intensity Score (1-6)	**Consequence Score (1-6)**	Confidence score (1-2)	Rationale
	Other non extractive activities	1	4	4	Habitat structure and Function	North Western Oceanic Pelagic Province	5.1	2	**1**	1	Shipping occurs daily throughout the NWSTF and the WA coast. Shipping considered to impact bio- and geo-chemical cycles of pelagic waters of the Western Coastal and Oceanic Pelagic environments by disturbing mixed depth layer, and addition of non biological materials. Intensity: minor because natural levels of mixing and re-mixing considered high in these habitats and benthic impacts localised over scale of fishery area. Consequence: negligible - Interactions which affect bio- & geochemical cycling unlikely to be detectable against natural variation. Benthic detection decreases with time and objects form basis of reef structure which will be colonized over time (more rapidly in waters < 200m. Confidence: low because of a lack of information on shipping-animal interactions plus insufficient knowledge on effects of ships on bio- and geo-chemical cycling
	Other anthropogenic activities	0									

2.3.1 Level 1 (SICA) Documents L1.5 - Community Component

Direct impact of Fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (from S2.1)	Intensity Score (1-6)	**Consequence Score (1-6)**	Confidence score (1-2)	Rationale
Capture	Bait collection	0									
	Fishing	1	5	4	Functional group	North Western Transition 250-565m	2.1	3	**3**	1	Fishery spans 11 degrees of latitude - spatial scale is 660 nm=>community chosen where majority of effort occurring=> Fishing occurs between 100-200 days per year =>Scampi are long-living and slow-growing with low fecundity, and do not disperse widely. Velvet scampi is the main target species, and catches are declining=> change in epeibenthic/megabenthos functional grp composition or trophic size/structure=>intensity moderate as fishing grounds are thought to be fully exploited => consequence moderate as stocks are likely to be at full exploitation rate (Lynch and Garvey 2005) => confidence low as no fishery independent surveys to confirm trends
	Incidental behaviour	1	5	3	Species composition	North Western Oceanic (1) 0-800m	1.1	1	**1**	2	Recreational trolling may impact pelagic species composition=> intensity minor as fishing from vessels not infrequent and spatially spread=>consequence minor as variation undetectable against natural variation
Direct impact without capture	Bait collection	0									
	Fishing	1	5	4	Trophic/size structure	North Western Transition 250-565m	4.1	2	**2**	1	Juvenile prawns may be too small to be captured but damaged by passing through the net, as they are fragile =>change in population size structure=> intensity minor as little targeting of prawns has occurred in recent years => consequence minor as not likely to have detectable impact on population size=> confidence low due to lack of information
	Incidental behaviour	1			Species composition	North Western Oceanic (1) 0-800m	1.1	1	**1**	2	Recreational trolling may impact pelagic species composition=> intensity minor as fishing from vessels not infrequent and spatially spread=>consequence minor as variation undetectable against natural variation
	Gear loss	1	5	3	Functional group	North Western Transition 250-565m	2.1	1	**1**	2	North Western Transition most activity there=>Lost nets may form a movement barrier to bottom-dwelling scampi - scampi more likely to be affected than more mobile prawns => intensity negligible occurs infrequently & localized => consequence negligible as any impact is unlikely to be detectable => confidence high as little gear is lost

Direct impact of Fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (from S2.1)	Intensity Score (1-6)	**Consequence Score (1-6)**	Confidence score (1-2)	Rationale
	Anchoring/ mooring	0									
	Navigation/ steaming	1	5	4	Distribution of community	North Western Oceanic (1) 0-800m	3.1	1	**1**	1	Pelagic prawns & fish more likely to be affected by vessel navigation/steaming than bottom-dwellers => intensity negligible as few vessels currently operating in the fishery => consequence negligible as prawns migrate to mid-water at night, not surface, so unlikely to suffer direct impact => confidence low due to lack of information
Addition/ movement of biological material	Translocation of species	1	5	4	Species composition	North Western Oceanic (1) 0-800m	1.1	2	**2**	1	Hull fouling may translocate organisms within communities of the NWSF and between fisheries by vessels with permits in multiple fisheries (e.g. Northern Prawn Fishery) => intensity minor as potential pests from Northern Prawn Fishery unlikely to survive during long steaming time between fisheries=> consequence minor => confidence low due to lack of information
	On board processing	1	5	4	Species composition	North Western Transition 250-565m	1.1	2	**1**	1	Small scampi are tailed onboard. Discarded organic matter sinking to the benthos may alter the abundance of detrital food available to crustaceans. This may result in increased movement of deepwater scampi and other crustaceans into the area causing changes to community comp => intensity minor as detectability rare => consequence negligible as impact unlikely to be detectable => confidence low due to lack of data
	Discarding catch	1	5	4	Species composition	North Western Transition 250-565m	1.1	2	**1**	1	Discards sinking to the benthos may alter the abundance of detrital food available to crustaceans. This may result in increased movement of deepwater scampi into the area => intensity minor as detectability rare => consequence negligible as impact unlikely to be detectable => confidence low due to lack of data
	Stock enhancement	0									
	Provisioning	0									
	Organic waste disposal	1	5	4	Species composition	North Western Transition 250-565m	1.1	1	**1**	1	Discards sinking to the benthos may alter the abundance of detrital food available to crustaceans. This may result in increased movement of deepwater scampi into the area => intensity negligible as few vessels in the fishery => consequence negligible as impact unlikely to be detectable => confidence low due to lack of information

Direct impact of Fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (from S2.1)	Intensity Score (1-6)	**Consequence Score (1-6)**	Confidence score (1-2)	Rationale
Addition of non-biological material	Debris	1	5	4	Distribution of community	North Western Transition 250-565m	3.1	1	**1**	2	Debris may form a movement barrier to bottom-dwelling scampi - scampi more likely to be affected than more mobile prawns => intensity negligible as debris is negligible => consequence negligible => confidence high as debris is minimal
	Chemical pollution	1	5	4	Functional group	North Western Transition 250-565m	2.1	1	**1**	1	Scampi may consume contaminated detritus. Chemical pollutants that filter down to the benthos are likely to enter this trophic level as a first impact =>adversely affect epibenthic/megabenthos/detritivore species=>decline in species cause change to functional grp=> intensity negligible as chemical pollutants introduced by fishery are negligible => consequence is negligible undetectable => confidence low due to lack of information
	Exhaust	1	5	4	Species composition	North Western Oceanic (1) 0-800m	1.1	1	**1**	2	Most exhaust enters the atmosphere, or immediately below the water from engines. Dissolved gases and particulates not believed to be of consequence to benthic/mid-water communities. Confidence high due to logical consideration
	Gear loss	1	5	3	Functional group	North Western Transition 250-565m	2.1	1	**1**	2	Lost nets may form a movement barrier to bottom-dwelling scampi - scampi more likely to be affected than more mobile prawns => intensity negligible as little gear is lost=>epibenthic functional group distribution altered=> consequence negligible as any impact is unlikely to be detectable => confidence high by logic.
	Navigation/ steaming	1	5	4	Functional group	North Western Oceanic (1) 0-800m	2.1	1	**1**	1	Pelagic prawns & fish more likely to be affected by noise from vessel navigation/steaming than bottom-dweller =>disruption of pelagic crustaceans causing them to relocate=> change in functional grp => intensity negligible as few vessels currently operating in the fishery => consequence negligible as prawns migrate to mid-water at night, not surface, so unlikely be disturbed by vessel noise => confidence low due to lack of information
	Activity/ presence on water	1	5	4	Functional group	North Western Oceanic (1) 0-800m	2.1	1	**1**	1	Prawns more likely to be affected vessel activity than bottom-dwelling scampi, as they rise to mid-water at night => pelagic crustacean functional grp composition altered => intensity negligible as few vessels currently operating in the fishery => consequence negligible as prawns migrate to mid-water at night, not surface, so unlikely be disturbed by vessel activity => confidence low due to lack of information
Disturb	Bait collection	0									

Direct impact of Fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (from S2.1)	Intensity Score (1-6)	**Consequence Score (1-6)**	Confidence score (1-2)	Rationale
physical processes	Fishing	1	5	4	Trophic/size structure	North Western Transition 250-565m	4.1	3	**3**	1	Juvenile scampi are likely to inhabit the same grounds as adult stocks. They are not caught by trawling but destruction of burrows and disturbance of sediment by trawling may result in a significant mortality of pre-recruit age classes (Phillips 1992)=> trophic size/structure intensity moderate as fishing has been confined to relatively small areas within the NWS => consequence moderate as long-term recruitment does not appear to have been affected as catch rates have not declined dramatically => confidence low due to lack of information
	Boat launching	0									
	Anchoring/ mooring	0									
	Navigation/steaming	1	5	4	Functional group	North Western Oceanic (1) 0-800m	2.1	1	**1**	1	Prawns more likely to be affected by disturbance of physical processes from vessel navigation/steaming than bottom-dwelling scampi, as they rise to mid-water at night =>disrupt pelagic crustacean functional grp composition=> intensity negligible as few vessels currently operating in the fishery => consequence negligible as prawns migrate to mid-water at night, not surface, so unlikely be disturbed => confidence low (no information)
External hazards (specify the particular example within each activity area)	Other fisheries	1	5	4	Functional group	North Western Transition 250-565m	2.1	2	**2**	1	Several fisheries overlap or are adjacent to the NWS. WDWT has been targeting bugs. The WDWTF also catches scampi, but species are not identified, and it is not known if they are the same stocks as those exploited in the NWSTF
	Aquaculture	0									
	Coastal development	0	0	0							

Direct impact of Fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (from S2.1)	Intensity Score (1-6)	**Consequence Score (1-6)**	Confidence score (1-2)	Rationale
	Other extractive activities	1	3	4	Functional group; **b**io-geochemical cycles	North Western Transition 250-565m	2.1, 5.1	3	**2**	2	Oil and gas extraction and exploration occurs in North Western Province shelf => Extraction occurs on a daily basis throughout the year => Bio- and geo-chemical cycles are likely to be affected also functional group composition => Shelf communities are the most likely to be adversely affected by construction of well heads and rigs and the pipelines that span across the shelf to the coast. Well construction is likely to lead to modifications to sediment & habitat and water chemistry as well as occasional spills or leaks. => Moderate intensity: rigs, pipelines and umbilical chords occur across a broad spatial scale but are restricted to localized sites. => Negligible consequence: time taken to return to pre-disturbed state is on the decadal scale but an extremely low percentage of the habitat will be affected. => High confidence: consensus and logical consideration.
	Other non-extractive activities	1	3	3	Functional group	North Western Oceanic (1) 0-800m	2.1	2	**2**	2	Shipping occurs most days throughout the year but more coastal => Species composition is likely to be affected before the other community subcomponents. => Continental shelf benthic waters are most likely to be adversely affected by ballast exchange from foreign ships therefore => Minor negligible Shipping occurs over a broad spatial scale and closer inshore but exchange of ballast at sea is unlikely to introduce new benthic species. => Negligible consequence: open ocean habitats are constantly being naturally 'seeded' by planktonic dispersal stages of enumerable organisms. => High confidence: consensus and logical consideration.
	Other anthropogenic activities	1	5	4	Species composition	North Western Oceanic (1) 0-800m	2.1	1	**1**	2	Tourism, gamefishing might occur out to shelf break=>but rarely impinge in fishery boundary?=> affect species composition=> intensity minor=> Consequence negligible undetectable against natural variation

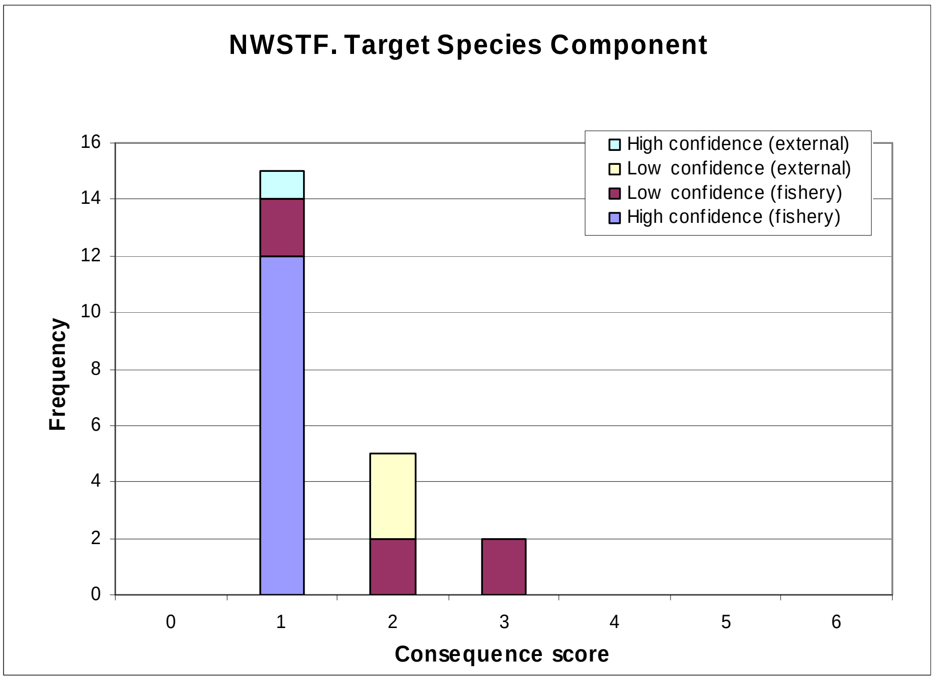
2.3.11 Summary of SICA results

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).

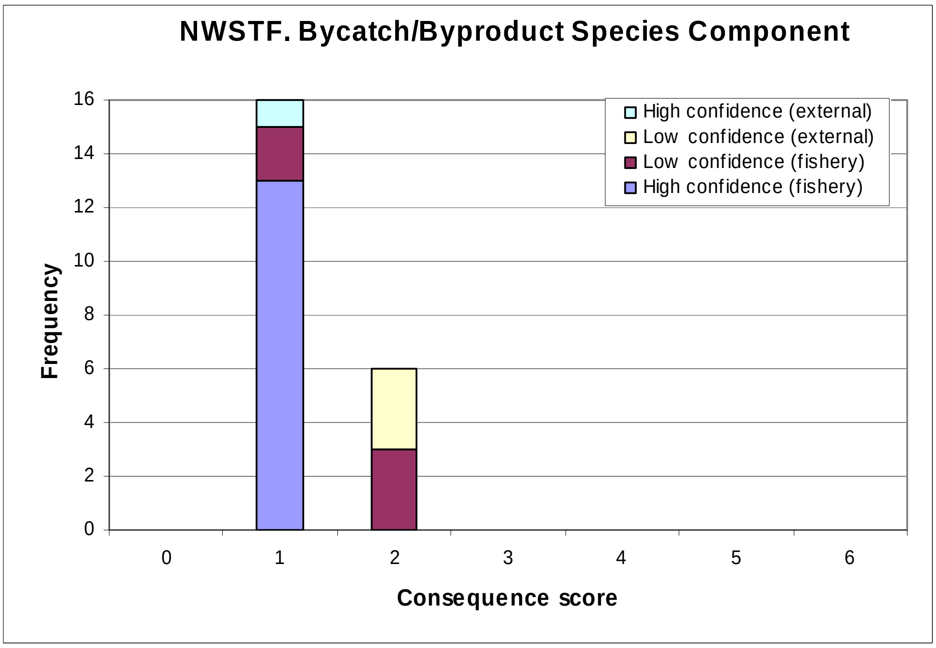
Level 1 (SICA) Document L1.6. Summary table of consequence scores for all activity/component combinations.

Direct impact	Activity	Target species	Byproduct and bycatch species	TEP species	Habitats	Communities
Capture	Fishing	3	2	1	4	3
	Incidental behaviour	1	1	1	1	1
Direct impact without capture	Fishing	2	1	2	4	2
	Incidental behaviour	1	1	1	1	1
	Gear loss	1	1	1	2	1
	Navigation/ steaming	1	1	1	1	1
Addition/ movement of biological material	Translocation of species	2	1	1	1	2
	On board processing	1	1	2	1	1
	Discarding catch	1	2	2	2	1
	Organic waste disposal	1	1	2	2	1
Addition of non-biological material	Debris	1	1	2	2	1
	Chemical pollution	1	1	2	2	1
	Exhaust	1	1	1	1	1
	Gear loss	1	1	1	1	1
	Navigation/ steaming	1	1	2	1	1
	Activity/ presence on water	1	1	2	1	1
Disturb physical processes	Fishing	3	2	1	3	3
	Navigation/ steaming	1	1	1	1	1
External hazards (specify the particular example within each activity area)	Other fisheries	2	2	2	2	2
	Other extractive activities	2	2	2	4	2
	Other non extractive activities	2	2	2	1	2
	Other anthropogenic activities	1	1	1	1	1

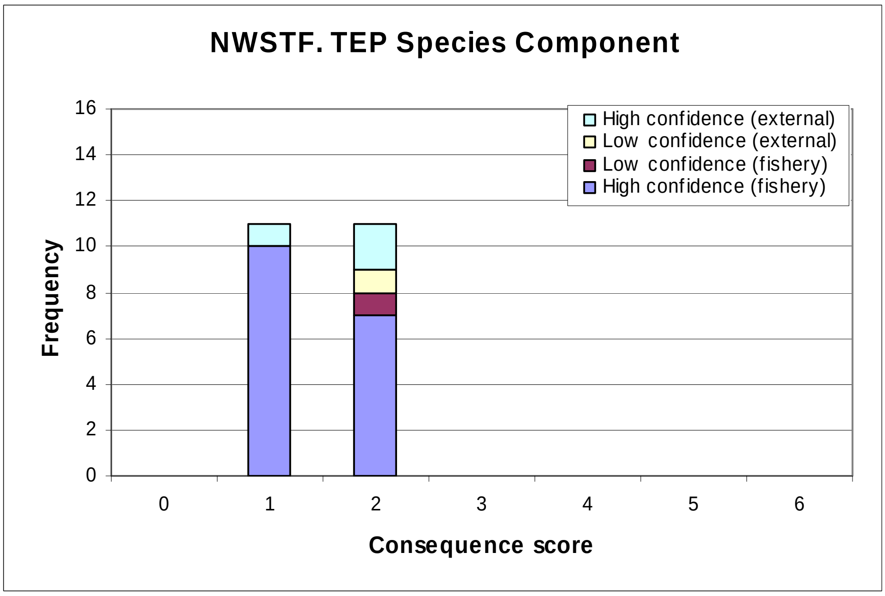
Target species: Frequency of consequence score differentiated between high and low confidence.



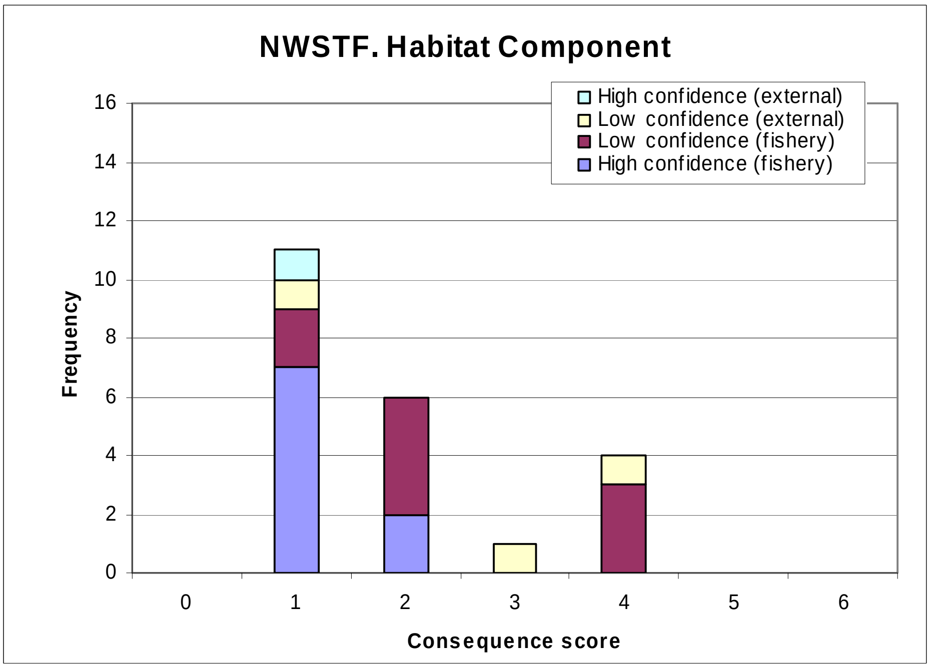
Byproduct and bycatch species: Frequency of consequence score differentiated between high and low confidence



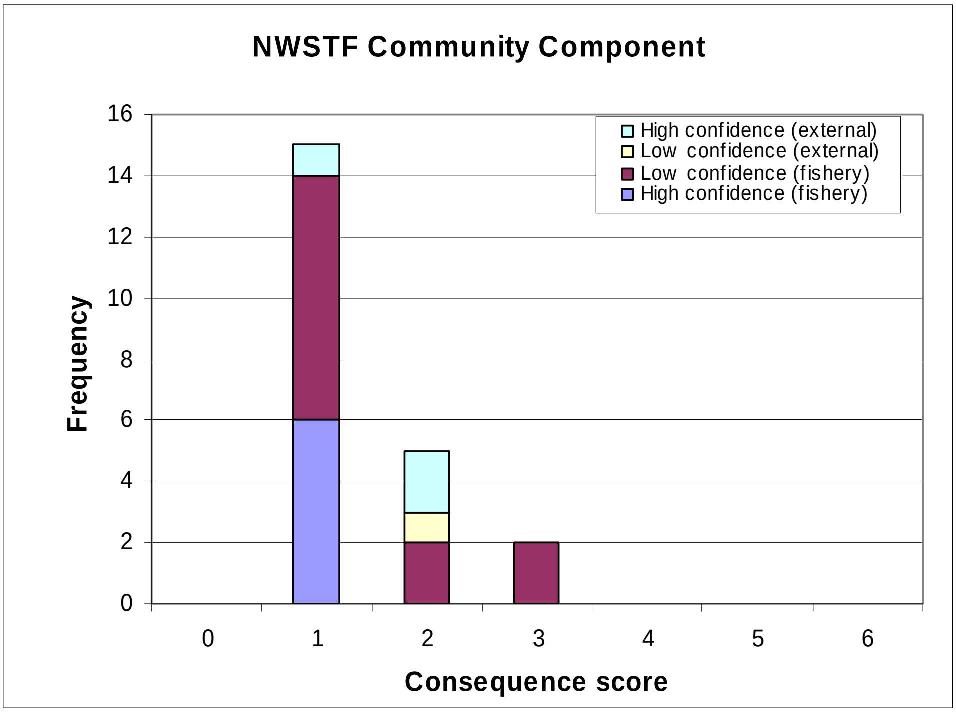
TEP species: Frequency of consequence score differentiated between high and low confidence



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



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



2.3.12 Evaluation/discussion of Level 1

The target species, habitat and community components all have consequence scores of 3 (moderate) or above for at least one activity. The hazards that led to the high consequence scores were: capture by fishing, direct impact of fishing without capture, and disturbance of physical processes due to fishing.

Two of these hazards were assessed to have a major impact (consequence score 4) on habitats. Age and regeneration times have been shown to significantly increase with depth in a number of deep water invertebrate species. Due to very slow growth rates, habitat recovery at these depths may take decades or even hundreds of years (if at all), depending on the degree of modification and connectivity to recruitment sources. Gear contact with the bottom causes sediment resuspension which potentially smothers animals dependent on non-turbid conditions. The sheltering habitat of crustaceans can be destroyed in the process of the trawl passing. The recovery capacity of sessile species removed by the net is unknown for many groups, but generally increases with depth. Recovery seems to favor rapidly colonizing, predatory species. The confidence for these scores is low, as few data exist for deep tropical waters, and the recovery rates of deep fauna are unknown.

The North West Slope is of prime interest to oil and gas stakeholders. Oil and gas exploration, including seismic activity and exploratory well drilling, occurs regularly within the NWSTF to depths of up to >1500m, with the main focus in waters of ~200m. As of 2003, 1 Production licence, 48 exploration permits, and 8 retention leases overlap with the NWSTF. Activity is concentrated on the shelf, although there may be pollution and associated stimuli from the petrochemical industry in both shallow and deep water. The effect of these activities on species and habitats is unknown.

The byproduct/bycatch and TEP species components have been assessed to only be at minor risk in this fishery. There are few non-target species retained in the NWSTF. Squid are the most important byproduct in the NWSTF in terms of tonnage and value, but they are taken intermittently in small and variable volumes. The small catch is considered unlikely to impact this productive stock.

Compared to other tropical trawl fisheries, bycatch volume and composition in the NWSTF is small, due to the greater depth range at which the fishery operates. The two observer cruises so far undertaken in this fishery each report many more bycatch species than are recorded in logbooks. However many of these are not identified to species level, and have not been included in this analysis. Most of these species are caught in small volumes. A future analysis should make more effort to identify and include a greater range of bycatch species. More detailed observer data will assist in this.

There are no recorded interactions with TEP species in the NWSTF. Frigate birds are reported to follow boats, but are not observed to interact with fishing gear. The offshore and deepwater nature of the NWSTF reduces the likelihood of interactions with TEP species.

2.3.13 Components to be examined at Level 2

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

- *Target species*
- *Habitats*
- *Communities*

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

- *Bycatch/byproduct species*
- *TEP species*

2.4 Level 2 Productivity and Susceptibility Analysis (PSA)

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

The PSA approach is based on the assumption that the risk to an ecological component will depend on two characteristics of the component units: (1) the extent of the impact due to the fishing activity, which will be determined by the susceptibility of the unit to the fishing activities (Susceptibility) and (2) the productivity of the unit (Productivity), which will determine the rate at which the unit can recover after potential depletion or damage by the fishing. It is important to note that the PSA analysis essentially measures potential for risk. 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 subfishery with habitat defined at biomic scale	Habitat occurs within the management area
Encounterability	Depth zone and feature type	Habitat encountered at the depth and location at which fishing activity occurs	Fishing takes place where habitat occurs
	Ruggedness (fractal dimension of substratum and seabed slope)	Relief, rugosity, hardness and seabed slope influence accessibility to different sub-fisheries	Rugged substratum is less accessible to mobile gears. Steeply sloping seabed is less accessible to mobile gears
	Level of disturbance	Gear footprint and intensity of encounters	Degree of impact is determined by the frequency and intensity of encounters (inc. size, weight and mobility of individual gears)
Selectivity	Removability/ mortality of fauna/ flora	Removal/ mortality of structure forming epifauna/ flora (inc. bioturbating infauna)	Erect, large, rugose, inflexible, delicate epifauna and flora, and large or delicate and shallow burrowing infauna (at depths impacted by mobile gears) are preferentially removed or damaged.
	Areal extent	How much of each habitat is present	Effective degree of impact greater in rarer habitats: rarer habitats may maintain rarer species.
	Removability of substratum	Certain size classes can be removed	Intermediate sized clasts (~6 cm to 3 m) that form attachment sites for sessile fauna can be permanently removed
	Substratum hardness	Composition of substrata	Harder substratum is intrinsically more resistant
	Seabed slope	Mobility of substrata once dislodged; generally higher levels of structural fauna	Gravity or latent energy transfer assists movement of habitat structures, e.g. turbidity flows, larger clasts. Greater density of filter feeding animals found where currents move up and down slopes.
Productivity			
Productivity	Regeneration of fauna	Accumulation/ recovery of fauna	Fauna have different intrinsic growth and reproductive rates which are also variable in different conditions of temperature, nutrients, productivity.
	Natural disturbance	Level of natural disturbance affects intrinsic ability to recover	Frequently disturbed communities adapted to recover from disturbance

Communities

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

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

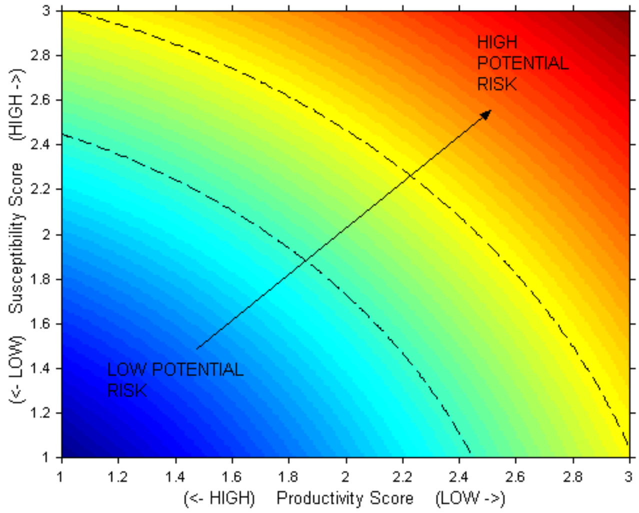


Figure 13. The axes on which risk to the ecological units is plotted. The *x*-axis includes attributes that influence the productivity of a unit, or its ability to recover after impact from fishing. The *y*-axis includes attributes that influence the susceptibility of the unit to impacts from fishing.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

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

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

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

ERA_SPECIES_ID	TAXA_NAME	SCIENTIFIC_NAME	CAAB_CODE	FAMILY_NAME	COMMON_NAME	CODE_ROLE_IN_FISHERY	SOURCE	Reason for removal

No units were 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* (2006).

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. The level of observer data for this fishery is regarded as low. AFMA observers have taken part in 2 trips on the NWSTF – in June 2004 and June 2005.

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)], together with categorisation of risk (refer to section 2.4.8).

<u>Target species *NWS trawl fishery*</u>

ERA species ID	Scientific Name	Common Name	Average logbook catch (kg) (2001-04)	Missing > 3 attributes (Y/N)	Number of missing productivity attributes (out	Number of missing susceptibility attributes (out	Productivity (additive) 1- low risk, 3 - high risk	Susceptibility (mult) 1- low risk, 3 - high risk	2D risk value (P&S) 1.41- low risk, 4.24 - high risk	Susceptibility override used?	PSA risk category	High/Med risk category (Refer 2.4.8)	Comments
Invertebrate													
16	Aristaeopsis edwardsiana	Scarlet Prawn	43	N	1	0	1.43	3.00	3.32	N	High	Spatial uncertainty	
1332	Metanephrops australiensis	Australiensis scampi	20,134	N	1	0	1.71	2.33	2.90	N	Med	Spatial uncertainty	
1333	Metanephrops boschmai	Boschmai scampi	6,877	N	1	0	1.71	2.33	2.90	N	Med	Spatial uncertainty	
1335	Metanephrops velutinus	Velvet scampi	9,336	N	1	0	1.71	2.33	2.90	N	Med	Spatial uncertainty	
15	Aristaeomorpha foliacea	giant red prawn (wa)	975	N	1	0	1.43	2.33	2.74	N	Med	Spatial uncertainty	
1326	Aristeus virilis	Pink striped prawn	820	N	0	1	1.57	1.67	2.29	N	Low		
17	Haliporoides sibogae	Royal Red Prawn	7,221	N	0	0	1.14	1.67	2.02	N	Low		

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	Productivity score (Average)	Susceptibility score (Multiplicative)	Overall Risk Value (P&Sm)	Overall Risk Ranking	Risk Ranking Override	Rational for Risk Ranking Override
3663	143	upper slope	slope	mud, unrippled, large sponges	001	3.00	2.30	3.78	High		
3664	144	upper slope	Canyon, Slope	Mud, Unrippled, Sedentary	007	3.00	2.30	3.78	High		
3697	227	upper slope	Slope	Fine sediments, unrippled, large sponges	101	3.00	2.30	3.78	High		
3644	078	upper slope	Canyon, Terrace, Slope	Fine sediments, unrippled, Solitary epifauna	107	3.00	2.30	3.78	High		
3700	231	upper slope	Slope	Fine sediments, irregular, glass sponge (stalked)	137	3.00	2.30	3.78	High		
#2	TBC	upper slope	slope	Likely: fine sediments, subcrop, mixed faunal community (corals)	153	3.00	2.35	3.81	High		
3728	284	upper slope	slope	Coarse sediments, unrippled, large sponges	201	3.00	2.30	3.78	High		
3729	285	upper slope	slope	Coarse sediments, unrippled, octocorals	205	3.00	2.30	3.78	High		
3619	045	upper slope	slope	coarse sediments, unrippled, sedentary	207	3.00	2.30	3.78	High		
3703	236	upper slope	Slope	Coarse sediments, rippled, solitary epifauna	217	3.00	2.30	3.78	High		
3705	238	upper slope	Slope	Coarse sediments, irregular, octocorals (matrix of solsomalia)	235	3.00	2.30	3.78	High		
#1	TBC	upper slope	slope	Likely: coarse sediments, subcrop, mixed faunal community (corals)	253	3.00	2.35	3.81	High		
3652	131	upper slope	slope	cobble, debris flow, octocorals	445	3.00	2.24	3.75	High		
3730	286	upper slope	slope	Cobble/ boulder, debris, sedentary	447	3.00	2.24	3.75	High		
3706	239	upper slope	Slope	Coarse sediments, subcrop, large (?) sponges	251	3.00	2.14	3.69	High		
3655	134	upper slope	slope	fine sediments, subcrop, large sponges	151	3.00	2.14	3.69	High		
3615	040	upper slope	slope	fine sediments, subcrop, sedentary	157	3.00	2.35	3.81	High		
3636	067	upper slope	canyon, slope	Sedimentary rock, subcrop, large sponges	651	3.00	2.24	3.75	High		
3610	033	upper slope	slope	Sedimentary rock, subcrop, mixed faunal community	653	3.00	2.04	3.63	High		
3667	148	upper slope	Terrace, Slope	Sedimentary rock, Subcrop, Octocorals (gold corals / seawhips)	655	3.00	2.14	3.69	High		
3707	240	upper slope	Slope	Sedimentary rock, subcrop, octocorals	655	3.00	1.93	3.57	High		
3736	292	upper slope	slope	Sedimentary Rock (?), subcrop, sedentary	657	3.00	2.04	3.63	High		
3662	142	upper slope	slope	mud, unrippled, encrustors	006	2.00	2.07	2.88	Med		

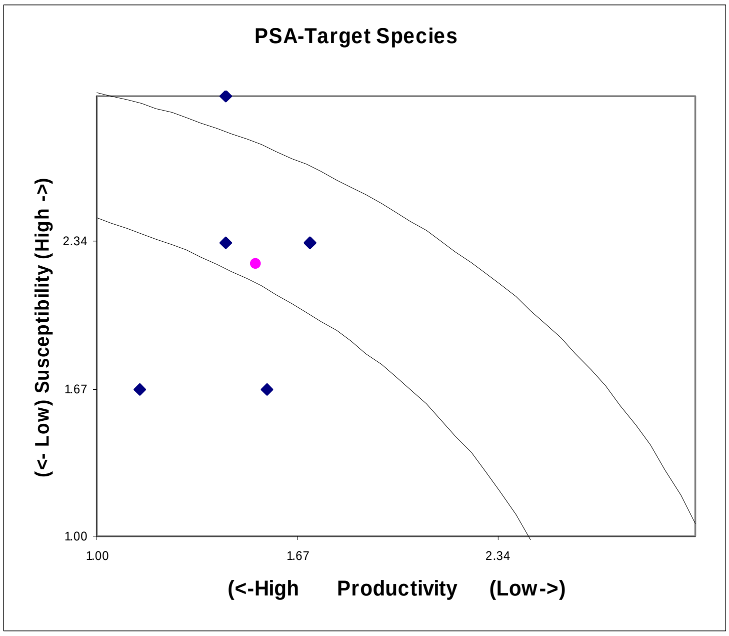
Record #	ERA habitat #	Sub-biome	Feature	Habitat Name	SGF Score	Productivity score (Average)	Susceptibility score (Multiplicative)	Overall Risk Value (P&Sm)	Overall Risk Ranking	Risk Ranking Override	Rational for Risk Ranking Override
3661	141	upper slope	Slope	mud, unrippled, bioturbators	009	2.00	2.07	2.88	Med		
3660	140	upper slope	slope	mud, irregular, bioturbators	039	2.00	2.07	2.88	Med		
3657	137	upper slope	slope	fine sediments, unrippled, small sponges	102	2.00	2.19	2.96	Med		
3656	136	upper slope	slope	fine sediments, unrippled, encrustors	106	2.00	2.07	2.88	Med		
3618	044	upper slope	slope, canyon, terrace	fine sediments, unrippled, bioturbators	109	2.00	2.07	2.88	Med		
3641	073	upper slope	Canyon, Terrace	Fine sediments, irregular, Small encrustors / erect forms (including bryozoans)	136	2.00	2.07	2.88	Med		
3616	041	upper slope	Slope	Fine sediments, irregular, bioturbators	139	2.00	2.07	2.88	Med		
3643	077	upper slope	canyon, slope	fine sediments, subcrop, small sponges	152	2.00	2.04	2.85	Med		
3617	043	upper slope	slope	coarse sediments, unrippled, low mixed encrustors	206	2.00	2.07	2.88	Med		
3704	237	upper slope	Slope	Coarse sediments, wave rippled, bryozoan turf	226	2.00	2.07	2.88	Med		
3642	076	upper slope	canyon, slope	coarse sediments, irregular, low mixed encrustors	236	2.00	2.07	2.88	Med		
3640	072	upper slope	Slope	Coarse sediments, rippled, bioturbators	239	2.00	2.07	2.88	Med		
3708	241	upper slope	Slope	Coarse sediments, subcrop, low encrusting community	256	2.00	1.93	2.78	Med		
3658	138	upper slope	slope	gravel, debris flow, encrustors	346	2.00	2.19	2.96	Med		
3653	132	upper slope	slope	cobble, debris flow, small sponges	442	2.00	2.14	2.93	Med		
3650	129	upper slope	slope	cobble, debris flow, encrustors	446	2.00	2.04	2.85	Med		
3638	070	upper slope	canyon	Sedimentary rock, subcrop, small sponges	652	2.00	2.14	2.93	Med		
3613	036	upper slope	Slope	Sedimentary rock, subcrop, small encrustors	656	2.00	1.83	2.71	Med		
3649	128	upper slope	slope	Bryozoan based communities	XX6	2.00	2.19	2.96	Med		
3724	265	upper slope	Slope	Sedimentary rock, high outcrop, no fauna	690	2.00	1.71	2.63	Low		
3611	034	upper slope	slope	Sedimentary rock, high outcrop, encrustors	696	2.00	1.71	2.63	Low		
#3	TBC	upper slope	slope	Likely: fine seds, low outcrop, mixed faunal community (corals)	173	3.00	2.35	3.81	High	Low	low encounterability with outcrops
#4	TBC	upper slope	slope	Likely: coarse seds, low outcrop, mixed faunal community (corals)	273	3.00	2.35	3.81	High	Low	low encounterability with outcrops
3637	069	upper slope	canyon	cobble, low outcrop, crinoids	464	3.00	2.45	3.87	High	Low	low encounterability with outcrops
3731	287	upper slope	slope	slabs and boulders, low outcrop, octocorals	475	3.00	2.24	3.75	High	Low	low encounterability with outcrops
3732	288	upper slope	slope	Igneous Rock (?), low outcrop, octocorals	565	3.00	1.93	3.57	High	Low	low encounterability

Record #	ERA habitat #	Sub-biome	Feature	Habitat Name	SGF Score	Productivity score (Average)	Susceptibility score (Multiplicative)	Overall Risk Value (P&Sm)	Overall Risk Ranking	Risk Ranking Override	Rational for Risk Ranking Override
											with outcrops
3733	289	upper slope	slope	Igneous Rock (?), low outcrop, mixed faunal community	573	3.00	1.93	3.57	High	Low	low encounterability with outcrops
3735	291	upper slope	slope	Igneous Rock (?), high outcrop, mixed faunal community	593	3.00	1.80	3.50	High	Low	low encounterability with outcrops
3719	256	upper slope	Slope	Sedimentary rock, low outcrop, octocorals	665	3.00	2.04	3.63	High	Low	low encounterability with outcrops
3665	145	upper slope	Canyon	Sedimentary rock, low outcrop, large sponges	671	3.00	2.24	3.75	High	Low	low encounterability with outcrops
3692	216	upper slope	Canyon	Sedimentary rock, low outcrop, Octocorals (gold corals / seawhips)	675	3.00	2.24	3.75	High	Low	low encounterability with outcrops
3721	261	upper slope	Slope	Sedimentary rock, low outcrop, sedentary	677	3.00	2.04	3.63	High	Low	low encounterability with outcrops
3723	264	upper slope	Slope	Sedimentary rock, high outcrop, octocorals	683	3.00	1.89	3.55	High	Low	low encounterability with outcrops
3614	039	upper slope	slope	Sedimentary rock, high outcrop, crinoids	684	3.00	1.89	3.55	High	Low	low encounterability with outcrops
3694	218	upper slope	Canyon	Sedimentary rock, High Outcrop, Sedentary: e.g. seapens	687	3.00	2.07	3.64	High	Low	low encounterability with outcrops
3635	066	upper slope	canyon	Sedimentary rock, high outcrop, crinoids	694	3.00	2.07	3.64	High	Low	low encounterability with outcrops
3726	269	upper slope	Slope	Sedimentary, high outcrop, octocorals	695	3.00	1.89	3.55	High	Low	low encounterability with outcrops
3727	270	upper slope	Slope	Sedimentary, high outcrop, solitary epifauna	697	3.00	1.89	3.55	High	Low	low encounterability with outcrops
3737	293	upper slope	slope	Rock/ biogenic matrix, low outcrop, mixed faunal community	763	3.00	2.35	3.81	High	Low	low encounterability with outcrops
3712	247	upper slope	Slope	boulders, low outcrop, no fauna	470	2.00	2.04	2.85	Med	Low	low encounterability with outcrops
3734	290	upper slope	slope	Igneous Rock (?), high outcrop, no fauna	590	2.00	1.83	2.71	Med	Low	low encounterability with outcrops
3612	035	upper slope	Slope	Sedimentary rock, low outcrop, small encrustors	666	2.00	1.83	2.71	Med	Low	low encounterability with outcrops
3720	257	upper slope	Shelf break	Sedimentary rock, low outcrop, no fauna	670	2.00	1.93	2.78	Med	Low	low encounterability with outcrops
3666	146	upper slope	slope	Sedimentary rock, low outcrop, small sponges	672	2.00	1.93	2.78	Med	Low	low encounterability

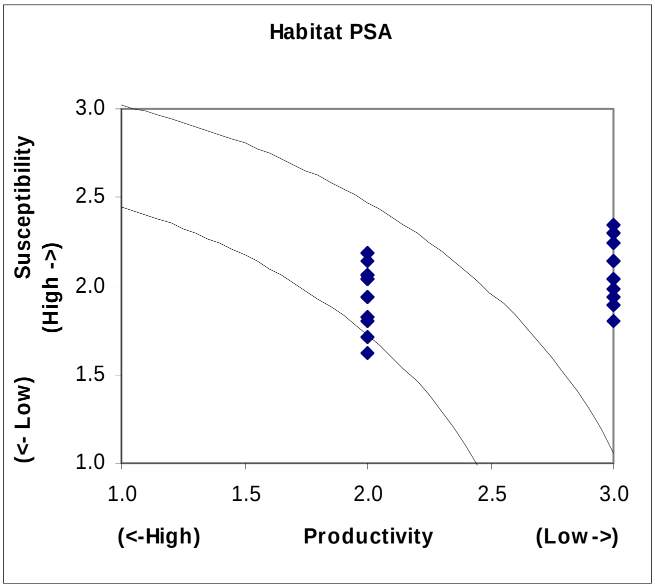
Record #	ERA habitat #	Sub-biome	Feature	Habitat Name	SGF Score	Productivity score (Average)	Susceptibility score (Multiplicative)	Overall Risk Value (P&Sm)	Overall Risk Ranking	Risk Ranking Override	Rational for Risk Ranking Override
											with outcrops
3639	071	upper slope	Shelf break	Sedimentary rock, low outcrop, small encrustors	676	2.00	1.93	2.78	Med	Low	low encounterability with outcrops
3693	217	upper slope	Canyon	Sedimentary rock, High Outcrop, Small encrustors / erect forms	686	2.00	1.89	2.75	Med	Low	low encounterability with outcrops
3725	267	upper slope	Slope	Sedimentary rock, high outcrop, small sponges	692	2.00	1.80	2.69	Med	Low	low encounterability with outcrops
3683	202	upper slope	Terrace, Slope	mud, unrippled, no fauna	000	2.00	2.07	2.88	Med	Low	sediments no fauna
3620	046	upper slope	slope	fine sediments, unrippled, no fauna	100	2.00	2.07	2.88	Med	Low	sediments no fauna
3654	133	upper slope	Slope	Fine sediments, current rippled, no fauna	110	2.00	2.07	2.88	Med	Low	sediments no fauna
3702	235	upper slope	Slope	Coarse sediments, rippled, no fauna	210	2.00	2.07	2.88	Med	Low	sediments no fauna
3651	130	upper slope	slope	cobble, debris flow, no fauna	440	2.00	2.04	2.85	Med	Low	sediments no fauna
3716	251	upper slope	Slope	Sedimentary rock, subcrop, no fauna	650	2.00	1.83	2.71	Med	Low	sediments no fauna

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

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



PSA plot for target species



PSA plot for habitats

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

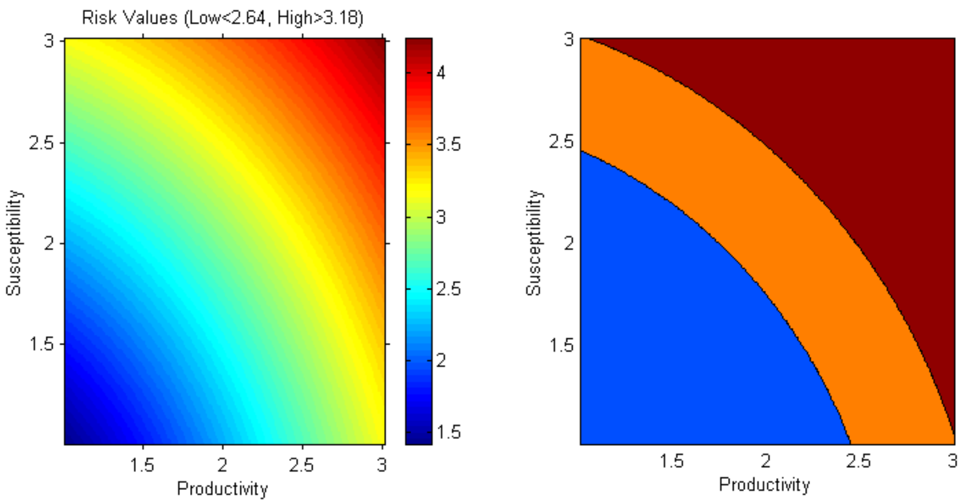


Figure 17. Overall risk values in the PSA plot. Left panel. Colour map of the distribution of the euclidean overall risk values. Right panel. The PSA plot contoured to show the low risk (blue), medium risk (orange) and high risk (red) values.

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

2.4.5 Uncertainty analysis ranking of overall risk (Step 5)

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

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

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

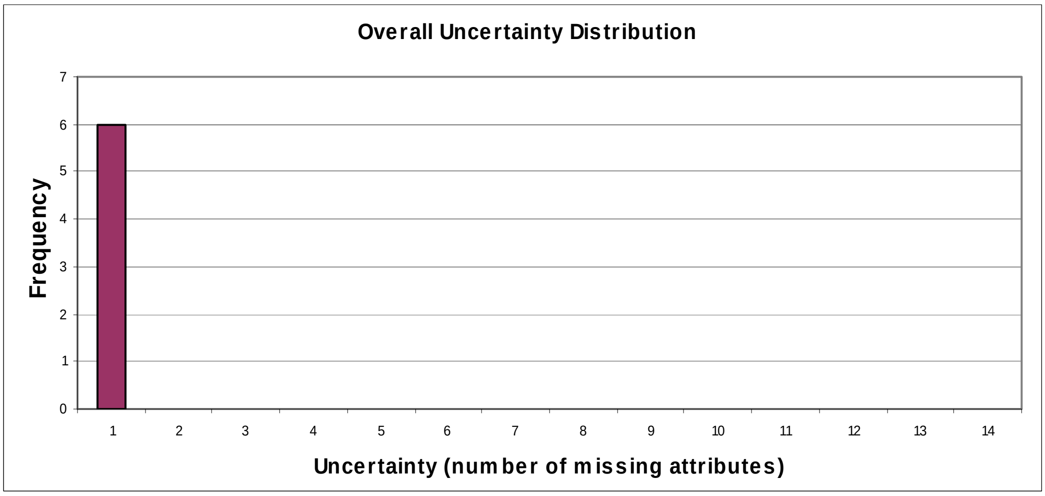
Availability of information

The ability to score each species based on information on each attribute did not vary between the attributes (as per summary below). With regard to the productivity attributes, trophic level was missing in three of the seven species, and so the most conservative score was used. Information on most productivity attributes could be found or calculated for all species. The current method of scoring the susceptibility attributes provides a value for each attribute for each species – some of these are based on good information, whereas others are merely sensible default values.

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

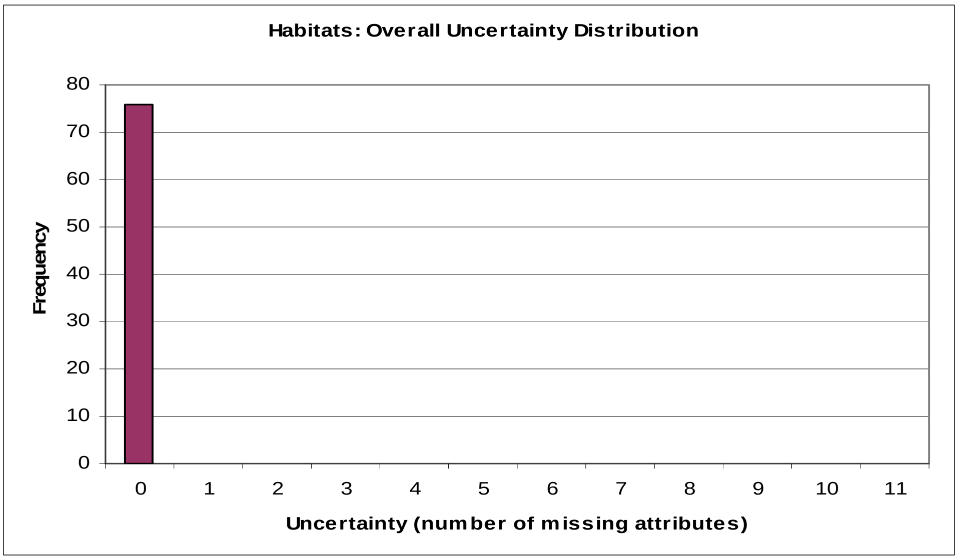
Productivity Attributes	Average age at maturity	Average max age	Fecundity	Average max size	Average size at Maturity	Reproductive strategy	Trophic level (FishBase)
Total species scores for attribute	7	7	5	7	7	7	4
n species scores with attribute unknown, (conservative score used)	0	0	2	0	0	0	3
% unknown information	0	0	29	0	0	0	43
Susceptibility Attributes	Availability	Encounterability		Selectivity	PCM		
		Bathymetry overlap	Habitat				
Total species scores for attribute	7	7	6	7	7	7	7
n species scores with attribute unknown, (conservative score used)	0	0	1	0	0	0	0
% unknown information	0	0	14	0	0	0	0

Each species considered in the analysis had information for an average of 6.29 (90%) productivity attributes and 3.9 (98%) susceptibility attributes. This meant that, on average, conservative scores were used for less than 7% of the attributes for a single species. Species had missing information for between 0 and 1 of the combined 12 productivity and susceptibility attributes.



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

Habitats: Eleven attributes were used in the habitat PSA. All attributes were scored according to Habitat attribute tables 9-27. Only attributes that could be ranked were utilized and therefore there are no missing attributes. It is important to note that habitat attributes relating to fauna are based on taxa specific generalizations, not species specific metrics.



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

Correlation between attributes

In situations where attributes are strongly correlated only one of them should be included in the final PSA (Stobutzki *et al.*, 2001).

Species component: Some of the attributes selected for productivity and susceptibility were strongly correlated (as per correlation matrix below for Productivity and susceptibility). However with only seven species considered, this analysis is not particularly meaningful. Correlations were not calculated for the Susceptibility attributes as there was no variation between species for most attributes.

	Age at maturity	Max age	Fecundity	Max size	Min size at maturity	Reproductive strategy	Trophic level
Age at maturity	X						
Max age	-0.55	X					
Fecundity	0.65	-0.35	X				
Max size	-	-	-	X			
Min size at maturity	-	-	-	-	X		
Reproductive strategy	-1.00	0.55	-0.65	-	-	X	
Trophic level	-0.68	0.94	-0.22	-	-	0.68	X

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.

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

Habitat Component: The correlation between the productivity attributes Regeneration of Fauna and Natural disturbance could not be calculated because there was no variation in the Natural disturbance score. 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 no correlation between the attributes used to calculate Encounterability and Selectivity. All attributes were suitable for inclusion in the PSA

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

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.

Susceptibility Correlation Matrix	Availability score	Encounterability score (average)	Selectivity score (average)
Availability score	X		
Encounterability score (average)	-	X	
Selectivity score (average)	-	-0.13	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.

<u>Productivity and susceptibility risk values for Species</u>

The average productivity score for all species was 1.53 ± 0.12 (mean ± SD of scores calculated using n-1 attributes) and the mean susceptibility score was 2.24 (as per summary of average productivity and susceptibility scores as below). Individual scores are shown in section 2.4.2: Summary of PSA results. Information was missing for an average of 0.86 attributes out of 12 possible for each species.

<u>Productivity and susceptibility risk values for habitat units.</u>

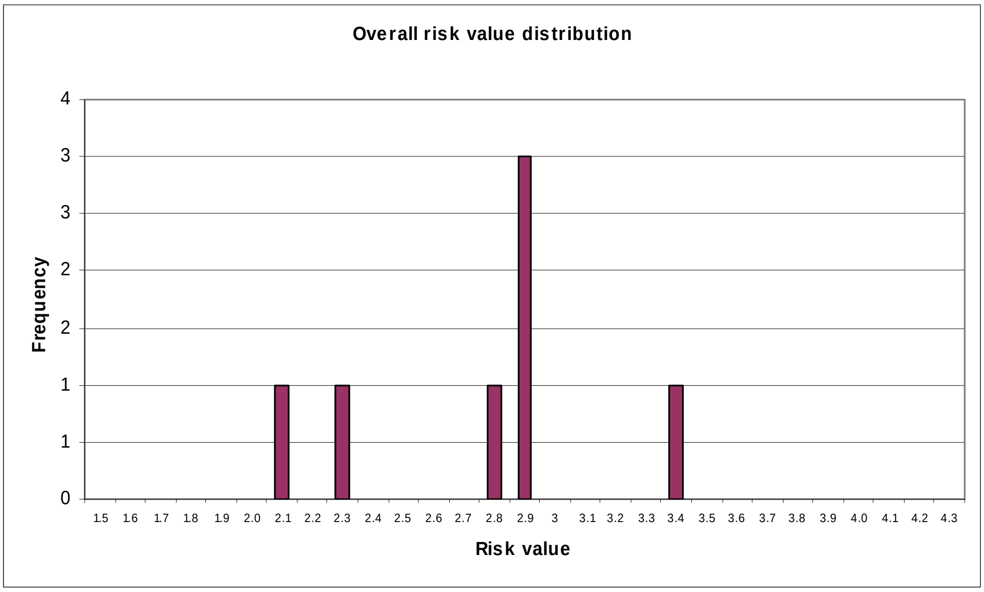
The average productivity score for all habitats was 2.53 ± 0.5 (mean ± SD of scores calculated using n-1 attributes) and the mean susceptibility score was 2.09 ± 0.18 (as per summary of average productivity and susceptibility scores as below). Individual scores are shown in section 2.4.3: Summary of PSA results.

<u>Overall Risk Values for Species</u>

The overall risk values (Euclidean distance on the PSA plot) could fall between 1 and 4.24 (scores of 1&1 and 3&3 for both productivity and susceptibility respectively). The mean observed overall risk score was 2.72, with a range of 1.84 – 3.32**.**

The actual values for each species are shown in section 2.4.2 Summary of PSA results. One unit was classed as high risk, four were in the medium risk category, and three were classed as low risk**.**

Results: Frequency distribution of the overall PSA risk values

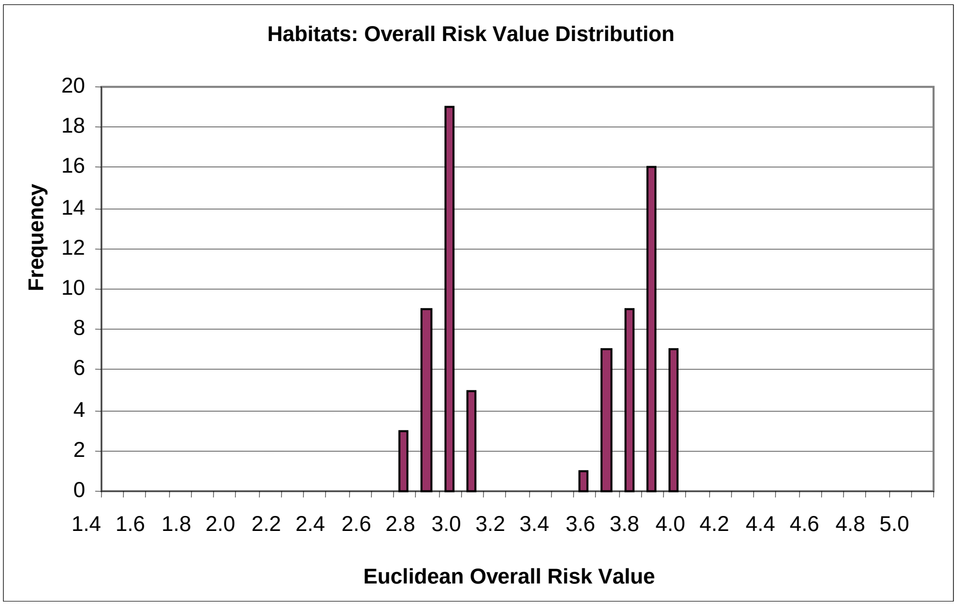


Frequency distribution of the overall risk values generated for the 7 species in the NWSTF PSA.

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 3.01, with a range of 2.18- 3.97**.**

The actual values for each species are shown in section 2.4.3: Summary of PSA results. A total of 22 units, (29%) were classed as high risk, 20 units, (26%) were in the medium risk category, and 34 (45%) as low risk**.**



Frequency distribution of the overall risk values generated for the 76 habitat types in the NWSTF PSA.

2.4.6 Evaluation of the PSA results (Step 6)

The Level 2 (or PSA) analysis of the species in the North West Slope Trawl Fishery was presented to, and reviewed by, WESTMAC members at a meeting in Fremantle on 7 March 2006. The PSA methodology has since been reviewed and revised. The following results reflect the revised methodology (as at 30 April 2006).

Overall

A total of seven target species were considered. For most species there was little missing data. The average number of missing attributes was 0.86 out of a possible 12. No expert over rides were used, and no species had more than three missing attributes.

Table 1. Summary of average productivity, susceptibility and overall risk scores.

Component	Measure	
Target species	Number of species	7
	Average of productivity total	1.53
	Average of susceptibility total	2.24
	Average of overall risk value	2.72
	Average number of missing attributes	0.86

Table 2. Risk categories for each species component (all invertebrates).

Risk Category	High	Medium	Low	Total
Target species	1	4	2	7

Target species

Scarlet prawn was assessed to be at high risk. It is the largest prawn found in the NWSTF, and therefore has a higher selectivity score than the other crustaceans. It is important to note that the PSA assesses potential risk. Currently catches of scarlet prawn are very low in the NWSTF, so it is unlikely to be at risk from the fishery at present. It would be a commercially attractive species if found in larger quantities. Australian scampi, Boschmai scampi, velvet scampi and giant red prawn are at medium risk, and pink striped prawn and pink prawn (or royal red prawn) are at low risk.

Habitat Component:

A Level 1 (or SICA) analysis of the potentially vulnerable habitats from the North West Slope Trawl Fishery region was presented to, and reviewed by, WESTMAC members at a meeting in Fremantle on 7 March 2006. The detailed Scoping for habitats has been completed since, the SICA populated with revised Units of Analysis, and a PSA has recently been completed but not reviewed by stakeholders. The following results reflect the revised PSA methodology (as at 30 April 2006).

Overall

A total of 76 habitat types were considered. Eleven attributes were scored for all habitats. Risk ranking categories were adjusted following the PSA based on stakeholder feedback and expert opinion. The resulting PSA risk rankings (H, M or L) including overrides are considered in the following discussion. Overrides are made according to the rationales discussed in the evaluation and are included in section 2.4.3: Summary of PSA Results, which lists all habitats assessed in the PSA. Overrides are a category adjustment only, as the Productivity and Susceptibility scores could not be adjusted further to automatically over ride overall risk values.

Summary of average productivity, susceptibility and overall risk scores

Component	Measure	
All habitats	Number of habitats	76
	Average of productivity total	2.53
	Average of susceptibility total	2.09
	Average of overall risk value	3.29
	Average number of missing attributes	0

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

Risk Score	Coastal Margin	Inner-shelf	Outer-shelf	Upper-slope	Mid-slope	Total habitats
High	0	0	0	40	0	40
Medium	0	0	0	34	0	34
Low	0	0	0	2	0	2
Total	0	0	0	76	0	76
	Not in fishery	Not in fishery	Not in fishery		no effort	

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

Risk Score	Coastal Margin	Inner-shelf	Outer-shelf	Upper-slope	Mid-slope	Total habitats
High	0	0	0	22	0	22
Medium	0	0	0	20	0	20
Low	0	0	0	34	0	34
Total	0	0	0	76	0	76
	Not in fishery	Not in fishery	Not in fishery		no effort	

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

Risk Category	High	Medium	Low	Total
Total Habitats	22	20	34	76

Only habitats of the upper slope were scored; these were mostly at low risk (34), with near-equal numbers at medium risk (20) and high risk (22). Effort in this fishery area does not extend onto the mid-continental slope (> 700 m depth); no continental shelf habitats were scored because the shallow operating depth of the fishery is 200 m.

Discussion

The poor knowledge of upper slope seabed habitats in this large fishery area required a list of habitats to be generated based on (1) the presence of known coarse-scale habitat types (‘geomorphic features’) and (2) the presence of fine-scale habitats inferred from better known adjacent or similar fishery areas (Scoping method 2). A precautionary approach is taken, in which all upper slope habitats of geomorphic features were included: canyons, trenches, troughs, seamounts, pinnacles, plateaus and terrace (Geoscience Australia, National Bioregionalization). In addition, seabed habitat data from a recent (late-2005) CSIRO survey of deep benthic biodiversity off the western WA coast were also considered. Rankings are consistent with the same habitat types from other Commonwealth fisheries utilizing similar gear in upper slope depths (i.e. SET OT, WDWT, GABT).

This alternative scoping method generated a conservatively large list of potentially encounterable habitats (76) and included many habitat types in each risk category. However, these detailed habitat types can be readily aggregated into a smaller number of general categories for interpretation. This is because many types are similar, differing in only one respect of substratum or geomorphology or dominant fauna, and therefore attracting similar PSA scores and the same risk rankings. For example, one general type will group together the habitats of a depth zone characterized by similar substratum and geomorphology but different large fauna (sponges, crinoids, octocorals or mixed communities).

The distribution of risk values for the NWSTF is 22 (29%) high, 20 (26%) medium and 34 (45%) low. All habitat types were on the upper continental slope (200-700 m depth).

Factors contributing to the high risk ranking of 22 habitats were predominantly the relatively high overall level of disturbance of bottom trawling and use of continental slope habitats where productivity is relatively low (compared to the continental shelf). There is potentially high removability of epifauna that are large, erect or delicate, particularly where habitats have low ruggedness and low resistance (e.g. sediments). In overview,

- 22 high risk upper slope habitats included 15 categories of ‘soft bottom’ types and 7 ‘hard bottom’ types. Soft bottom habitats are muds, fine and coarse sediments characterized by large, erect or delicate epifauna (large demosponges, glass sponges, octocorals, solitary and sedentary fauna). Hard types fall into two categories: 2 types of low-relief cobble bottom characterized by octocorals and sedentary fauna, and 5 types of low, sub-cropping, soft sedimentary rock with large, erect or delicate epifauna consisting of sponges, octocorals, mixed and sedentary epifauna. Outcropping rocky habitats with vulnerable fauna (particularly large erect types) scored at high risk due to low productivity on the continental slope (compared to the shelf) but were down-ranked to low risk because of low accessibility (encounterability). A similar down-ranking of the 5 sub-cropping hard bottom types is also likely to be appropriate for crustacean trawling that targets prawns and scampi on sediment bottoms using light gear. However, this category is left at high risk as a precautionary measure until more information is available.

Factors contributing to the medium risk ranking of 20 habitats are largely the same as for high risk types, although only habitats with small, low or bioturbating (burrowing) fauna score at medium risk. The 34 habitat types scored at low risk are mostly down-ranked from high risk based on their low encounterability by bottom trawling.

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 or be further examined for risk within the particular ecological component at Level 3. Units at low risk, in the lower third (risk value <2.64), will be deemed not at risk from the sub-fishery and the assessment is concluded for these units.

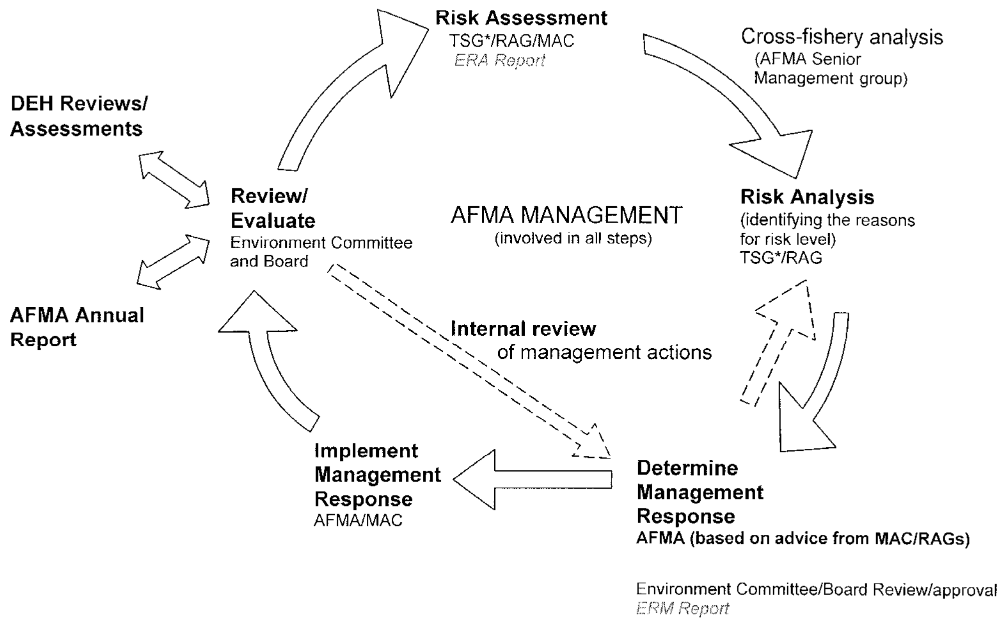
For example, if in a Level 2 analysis of habitat types, two of seven habitat types were determined to be at risk from the sub-fishery, only those two habitat types would be considered at Level 3.

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

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

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

Figure x: Ecological Risk Management Framework



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

2.4.8 High/Medium risk categorisation (Step 8)

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

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

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

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

Categorisation results - High risk species

Detailed species by species results of the categorisation are presented for medium and high risk species in the Tables in section 2.4.2 of this report. The following is a brief summary of the results for species classified as high risk from the PSA analyses.

Of the 1 species classified as high risk in the NWS fishery, 1 had spatial uncertainty (Category 4).

High risk Category	Description	Total
Category 1	High risk - Missing data for more that 3 attributes	0
Category 2A	High risk - Widely distributed outside fishery	0
Category 2B	High risk - Low overlap inside fishery	0
Category 3	High risk - One (susceptibility) attribute scored low	0
Category 4	High risk - Spatial uncertainty	1
Category 5	High risk -other	0
	Total High	1

It is important to stress that this categorization does not imply a down-grading of risk. It is intended as a tool to focus subsequent discussions on risk treatment and identify needs for further data. Sensitivity analysis to the particular cutoffs has not been undertaken in a formal sense, and may not be required, as these categories are intended as guides to focus further consideration of the high risk species. These categories may also indicate the presence of false positives in the high risk species category, but only further analysis or data can determine this.

2.5 Level 3

CPUE trends for the three scampi species were calculated in 2004 (Lynch and Garvey, 2005). This analysis shows that CPUE for all species has declined since 1985. No evidence of growth overfishing was found, and stocks are not considered to be over-exploited at current catch levels.

3. General discussion and research implications

The North West Slope Trawl Fishery operates in deep water (greater than 200m) off the north-west coast of Western Australia, between North West Cape and Cartier Island. It is based on commercial stocks of deepwater crustaceans, principally scampi and prawns.
It is mainly fished by Northern Prawn Fishery trawlers that operate on an opportunistic basis during closures in the NPF. Demersal prawn trawling gear modified for deepwater trawling is used.

3.1 Level 1

The SICA analysis identified three components at potential risk from the fishery – the target species, habitats and communities. Target species and habitats have both been assessed further at Level 2 using the PSA analysis. The hazards identified to be of concern at Level 1 were capture by fishing, direct impact of fishing without capture, and disturbance of physical processes due to fishing. Habitats were considered to be potentially at major risk from the fishery (risk score 4).

The byproduct/bycatch and TEP species components have been assessed to only be at minor risk in this fishery. There are few non-target species retained in the NWSTF. Compared to other tropical trawl fisheries, bycatch volume and composition in the NWSTF is small, due to the greater depth range at which the fishery operates. However, observer reports show that many more bycatch species are caught than have been included in this analysis. A future analysis should make more effort to identify and include a greater range of bycatch species. More detailed observer data will assist in such analyses.

The offshore and deepwater nature of the NWSTF reduces the likelihood of interactions with TEP species. The two existing observer reports show no interactions with TEP species.

3.2 Level 2

Of the seven target species assessed, one was found to be at high risk, four at medium risk, and two at low risk. Twenty-two of the 76 habitats assessed were also found to be at potential high risk from trawling, though see also discussion below.

3.2.1 Species at risk

Of the list of species rated as high risk from the PSA analyses, the authors consider that 1 species (Scarlet prawn) may, in future, need further evaluation or management response. This expert judgment is based on taxonomy/identification, distribution, stock structure, movements, conservation status and overlap with this/other fisheries. This and other species are discussed below.

Species	Risk category	Role
Invertebrate		
• Scarlet prawn	Spatial uncertainty	Target

Scarlet prawn is the only species assessed to be at high risk in the NWSTF. It is the largest commercial crustacean targeted, and thus has the highest selectivity score. Currently catches of scarlet prawn are very low in the NWSTF (<100 kg per year), so it is unlikely to be at risk from the fishery at present. It would be commercially attractive if found in larger quantities. Worldwide, this species has been recorded to depths of 1800m, so it is conceivable that further resources may be discovered if the deeper waters of the North West slope are explored (Wadley, 1992).

Scampi are currently the main target in the NWSTF. They have been assessed in more detail in other analyses (Lynch and Garvey, 2005). Although catch rates have declined, they are not considered to be over-exploited at current catch levels.

There is no information available for any of the target species on the overlap of their range with effort in the fishery. Fishing for scampi in the NWSTF has been confined to relatively small areas. There is no evidence of serial depletion of scampi in the fishery (Lynch and Garvey, 2005).

Residual risk

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

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

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

3.2.2 Habitats at risk

The Level 2 habitat PSA analyses have highlighted a range of habitat types likely to be at high risk from trawling. These habitat types cover both hard and soft ground (the former still able to be trawled), and generally involve habitats with large, erect and fragile epifauna of various types. Habitats characterized by what appears to be a very rich bioturbating fauna including large animals (e.g. scampi) are scored at medium risk, acknowledging both a potentially deleterious impact from trawling and the vast expanses of these habitats that exist in the NWSTF with low trawl fishing effort.

Initially, the information required for an informed management response includes knowledge of what habitats exist, how much of each type there is, and where they are found. So that goals can be clearly defined, it is also necessary to know whether a habitat is essential to maintaining a part of the fishery ecosystem (is important for commercial species), or has important biodiversity values. The Level 2 analysis for the NWSTF provides only an evaluation of what habitats exist at a relevant level of detail for initial risk assessment. Very little information, even at a coarse scale, has been analysed to address other key issues for fishery habitats in this area: the “how much” and “where”, value to the fishery or biodiversity value. These issues require further analysis (and over time, further data collection).

Additional information to that used in the risk assessment does exist and would enable a preliminary examination of management options. Relevant findings can also be inferred from other continental slope areas that are better known (e.g. those in the eastern and southeastern regions of the SESSF) or the well-documented North West Shelf area shoreward of this fishery. Primarily this is finer scale information on habitat distribution (how much and where), but information on the role of habitat for ecosystem function (e.g. providing refuge for commercial species) is available – especially for North West Shelf species. Example of unused data include surveys by AIMS and CSIRO (respectively, in this and the adjacent WDWTF). The CSIRO data show two underlying and relevant patterns in benthic habitats of the WDWTF: vast areas of bioturbated sediments (medium to low risk) and concentrations of hard bottom habitats (high to low risk) at particular latitudes and depths, and associated with particular features (e.g. canyons) that may be largely untrawlable. These data, used in conjunction with the information being incorporated in MPA planning, will be very helpful in understanding the area planning issues for the fishery.

In summary: while high risk habitats have been identified, several factors point to there being no immediate needs to protect fishery habitat. These include the large size of the fishery, low effort, a narrow (if not exclusive) focus on crustacean target species, the use of relatively light trawl gear (compared to scalefish gear), the probability that extensive tracts of inaccessible bottom exist, and a rapidly developing program to implement offshore MPAs. Two factors that may require a management response would be an expansion of fishing effort using heavier fish trawl gear, and/or if habitats of seamounts and pinnacles, widely recognized as being hotspots for both fishery production and biodiversity value, were discovered and exploited. Any consideration of spatial management for habitat protection should also involve an analysis of the extent to which it would or would not help mitigate impacts on high risk species. A key element of this is to examine the ecosystem services provided by complex fishery habitat to commercial species and their prey. Both developments will rely on an increased knowledge of the fishery landscape through mapping existing data at relevant scales.

3.2.3 Communities at risk

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

3.3. Key Uncertainties / Recommendations for Research and Monitoring

In assessing risk to species, it is not possible to assess absolute risk without supplementary information on either abundance or total mortality rates, and such data are not available for this fishery. At the moment, the only inferences that can be drawn about stock status are from trends in CPUE.

In assessing risk to habitats, similar issues arise. In general we do not have detailed information on the amount of each habitat type present in the area of the fishery, nor of its spatial distribution.

Specific recommendations arising from this assessment include:

- Continue the observer program with better taxonomic resolution to better identify bycatch species and document any wildlife interactions
- Revisit risk assessment for byproduct/bycatch species once better species lists are compiled

References

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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 Chondrichthyans 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

Date	Format received	Comment from stakeholder	Action/explanation
		No specific comments provided for this fishery	

Appendix B: PSA results summary of stakeholder discussions

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

PSA results were not discussed for this sub-fishery.

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

Appendix C: SICA Scoring Table

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	**2. Geographic range** Possible detectable change in geographic range but minimal impact on population	**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
	background variability for this population.	range and none on dynamics, change in geographic range up to 5 % of original.				
Genetic structure	**3. Genetic structure** No detectable change in genetic structure. Unlikely to be detectable against background variability for this population.	**3. Genetic structure** Possible detectable change in genetic structure. Any change in frequency of genotypes, effective population size or number of spawning units up to 5%.	**3. Genetic structure** Detectable change in genetic structure. Change in frequency of genotypes, effective population size or number of spawning units up to 10%.	**3. Genetic structure** Change in frequency of genotypes, effective population size or number of spawning units up to 25%.	**3. Genetic structure** Change in frequency of genotypes, effective population size or number of spawning units up to 50%.	**3. Genetic structure** Change in frequency of genotypes, effective population size or number of spawning units > 50%.
Age/size/sex structure	**4. Age/size/sex structure** No detectable change in age/size/sex structure. Unlikely to be detectable against background variability for this population.	**4. Age/size/sex structure** Possible detectable change in age/size/sex structure but minimal impact on population dynamics.	**4. Age/size/sex structure** Detectable change in age/size/sex structure. Impact on population dynamics at maximum sustainable level, long-term recruitment dynamics not adversely damaged.	**4. Age/size/sex structure** Long-term recruitment dynamics adversely affected. Time to recover to original structure up to 5 generations free from impact.	**4. Age/size/sex structure** Long-term recruitment dynamics adversely affected. Time to recover to original structure up to 10 generations free from impact.	**4. Age/size/sex structure** Long-term recruitment dynamics adversely affected. Time to recover to original structure > 100 generations free from impact.
Reproductive capacity	**5. Reproductive capacity** No detectable change in reproductive capacity. Unlikely to be detectable against background	**5. Reproductive capacity** Possible detectable change in reproductive capacity but minimal impact on population dynamics.	**5. Reproductive capacity** Detectable change in reproductive capacity, impact on population dynamics at maximum	**5. Reproductive capacity** Change in reproductive capacity adversely affecting long-term recruitment dynamics. Time to	**5. Reproductive capacity** Change in reproductive capacity adversely affecting long-term recruitment	**5. Reproductive capacity** Change in reproductive capacity adversely affecting long-term recruitment dynamics. Time to recovery > 100

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

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

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

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

Table 5D. Habitats. Description of consequences for each component and each sub-component. Use table as a guide for scoring the level of consequence for habitats. Note that for sub-components Habitat types and Habitat structure and function, time to recover from impact scales differ from substrate, water and air. Rationale: structural elements operate on greater timeframes to return to pre-disturbance states.

(Modified from Fletcher *et al*. 2002)

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

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

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

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/increasing outside of historical range and/or allowed/facilitated new species to appear. Recovery period measured in years.	1. Species composition Change to ecosystem structure and function. Ecosystem dynamics currently shifting as different species appear in fishery. Recovery period measured in years to decades.	1. Species composition Total collapse of ecosystem processes. Long-term recovery period required, on the scale of decades to centuries
Functional group composition	2. Functional group composition Interactions which affect the internal dynamics of communities leading to change in functional group composition not detectable against natural variation.	2. Functional group composition Minor changes in relative abundance of community constituents up to 5%.	2. Functional group composition Changes in relative abundance of community constituents, up to 10% chance of flipping to an alternate state/ trophic cascade.	2. Functional group composition Ecosystem function altered measurably and some functional groups are locally missing/declining/increasing outside of historical range and/or allowed/facilitated new species to appear. Recovery period measured in months to years.	2. Functional group composition Ecosystem dynamics currently shifting, some functional groups are missing and new species/groups are now appearing in the fishery. Recovery period measured in years to decades.	2. Functional group composition Ecosystem function catastrophically altered with total collapse of ecosystem processes. Recovery period measured in decades to centuries.
Distribution of the	3. Distribution of	3. Distribution of	3. Distribution of	3. Distribution of the	3. Distribution of the	3. Distribution of the

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

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