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Australian Government
Australian Fisheries Management Authority

Ecological Risk Assessment for Effects of Fishing

REPORT FOR THE WESTERN DEEPWATER TRAWL FISHERY

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This fishery ERA report should be cited as

Wayte, S., Dowdney, J., Williams, A. Fuller, M., Bulman, C., Sporcic, M., Smith, A. (2007) Ecological Risk Assessment for the Effects of Fishing: Report for the Western Deepwater 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 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 Western Deepwater 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 Western Deepwater Trawl Fishery includes the following:

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

Fishery Description

Gear:	Otter trawl (minimum 90mm cod-end) Crustacean trawl (45 mm cod-end)
Area:	Cape Leeuwin to North West Cape
Depth range:	200 to 1300m
Fleet size:	11 vessels (7 active in 2004)
Effort:	Approximately 1,000 shots per year
Landings:	Approximately 200 t per year
Discard rate:	unknown
Main target species:	orange roughy, mirror dory, gemfish, deepwater flathead, ruby snapper, Tang's snapper, scampi and bugs
Management:	11 transferable fishing permits issued
Observer program:	none

Ecological Units Assessed

Target species:	17
Byproduct species:	100
Discard Species:	12
TEP species:	125
Habitats:	51 (48 demersal, 3 pelagic)
Communities:	28 (21 demersal, 7 pelagic)

Level 1 Results

The TEP species component was eliminated at Level 1. There was at least one risk score of 3 – moderate – or above for all 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, byproduct/bycatch, habitats and communities), and indirect impact of fishing on habitats.

Significant external hazards included other fisheries in the region, and other extractive activities.

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

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

Level 2 Results

Species

129 species were assessed at Level 2 using the PSA analysis. Operators in the WDWTF use different mesh size depending on whether finfish or crustaceans are being targeted. This will change the selectivity of the gear. To take this into account he PSA has been run separately for the 2 mesh sizes. For the finfish gear, 20 species were assessed to be at high risk, including 3 target species, 16 byproduct species, and one bycatch species. By taxa, the high risk species comprised 11 chondrichthyans (sharks and rays), 8 teleosts, and one invertebrate. For the crustacean gear, one more target species and one more byproduct species moved into the high risk category. Of the 129 species assessed at Level 2, expert over rides were used on five species. Of the 20 species assessed to be at high risk, two had more than three missing attributes.

The main ecological sustainability issue for species appears to be a number of chondrichthyan species taken as byproduct in the fishery. In general, the chondrichthyan species are at risk because of low productivity, combined with high exposure to fishing (high proportion of range within the fishery, live in habitats that are likely to encounter the gear, and are the right size to be selected by the fishery).

Of the 11 high risk chondrichthyans, three are found only in southern and western Australia, and three more are endemic to Australia or at risk from adjacent fisheries. Most are found on the upper slope which is the main depth at which effort is deployed in the fishery. The species of concern are endeavour dogfish, green eyed dogfish, ornate angel shark, whitefin chimaera, dusky shark and brier shark. These species should be the focus of further analysis and/or specific management action. Whitefin chimaera has been added to the species list as a member of the group ‘shortnose chimaeras’, of which an average of less than one tonne has been caught in the last four years. This group consists of 17 species, of which four are found in the area of the WDWTF. Whitefin chimaera is the only one that has a distribution restricted to western Australia. Improved species identification of chimaeras would verify which species are caught. Piked dogfish was the only discard species identified at high risk.

Of the five high risk teleost species in the byproduct component, two have a range restricted to southern and western Australia, and these should be the focus of further analysis and/or specific management action. These are: bigscale rubyfish and Australian tusk. Current catches of these species in the fishery are extremely low (less than 50 kg per year). Two of the other three species are more widely distributed, and would be of concern if they formed local stocks in southern or western Australia. One species is missing productivity information.

Habitats

48 habitats were assessed at Level 2 using the habitat PSA analysis. Habitat types were classified based on substratum, geomorphology, and dominant fauna, using photographic data from a recent CSIRO survey. Of the 48 habitat types, 20 were assessed to be at high risk, 12 medium, and 16 low. The high risk habitats are found at both the upper and mid slope depths.

High risk habitats include several categories of both hard and soft bottom with delicate erect epifauna. The spatial extent and location of these habitat types is not well known. While a number of high risk habitat types have been identified, several factors suggest that habitat impacts are not as urgent an issue as in some other trawl fisheries. These include the large area fished, and the limited amount of effort currently deployed in the fishery. There are also extensive areas of untrawlable bottom in the region. However it is important to obtain more information about the extent and location of key habitat types in this fishery, well before effort may increase.

Communities

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

Summary

Two issues emerge from the ERAEF analysis of the Western Deepwater Trawl Fishery, both related to direct impacts from fishing. There is a suite of about a dozen byproduct and bycatch species that have been assessed to be potentially at high risk, including several species endemic to southern and western Australia. Most of these species are found on the upper slope. There is also a group of habitats with large and erect epifauna that would be at risk if fishing effort increased or spread.

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 contrarary.

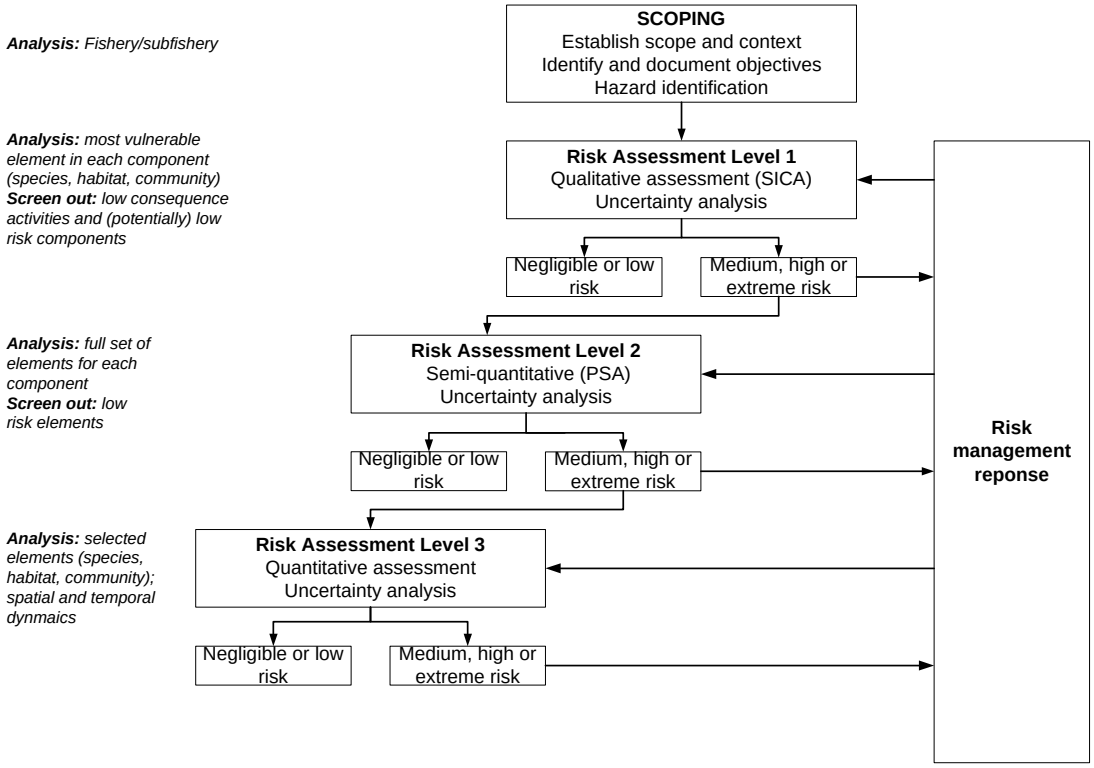


Figure 1. Overview of ERAEF showing focus of analysis for each level at the left in italics.

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.

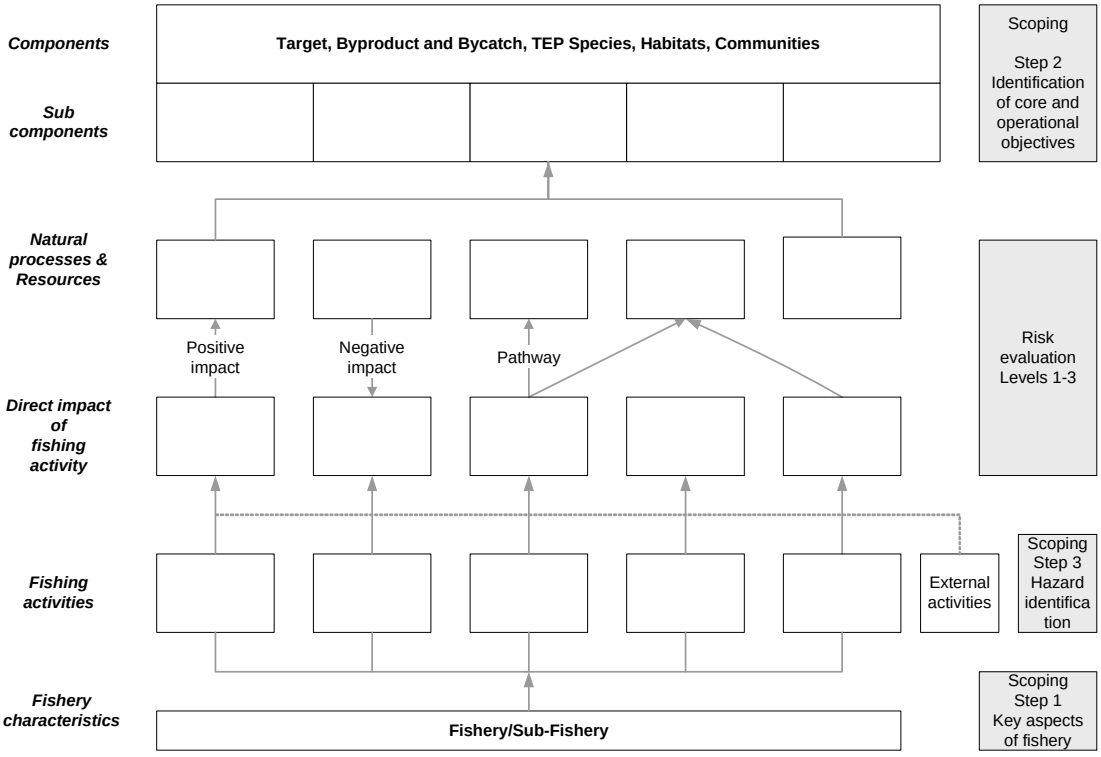


Figure 2. Generic conceptual model used in ERAEF.

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 finalize the set of activities. Many activities will be self-evident (e.g. fishing, which obviously occurs), but for others, expert or anecdotal evidence may be required.

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

The SICA analysis evaluates the risk to ecological components resulting from the stakeholder-agreed set of activities. Evaluation of the temporal and spatial scale, intensity, sub-component, unit of analysis, and credible scenario (consequence for a sub-component) can be undertaken in a workshop situation, or prepared ahead by the draft 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 Western Deepwater Trawl Fishery.

2.1 Stakeholder Engagement

2.1 Summary Document SD1. Summary of stakeholder involvement for fishery

Western Deepwater 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 draft

ERA report stage	Type of stakeholder interaction	Date of stakeholder interaction	Composition of stakeholder group (names or roles)	Summary of outcome
	Meeting/Workshop	May 27, 2004, to AFMA manager	Document distributed to WESTMAC members ahead of meeting. To be discussed at meeting.	
	email	September 26 2005	Wade Whitelaw	Requested observer reports – none available
Level 1 (SICA)	Verbal, face to face	5 October 2005	Alan Williams, CSIRO	Discussed species found, likely risks, provided scientific papers
	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)	Phone discussion	16 February 2006	David Guillot WESTMAC industry representative. WDWTF operator.	Discussion of gear and mesh size used in WDWTF
	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

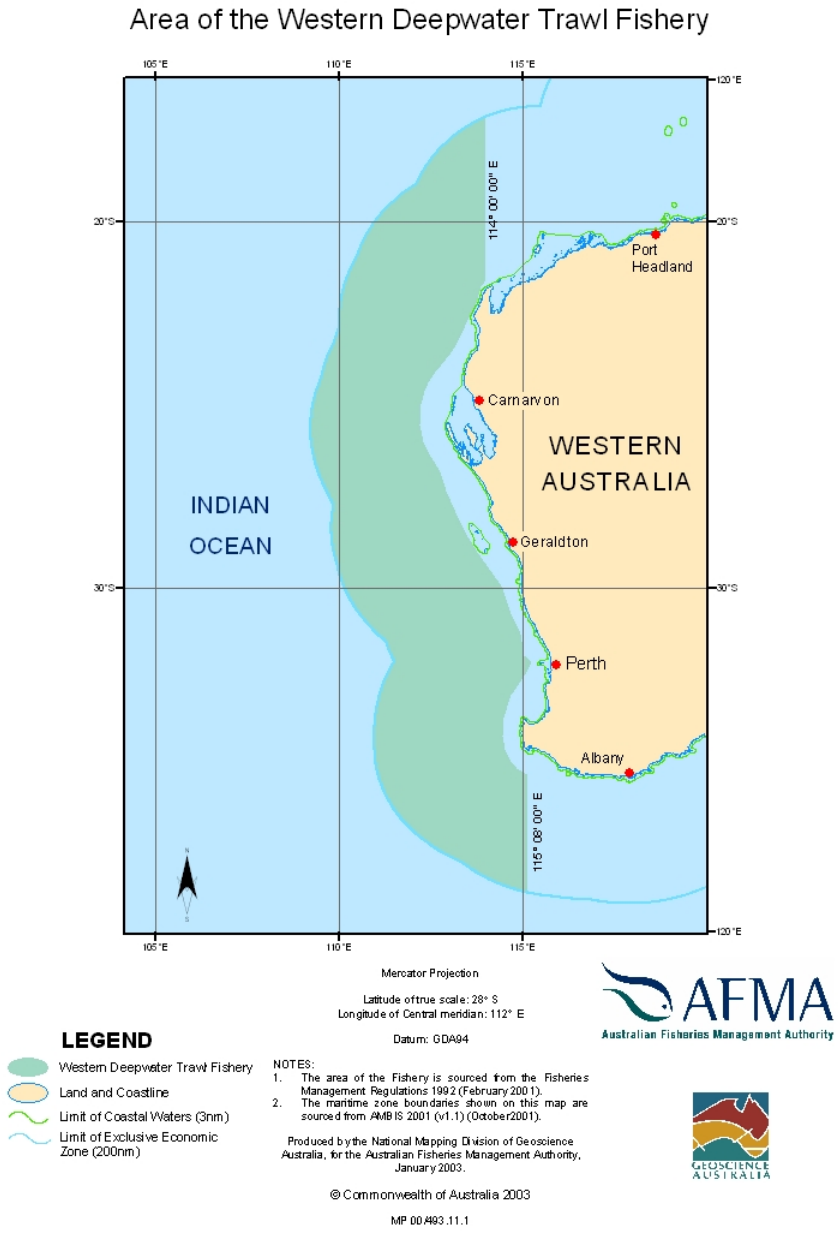
2.2.1 General Fishery Characteristics (Step 1).

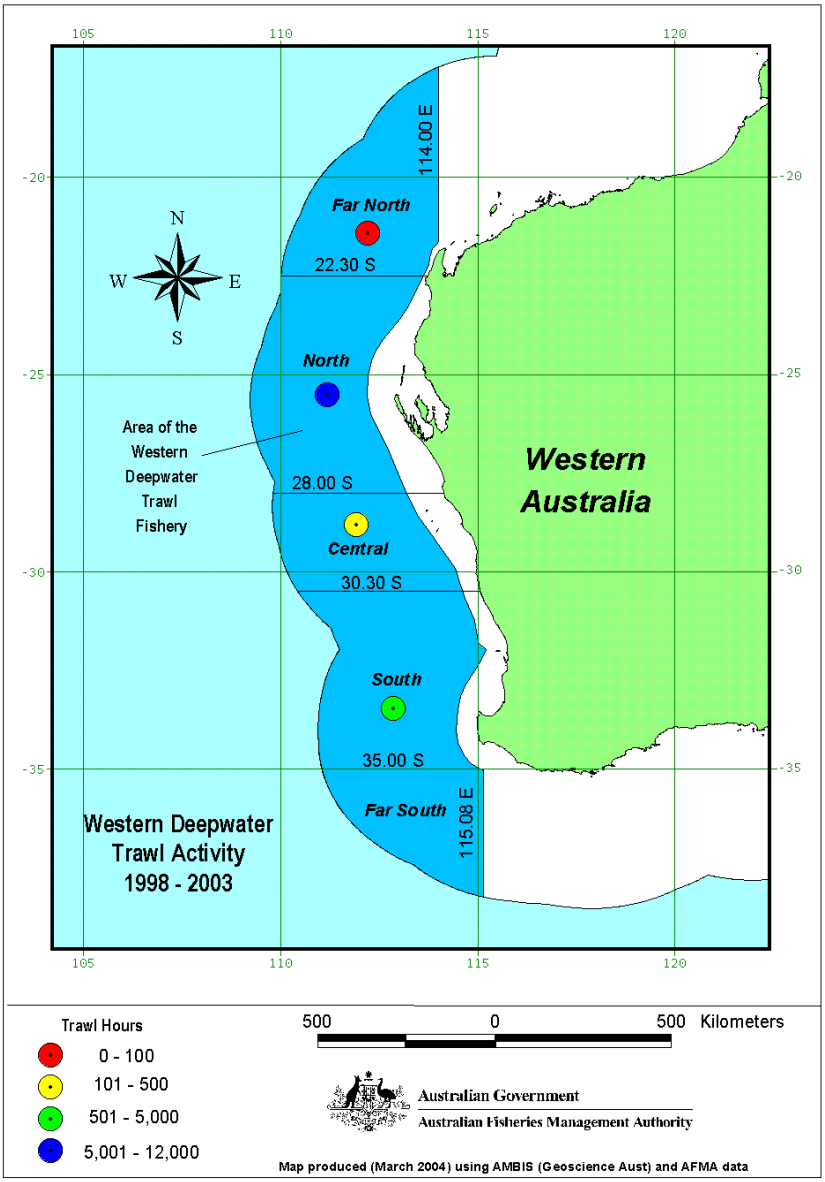
The information used to complete this step may come from a range of documents such as the Fishery's Management Plan, Assessment Reports, Bycatch Action Plans, and any other relevant background documents. The level and range of information available will vary. Some fisheries/sub-fisheries will have a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

Scoping Document S1 General Fishery Characteristics

Fishery Name: Western Deepwater Trawl Fishery
Date of assessment: May 2006
Assessor: Sally Wayte

General Fishery Characteristics	
Fishery Name	Western Deepwater Trawl (WDWTF)
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.* Whole fishery assessed
Start date/history	*Provide an indication of the length of time the fishery has been operating.* The WDTF began in 1987 as an extension of the North West Slope Trawl Fishery (NWSTF) as operators extended their exploratory fishing for scampi and deepwater prawns. After poor catches in the early years the interest in crustacean resources diminished in the WDWTF. The fishery subsequently evolved principally into a finfish trawl fishery of considerable species diversity. Targeting of bugs has also occurred in more recent years and now constitutes the majority of catch.

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 WDWTF is located in deepwater off Western Australia operating from a management line approximating the 200m isobath outwards to the edge of the AFZ. 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.  **S1 Figure 1 Waters of the WDWTF**

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 WDWTF is not managed through spatial zones or regions. Delineation of the fishery however is evident by inherent patterns in effort and catch composition. Patterns in effort and species composition segregate the southern and northern regions of the fishery (S1.1 Figure 2). In the southern areas of the WDWTF, important commercial fishes include bugs (Scyllaridae), deepwater flathead (*Platycephalus conatus*), boarfish (Penacerotidae), gemfish (*Rexea solandri*), orange roughy (*Hoplostethus atlanticus*) oreos (Oreosomatidae) and dory species (Zediae).  **S1 Figure 2** Distribution of fishing effort in the Western Deep Water Trawl Fishery between 1998-2003 In the northern area of the WDWTF (north of 28°S) fishing has concentrated on the upper continental slope (200-400m) where important commercial finfish species have been eteline snappers (Lutjanidae: Etelinae), principally ruby snapper (*Etelis carbunculus*) and tang snapper (*Lipocheilus carnolabrum*), and apsiline snappers (Lutjanidae: Apsilinae). Scampi (*Metanephrops spp*) is also caught in northern region and within the last three years bugs (*Ibacus spp*) have dominated catches.

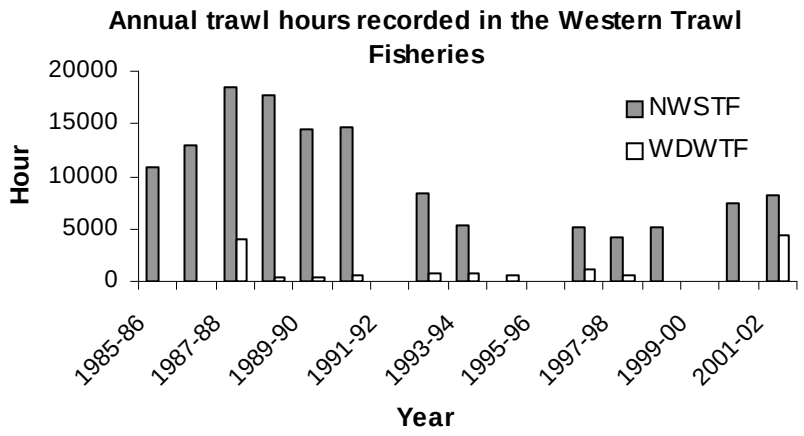
<table>
<tr><td>Fishing season</td><td>What time of year does fishing in each sub-fishery occur?
The WDWTF is open to fishing the entire year, however to date, operators have generally chosen to access the fishery on a part time or opportunistic basis as an adjunct to other Commonwealth fisheries (Northern Prawn Fishery, Shark Bay Scallop and South East Trawl Fishery). There is a distinct increase in effort between June and August, corresponding to seasonal closures in the Northern Prawn Fishery.</td></tr>
<tr><td>Target species and stock status</td><td>Species targeted and where known stock status.
The WDWTF can be defined as a byproduct or mixed fish species fishery due to the wide range of species taken in low volumes. In the southern area of the WDWTF (south of 27°S) the important commercial fishes include orange roughy (Hoplostethus atlanticus) and oreos (Oreosomatidae), big spine boarfish (Pentaceros decacanthus), alfonsino (Beryx splendens), mirror dory (Zenopsis nebulosus), gemfish (Rexea solandri) and deepwater flathead (Platycephalus conatus).

In the northern area of the WDWTF (north of 27°S) the important commercial species have been eteline snappers (Lutjanidae: Etelinae), principally Ruby snapper (Etelis carbunculus) and Tang’s snapper (Lipocheilus carnolabrum), apsiline snappers (Lutjanidae: Apsilinae) and sea bream (Lethrinidae). In the past scampi (Metanephrops spp.) has been targeted in 300-500m of water and recently bugs (Ibacus spp.) have formed an important and growing component of the catch.

The stock status for all of the WDWTF resources remains uncertain.</td></tr>
<tr><td>Bait Collection and usage</td><td>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.</td></tr>
<tr><td>Current entitlements</td><td>The number of current entitlements in the fishery. Note latent entitlements. Licences/permits/boats and number active.
11 transferable fishing permits have been issued for 5 years (due to expire in August 2006). 7 vessels operated in the fishery in 2001-02, 2002-03 and 2003-04.</td></tr>
<tr><td>Current and recent TACs, quota trends by method</td><td>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</td></tr>
<tr><td>Current and recent fishery effort trends by method</td><td>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

<table>
<tr><th>Year
(financial)</th><th>active vessels</th><th>Effort (hours)</th></tr>
<tr><td>2000-01</td><td>3</td><td>confidential</td></tr>
<tr><td>2001-02</td><td>6</td><td>4,371</td></tr>
<tr><td>2002-03</td><td>7</td><td>6,266</td></tr>
<tr><td>2003-04</td><td>7</td><td>2,349</td></tr>
</table>

S1 Figure 3 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.</td></tr>
</table>

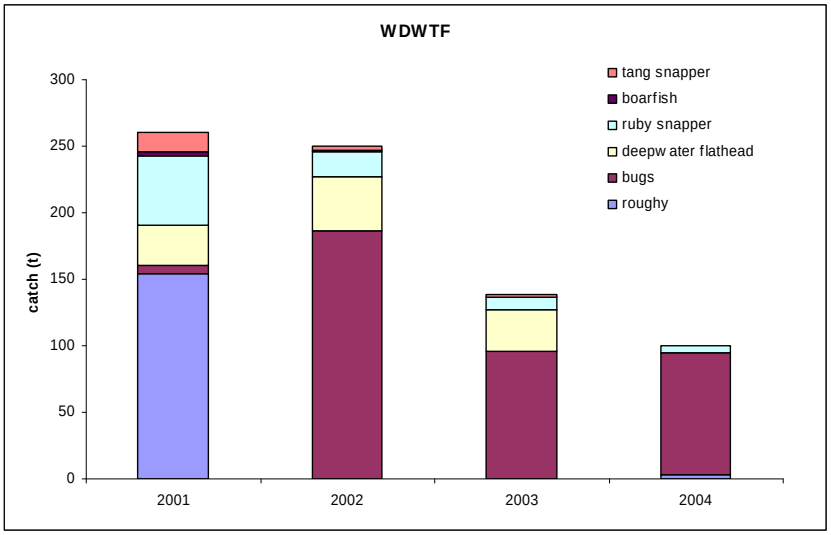


S1 Figure 3. Total trawl hours recorded in the North West Slope Trawl (NWSTF) and Western Deepwater Trawl Fisheries (WDWTF). Zero trawl hours are due to confidentiality of data when fewer than five vessels have operated except prior to 1987 in the WDWTF when the fishery was not in existence.

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	Catch (t)
2000-01	confidential
2001-02	243
2002-03	253
2003-04	107



S1 Figure 4. Recent catches in the WDWTF.

Until 1992-93, the majority of demersal fish catches species were characteristic of upper slope depths (200-700m), predominantly big spined boarfish (*Pentaceros decacanthus*) and mirror dory (*Zenopsis nebulosus*) to the south, and ruby snapper (*Etelis carbunculus*) and deepsea snapper (*Dentex tumifrons*) further north (Wallner *et al* 1995). During the winter of 1992 two small, commercially viable spawning aggregations of orange roughy (*Hoplostethus atlanticus*) were discovered south of Albany in the GABTF. This prompted explorative industry efforts in the adjacent southern area of the WDWTF. Subsequently, December 1992 saw encouraging catches of orange roughy and smooth oreo (*Pseudocyttus maculatus*) taken from this area (Wallner *et al* 1995).

In the mid-1990s most of the catch was taken in the southern region (south of 27°S) of the fishery. In 1994-95 77% of the total catch tonnage (305 tonne) was comprised of orange roughy (Wallner *et al* 1995). The following season In 1994-95 of which was orange roughy targeted from mid slope regions (below 700m). Upper-slope species in the northern part of the fishery (north of 27°S) only accounted for 10% of the catch.

During 1996-97 trawl hours increased by almost 87% (1150 hours) from 1994-95. More than half (56%) of this effort remained in the south of latitude 26°S. Accordingly catch continued to be dominated by southern species (63%) however the composition began moving away from orange roughy fishing to upper-slope species (300-500m). Catch consisted mainly of gemfish (*Rexea* spp.), mirror dory, big-spined boarfish, deepwater flathead (*Neoplatycephalus conatus*) and deepwater sharks. Catch north of 27°S (39%) was dominated by snappers.

In 1997-98 effort switched to the northern area of the fishery with 75% of tows occurring north of latitude 27°S. This trend continued in 1999-2000 with greater than 80% of the catch taken in the northern region. Significant increases in bug catch also occurred and have dominated catches to present.

Current and recent value of fishery ($)

Note current and recent value trends by sub-fishery. In table form

Year	Value ($million)
2000-01	confidential
2001-02	1.77
2002-03	unavailable
2003-04	0.98

Between 1997/98 to 2001/02 the average GVP was $ 983 000.

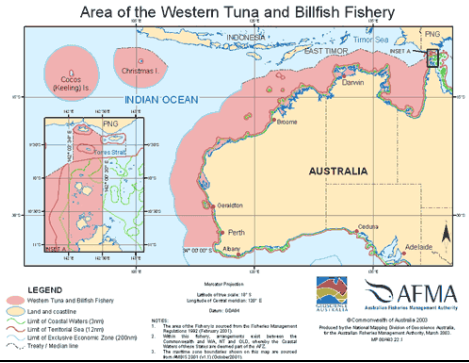
Relationship with other fisheries

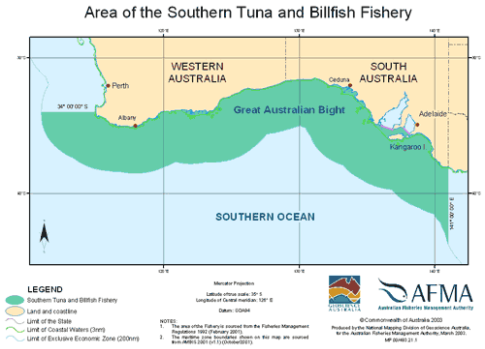
Commercial and recreational, state, national and international fisheries List other fisheries operating in the same region any interactions

Commonwealth Fisheries

a) Southern and Western Tuna and Billfish Fisheries (STBF & WTBF)

The Western Tuna and Billfish Fishery (142° 30'E to 34° 00'S) operates in the same region as the WDWTF. The Southern Tuna and Billfish Fishery (34° 00'S to 141° 00'S) overlaps with the WDWTF in the south (S1 Figure 5). Both the STBF and WTBF target pelagic species using longlines, purse seines and minor lines (hand line, rod and reel, troll, and polling). Western Trawl Fisheries in contrast target demersal resources. Direct interaction with the WTBF is negligible.

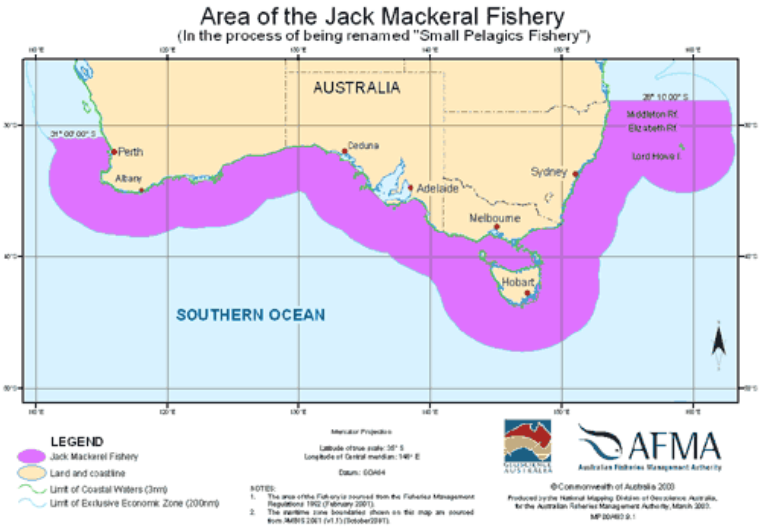




S1 Figure 5. Waters of the Southern and Western Tuna and Billfish Fisheries

b) Small Pelagic Fishery (SPF)

SPF extends from 31° 00'S to 28° 00'S overlapping with the southern region of the WDWTF (S1 Figure 6). Similarly to the tuna and billfish fisheries, SPF targets pelagic species using midwater longlines and purse seines. There is limited interaction between these fisheries.



S1 Figure 6 Area of the Small Pelagic Fishery

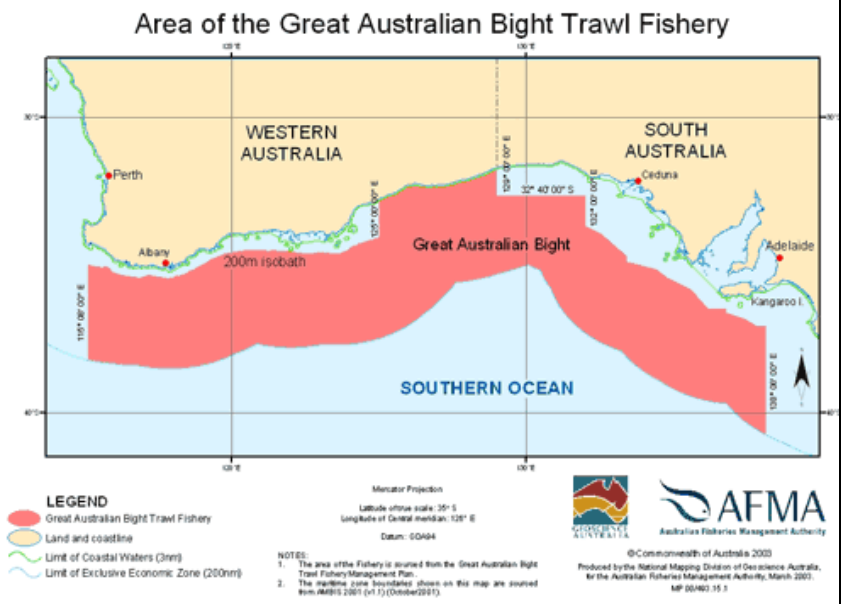
c) Great Australian Bight Trawl Fishery (GABTF)

The GABTF is immediately adjacent to the southern boarder of the WDWTF, extending from 115° 08'S to 138° 08'S (S1 Figure 7). Although these fisheries do not operate in the same fishing grounds stocks may be shared. Deepwater flathead, orange roughy, gemfish and oreo species are caught by both fisheries. Significantly smaller catches of each species are taken in the WDWTF. Total yields of deepwater flathead (99 tonnes) between 1992 and 2003 in the WDWTF for example, constitutes less 9% of the 2002 catch taken in the GABTF (Lynch & Garvey 2003).

The GABTF is a demersal and developmental mid-water trawl fishery using otter and midwater trawling methods respectively. Catches are derived from two distinct depth regions: the shelf/upper slope (up to 400m isobath) fishery and the deepwater slope fishery. The majority of the catch is taken from depths of 100-200 metres at the 'head' of the Bight (Lynch & Garvey 2003). Deepwater flathead dominates shelf catches followed by bight redfish. The deepwater slope fishery is seasonal and targets orange roughy and oreo dories in waters around 1000 metres in depth. Orange roughy and oreo dories were the only two species taken in significant volumes in the far western

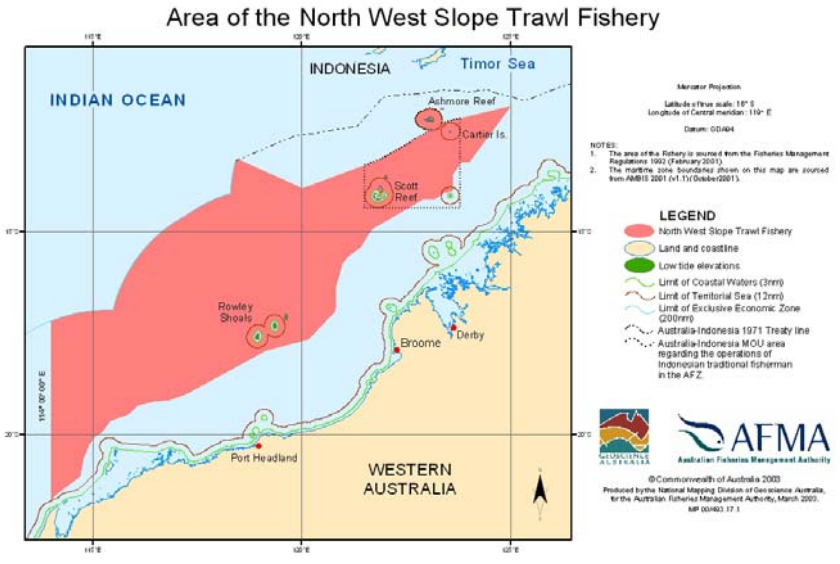
zone, adjacent to the WDWTF, between 1990-2002 (Lynch & Garvey 2003).

A detailed investigation into the extent and significance of potential stock sharing impacts is yet to be conducted. Uncertainties in stock distributions and validity of species lists available to the WDWTF represent current analysis difficulties.



S1 Figure 7 Waters of the Great Australian Bight Trawl Fishery

d) 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) (S1 Figure 8). 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. The NWSTF mainly targets scampi, which are caught in small quantities in the WDWTF.



S1 Figure 8 Waters of the North West Slope 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) Shark Bay Snapper Fishery (SBSF)

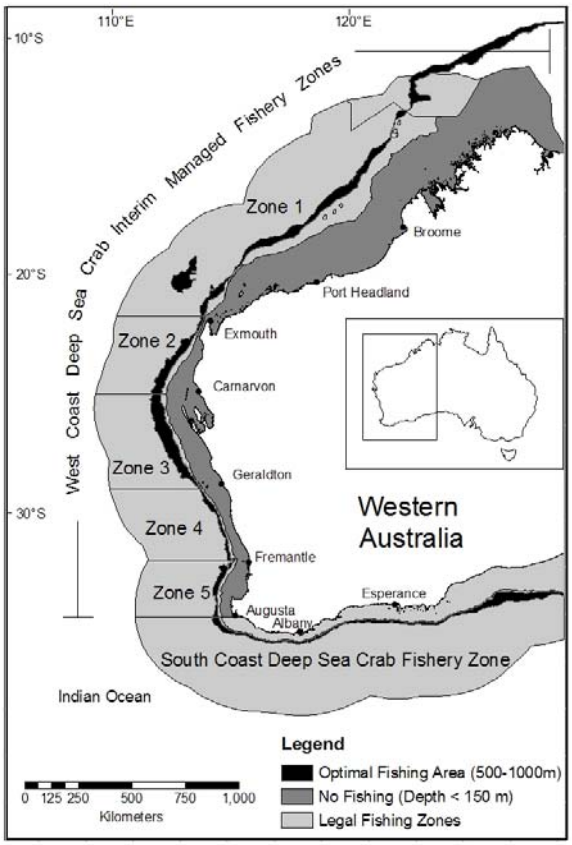
Potential resource sharing exists between the WDWTF and the Shark Bay Snapper Fishery (SBSF). The SBSF includes waters between latitudes 23°34'S and 26°30'S, seaward to 200nm including waters within Shark Bay. Pink snapper (*Paguras auratus*) is the principal target species of the SBSF with a variety of finfish making up a minor component of the total catch composition (Penn 2002). Ocean snapper stocks are considered distinct from the inner Shark Bay stocks (Penn 2002). Fish are caught by mechanised handline. In 2001 under new management arrangements a total allowable catch (TACs) was set at 550 tonnes. The fishery has been identified as fully exploited.

WDWTF also targets snappers north of 28°00'S. Relative catch rates are considerably lower in the WDWTF. The cumulative catch of pink snapper between 1992 and 2003 represents 4% of the total catch in 2001 taken by the State fishery (362 tonnes). Although relative catches are low, the level of stock sharing may have tangible impacts on overall stock productivity given that the SBSF is fully exploited. In 2001 the SBST was 83 tonnes short of reaching their TAC.

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

The WDWTF shares waters of operation with the WCDSCF. The WCDSCF includes waters between Cape Leeuwin and the Northern Territory border seaward to the AFZ boundary (S1 Figure 9). 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 Western Trawl Fisheries and WCDSCF exist as both operate demersally in the same waters. Two levels of interactions are identified - direct resource sharing and indirect resource impacts. Small yields of snow crabs have been taken in the WDWTF. 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.



S1 Figure 9 Waters of the West Coast Deep-Sea Crab Fishery (Source: Department of Fisheries, Government of Western Australia).

c) West Coast Demersal Gillnet and Demersal Longline Fishery

The WCDGDLF extends north from latitude 26°S to 33°S. The majority of operators use demersal gillnets and primarily target 3 species of shark – dusky whaler, whiskery and gummy shark (Penn *et al* 2005)). Of these, only gummy shark are caught in small quantities in the WDWTF.

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.
Such a diverse range of vessels have operated in the fishery since its inception that it is impossible to characterise vessels, trawl types or fishing methods for the WDWTF. Vessels range from 18 metre converted tuna boats to 85-90 metre factory ships, and include Northern Prawn Fishery, Shark Bay Scallop and South East Fishery trawlers. A wide variety of nets, targeting techniques and processing methods have also been employed. Either demersal fish trawls or crustacean trawls are typically utilised.

Demersal fish trawlers in the WDWTF tow a net along the ocean floor in depths from 200 metres to greater than 700 metres. Wing meshes in the WDWTF can vary from

	200 mm to 1.6 metres or more (Evans 1992). Codend meshes of 50-110mm are generally used although no mesh size limits are currently regulated (Evans 1992). Bobbins are typically the ground gear attached to the footrope of the demersal fish trawls. The crustacean trawls use a mesh size of 45 mm.
Fishing gear restrictions	*Any restrictions on gear* 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. Use and design specifications however can regulate broad levels of catch selectivity. The operator's decision to use crustacean or finfish trawl gear and to actively target known fishing grounds can reduce the incidental capture of non-target organisms. Gear modifications such as turtle excluder devices and bycatch reduction devices in other trawl fisheries have proven to be very successful in excluding unwanted species and altering the overall catch composition.
Selectivity of gear and fishing methods	*Description of the selectivity of the sub-fishery methods* The finfish gear typically uses a mesh size of 90 mm, and crustacean gear uses a mesh size of 45 mm.
Spatial gear zone set	*Description where gear set i.e. continental shelf, shelf break, continental slope (range nautical miles from shore)* 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. Commercial fish species are taken in the upper and mid continental slopes.
Depth range gear set	*Depth range gear set at in metres* 200 metres to greater than 700 metres.
How gear set	*Description how set, pelagic in water column, benthic set (weighted) on seabed* The net is towed behind the vessel by long wires, the warps, and is deployed and retrieved from the stern of the vessel by winches. The net opening, or mouth, is spread horizontally by the outward hydrodynamic forces acting on the otter boards as they are towed through the water. The bottom of the net opening, the footrope, is weighted bringing the net opening close to the bottom and has ground gear attached, principally bobbins, to enable the gear to be towed across the substrate with minimal hook-ups. The top of the mouth, the headline, is lifted vertically by floats.
Area of gear impact per set or shot	*Description of area impacted by gear per set (square metres)* Not available
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, d 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
Issues	
Target species issues	*List any issues, including biological information such as spawning season and spawning location, major uncertainties about biology* Limited information exists regarding the biological dynamics of fisheries resources in the Western Trawl Fisheries. The lack of empirical data is primarily a function of the relatively small scale of the fishery, the multitude of species targeted, variability in catch composition through time and the large spatial scale of the fishery. The fishery has opportunistically targeted species according to availability and market demands. Given the exploratory nature of the fishery, potential to discover new exploitable stocks remains. The major challenge for management therefore is to develop strategies that provide safety measures in the face of resource uncertainty and changing fishery dynamics. Currently AFMA manages the fishery through limited entry. The major

assumption is that current effort levels are sustainable. This approach indirectly relies on external regulating factors including the part-time participation by fishers and spatial refuge of stocks yet to be efficiently targeted.

Further research is needed to determine the stock status of the target species in this fishery. Limited research has been conducted on resources exploited by the WDWTF but it is widely acknowledged that a number of species are slow growing and long lived. These species include, but may not be limited to, orange roughy (longevity over 100 years), oreo species and eteline snappers (longevity over 25 years). Risk to overfishing is subsequently higher for these species. Adopting a harvest strategy with performance indicators may be a useful management tool to avoid the overexploitation of species such as orange roughy that has occurred both over-seas and domestically. Orange roughy resources in particular will need to be monitored carefully since their classification as 'overfished' in the latest BRS Status report (2004).

The only stock assessment that has been undertaken was done for ruby snapper (*Etelis carbunculus*) (Hunter 2001). Despite data uncertainties, Hunter (2001) recommended a precautionary approach be adopted by treating harvest levels as overfishing. Hunter (2001) also suggested that snapper aggregations targeted by the fishery may be associated with spawning periods therefore exacerbating the potential for stock depletion.

Byproduct and bycatch issues and interactions

List any issues, as for the target species above

Byproduct and bycatch species are poorly defined in this fishery. The combination of non-selective trawl gear in a multi-species fishery make for a complex catch composition with (potentially) many useful species. More work is needed to distinguish useful, marketable species from bycatch. In the meantime, work will need to be carried out to determine sustainable harvest levels of both byproduct and bycatch, and the best way to mitigate bycatch.

Validation of WDWTF logbook data and improved recording detail is required. Bycatch is usually listed as an estimated weight of total discards. Composition and quantity per species is not always recorded or routinely verified by independent observers. AFMA is developing an observer program to address these data needs. The observer program was due to be implemented in 2004, but information is not yet available.

According to logbooks for 2001 and 2002, between a third and a half of the total catch is discarded (see table below). Of these discards, about a quarter are not identified. No bycatch was recorded in logbooks in 2003 or 2004.

year	Total kept (t)	Total discarded	Discarded unidentified	% catch discarded	% discards unidentified
2001	334	152	31	31	20
2002	304	245	69	45	28
2003	182	0	0	?	?
2004	110	0	0	?	?

TEP issues and interactions

List any issues. This section should consider all TEP species groups: marine mammals, chondrichthyans (sharks, rays etc.), marine reptiles, seabirds, teleosts (bony fishes), include any key spawning/breeding/aggregation locations that might overlap with the fishery/sub-fishery.

A wide range of Threatened, Endangered or Protected (TEP) species declared under the *EPBC Act* occur within the WDWTF area of operation. Recorded interactions are infrequent. The only recorded interaction was the incidental capture of a grey nurse shark *(Carcharias taurus*) in the WDWTF in 1994. Under the *EPBC Act* grey nurse sharks (west coast population) are classified as vulnerable.

	Dogfish (Family: Squalidae) have been identified as a high conservation concern due to documented declines off south-eastern Australia (Pogonoski *et al* 2002). Three species of dogfish considered to be of high conservation concern are known to occur within the WDWTF region (gulper shark, *Centrophorus granulosus*; southern dogfish *C. uyato*; black shark; *Dalatias licha*) (Williams *et al* 1996). Occasional catches of dogfish can be expected in the WDWTF.
Habitat issues and interactions	*List any issues for any of the habitat units identified in **Scoping Document S1.2**. This should include reference to any protected, threatened or listed habitats* 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: • 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 (*Puesdocarcinus 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). 10% of sessile fauna is reportedly detached annually from the Pilbara Demersal Finfish Fishery (Penn 2002). CSIRO conducted a recent benthic survey in the area, the preliminary results of which have been used to scope and score the habitats.
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.* Discards include non-target species and small size classes of target species that pose marketing difficulties (Williams 1992). In the years from 2000-04, the following species/groups were the most commonly recorded as discarded: sponges, spikey dogfish, Darwin's roughy and boarfishes.
Management: planned and those implemented	
Management Objectives	*The management objectives from the most recent management plan* AFMA manages WDWTF in a precautionary manner in accordance with objectives under the *Fisheries Management Act 1991*. 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	*Is there a fisheries management plan is it in the planning stage or implemented what are the key features*

plan	The WDWTF does not have a statutory management plan. Instead it has a Statement of Management Arrangements, describing the arrangements in place for the fishery. The WDWTF 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.* 11 transferable fishing permits have been issued.
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.* none
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.*
Initiatives and strategies	*BAPs; TEDs; industry codes of conduct, MPAs, Reserves* The Ningaloo Marine Park marine protected area occurs within the area of operation the WDWTF. Commercial fishing is prohibited in this zone. The Shark Bay World Heritage Area is **adjacent** to the WDWTF. Animals may transit between the World Heritage area and the fishery (e.g. Humpback whales)
Enabling processes	*Monitoring (logbooks, observer data, scientific surveys); assessment (stock assessments); performance indicators (decision rules, processes, compliance; education; consultation process* 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* Currently none.
Other data	*Studies, surveys* CSIRO undertook an exploratory fishing survey of the WDWTF in 1991. CSIRO undertook a voyage to map benthic ecosystems in the area of WDWTF in 2005.

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
17	100	12	125	51	28

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 *Western Deepwater Trawl Fishery*
List the target species of the sub- 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.

The species in this list are those that have occurred in AFMA logbook data, and have been identified by fishers as target species of the fishery.

ERA species number	Taxa	Family name	Scientific name	Common name	CAAB code
1332	Invertebrate	Nephropidae	*Metanephrops australiensis*	Australiensis scampi	28786001
1333	Invertebrate	Nephropidae	*Metanephrops boschmai*	Boschmai scampi	28786002
1335	Invertebrate	Nephropidae	*Metanephrops velutinus*	Velvet scampi	28786005
1339	Invertebrate	Scyllaridae	*Ibacus alticrenatus*	Deepwater bug; Wollongong bug	28821001

ERA species number	Taxa	Family name	Scientific name	Common name	CAAB code
1340	Invertebrate	Scyllaridae	*Ibacus pubescens*	Western balmain bug; Bugs	28821002
68	Teleost	Berycidae	*Centroberyx gerrardi*	bight redfish	37258004
1066	Teleost	Gempylidae	*Rexea solandri*	Gemfish	37439002
600	Teleost	Lutjanidae	*Etelis carbunculus*	Ruby snapper; Northwest Ruby Fish	37346014
685	Teleost	Lutjanidae	*Lipocheilus carnolabrum*	Tang Snapper	37346031
682	Teleost	Lutjanidae	*Pristipomoides filamentosus*	Rosy Jobfish / King Snapper	37346032
171	Teleost	Pentacerotidae	*Pentaceros decacanthus*	big-spined boarfish	37367004
1038	Teleost	Percichthyidae	*Polyprion oxygeneios*	Hapuku	37311006
113	Teleost	Platycephalidae	*Neoplatycephalus conatus*	Deepwater Flathead	37296002
132	Teleost	Serranidae	*Epinephelus septemfasciatus*	bar cod	37311060
561	Teleost	Trachichthyidae	*Hoplostethus atlanticus*	Orange roughy	37255009
539	Teleost	Triglidae	*Chelidonichthys Kumu*	Red Gurnard	37288001
1097	Teleost	Zeidae	*Zenopsis nebulosus*	Mirror Dory	37264003

Byproduct species *Western Deepwater Trawl Fishery*

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

The species in this list are those that have occurred in AFMA logbook data, and have been identified by fishers as byproduct species of the fishery. Some species have been added because they are components of a commercial grouping code used in the logbooks.

ERA species number	Taxa	Family name	Scientific name	Common name	CAAB code
286	Chondrichthyan	Callorhinchidae	*Callorhinchus milii*	Elephantfish	37043001
535	Chondrichthyan	Carcharhinidae	*Carcharhinus brachyurus*	Bronze Whaler	37018001
619	Chondrichthyan	Carcharhinidae	*Carcharhinus dussumieri*	Whitecheek shark	37018009
808	Chondrichthyan	Carcharhinidae	*Carcharhinus obscurus*	Dusky Shark	37018003
630	Chondrichthyan	Carcharhinidae	*Carcharhinus sorrah*	Sorrah shark	37018013
866	Chondrichthyan	Carcharhinidae	*Rhizoprionodon acutus*	Milk shark	37018006
371	Chondrichthyan	Centrophoridae	*Centrophorus moluccensis (west)*	Endeavour Dogfish	37020001
604	Chondrichthyan	Centrophoridae	*Deania calcea*	Brier Shark	37020003
609	Chondrichthyan	Centrophoridae	*Deania quadrispinosa*	Platypus Shark	37020004
786	Chondrichthyan	Chimaeridae	*Chimaera sp. A*	southern chimaera	37042005
2705	Chondrichthyan	Chimaeridae	*Chimaera sp. C*	longspine chimaera	37042007
534	Chondrichthyan	Chimaeridae	*Chimaera sp. E*	whitefin chimaera	37042009
955	Chondrichthyan	Chimaeridae	*Hydrolagus lemures*	bight ghost shark	37042003
1040	Chondrichthyan	Pristiophoridae	*Pristiophorus cirratus*	common saw shark	37023002
1079	Chondrichthyan	Squalidae	*Squalus mitsukurii*	Green-Eyed Dogfish	37020007
668	Chondrichthyan	Squatinidae	*Squatina tergocellata*	ornate angel shark	37024002
936	Chondrichthyan	Triakidae	*Galeorhinus galeus*	School Shark, Tope shark	37017008
999	Chondrichthyan	Triakidae	*Mustelus antarcticus*	Gummy Shark	37017001
465	Invertebrate	Eriphiidae	*Pseudocarcinus gigas*	Giant crab	28925001
1334	Invertebrate	Nephropidae	*Metanephrops neptunus*	Neptune scampi, neppie scampi	28786003
2212	Invertebrate	Nephropidae	*Metanephrops sibogae*	Siboga scampi	28786004

ERA species number	Taxa	Family name	Scientific name	Common name	CAAB code
11	Invertebrate	Ommastrephidae	*Nototodarus gouldi*	Arrow Squid	23636004
1347	Invertebrate	Portunidae	*Chaceon bicolor*	crystal crab	28910001
1352	Invertebrate	Portunidae	*Hypothalassia acerba*	champagne crab	28925009
24	Invertebrate	Scyllaridae	*Thenus orientalis*	BUG	28821008
2287	Invertebrate		*Nephrosis serrata*	Deep-sea scampi	28786007
2288	Invertebrate		*Nephrosis stewarti*	Stewart's scampi	28786008
282	Teleost	Berycidae	*Beryx splendens*	Alfonsino	37258002
332	Teleost	Berycidae	*Centroberyx affinis*	Redfish	37258003
593	Teleost	Carangidae	*Elagatis bipinnulata*	rainbow runner	37337029
150	Teleost	Carangidae	*Pseudocaranx dentex*	Silver Trevally	37337062
591	Teleost	Carangidae	*Seriola dumerili*	Eye Streak Kingfish/ Amberjack	37337025
148	Teleost	Carangidae	*Seriola lalandi*	Yellowtail Kingfish	37337006
1088	Teleost	Carangidae	*Trachurus declivis*	Jack Mackerel	37337002
215	Teleost	Centrolophidae	*Centrolophus niger*	Rudderfish	37445004
958	Teleost	Centrolophidae	*Hyperoglyphe antarctica*	Blue Eye Trevalla	37445001
218	Teleost	Centrolophidae	*Schedophilus labyrinthica*	ocean blue-eye	37445014
1068	Teleost	Centrolophidae	*Seriolella brama*	Blue Warehou	37445005
217	Teleost	Centrolophidae	*Seriolella caerulea*	White Trevalla	37445011
1069	Teleost	Centrolophidae	*Seriolella punctata*	Spotted Warehou	37445006
1012	Teleost	Cheilodactylidae	*Nemadactylus macropterus*	Jackass Morwong	37377003
178	Teleost	Cheilodactylidae	*Nemadactylus valenciennesi*	queen snapper	37377004
848	Teleost	Diretmidae	*Diretmichthys parini*	parins spinyfin	37254001
658	Teleost	Emmelichthyidae	*Plagiogeneion macrolepis*	bigscale rubyfish	37345002
596	Teleost	Emmelichthyidae	*Plagiogeneion rubiginosus*	Ruby Fish	37345003
204	Teleost	Gempylidae	*Ruvettus pretiosus*	Oilfish	37439003
1087	Teleost	Gempylidae	*Thyrsites atun*	Barracouta	37439001
667	Teleost	Glaucosomatidae	*Glaucosoma buergeri*	Northern Jewfish	37320001
693	Teleost	Glaucosomatidae	*Glaucosoma hebraicum*	West Australian dhufish	37320004
670	Teleost	Holocentridae	*Sargocentron rubrum*	Red Squirrel Fish	37261001
671	Teleost	Kyphosidae	*Neatypus obliquus*	Footballer Sweep	37361002

ERA species number	Taxa	Family name	Scientific name	Common name	CAAB code
607	Teleost	Kyphosidae	*Scorpis lineolata*	Sweep	37361009
615	Teleost	Labridae	*Achoerodus viridis*	Eastern Blue Groper	37384043
185	Teleost	Labridae	*Bodianus vulpinus*	Pigfish	37384001
181	Teleost	Latridae	*Latridopsis forsteri*	Bastard Trumpeter	37378002
597	Teleost	Lutjanidae	*Aphareus rutilans*	rusty jobfish	37346001
723	Teleost	Lutjanidae	*Etelis coruscans*	sea perch/snapper	37346038
684	Teleost	Lutjanidae	*Lutjanus malabaricus*	Scarlet Sea Perch / Large Mouth Nannygai	37346007
1546	Teleost	Lutjanidae	*Lutjanus russelli [The eastern form]*	[a tropical snapper]	37346065
599	Teleost	Lutjanidae	*Lutjanus sebae*	Red Emperor	37346004
1380	Teleost	Lutjanidae	*Lutjanus sp. [The western form]*	Russell's snapper	37346012
598	Teleost	Lutjanidae	*Pristipomoides multidens*	Gold Band Snapper	37346002
2706	Teleost	Lutjanidae	*Pristipomoides typus*	threadfin snapper;sharptooth snapper	37346019
982	Teleost	Merlucciidae	*Macruronus novaezelandiae*	Blue Grenadier	37227001
233	Teleost	Monacanthidae	*Nelusetta ayraudi*	Chinaman-Leatherjacket	37465006
70	Teleost	Monocentridae	*Cleidopus gloriamaris*	pineapple fish	37259001
997	Teleost	Moridae	*Mora moro*	Ribaldo	37224002
592	Teleost	Ophidiidae	*Dannevigia tusca*	Australian Tusk	37228001
933	Teleost	Ophidiidae	*Genypterus blacodes*	Ling	37228002
175	Teleost	Oplegnathidae	*Oplegnathus woodwardi*	Knifejaw	37369002
82	Teleost	Oreosomatidae	*Allocyttus niger*	Black Oreo	37266005
1013	Teleost	Oreosomatidae	*Neocyttus rhomboidalis*	Spiky Oreo	37266001
631	Teleost	Oreosomatidae	*Pseudocyttus maculatus*	Smooth oreo	37266003
169	Teleost	Pentacerotidae	*Paristiopterus gallipavo*	Yellow-Spotted Boarfish	37367001
173	Teleost	Pentacerotidae	*Pseudopentaceros richardsoni*	Richardson's Boarfish /Southern	37367009
746	Teleost	Priacanthidae	*Priacanthus hamrur*	bigeye	37326005
136	Teleost	Priacanthidae	*Priacanthus macracanthus*	bigeye	37326001
749	Teleost	Priacanthidae	*Priacanthus tayenus*	bigeye	37326003

ERA species number	Taxa	Family name	Scientific name	Common name	CAAB code
147	Teleost	Rachycentridae	*Rachycentron canadum*	cobia	37335001
162	Teleost	Sciaenidae	*Argyrosomus hololepidotus*	Jewfish	37354001
163	Teleost	Sciaenidae	*Protonibea diacanthus*	banded/spotted croaker	37354003
211	Teleost	Scombridae	*Sarda australis*	australian bonito	37441020
210	Teleost	Scombridae	*Scomber australasicus*	Blue Mackerel	37441001
873	Teleost	Scombridae	*Scomber scombrus*	Atlantic mackerel	37441790
620	Teleost	Scombridae	*Scomberomorus commerson*	Spanish Mackerel	37441007
62	Teleost	Scombridae	*Thunnus obesus*	Bigeye Tuna	37441011
97	Teleost	Scorpaenidae	*Scorpaena papillosa*	Red Rock Cod	37287008
941	Teleost	Sebastidae	*Helicolenus percoides*	Ocean Perch - inshore	37287001
420	Teleost	Serranidae	*Epinephelus lanceolatus*	rock cod	37311061
444	Teleost	Serranidae	*Epinephelus multinotatus*	white-spotted rock cod	37311010
690	Teleost	Serranidae	*Epinephelus radiatus*	Oblique-banded Grouper /Radiant cod	37311042
123	Teleost	Serranidae	*Lepidoperca pulchella*	Orange Perch	37311001
158	Teleost	Sparidae	*Pagrus auratus*	Snapper/Squirefish	37353001
888	Teleost	Trachichthyidae	*Gephyroberyx darwinii*	darwin's roughy	37255004
209	Teleost	Trichiuridae	*Trichiurus lepturus*	smallhead hairtail	37440004
109	Teleost	Triglidae	*Pterygotrigla polyommata*	Latchet	37288006
84	Teleost	Veliferidae	*Metavelifer multiradiatus*	veilfin	37269001
214	Teleost	Zeidae	*Cyttus australis*	Silver dory	37264002
71	Teleost	Zeidae	*Cyttus traversi*	King Dory	37264001
72	Teleost	Zeidae	*Zeus faber*	John Dory	37264004

Discard species *Western Deepwater Trawl Fishery*

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.

Species where weight of discards recorded in AFMA logbooks is more than twice the retained weight over 2001-04.

ERA species number	Taxa	Family name	Scientific name	Common name	CAAB code
179	Chondrichthyan	Alopiidae	*Alopias vulpinus*	Thintail Thresher Shark, thresher shark	37012001
60	Chondrichthyan	Hexanchidae	*Notorynchus cepedianus*	Broadnose sevengill shark	37005002
964	Chondrichthyan	Lamnidae	*Isurus oxyrinchus*	Shortfinned Mako or Blue Pointer	37010001
853	Chondrichthyan	Myliobatidae	*Manta birostris*	Manta Ray	37041004
1078	Chondrichthyan	Squalidae	*Squalus megalops*	Piked Dogfish	37020006
654	Teleost	Carangidae	*Carangoides caeruleopinnatus*	trevally	37337021
657	Teleost	Carangidae	*Carangoides chrysophrys*	trevally	37337011
252	Teleost	Molidae	*Mola mola*	ocean sunfish	37470002
686	Teleost	Peristediidae	*Satyrichthys cf moluccense*	Armoured Gurnard	37288012
691	Teleost	Sparidae	*Dentex tumifrons*	Yellowback bream	37353002
86	Teleost	Trachipteridae	*Trachipterus arawatae*	Ribbon or Dealfish	37271001
208	Teleost	Trichiuridae	*Lepidopus caudatus*	Southern Frostfish	37440002

TEP species *Western Deepwater Trawl Fishery*

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
315	Chondrichthyan	Lamnidae	*Carcharodon carcharias*	white shark	37010003
313	Chondrichthyan	Odontaspididae	*Carcharias taurus*	grey nurse shark	37008001
1067	Chondrichthyan	Rhincodontidae	*Rhincodon typus*	whale shark	37014001
1428	Marine bird	Diomedeidae	*Diomedea amsterdamensis*	Amsterdam Albatross	40040018
1429	Marine bird	Diomedeidae	*Diomedea dabbenena*	Tristan Albatross	40040019
753	Marine bird	Diomedeidae	*Diomedea epomophora*	Southern Royal Albatross	40040005
451	Marine bird	Diomedeidae	*Diomedea exulans*	Wandering Albatross	40040006
755	Marine bird	Diomedeidae	*Diomedea gibsoni*	Gibson's Albatross	40040010
799	Marine bird	Diomedeidae	*Diomedea sanfordi*	Northern Royal Albatross	40040012
1008	Marine bird	Diomedeidae	*Phoebetria fusca*	Sooty Albatross	40040008
1031	Marine bird	Diomedeidae	*Thalassarche carteri*	Indian Yellow-nosed Albatross	40040014
1033	Marine bird	Diomedeidae	*Thalassarche cauta*	Shy Albatross	40040002
1034	Marine bird	Diomedeidae	*Thalassarche chlororhynchos*	Yellow-nosed Albatross, Atlantic Yellow-	40040003
1035	Marine bird	Diomedeidae	*Thalassarche chrysostoma*	Grey-headed Albatross	40040004
1085	Marine bird	Diomedeidae	*Thalassarche melanophrys*	Black-browed Albatross	40040007
2272	Marine bird	Laridae	*Anous tenuirostris melanops*	Australian Lesser Noddy	

ERA species number	Taxa	Family name	Scientific name	Common name	CAAB code
325	Marine bird	Laridae	*Catharacta skua*	Great Skua	40128005
939	Marine bird	Procellariidae	*Halobaena caerulea*	Blue Petrel	40041005
73	Marine bird	Procellariidae	*Macronectes giganteus*	Southern Giant-Petrel	40041007
981	Marine bird	Procellariidae	*Macronectes halli*	Northern Giant-Petrel	40041008
1048	Marine bird	Procellariidae	*Pterodroma mollis*	Soft-plumaged Petrel	40041032
1439	Marine mammal	Balaenidae	*Balaenoptera bonaerensis*	Antarctic Minke Whale	41112007
289	Marine mammal	Balaenidae	*Caperea marginata*	Pygmy Right Whale	41110002
896	Marine mammal	Balaenidae	*Eubalaena australis*	Southern Right Whale	41110001
256	Marine mammal	Balaenopteridae	*Balaenoptera acutorostrata*	Minke Whale	41112001
261	Marine mammal	Balaenopteridae	*Balaenoptera borealis*	Sei Whale	41112002
262	Marine mammal	Balaenopteridae	*Balaenoptera edeni*	Bryde's Whale	41112003
265	Marine mammal	Balaenopteridae	*Balaenoptera musculus*	Blue Whale	41112004
268	Marine mammal	Balaenopteridae	*Balaenoptera physalus*	Fin Whale	41112005
984	Marine mammal	Balaenopteridae	*Megaptera novaeangliae*	Humpback Whale	41112006
612	Marine mammal	Delphinidae	*Delphinus delphis*	Common Dolphin	41116001
902	Marine mammal	Delphinidae	*Feresa attenuata*	Pygmy Killer Whale	41116002
934	Marine mammal	Delphinidae	*Globicephala macrorhynchus*	Short-finned Pilot Whale	41116003
935	Marine mammal	Delphinidae	*Globicephala melas*	Long-finned Pilot Whale	41116004
937	Marine mammal	Delphinidae	*Grampus griseus*	Risso's Dolphin	41116005
970	Marine mammal	Delphinidae	*Lagenodelphis hosei*	Fraser's Dolphin	41116006
971	Marine mammal	Delphinidae	*Lagenorhynchus obscurus*	Dusky Dolphin	41116008
61	Marine mammal	Delphinidae	*Lissodelphis peronii*	Southern Right Whale Dolphin	41116009
1002	Marine mammal	Delphinidae	*Orcinus orca*	Killer Whale	41116011
1007	Marine mammal	Delphinidae	*Peponocephala electra*	Melon-headed Whale	41116012
1044	Marine mammal	Delphinidae	*Pseudorca crassidens*	False Killer Whale	41116013
1076	Marine mammal	Delphinidae	*Sousa chinensis*	Indo-Pacific Humpback Dolphin	41116014
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

ERA species number	Taxa	Family name	Scientific name	Common name	CAAB code
1494	Marine mammal	Delphinidae	*Tursiops aduncus*	Indian Ocean bottlenose dolphin	41116020
1091	Marine mammal	Delphinidae	*Tursiops truncatus*	Bottlenose Dolphin	41116019
813	Marine mammal	Dugongidae	*Dugong dugon*	Dugong	41206001
1000	Marine mammal	Otariidae	*Neophoca cinerea*	Australian Sea-lion	41131005
968	Marine mammal	Physeteridae	*Kogia breviceps*	Pygmy Sperm Whale	41119001
969	Marine mammal	Physeteridae	*Kogia simus*	Dwarf Sperm Whale	41119002
1036	Marine mammal	Physeteridae	*Physeter catodon*	Sperm Whale	41119003
269	Marine mammal	Ziphiidae	*Berardius arnuxii*	Arnoux's Beaked Whale	41120001
959	Marine mammal	Ziphiidae	*Hyperoodon planifrons*	Southern Bottlenose Whale	41120002
1440	Marine mammal	Ziphiidae	*Indopacetus pacificus*	Longman's Beaked Whale	41120003
985	Marine mammal	Ziphiidae	*Mesoplodon bowdoini*	Andrew's Beaked Whale	41120004
986	Marine mammal	Ziphiidae	*Mesoplodon densirostris*	Blainville's Beaked Whale	41120005
987	Marine mammal	Ziphiidae	*Mesoplodon gingkodens*	Gingko Beaked Whale	41120006
988	Marine mammal	Ziphiidae	*Mesoplodon grayi*	Gray's Beaked Whale	41120007
989	Marine mammal	Ziphiidae	*Mesoplodon hectori*	Hector's Beaked Whale	41120008
990	Marine mammal	Ziphiidae	*Mesoplodon layardii*	Strap-toothed Beaked Whale	41120009
991	Marine mammal	Ziphiidae	*Mesoplodon mirus*	True's Beaked Whale	41120010
1030	Marine mammal	Ziphiidae	*Tasmacetus shepherdi*	Tasman Beaked Whale	41120011
1098	Marine mammal	Ziphiidae	*Ziphius cavirostris*	Cuvier's Beaked Whale	41120012
324	Marine reptile	Cheloniidae	*Caretta caretta*	Loggerhead	39020001
541	Marine reptile	Cheloniidae	*Chelonia mydas*	Green turtle	39020002
822	Marine reptile	Cheloniidae	*Eretmochelys imbricata*	Hawksbill turtle	39020003
857	Marine reptile	Cheloniidae	*Natator depressus*	Flatback turtle	39020005
613	Marine reptile	Dermochelyidae	*Dermochelys coriacea*	Leathery turtle	39021001
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
1414	Marine reptile	Hydrophiidae	*Aipysurus laevis*	Olive Seasnake, Golden Seasnake	39125007
1425	Marine reptile	Hydrophiidae	*Aipysurus pooleorum*	Shark Bay Seasnake	39125034

ERA species number	Taxa	Family name	Scientific name	Common name	CAAB code
254	Marine reptile	Hydrophiidae	*Astrotia stokesii*	Stokes' seasnake	39125009
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
1419	Marine reptile	Hydrophiidae	*Ephalophis greyi*	North-western Mangrove Seasnake	39125014
1531	Marine reptile	Hydrophiidae	*Hydrophis czeblukovi*	fine-spined seasnake	39125020
957	Marine reptile	Hydrophiidae	*Hydrophis elegans*	Elegant seasnake	39125021
1423	Marine reptile	Hydrophiidae	*Hydrophis ornatus*	seasnake	39125028
1005	Marine reptile	Hydrophiidae	*Pelamis platurus*	yellow-bellied seasnake	39125033
1074	Teleost	Solenostomidae	*Solenostomus cyanopterus*	Blue-finned Ghost Pipefish, Robust Ghost	37281001
105	Teleost	Syngnathidae	*Acentronura australe*	Southern Pygmy Pipehorse	37282034
53	Teleost	Syngnathidae	*Bulbonaricus brauni*	Braun's Pughead Pipefish, Pug-headed Pipefish	37282037
287	Teleost	Syngnathidae	*Campichthys galei*	Gale's Pipefish	37282039
388	Teleost	Syngnathidae	*Choeroichthys brachysoma*	Pacific Short-bodied Pipefish, Short-bodied pipefish	37282042
389	Teleost	Syngnathidae	*Choeroichthys suillus*	Pig-snouted Pipefish	37282046
568	Teleost	Syngnathidae	*Doryrhamphus malus*	Flagtail Pipefish, Negros Pipefish	37282060
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
454	Teleost	Syngnathidae	*Halicampus spinirostris*	Spiny-snout Pipefish	37282070
360	Teleost	Syngnathidae	*Haliichthys taeniophorus*	Ribboned Seadragon, Ribboned Pipefish	37282007
942	Teleost	Syngnathidae	*Heraldia nocturna*	Upside-down Pipefish	37282071
549	Teleost	Syngnathidae	*Hippocampus angustus*	Western Spiny Seahorse	37282005
947	Teleost	Syngnathidae	*Hippocampus breviceps*	Short-head Seahorse, Short-snouted Seaho	37282026
453	Teleost	Syngnathidae	*Hippocampus jugumus*	Spiny Seahorse	37282112
951	Teleost	Syngnathidae	*Hippocampus planifrons*	Flat-face Seahorse	37282078
548	Teleost	Syngnathidae	*Hippocampus subelongatus*	West Australian Seahorse	37282123
954	Teleost	Syngnathidae	*Histiogamphelus cristatus*	Rhino Pipefish, Macleay's Crested Pipefish	37282081
979	Teleost	Syngnathidae	*Lissocampus caudalis*	Australian Smooth Pipefish, Smooth Pipefish	37282016
390	Teleost	Syngnathidae	*Lissocampus fatiloquus*	Prophet's Pipefish	37282084

ERA species number	Taxa	Family name	Scientific name	Common name	CAAB code
980	Teleost	Syngnathidae	*Lissocampus runa*	Javelin Pipefish	37282009
983	Teleost	Syngnathidae	*Maroubra perserrata*	Sawtooth Pipefish	37282085
547	Teleost	Syngnathidae	*Micrognathus micronotopterus*	Tidepool Pipefish	37282088
1243	Teleost	Syngnathidae	*Mitotichthys meraculus*	Western Crested Pipefish	37282092
1242	Teleost	Syngnathidae	*Nannocampus subosseus*	Bony-headed Pipefish	37282094
1010	Teleost	Syngnathidae	*Phycodurus eques*	Leafy Seadragon	37282001
1011	Teleost	Syngnathidae	*Phyllopteryx taeniolatus*	Weedy Seadragon, Common Seadragon	37282002
1061	Teleost	Syngnathidae	*Pugnaso curtirostris*	Pug-nosed Pipefish	37282021
320	Teleost	Syngnathidae	*Solegnathus guentheri*	Indonesian Pipefish, Gunther's Pipehorse	37282003
1026	Teleost	Syngnathidae	*Stigmatopora argus*	Spotted Pipefish	37282017
1027	Teleost	Syngnathidae	*Stigmatopora nigra*	Wide-bodied Pipefish, Black Pipefish	37282018
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
1092	Teleost	Syngnathidae	*Urocampus carinirostris*	Hairy Pipefish	37282008
1093	Teleost	Syngnathidae	*Vanacampus margaritifer*	Mother-of-pearl Pipefish	37282102
1094	Teleost	Syngnathidae	*Vanacampus phillipi*	Port Phillip Pipefish	37282023
1095	Teleost	Syngnathidae	*Vanacampus poecilolaemus*	Australian Long-snout Pipefish, Long-snouted Pipefish	37282024

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).

Habitat data used for assessment of the WDWTF otter trawl sub-fishery were images taken during a CSIRO survey from Cape Leeuwin and NW Cape in 2005 in depths from ~100 to 1000 m. Some WDWTF habitats were inferred from corresponding depths in temperate Australia due to the relative paucity of knowledge of the WDWTF.

A list of the Benthic habitats for the WDW Trawl fishery derived from image data. Shading denotes habitats occurring within the jurisdictional boundary of the fishery that are not subject to effort from otter trawling.

ERA record No.	ERA Habitat #	Sub-biome	Feature	ERA Habitat type	SGF Score	Depth (m)	Image available	Reference image location
2197	221	mid-slope	Slope	Mud, irregular, crinoids/ seawhips	005	700-1500	Y	WA Image Collection
2198	222	mid-slope	Slope	Mud, flat, solitary	007	700-1500	Y	WA Image Collection
2199	159	mid-slope	Slope	Mud, irregular, bioturbators	039	700-1500	Y	WA Image Collection
2200	156	mid-slope	Slope	Fine sediments, unripped, no fauna	100	700-1500	Y	WA Image Collection
2201	228	mid-slope	Slope	Fine sediments, unrippled, solitary	107	700-1500	Y	WA Image Collection
2202	230	mid-slope	Slope	Fine sediments, irregular, no fauna	130	700-1500	Y	WA Image Collection
2203	232	mid-slope	Slope	Fine sediments, subcrop, octocorals	155	700-1500	Y	WA Image Collection
2204	243	mid-slope	Slope	Gravel, irregular, low encrustings	336	700-1500	2	WA Image Collection
2205	244	mid-slope	Slope	Igneous boulder, rubble bank, no fauna	440	700-1500	Y	WA Image Collection

ERA record No.	ERA Habitat #	Sub-biome	Feature	ERA Habitat type	SGF Score	Depth (m)	Image available	Reference image location
2206	245	mid-slope	Slope	boulders and slabs, subcropping, octocorals	455	700-1500	Y	WA Image Collection
2207	248	mid-slope	Slope	Igneous rock, rubble bank, no fauna	540	700-1500	Y	WA Image Collection
2208	249	mid-slope	Seamount	Igneous rock, rubble bank, octocorals	545	700-1500	Y	WA Image Collection
2209	250	mid-slope	Seamount	Igneous rock, low outcrop, no fauna	570	700-1500	Y	WA Image Collection
2210	213	mid-slope	Seamount	Igneous rock (?), low outcrop, octocorals	575	700-1500	Y	WA Image Collection
2211	157	mid-slope	Slope	Igneous rock, high outcrop, octocorals	595	700-1500	Y	WA Image Collection
2212	165	mid-slope	Slope	Sedimentary rock, subcrop, octocorals	655	700-1500	Y	WA Image Collection
2213	252	mid-slope	Slope	Sedimentary rock, subcrop, small encrustors	656	700-1500	2	WA Image Collection
2214	253	mid-slope	Slope	Consolidated rock conglomerate, subcrop, bioturbators	659	700-1500	Y	WA Image Collection
2215	262	mid-slope	Slope	sedimentary/mudstone, high outcrop, no fauna	680	700-1500	Y	WA Image Collection
2141	202	upper slope	Slope	mud, unrippled, no fauna	000	200- 700	Y	WA Image Collection
2169	141	upper slope	Slope	mud, unrippled, bioturbators	009	200- 700	Y	WA Image Collection
2170	227	upper slope	Slope	Fine sediments, unrippled, large sponges	101	200- 700	Y	WA Image Collection
2171	078	upper slope	Slope	Fine sediments, unrippled, Solitary epifauna	107	200- 700	2	WA Image Collection
2172	133	upper slope	Slope	Fine sediments, current rippled, no fauna	110	200- 700	Y	WA Image Collection
2173	231	upper slope	Slope	Fine sediments, irregular, glass sponge (stalked)	137	200- 700	Y	WA Image Collection
2174	041	upper slope	Slope	Fine sediments, irregular, bioturbators	139	200- 700	3	WA Image Collection
2175	235	upper slope	Slope	Coarse sediments, rippled, no fauna	210	200- 700	Y	WA Image Collection
2175	236	upper slope	Slope	Coarse sediments, rippled, solitary epifauna	217	200- 700	Y	WA Image Collection
2177	237	upper slope	Slope	Coarse sediments, wave rippled, bryozoan turf	226	200- 700	Y	WA Image Collection
2178	238	upper slope	Slope	Coarse sediments, irregular, octocorals (matrix of solsomalia – dead corals)	235	200- 700	Y	WA Image Collection
2176	072	upper slope	Slope	Coarse sediments, rippled, bioturbators	239	200- 700	Y	WA Image Collection
2179	239	upper slope	Slope	Coarse sediments, subcrop, large sponges	251	200- 700	Y	WA Image Collection
2180	240	upper slope	Slope	Sedimentary rock, subcrop, octocorals	255	200- 700	Y	WA Image Collection
2181	241	upper slope	Slope	Coarse sediments, subcrop, low encrusting community (ascidians)	256	200- 700	Y	WA Image Collection
2182	247	upper slope	Slope	boulders, low outcrop, no fauna	470	200- 700	Y	WA Image Collection
2183	251	upper slope	Slope	Sedimentary rock, subcrop, no fauna	650	200- 700	Y	WA Image Collection
2184	036	upper slope	Slope	Sedimentary rock, subcrop, small encrustors (hydroids?)	656	200- 700	Y	WA Image Collection
2185	256	upper slope	Slope	Sedimentary rock, outcrop, octocorals	665	200- 700	Y	WA Image Collection
2186	035	upper slope	Slope	Sedimentary rock, outcrop, small encrustors	666	200- 700	Y	WA Image Collection
2187	257	upper slope	Shelf break	Sedimentary rock, low outcrop, no fauna	670	200- 700	3	WA Image Collection
2188	145	upper slope	Canyon	Sedimentary rock, low outcrops on steep slope, large sponges	671	200- 700	2	WA Image Collection

ERA record No.	ERA Habitat #	Sub-biome	Feature	ERA Habitat type	SGF Score	Depth (m)	Image available	Reference image location
2189	071	upper slope	Shelf break	Sedimentary rock, low outcrop, small encrustors	676	200- 700	3	WA Image Collection
2190	261	upper slope	Slope	Sedimentary rock, outcrop, sedentary (anemones)	677	200- 700	Y	WA Image Collection
2191	264	upper slope	Slope	Sedimentary rock, high outcrop, octocorals	683	200- 700	Y	WA Image Collection
2193	265	upper slope	Slope	Sedimentary rock (mudstone?), high outcrop, no fauna	690	200- 700	3	WA Image Collection
2194	267	upper slope	Slope	Sedimentary rock (mudstone?), high outcrop, small sponges	692	200- 700	Y	WA Image Collection
2195	269	upper slope	Slope	Sedimentary rock, high outcrop, octocorals	695	200- 700	Y	WA Image Collection
2196	270	upper slope	Slope	Sedimentary rock, high outcrop, solitary epifauna	697	200- 700	Y	WA Image Collection
2132	229	inner shelf	Canyon	Fine sediments, current rippled, no fauna	110	25-100	Y	WA Image Collection
2133	095	inner shelf	Shelf	Fine sediments, Wave rippled, No fauna	120	25-100	Y	WA Image Collection
2134	205	inner shelf	Shelf	Coarse sediments, current swept, mixed low epifauna	206	25-100	Y	WA Image Collection
2135	234	inner shelf	Shelf	Coarse sediments, unrippled, solitary epifauna	207	25-100	Y	WA Image Collection
2136	010	inner shelf	Shelf	Coarse sediments, current rippled, no fauna	210	25-100	Y	WA Image Collection
2137	089	inner shelf	Shelf	Coarse sediments, irregular, bryozoan turf	236	25-100	Y	WA Image Collection
2138	242	inner shelf	Shelf	Gravel, irregular, no fauna	330	25-100	Y	WA Image Collection
2139	271	inner shelf	Shelf	Rock/ biogenic matrix, high outcrop, large sponges	719	25-100	Y	WA Image Collection
2140	272	inner shelf	Shelf	Rock/ biogenic matrix, Wave rippled, No fauna	720	25-100	Y	WA Image Collection
2145	273	inner shelf	Shelf	Rock/ biogenic matrix, subcrop, large sponges	751	25-100	3	WA Image Collection
2146	274	inner shelf	Shelf	Rock/ biogenic matrix, subcrop, small encrustors	756	25-100	Y	WA Image Collection
2142	275	inner shelf	Shelf	Rock/ biogenic matrix, low outcrop, mixed faunal community	763	25-100	Y	WA Image Collection
2143	276	inner shelf	Shelf	Rock/ biogenic matrix, low outcrop, octocorals	765	25-100	Y	WA Image Collection
2147	277	inner shelf	Shelf	Rock/ biogenic matrix, low outcrop, mixed faunal community	773	25-100	Y	WA Image Collection
2144	278	inner shelf	Shelf	Rock/ biogenic matrix, outcrop low, mixed faunal community	793	25-100	Y	WA Image Collection
2149	219	outer shelf	Shelf	mud, unrippled, large sponges	001	100- 200	Y	WA Image Collection
2150	220	outer shelf	Shelf	Mud, flat, octocorals	005	100- 200	Y	WA Image Collection
2151	100	outer shelf	Shelf	Mud, flat, sedentary (eg seapens)	007	100- 200	2	WA Image Collection
2148	279	outer shelf	Shelf	mud, current rippled, no fauna	010	100- 200	Y	WA Image Collection
2152	223	outer shelf	Shelf	mud, current rippled, bioturbators	019	100- 200	Y	WA Image Collection
2153	224	outer shelf	Shelf	mud, wave rippled, no fauna	020	100- 200	Y	WA Image Collection
2154	225	outer shelf	Shelf	Mud, irregular, bioturbators	039	100- 200	Y	WA Image Collection
2155	226	outer shelf	Shelf	Mud, subcrop, mixed faunal community	053	100- 200	Y	WA Image Collection
2156	111	outer shelf	Shelf	Fine sediments, unrippled, large/ erect sponges	101	100- 200	3	WA Image Collection
2157	017	outer shelf	Shelf	Fine sediments, subcrop, large sponges	151	100- 200	3	WA Image Collection

ERA record No.	ERA Habitat #	Sub-biome	Feature	ERA Habitat type	SGF Score	Depth (m)	Image available	Reference image location
2158	233	outer shelf	Shelf	Coarse sediments, unrippled, octocoral/ and bryozoans	205	100- 200	Y	WA Image Collection
2159	246	outer shelf	Shelf	slabs, low outcrop, mixed low encrustors	466	100- 200	Y	WA Image Collection
2160	126	outer shelf	Shelf	Sedimentary rock (?), subcrop, large erect sponges	651	100- 200	3	WA Image Collection
2216	254	outer shelf	Shelf	Sedimentary rock (?), low outcrop, large erect sponges	661	100- 201	Y	WA Image Collection
2161	255	outer shelf	Shelf	Sedimentary rock (?) low outcrop, mixed faunal community	663	100- 200	Y	WA Image Collection
2162	023	outer shelf	Shelf	Sedimentary rock (?), low outcrop, large sponges	671	100- 200	2	WA Image Collection
2163	258	outer shelf	Shelf	Sedimentary rock (?), low outcrop, mixed faunal community	673	100- 200	Y	WA Image Collection
2164	259	outer shelf	Shelf	Sedimentary rock (?), low outcrop, encrustors	676	100- 200	Y	WA Image Collection
2165	260	outer shelf	Shelf	Sedimentary rock (?), low outcrop, solitary	677	100- 200	Y	WA Image Collection
2217	280	outer shelf	Shelf	Sedimentary rock (?), high outcrop, solitary	681	100- 201	Y	WA Image Collection
2166	263	outer shelf	Shelf	Sedimentary rock (?), high outcrop, small sponges	682	100- 200	Y	WA Image Collection
2167	266	outer shelf	Shelf	Sedimentary rock (?), high outcrop, large sponges	691	100- 200	Y	WA Image Collection
2168	268	outer shelf	Shelf	Sedimentary rock (?), high outcrop, mixed fauna	693	100- 200	Y	WA Image Collection
2218	281	outer shelf	Shelf	Rock/ biogenic matrix, low outcrop, mixed faunal community	763	100-200	Y	WA Image Collection

Scoping Document S2B2. Pelagic Habitats

A list of the pelagic habitats for the WDW Trawl fishery. Shading denotes habitats occurring within the jurisdictional boundary of the fishery that are not subject to effort from otter trawling.

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
P10	Western Pelagic Province - Coastal	0-200		dow167A1, A2, A4
P11	Western Pelagic Province - Oceanic	0 – > 400	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 Western Deepwater 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,]										x	x	x	x	x					
Upper Slope 250 – 565m [3]										x	x	x	x	x					
Mid–Upper Slope 565 – 820m [3]										x	x	x	x	x					
Mid Slope 820 – 1100m [3]										x		x	x						
Lower slope/ Abyssal > 1100m [6]												x	x	x					
Reef 0 -110m [7, 8]																			
Reef 110-250m [8]																			
Seamount 0 – 110m																			
Seamount 110- 250m																			
Seamount 250 – 565m																			
Seamount 565 – 820m																			
Seamount 820 – 1100m																			

Seamount 1100 – 3000m																			
Plateau 0 – 110m																			
Plateau 110- 250m[4]																			
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 Western Deepwater trawl subfishery (x). Shaded cells indicate all communities that exist in the province.

Pelagic community	Northeastern	Eastern	Southern	Western	Northern	Northwestern	Heard and McDonald Is[2]	Macquarie Is
Coastal pelagic 0-200m[1,2]								
Oceanic (1) 0 – 600m								
Oceanic (2) >600m								
Seamount oceanic (1) 0 – 600m								
Seamount oceanic (2) 600-3000m								
Oceanic (1) 0 – 200m			x					
Oceanic (2) 200-600m			x					
Oceanic (3) >600m			x					
Seamount oceanic (1) 0 – 200m								
Seamount oceanic (2) 200 – 600m								
Seamount oceanic (3) 600-3000m								
Oceanic (1) 0-400m				x				
Oceanic (2) >400m				x				
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: Western Deepwater Trawl Fishery
Sub-fishery Name:
Date: May 2006

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.
	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 WTF 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 WDWTF.
	Coastal development	0	The WDWTF 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, 15 exploration permits and 1 retention lease overlapped with the WDWTF
	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 • Shipping traffic also traverses the WDWTF into Albany where grain is currently the main export.
	Other anthropogenic activities	0	No other anthropogenic activities identified

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. Three out of 6 external activities were identified. Thus, a total of 21 activity-component scenarios will be considered at Level 1. This results in 105 total scenarios (of 160 possible) to be developed and evaluated using the unit lists (species, habitats, communities).

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

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

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

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

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

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

2.3.2 Score spatial scale of activity (Step 2)

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

Spatial scale score of activity

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

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

2.3.3 Score temporal scale of activity (Step 3)

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

Temporal scale score of activity

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

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

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

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

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

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

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

2.3.6 Select the most appropriate operational objective (Step 6)

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

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

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

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

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

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

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

The consequence of the activity is a measure of the likelihood of not achieving the operational objective for the selected sub-component and unit of analysis. It considers the flow on effects of the direct impacts from Step 7 for the relevant indicator (e.g. decline in biomass below the selected threshold due to direct capture). Activities are scored as per consequence scores below. A more detailed description of the consequences at each level for each component (target, bycatch and byproduct, TEP species, habitats, and communities) is provided as a guide for scoring the consequences of the activities in the description of consequences table (see **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	6	5	Population size	Orange Roughy	1.1	3	**4**	1	Fishery spans 20 degrees of longitude - spatial scale is 1200 nm => Fishing occurs between 200-300 days per year => Orange Roughy are highly vulnerable as they have low productivity and also form localised aggregations making them easy to target => intensity moderate as large volumes are sporadically taken within the fishery => consequence major as recruitment state of stocks likely to be affected if fishing continues, although local extinctions unlikely => confidence low as stock size and structure in the area is unknown
	Incidental behaviour	1	6	4		none		1	**1**	2	Recreational trolling is unlikely to affect deepwater target species
Direct impact without capture	Bait collection	0									
	Fishing	1	6	5	Population size	Ruby snapper	1.1	3	**2**	1	Juvenile ruby snapper do pass through the net, because if fishers use a smaller mesh than usual juveniles are caught => intensity moderate => consequence minor as minimal impact on population dynamics expected => confidence low as it is not known whether juvenile fish survive passage through the net
	Incidental behaviour	1	6	4		none		1	**1**	2	Recreational trolling is unlikely to affect deepwater target species
	Gear loss	1	6	3	Behaviour/movement	Deepwater bugs	6.1	1	**1**	2	Lost nets may form a movement barrier to benthic bugs - bugs more likely to be affected than other demersal and more mobile species => intensity negligible => consequence negligible as any impact is unlikely to be detectable => confidence high by logic.
	Anchoring/ mooring	0									
	Navigation/ steaming	1	6	5	Behaviour/Movement	none		1	**1**	2	Navigation/steaming is unlikely to directly affect deepwater target species

Direct impact of Fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (from S2.1)	Intensity Score (1-6)	**Consequence Score (1-6)**	Confidence score (1-2)	Rationale
Addition/ movement of biological material	Translocation of species	1	6	5	Reproductive capacity	Deepwater bugs	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 in colder deeper waters of WDWTF => consequence neglible => confidence low due to lack of information
	On board processing	1	6	5	Population size	Deepwater bugs	1.1	2	**1**	1	Bugs 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 bugs and other crustaceans (snow crabs) 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	6	5	Behaviour/movement	Deepwater bugs	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 bugs and other crustaceans (snow crabs) 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	6	5	Behaviour/movement	Deepwater bugs	6.1	1	**1**	1	Organic discards sinking to the benthos may alter the abundance of detrital food available to crustaceans. This may result in increased movement of deepwater bugs and other crustaceans (snow crabs) into the area => intensity negligible => consequence negligible as impact unlikely to be detectable => confidence low due to lack of data
Addition of non-biological material	Debris	1	6	5	Behaviour/movement	Deepwater bugs	6.1	1	**1**	2	Debris may form a movement barrier to benthic bugs - bugs more likely to be affected than other demersal and more mobile species => intensity negligible as debris is negligible => consequence negligible => confidence high by logic
	Chemical pollution	1	6	5	Reproductive capacity	Deepwater Bugs	5.2	1	**1**	2	Bugs are benthic detrital feeders and most likely to consume contaminated detritus/detrital feeders. 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.

Direct impact of Fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (from S2.1)	Intensity Score (1-6)	**Consequence Score (1-6)**	Confidence score (1-2)	Rationale
	Exhaust	1	6	5		none		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 target species. Confidence high due to logical consideration
	Gear loss	1	6	3	Behaviour/movement	Deepwater Bugs	6.1	1	**1**	2	Lost nets may form a movement barrier to benthic bugs - bugs more likely to be affected than other demersal and more mobile species => intensity negligible => consequence negligible as any impact in unlikely to be detectable => confidence high by logic.
	Navigation/ steaming	1	6	5	Behaviour/movement	Deepwater flathead	6.1	1	**1**	2	Deepwater flathead are reported to form aggregations by sex (Fishbase) - these may be disrupted in response to the sound of fishing vessels steaming above => intensity minor as effect likely to be undetectable => Consequence for the species is negligible given the depth of the water => confidence high by logic
	Activity/ presence on water	1	6	3	Behaviour/movement	orange roughy	6.1	2	**2**	1	orange roughy known to have an avoidance reaction to acoustic signals - spawning aggregations could be disturbed => intensity scored as minor as there has been little fishing for roughy in the area => consequence minor => confidence low as it is unknown whether spawning aggregations exist in the area
Disturb physical processes	Bait collection	0									
	Fishing	1	6	5	Population size	Deepwater Bugs	1.1	2	**2**	1	Benthic/demersal trawl disturbs the substrate - bugs burrow in soft bottoms => 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	6	5		none		1	**1**	2	Disturbance of physical processes by navigation/steaming is unlikely to affect deepwater target species
External hazards (specify the particular example within each activity area)	Other fisheries	1	6	6	Population size	orange roughy	1.1	3	**3**	1	The Great Australian Bight Trawl Fishery is adjacent to the WDWTF. The GABTF also targets orange roughy which may come from the same stock as roughy in the WDWTF. => intensity moderate as catches of orange roughy in the western part of the GAB have declined since 1999 => consequence moderate as if fish are from same stock the potential for overfishing exists => confidence low as stock structure is not known
	Aquaculture	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
	Coastal development	0									
	Other extractive activities	1	3	6	Population size	Deepwater bugs	1.1	3	**3**	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 moderate as local populations could be severely affected => confidence low due to lack of information
	Other non extractive activities	1	4	4	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	0									

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	6	5	Population size	Endeavour dogfish	1.1	3	**4**	1	Endeavour dogfish are vulnerable to over- fishing as they are long-lived and have low productivity. Currently they are abundant in this area, but due to low productivity are potentially at risk => intensity moderate as this species is caught regularly but in small numbers => consequence major due to risk of this species => confidence low as no stock assessments are available
	Incidental behaviour	1	6	5		none		1	**1**	2	Recreational trolling is unlikely to affect deepwater byproduct species
Direct impact without capture	Bait collection	0									
	Fishing	1	6	5	Population size	a finfish	1.1	2	**2**	1	A finfish is the most likely animal to suffer harm from passing through the net => confidence very low due to lack of information
	Incidental behaviour	1						1	**1**	2	Recreational trolling is unlikely to affect deepwater byproduct species
	Gear loss	1	6	3	Geographic Range	Scampi	2.1	1	**1**	2	Loss of trawl nets may create a movement barrier for scampi when such gear deposits on scampi burrows. This may force the scampi to relocate and build new burrows - but consequence for the target species is negligible with confidence constrained by logic.
	Anchoring/ mooring	0									
	Navigation/ steaming	1	6	5	Behaviour/movement	Gummy Shark	6.1	1	**1**	2	Gummy sharks are more pelagic than most of the targeted species - their behaviour or movement may be influenced through the vessel acting as a Fish Aggregating Device - Denser than usual aggregations of the shark may form - but consequence for the species is negligible. Confidence constrained by logic, consensus.
Addition/ movement of biological material	Translocation of species	1	6	5	Reproductive capacity	Scampi	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 in colder deeper waters of WDWTF => consequence neglible => 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
	On board processing	1	6	5	Behaviour/movement	Sharks	6.1	2	**2**	1	Bugs are tailed. If tails thrown overboard this could attract scavenging species, however consequences are considered minor. Confidence low due to lack of information on the amount of material thrown overboard.
	Discarding catch	1	6	5	Behaviour/movement	Sharks	6.1	2	**2**	1	Discarding of catch could attract scavenging species, however consequences are considered minor. Confidence low due to lack of information on likelihood of scavenging behaviour.
	Stock enhancement	0									
	Provisioning	0									
	Organic waste disposal	1	6	5	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	6	5	Population size	Sharks	1.1	1	**1**	2	Debris lost from boats is considered to be of minor 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	6	5	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	6	5	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	6	3	Geographic Range	Scampi	2.1	1	**1**	2	Loss of trawl nets may create a movement barrier for scampi when such gear deposits on scampi burrows. This may force the scampi to relocate and build new burrows - but consequence for the target species is negligible with confidence constrained by logic.
	Navigation/ steaming	1	6	5	Behaviour/movement	Sharks	6.1	1	**1**	2	This activity is widespread, but consequence for the byproduct species is negligible. Confidence constrained by logic, consensus.
	Activity/ presence on water	1	6	3	Behaviour/movement	Sharks	6.1	1	**1**	2	Simple presence of vessels on water might change the behavior 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.

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
Disturb physical processes	Bait collection	0									
	Fishing	1	6	5	Population Size	Scampi	1.1	3	**2**	1	Scampi burrow and the potential exists that demersal trawls can destroy their habitat where scampi 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	6	5	Behaviour/movement	Sharks	6.1	1	**1**	2	Disturbance of physical processes by navigation/steaming is unlikely to affect deepwater species
External hazards (specify the particular example within each activity area)	Other fisheries	1	6	6	Population size	Endeavour dogfish	1.1	2	**3**	1	Endeavour dogfish are vulnerable to over- fishing as they are long-lived and have low productivity. They are also caught in the adjoining Great Australian Bight Trawl Fishery, and could come from the same stock as those caught in the WDWTF. Confidence low as no stock structure information available.
	Aquaculture	0									
	Coastal development	0	0	0							
	Other extractive activities	1	3	6	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 => confidence low due to lack of information
	Other non extractive activities	1	4	4	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	0									

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	6	5	Population size	Grey nurse shark	1.1	2	**2**	2	Grey nurse shark is the only TEP species recorded as being caught in the WDWTF => intensity minor as only recorded once, so assume capture is infrequent, as the fishery has a history of recording discard species => consequence minor as low levels of capture unlikely to affect population size => confidence high due to logic
	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	6	5	Population size	Albatrosses	1.1	1	**1**	1	Some albatross species have low population numbers and low productivity. Albatrosses may get accidentally caught on wires on the warp during shooting or trawling and dragged underwater. => Negligible intensity: based on information from other trawl fisheries (there are no records of this occurring in the WDWTF) it is an unlikely event on any spatial or temporal scale. => Negligible consequence: due to in insignificant impact on population numbers. => Low confidence: due to lack of information from observers
	Incidental behaviour	1				none		1	**1**	2	No known incidental behaviour that could affect TEP species.
	Gear loss	1	6	3	Geographic range	Australian sea lion	2.1	2	**2**	2	Australian sea lions have lower population numbers and lower productivity than other seals and are endemic to southern Australia. Seals may forage on the bottom in search of prey and become entangled in ropes or netting associated with the lost gear. Lost gear resulting in damage/mortality most likely to affect geographic range of seals as local colonies could be at risk of extinction => Minor intensity: loss of gear is rare, potential incidents of entanglements would only occur in a few restricted locations. Sea lions generally forage in waters <250 m therefore little overlap with the WDWTF => Consequence minor as any impact unlikely to be detectable => High confidence due to low likelihood of sea lions encountering lost gear

Direct impact of Fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (from S2.1)	Intensity Score (1-6)	**Consequence Score (1-6)**	Confidence score (1-2)	Rationale
	Anchoring/ mooring	0									
	Navigation/ steaming	1	6	5	Population size	Humpback whale	1.1	2	**2**	2	The migratory routes of humpback whales take them through the area of the WDWTF for feeding and breeding. Collision between vessels and whales could occur and may possibly kill the whale. => Minor intensity: collisions are unlikely because fishing vessels steam slowly and both vessels (during the day) and whales are likely to avoid collisions. => Minor consequence: interactions are unlikely, and the impact on humpback whale stocks is unlikely to be measurable against background variability. =>High confidence: consensus and logical consideration, limited data.
Addition/ movement of biological material	Translocation of species	1	6	5		none		1	**1**	2	Can't think of any scenario where translocation of species could affect TEP species.
	On board processing	1	6	5	Behaviour / movement	Albatrosses	6.1	1	**2**	2	Seabirds considered to be readily attracted toward fishing vessels dispensing organic waste => Intensity negligible because there is remote likelihood of seabirds being adversely affected (aggregation during feeding frenzy a natural process) => disposal of organic waste from on-board processing in its own right is considered to have minimal consequence on seabirds, however, it is considered that disposal of organic waste is likely to increase chances of other negative interactions e.g. collision or entanglement => Confidence high because organic waste disposal from onboard processing considered unlikely to have detectable impacts on seabirds, given low levels of disposal.
	Discarding catch	1	6	5	Behaviour / movement	Albatrosses	6.1	2	**2**	2	Seabirds were chosen for analysis because as scavengers they are known to follow fishing vessels => intensity minor because discarding is common, but overall catch and effort levels are low=> The consequence was scored as minor because very few seabirds are observed following boats=> Confidence was recorded as high because fishers report it is not even necessary to follow discard code of conduct in this fishery due to low numbers of birds observed (although they DO follow the code)
	Stock enhancement	0									
	Provisioning	0									

Direct impact of Fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (from S2.1)	Intensity Score (1-6)	**Consequence Score (1-6)**	Confidence score (1-2)	Rationale
	Organic waste disposal	1	6	5	Behaviour / movement	Albatrosses	6.1	1	**2**	2	Seabirds considered to be readily attracted toward fishing vessels dispensing organic waste => Intensity negligible because there is remote likelihood of seabirds being adversely affected (aggregation during feeding frenzy a natural process) => Organic waste disposal in its own right is considered to have minimal consequence on seabirds, however, it is considered that disposal of organic waste is likely to increase chances of other negative interactions e.g. collision or entanglement => Confidence high because organic waste disposal considered unlikely to have detectable impacts on seabirds.
Addition of non-biological material	Debris	1	6	5	Population size	Albatrosses	1.1	2	**2**	2	Seabirds considered vulnerable to debris e.g. six pack holders =>Intensity was scored as Minor because debris – seabird interactions are considered to be rare => Consequence was considered minor on seabirds because damage/mortality due to debris from fishing vessels was considered unlikely to be measurable against background variability => Confidence was scored as high because debris originating from the small number of WDWTF vessels likely to be minimal
	Chemical pollution	1	6	5	Population size	Albatrosses	1.1	2	**2**	2	Albatrosses 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 although effect of chemical pollution on seabirds could be serious, it is not likely that fishing vessels are a major source of the pollution=> Confidence high due to logic
	Exhaust	1	6	5	Population size	Little penguin	1.1	1	**1**	2	The little penguin is considered vulnerable to oil slicks as a result of exhaust emissions => Intensity was scored as negligible because although the hazard was considered over a large range/scale, exhaust considered to only impact a small < 1 nm area and because little penguins are highly mobile strong avoidance was expected at the scale of 1 nm => Consequence was also considered negligible i.e. any consequence on little penguins in the WDWTF unlikely to be measurable => Confidence in the consequence score was considered high because localised exhaust unlikely to impact on behaviour/movement of little penguins.

Direct impact of Fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (from S2.1)	Intensity Score (1-6)	**Consequence Score (1-6)**	Confidence score (1-2)	Rationale
	Gear loss	1	6	3	Geographic range	Australian sea lion	2.1	2	**2**	2	Australian sea lions have lower population numbers and lower productivity than other seals and are endemic to southern Australia. Seals may forage on the bottom in search of prey and become entangled in ropes or netting associated with the lost gear. Lost gear resulting in damage/mortality most likely to affect geographic range of seals as local colonies could be at risk of extinction => Minor intensity: loss of gear is rare, potential incidents of entanglements would only occur in a few restricted locations. Sea lions generally forage in waters <250 m therefore little overlap with the WDWTF => Consequence minor as any impact unlikely to be detectable => High confidence due to low likelihood of sea lions encountering lost gear
	Navigation/ steaming	1	6	5	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 WDWTF 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 WDWTF
	Activity/ presence on water	1	6	3	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 WDWTF => Confidence high because of low number vessels operating in the WDWTF unlikely to have effect
Disturb physical processes	Bait collection	0									
	Fishing	1	6	5	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 WDWTF => Confidence high because of low number vessels operating in the WDWTF unlikely to have effect
	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	6	5	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 WDWTF => Confidence high because of low number vessels operating in the WDWTF unlikely to have effect
External hazards (specify the particular example within each activity area)	Other fisheries	1	6	6	Population size	Turtles	1.1	2	**2**	1	Turtles occasionally caught in the Western Tuna and Billfish Fishery which overlaps the WDWTF. Consequence: minor because reports of interactions low and turtles able to swim to surface for air and can be released alive (SWTBF ERA ERA report)
	Aquaculture	0									
	Coastal development	0	0	0							
	Other extractive activities	1	3	6	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 WDWTF
	Other non extractive activities	1	4	4	Behaviour / movement	Humpback whale	6.1	2	**3**	1	Shipping introduces sound waves that may impact on humpback whale behaviour=> intensity and consequence considered moderate as fishers have noticed drop in cpue of fishes after seismic surveys, so likely that whales would be affected=> Confidence low due to lack of information
	Other anthropogenic activities										

Level 1 (SICA) Document L1.4 - Habitat Component.

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	**Consequence Score (1-6)**	Confidence Score (1-2)	Rationale
Capture	Bait collection	0									
	Fishing	1	6	5	Habitat structure and Function	Fine sediments, unrippled, large sponges, upper slope	5.1	3	**4**	2	Fishing activity spans 20º (~1200nm) of the continental slope off Western Australia, covering tropical habitats in the North to sub-tropical/ temperate in the South. Operators utilise demersal fish trawl or crustacean trawl gear. Fishing is opportunistic, between 200-300 days per year, trawling around the clock. Bottom contact gear has large footprint (1- 3 large nets with otter boards, assisted by bobbins on the footropes, or 'tickler' chains to stimulate the surface substratum of the benthos) is dragged for 3-5 hour shots, less for crustacean trawls. Intensity: low to moderate over the area of the fishery, but locally concentrated around targeted features. Historically, different zones of the fishery have targeted specific depths. Upper slope (200-700m) and mid-slope (700-1500m) depths; technically all waters are > 200 m. Intensity: moderate over the area of the fishery, but locally concentrated around targeted features. Consequence: Mostly minor to moderate, but at least major when deep faunas with low productivity (resilience) are removed. Seafloor habitats on sediments and hard bottom with erect, large and fragile faunas within upper slope depths can be expected to sustain damage, mortality and some degree of modification through contact with trawl gear. Age and regeneration times have been shown to significantly increase with depth in a number of deep water invertebrate species. Due to slow growth rates, habitat recovery at these depths may take greater than decades depending on the degree of modification and connectivity to recruitment sources. Confidence: high, data exists but uncertainty for recovery rates of deep fauna.
	Incidental behaviour	1	6	4	Habitat structure and Function	Western Pelagic Province - Oceanic	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 capture	Bait collection	0									

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	**Consequence Score (1-6)**	Confidence Score (1-2)	Rationale
	Fishing	1	6	5	Habitat structure and Function	Fine sediments, unrippled, large sponges, upper slope	5.1	3	**4**	2	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. Trends indicate a reduction in catch for extended bottom contact hours (AFMA 2004). Consequence: Major, habitat modification in depths characterised by lower productivity, may lead to extended recovery times, however requires validation. Habitats are susceptible, regardless of catch rates and recent reduction in effort. 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: high, data exists, but uncertainty for recovery rates of deep fauna in this region.
	Incidental behaviour	1	6	4	Habitat structure and Function	Western Pelagic Province - Oceanic	5.1	1	**1**	2	Recreational fishing such as trolling may occur on the way to and from fishing grounds. Some impact without capture may occur within the pelagic habitat. Intensity and Consequence: negligible impact on pelagic environment. Confidence: high, constrained by logic.
	Gear loss	1	6	3	Habitat structure and Function	Sedimentary rock, high outcrop, octocorals, upper slope	5.1	2	**2**	2	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									
	Navigation/ steaming	1	6	5	Habitat structure and Function	Western Pelagic Province - Oceanic	5.1	1	**1**	2	Navigation/ steaming may occur daily during fishing season. The water quality of the 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.

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	**Consequence Score (1-6)**	Confidence Score (1-2)	Rationale
Addition/ movement of biological material	Translocation of species	1	6	5	Water quality	Western Pelagic Province - Oceanic	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 WDWT. Translocation could occur over the entire range of the fishery, potentially in any fishing event, 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	6	5	Water quality	Western Pelagic Province - Oceanic	1.1	2	**2**	1	Most processing involves freezing at sea or storing fish on ice or in refrigerated brine tanks. Some on board processing occurs at sea as bugs are tailed and discards dumped over the side, temporarily increases nutrient loads in the immediate water column. Volume considered low. Intensity and Consequence: minor as occurs but 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 current discarding rates.
	Discarding catch	1	6	5	Substrate quality	mud, unrippled, bioturbators, upper slope	3.1	2	**2**	1	Some potential for live discarding of berried female bugs (WESTMAC 10, 2004), otherwise discards mainly crustacean hard parts. Dead discards can be expected to be taken up opportunistically by pelagic scavengers, although potentially crustacean parts will take longer to break down. Unlikely that discard volumes would be great, and discarding likely to be random and dispersed with low intensity. Localised accumulation may occur in places, leading to anoxic substratum (particularly in fine sediments) and altered biogeochemistry for burrowing infauna. Large, erect fragile habitat could be damaged by discard weight. Intensity considered minor, as detectability on these scales improbable. Consequence: minor because only short term changes in benthic habitat structure, function and quality likely to occur. Confidence low: because of a lack of insufficient knowledge on trophic dynamics.
	Stock enhancement	0									
	Provisioning	0									

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	**Consequence Score (1-6)**	Confidence Score (1-2)	Rationale
	Organic waste disposal	1	6	5	Water quality	Western Pelagic Province - Oceanic	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.
Addition of non-biological material	Debris	1	6	5	Habitat structure and Function	Western Pelagic Province - Oceanic	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 Western Oceanic Pelagic habitats, 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. Consequence: low because the volume of debris generated and species susceptibility are unknown.
	Chemical pollution	1	6	5	Water quality	Western Pelagic Province - Oceanic	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 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	6	5	Air quality	Western Pelagic Province - Oceanic	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 (S2.1)	Intensity Score (1-6)	**Consequence Score (1-6)**	Confidence Score (1-2)	Rationale
	Gear loss	1	6	3	Habitat structure and Function	Sedimentary rock, high outcrop, octocorals, upper slope	5.1	2	**1**	2	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	6	5	Water quality	Western Pelagic Province - Oceanic	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	6	3	Water quality	Western Pelagic Province - Oceanic	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 habitat changes in its own right (logical constraints).
Disturb physical processes	Bait collection	0									

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	**Consequence Score (1-6)**	Confidence Score (1-2)	Rationale
	Fishing	1	6	5	Substrate quality	mud, unrippled, bioturbators, upper slope	3.1	3	**3**	1	Benthic processes will be most disturbed along on the band of the outer continental shelf edge and upper slope of Western Australia where fishing activity is currently concentrated. This zone is characterised by gently sloping plains of muddy sand 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. Shallow burrowing infaunal bioturbators may be dislodged leading to damage, mortality or relocation. Sheltering habitat of crustaceans destroyed in process of trawl passing, likely to be locally intense in some locations. Recovery capacity of sessile species removed by the net is unknown for many groups, however trends toward taking longer with depth. Recovery seems to favor rapidly colonizing, predatory species. Consequence: moderate as disturbance to physical processes most likely to be short term – the sea-bottom is generally flat so little need for using heavy gear Confidence: low inadequate knowledge on the impact of trawling on long term habitat/ substratum processes.
	Boat launching	0									
	Anchoring/ mooring	0									
	Navigation/steaming	1	6	5	Habitat structure and Function	Western Pelagic Province - Oceanic	5.1	1	**1**	2	Temporary disturbance to pelagic habitat function due to operation of the vessel that adds 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).
External Impacts (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	3	**3**	1	Other Commonwealth fisheries operating within the same region are the WTBF, STBF, SPF, and the GABT. The WTBF and STBF fisheries both target pelagic species using longlines, purse seines and minor line methods, in contrast to the Western trawl fisheries which rely on demersal gears. Direct interaction is likely to be minimal. The SPF overlaps with only the southern boundary of the WDWT. This is a pelagic fishery, currently exerting minimal effort in the purse seine sector. No overlap in effort occurs between the SPF and the WDWT. The GAB trawl fishery western boundary abuts the WDWTF boundary. Although these fisheries operate in different zones stocks may be shared. The implications for habitat connectivity are at present unknown, however propagules supplying some GAB habitats may be derived from the upstream WA Leeuwin current waters. Upstream loss of habitat/ destruction of recruitment sources may result in impaired recovery

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	**Consequence Score (1-6)**	Confidence Score (1-2)	Rationale
											capacity of downstream trawled grounds and communities, and potentially a reduction in areal extent of vulnerable habitat types. Western Australian State Fisheries also operating in the region under a negotiated OCS include; Shark Bay Snapper Fishery (SBSF), targeting Pink Snapper by pelagic methods (mechanized handline), and the West Coast Deep-Sea Crab Fishery (WCDSCF), a state managed crustacean fishery that primarily targets Chaceon bicolor, Hypthalassia acerba, and Pseudocarcinus gigas, in waters 600- 1200m deep. The traps used tend to be stationary on the seabed. The footprint of the gear must include dragging during retrieval, and although small in comparison with trawl gears, does leave trails of contact not dissimilar to trawl door impacts. Fragile epifauna, and habitats of surface layers of the substratum (small pits, holes, burrows) are likely to be crushed in the in the process.Intensity: moderate, the impact was considered to be negligible to moderate at broader spatial scale, but potentially severe at local scales. Consequence: moderate, because the cumulative effects of fishing are likely to have measurable changes to structure, function, extent, quality and regeneration capacity of vulnerable habitats. Loss of habitat results in short and long term loss of species, as habitats play a keystone role in ecosystem stability. Confidence: low because of insufficient knowledge of habitat dynamics, and ecosystem connectivity in this region. This may alter with further assessment of cumulative impacts.
	Aquaculture	0									
	Coastal development	0	0	0							
	Other extractive activities	1	3	6	Habitat structure and Function	Rock/ biogenic matrix, subcrop, large sponges, inner shelf	5.1	2	**2**	1	There is no current Production activity and only one Retention Lease associated with the area of the WDWTF. Fifteen Exploration permits provide opportunity for seismic surveys and exploratory drilling within defined regions within the WDWTF. This includes the *Eskdale 1* petroleum well which borders the Southern edge of the NWSTF, within which most Oil and gas exploration and production occurs. 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: minor as activity in this fishery low. Consequence: Cumulative impacts may exist, but considered minor as commercial fishing restricted within these zones. 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 (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	Western Pelagic Province - Oceanic	5.1	2	**1**	1	Shipping occurs daily throughout the WDWTF, with many ports along 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	0	0							

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	6	5	Species composition	Central Western Transition 250-565m	1.1	3	**3**	1	Fishery spans 20 degrees of longitude - spatial scale is 1200 nm => Fishing occurs between 200-300 days per year => Central Western Transition 250-565 community has highest spatial overlap with fishery => intensity moderate because impact likely to be detectable at broad spatial scale or locally severe => consequence moderate as stocks are unlikely to recover if fishing continues, although local extinctions unlikely => confidence low as stock structure in the area is unknown
	Incidental behaviour	1			Species composition	Western Oceanic (1) 0-400m	1.1	2	**2**	1	Recreational trolling may impact pelagic species=> 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	6	5	Trophic size/structure	Central Western Transition 250-565m	4.1	3	**2**	1	Juvenile fish do pass through the net, and may be damaged, but consequence minor as minimal impact on population dynamics expected => confidence low as it is not known whether juvenile fish survive passage through the net
	Incidental behaviour	1			Species composition	Central Western Transition 250-565m	1.1	1	**1**	1	Recreational trolling is unlikely to affect deepwater target species
	Gear loss	1	6	3	Species composition	Central Western Transition 250-565m	1.1	1	**1**	2	Central Western Transition 250-565 chosen as most gear loss is likely to occur there => intensity negligible as little gear is lost => consequence negligible as any effect on communities due to gear loss unlikely to be measurable against natural variation => confidence high
	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	6	5	Species composition	Western Oceanic (1) 0-400m	1.1	1	**1**	1	Navigation/steaming is unlikely to directly affect deepwater species. Western Oceanic 0-400 chosen as most fishing and therefore steaming occurs there => intensity negligible: although navigation/steaming is a large component of operations it is unlikely to have any measurable effect on communities => consequence negligible => confidence low due to lack of information
Addition/ movement of biological material	Translocation of species	1	6	5	Species composition	Central Western Transition 250-565m	1.1	1	**1**	1	Hull fouling may translocate organisms within communities 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 in colder deeper waters of WDWTF => consequence neglible => confidence low due to lack of information
	On board processing	1	6	5	functional group comp	Central Western Transition 0-400m	2.1	1	**1**	1	Bugs 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 bugs and other crustaceans (snow crabs) into the area =>functional groups comp may change=> intensity minor as detectability rare => consequence negligible as impact unlikely to be detectable => confidence low due to lack of data
	Discarding catch	1	6	5	functional group comp	Central Western Transition 250-565m	2.1	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 bugs and other crustaceans (snow crabs) into the area =>scavengers may be attracted=>functional groups composition may change=> 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	6	5	Species composition	Central Western Transition 250-565m	1.1	1	**1**	1	Organic waste disposal most likely to affect species composition of communities => Central Western Transition 250-565 chosen as most fishing occurs there => intensity negligible as although disposal occurs over a large range, each disposal event considered to affect only a small area => consequence negligible as effect considered unlikely to be measurable => 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	6	5	Species composition	Central Western Transition 250-565m	1.1	3	**1**	2	Central Western Transition 250-565 chosen as most fishing occurs there =>Species composition is likely to be affected before the other community subcomponents. => Benthic habitat of the continental shelf is most likely to be affected by the discharge of debris. Debris landing on sandy / muddy substrates will cause physical changes (loss or gain) to refuge and settlement sites for sessile species => Moderate intensity: the discarding of debris will occur across a broad area and could occur on a daily basis throughout the year but MARPOL rules? => Negligible consequence: time taken to return to pre-disturbed state is on the scale of years but an extremely low percentage of the habitat will be affected (<1%)=> confidence high as debris is minimal
	Chemical pollution	1	6	5	bio-geochemical cycles	Central Western Transition 250-565m	5.1	1	**1**	1	Chemical pollution most likely to affect bio- and geo-chemical cycles of communities => Central Western Transition 250-565 chosen as most fishing occurs there => intensity negligible as although chemical pollution could occur over a large range, each event considered to affect only a small area => consequence negligible as effect considered unlikely to be measurable => confidence low due to lack of information
	Exhaust	1	6	5	bio-geochemical cycles	Central Western Transition 250-565m	5.1	1	**1**	1	Most exhaust enters the atmosphere, or immediately below the water from engines. Dissolved gases and particulates not believed to be of consequence to demersal target species. confidence low due to lack of information
	Gear loss	1	6	3	Species composition	Central Western Transition 250-565m	1.1	1	**1**	2	Central Western Transition 250-565 chosen as most fishing occurs there => intensity negligible as lost gear is rare => consequence negligible as any effect on communities unlikely to be measurable => confidence high (logic)
	Navigation/ steaming	1	6	5	Species composition	Central Western Transition 250-565m	1.1	1	**1**	1	Central Western Transition 250-565 chosen as most fishing and therefore steaming occurs there => intensity negligible as detection of impact considered unlikely => consequence negligible as any effect on communities unlikely to be measurable => 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
	Activity/ presence on water	1	6	3	distribution of community	Central Western Transition 250-565m	3.1	2	**2**	1	Activity/ presence on water of fishing vessels considered to have most effect on distribution of communities as insonification could disturb spawning aggregations => Central Western Transition 250-565 chosen as this area most fished => consequence moderate as disturbance may cause a detectable change in the geographic range of seamount communities => confidence low as it is not known whether acoustic disturbance of a spawning aggregation could have a long-term effect on the distribution of the community
Disturb physical processes	Bait collection	0									
	Fishing	1	6	5	functional group comp	Central Western Transition 250-565m	2.1	2	**2**	1	Benthic/demersal trawl disturbs the substrate - functional group of infauna and epibenthos could be disturbed or destroyed => 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	6	5	Species composition	Central Western Transition 250-565m	1.1	1	**1**	2	Disturbance of physical processes by navigation/steaming is unlikely to affect deepwater communities
External hazards (specify the particular example within each activity area)	Other fisheries	1	6	6	functional composition	Central Western Transition 250-565m, 820-1100m	2.1	3	**3**	1	Several fisheries overlap or are adjacent to the WDWTF. The GABTF also targets orange roughy which may come from the same stock as roughy in the WDWTF. => intensity moderate as catches of orange roughy in the western part of the GAB have declined since 1999 => consequence moderate as if fish are from same stock the potential for overfishing exists => confidence low as stock structure is not known.
	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	6	bio-geochemical cycles, functional group composition	North Western Province 250-565m	5.1	3	**1**	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	4	4	functional group comp	Western Oceanic (1) 0-400m	2.1	1	**1**	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	0									

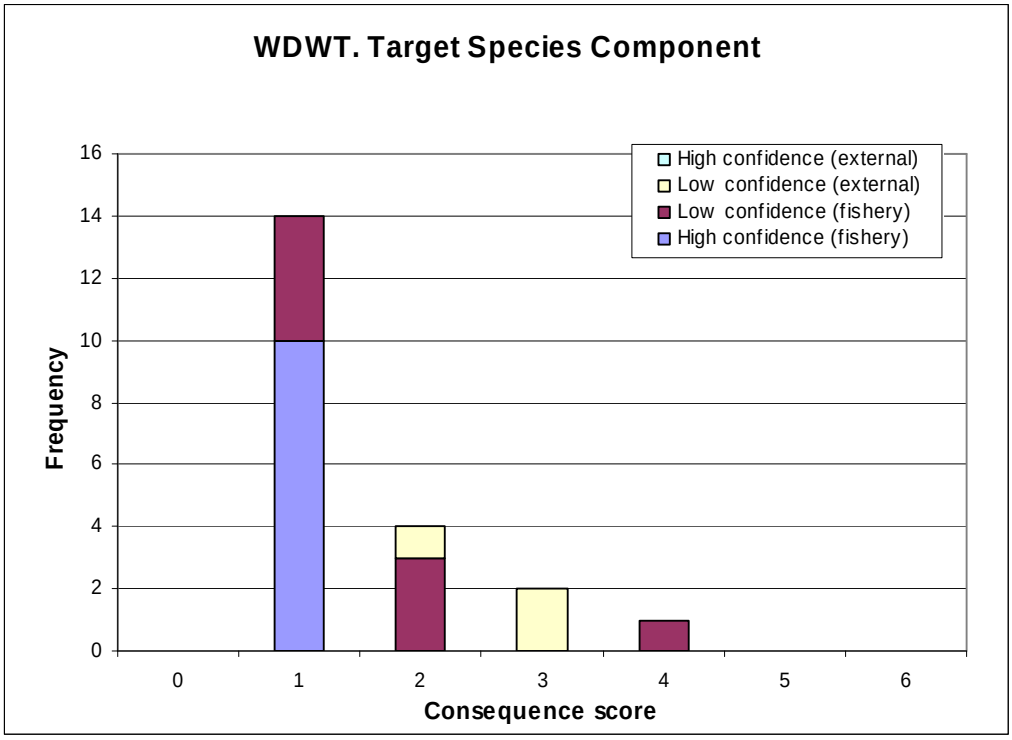
2.3.11 Summary of SICA results

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).

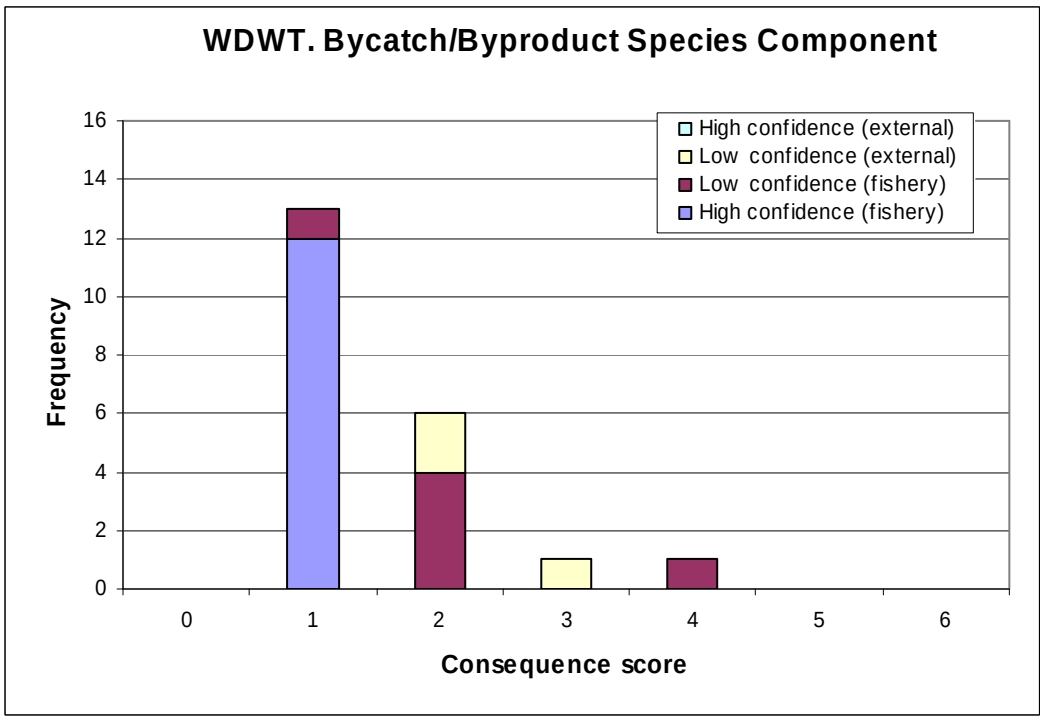
Level 1 (SICA) Document L1.6. Summary table of consequence scores for all activity/component combinations.

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

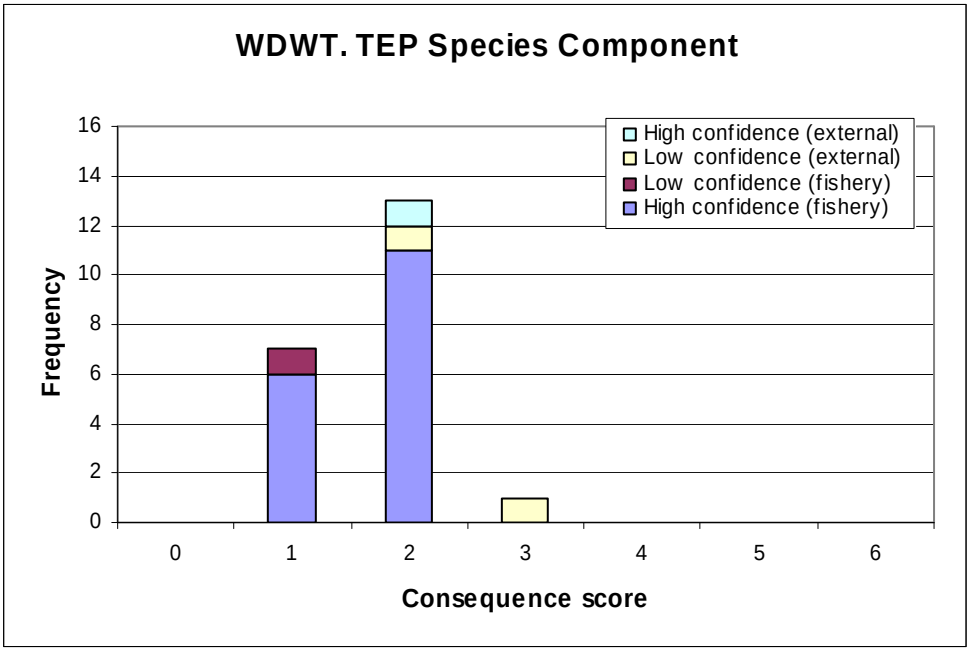
Target species: Frequency of consequence score differentiated between high and low confidence.



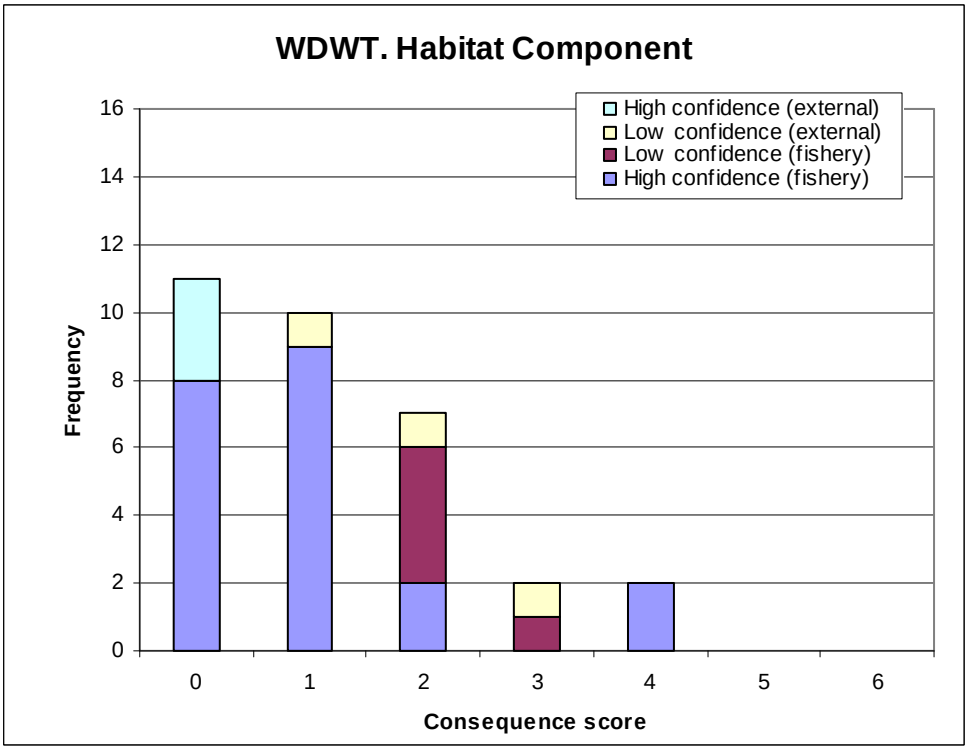
Byproduct and bycatch species: Frequency of consequence score differentiated between high and low confidence



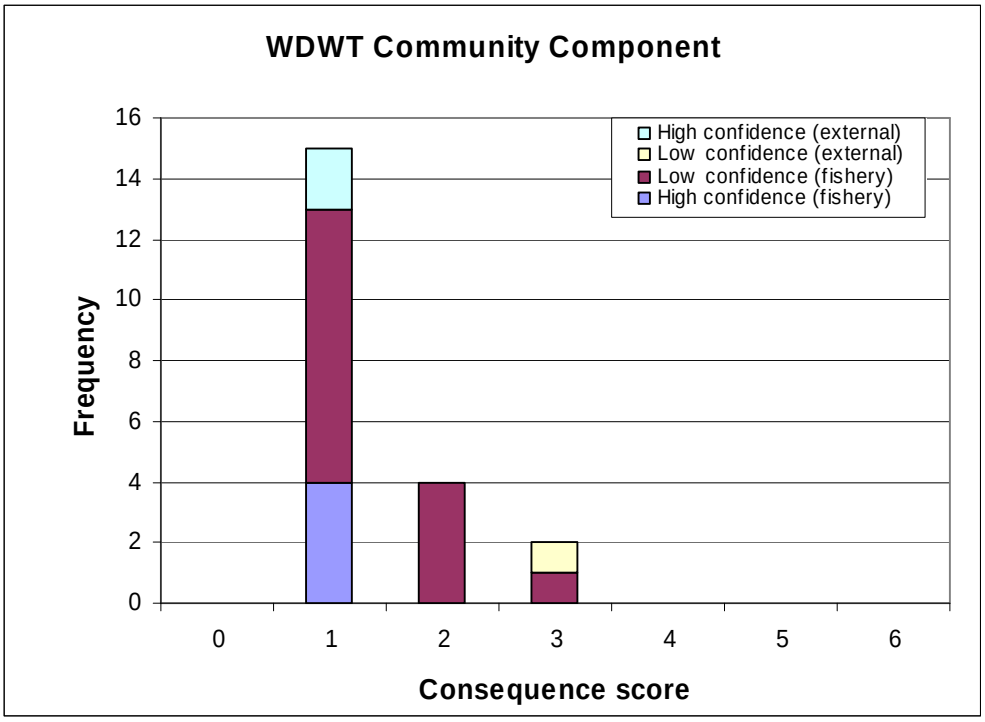
TEP species: Frequency of consequence score differentiated between high and low confidence



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, byproduct/bycatch 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.

Capture by fishing is assessed to potentially have a major impact on target species, byproduct/bycatch species and habitats. The target species most vulnerable to capture by fishing is considered to be orange roughy. Orange Roughy are highly vulnerable as they have low productivity and also form localised aggregations making them easy to target. Large catches are sporadically taken within this fishery, and evidence from other orange roughy fisheries suggests that stocks can be depleted rapidly. This risk score has low confidence as orange roughy stock size and structure in the area are unknown.

The byproduct species most vulnerable to capture by fishing is considered to be Endeavour dogfish. Endeavour dogfish are vulnerable to over- fishing as they are long-lived and have low productivity. Currently they are abundant in this area, but due to low productivity are potentially at risk. This species is caught regularly in the fishery, but in small numbers. This risk score has low confidence as stock size and structure in the area are unknown.

The effect of demersal trawling on habitats is potentially severe when deep faunas with low productivity (resilience) are removed. Potentially, all available (trawlable) seafloor habitats and attached communities within these depths can be expected to sustain

damage, mortality and some degree of habitat modification through contact with this type of gear. 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.

The Great Australian Bight Trawl Fishery is immediately adjacent to the southern border of the WDWTF. Although these fisheries do not operate in the same fishing grounds, stocks may be shared. Deepwater flathead, orange roughy, gemfish and oreo species are caught by both fisheries. Significantly smaller catches of each species are taken in the WDWTF. A detailed investigation into the extent and significance of potential stock sharing impacts is yet to be conducted. Uncertainties in stock distributions and validity of species lists available to the WDWTF make current analysis difficult.

The TEP species component has been assessed to only be at minor risk in this fishery. Assessment of low risk for this component was based on choice of grey nurse shark as the "plausible worst case" species at risk. Grey nurse shark is the only TEP species recorded as being caught in the WDWTF. However it has only been recorded once, so capture is assumed to be infrequent, as the fishery has a history of recording discard species. This species is more commonly found in waters shallower than 200m. Species that have been assessed to be at high risk in other trawl fisheries, such as seals, are also unlikely to forage in waters deeper than 200m. Fishers report that very few seabirds are observed following boats - it is not even necessary to follow the discard code of conduct in this fishery due to low numbers of birds observed (although the code *is* followed). Observers in the South East Trawl fishery (which uses the same fishing method) report that even when birds do follow the boats very few are captured or killed as a result of trawling. The offshore and deepwater nature of the WDWT fishery reduces the likelihood of interactions with TEP species. It would be preferable, however, to verify fishers' reports with observer information.

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*
- *Byproduct/bycatch 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

- *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).

Species

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

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

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

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

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

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

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

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

Habitats

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

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

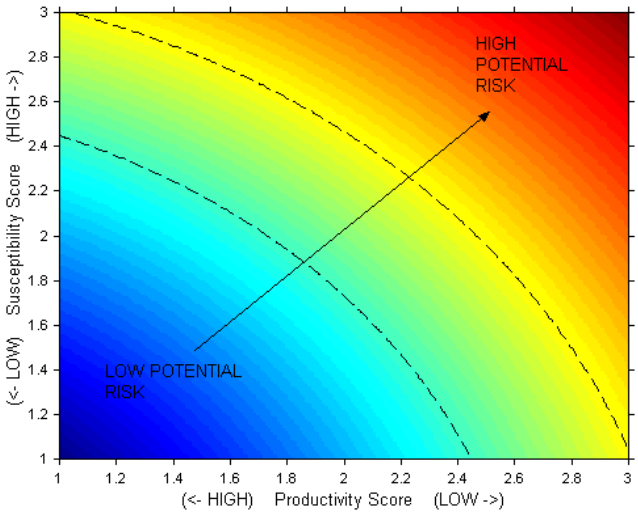


Figure 13. The axes on which risk of the ecological units is plotted. The *x*-axis includes attributes that influence the productivity of a unit, or its ability to recover after impact from fishing. The *y*-axis includes attributes that influence the susceptibility of the unit to impacts from fishing.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

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

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

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

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

ERA ID	TAXA_NAME	FAMILY_NAME	SCIENTIFIC_NAME	COMMON_NAME	CAAB code	Role	explanation
1372	Teleost	Serranidae	Aethaloperca & Anyperodon spp	Rock Cod	37311901	BP	deleted because undiff taxa - only 60 kg caught 2001-04
2093	Teleost	Apogonidae, Dinolestidae	Apogonidae, Dinolestidae - undifferentiated	cardinalfishes & long-finned pikes	37327000	BP	deleted because undiff taxa - only 75 kg caught 2001-04
2126	Teleost	Balistidae, Monacanthidae	Balistidae, Monacanthidae - undifferentiated	triggerfishes and leatherjackets	37465000	BP	deleted because undiff taxa - only 70 kg caught 2001-04
2143	Teleost	Multi-family group	Bothidae, Psettodidae & Pleuronectidae (all spp)	flounder	37990009	DI	deleted because undiff taxa - only 0 kg caught 2001-04
2036	Chondrichthyan	Brachaeluridae, Ginglymostomatidae	Brachaeluridae & related families - undifferentiated	blind, nurse, longtail carpet, cat, and zebra sharks	37013000	DI	deleted because undiff taxa - only 0 kg caught 2001-04
2026	Invertebrate	infraorder Brachyura	Brachyura - undifferentiated	crabs	28850000	DI	deleted because undiff taxa - only 96 kg caught 2001-04
2094	Teleost	Carangidae	Carangidae - undifferentiated	trevallies	37337000	BP	deleted because undiff taxa - only 10 kg caught 2001-04
1378	Teleost	Carangidae	Carangoides chrysophrys & Carangoides caeruleopinnatus	Mixed Scad	37337902	DI	commercial grouping code has been expanded
1359	Chondrichthyan	Carcharhinidae	Carcharhinus, Loxodon & Rhizoprionodon spp	Blacktip sharks	37018901	BP	commercial grouping code has been expanded
2120	Teleost	Centrolophidae	Centrolophidae - undifferentiated	trevallas	37445000	BP	deleted because undiff taxa - only 2 kg caught 2001-04
2050	Chondrichthyan	Chimaeridae	Chimaeridae - undifferentiated	shortnose chimaeras	37042000	BP	grouping code has been expanded
1540	Invertebrate	Majidae	Chionoecetes bairdi	tanner crab	28880158		imported species
1539	Invertebrate	Majidae	Chionoecetes opilio	snow crab	28880157		imported species
2010	Invertebrate	Class Asteroidea	Class Asteroidea - undifferentiated	starfish	25102000	DI	deleted because undiff taxa - only 0 kg caught 2001-04
2055	Teleost	Congridae, Colocongridae	Congridae, Colocongridae - undifferentiated	conger & short-tail conger eels	37067000	BP	deleted because undiff taxa - 1200 kg caught 2001-04 - too many species to expand
2046	Chondrichthyan	Dasyatidae	Dasyatidae - undifferentiated	stingrays	37035000	DI	deleted because undiff taxa - 2000 kg caught 2001-04 - too many species to expand
665	Chondrichthyan	Centrophoridae	Deania calcea & Deania quadrispinosa	Pearl Shark	37020905	BP	commercial grouping code has been expanded
1527	Teleost	Serranidae	Epinephelus ergastularius & Epinephelus septemfasciatus	bar rockcod	37311910	BP	commercial grouping code has been expanded

ERA ID	TAXA_NAME	FAMILY_NAME	SCIENTIFIC_NAME	COMMON_NAME	CAAB code	Role	explanation
1382	Teleost	Lutjanidae	Etelis spp.	Long Tail Rubies/Snapper	37346914	TA	commercial grouping code -members in already
1373	Teleost	Glaucosmatidae	Glaucosoma spp	Pearl Perch	37320901	BP	commercial grouping code -members in already
2186	Invertebrate		Infraorder Caridea - undifferentiated	shrimps|prawns	28730000	DI	deleted because undiff taxa - only 110 kg caught 2001-04
1999	Invertebrate	Loliginidae	Loliginidae - undifferentiated	squids	23617000	TA	undiff
1381	Teleost	Lutjanidae	Lutjanus spp.	Sea Perch	37346905	BP	commercial grouping code -members in already
2075	Teleost	Macrouridae	Macrouridae - undifferentiated	whiptails	37232000	DI	deleted because undiff taxa - only 100 kg caught 2001-04
2207	Invertebrate	Nephropidae	Metanephrops & Nephropsis spp.	scampi	28786902	BP	commercial grouping code has been expanded
2003	Invertebrate	Order Octopoda	Order Octopoda - undifferentiated	octopods	23650000	BP	deleted because undiff taxa - only 41 kg caught 2001-04
1998	Invertebrate	Order Teuthoidea	Order Teuthoidea - undifferentiated	squid	23615000	DI	deleted because undiff taxa - only 10 kg caught 2001-04
2022	Invertebrate	Palinuridae	Palinuridae - undifferentiated	spiny lobsters	28820000	BP	deleted because undiff taxa - only 94 kg caught 2001-04
2018	Invertebrate	Penaeoidea & Caridea	Penaeoidea & Caridea - undifferentiated	prawns	28710000	BP	deleted because undiff taxa - only 190 kg caught 2001-04
2103	Teleost	Pentacerotidae	Pentacerotidae - undifferentiated	boarfishes	37367000	DI	grouping code -members in already
2092	Teleost	Percichthyidae, Serranidae	Percichthyidae, Serranidae - undifferentiated	temperate basses & rockcods	37311000	BP	deleted because undiff taxa - only 35 kg caught 2001-04
1528	Teleost	Emmelichthyidae	Plagiogeneion spp	rubyfish	37345900	BP	commercial grouping code has been expanded
1981	Invertebrate		Porifera - undifferentiated	sponges	10000000	DI	deleted because undiff taxa
1374	Teleost	Priacanthidae	Priacanthus spp	Red bullseye (All Australian members of	37326901	BP	commercial grouping code has been expanded
312	Chondrichthyan	Pristiophoridae	Pristiophoridae - undifferentiated	Saw Shark	37023000	BP	must be common saw shark - only one in area
2147	Teleost	Lutjanidae	Pristipomoides multidens & Pristipomoides typus	goldband snapper	37346901	BP	commercial grouping code has been expanded
2045	Chondrichthyan	Rajidae	Rajidae - undifferentiated	skates	37031000	DI	deleted because undiff taxa - only 0 kg caught 2001-04
2023	Invertebrate	Scyllaridae	Scyllaridae - undifferentiated	shovel-nosed/slipper lobsters	28821000	TA	grouping code has been expanded to include species caught
1983	Invertebrate	Class Scyphozoa	Scyphozoa spp - undifferentiated	jellyfish	11120000	DI	deleted because undiff taxa - only 0 kg caught 2001-04
1996	Invertebrate	Sepiidae	Sepiidae - undifferentiated	cuttlefish	23607000	BP	deleted because undiff taxa - 1800 kg caught 2001-04 - too many species to expand
1765	Chondrichthyan	Multi-family group	Sharks - other	Sharks (other)	37990003	DI	deleted because undiff taxa - only 40 kg caught 2001-04
2042	Chondrichthyan	Squalidae	Squalidae - undifferentiated	dogfishes	37020000	DI	deleted because undiff taxa - only 192 kg caught 2001-04 - some members in list
2043	Chondrichthyan	Squatinidae	Squatinidae - undifferentiated	angel sharks	37024000	DI	deleted because undiff taxa - only 142 kg caught 2001-04 - some members in list
1764	Teleost	Tetraodontidae	Tetraodontidae - undifferentiated	toadfishes	37467000	DI	deleted because undiff taxa - only 0 kg caught 2001-04

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

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

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

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

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

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

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

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

Observer data and observer expert knowledge are important sources of information in the PSA analyses, particularly for the bycatch and TEP components.

Summary of Species PSA results

Operators in the WDWTF use different mesh size depending on whether finfish or crustaceans are being targeted. The PSA has been run separately for the two mesh sizes, and the risk categories for each mesh size are reported here. In this table the susceptibility and risk values are those calculated for the finfish mesh size. In some instances the susceptibility value will be different for the crustacean mesh size. For species where the risk category is different for the different mesh sizes the full set of information for the crustacean mesh size is shown in the table following the bycatch species.

A summary of the species considered at Level 2 is presented below, sorted by component, by taxa within components, and then by the overall risk score [high (>3.18), medium (2.64-3.18), low<2.64)], together with categorisation of risk (refer to section 2.4.8).

Target species *WDW finfish and crusteacean trawl fishery*

ERA species ID	Scientific Name	Common Name	Average logbook catch (kg) (2001-04)	Missing > 3 attributes (Y/N)	Number of missing productivity attributes (out of 7)	Number of missing susceptibility attributes (out of 5)	Productivity (additive) 1- low risk, 3 - high risk	Susceptibility (mult) 1- low risk, 3 - high risk	2D risk value (P&S) 1.41- low risk, 4.24 - high risk	Susceptibility override used?	PSA risk category	PSA risk category crusctacean	High/Med risk category (Refer 2.4.8)	Comments
Invertebrate														
1339	Ibacus alticrenatus	Deepwater bug; Wollongong bug	0	Y	4	0	2.29	1.22	2.59	N	Low	Med		Medium risk with smaller mesh due to small size at maturity
1340	Ibacus pubescens	Western balmain bug; Bugs	0	N	2	0	1.86	1.67	2.5	N	Low	Med		Medium risk with smaller mesh due to small size at maturity
1332	Metanephrops australiensis	Australiensis scampi	0	N	1	0	1.71	1.67	2.39	N	Low	Low		

ERA species ID	Scientific Name	Common Name	Average logbook catch (kg) (2001-04)	Missing > 3 attributes (Y/N)	Number of missing productivity attributes (out of 7)	Number of missing susceptibility attributes (out of 5)	Productivity (additive) 1- low risk, 3 - high risk	Susceptibility (mult) 1- low risk, 3 - high risk	2D risk value (P&S) 1.41- low risk, 4.24 - high risk	Susceptibility override used?	PSA risk category	PSA risk category crusctacean	High/Med risk category (Refer 2.4.8)	Comments
1333	Metanephrops boschmai	Boschmai scampi	0	N	1	0	1.71	1.67	2.39	N	Low	Low		
1335	Metanephrops velutinus	Velvet scampi	0	N	1	0	1.71	1.67	2.39	N	Low	Low		
Teleost														
1066	Rexea solandri	Gemfish	3329	N	0	0	1.71	3	3.46	N	High	High	Widely distributed	Additional information on distribution: restricted to southern Australia and NZ
685	Lipocheilus carnolabrum	Tang Snapper	4997	N	0	0	1.43	3	3.32	N	High	High	Widely distributed	Additional information on distribution: widely distributed outside of the fishery (Rees *et al* 1999) but high availability within the fishery;only at high risk if separate stock in South Western Australia
1097	Zenopsis nebulosus	Mirror Dory	2208	N	0	0	1.43	3	3.32	N	High	High	Widely distributed	Additional information on distribution:Widely distributed outside of the fishery (Rees *et al* 1999) but high availability within the fishery;only at high risk if separate stock in South Western Australia

ERA species ID	Scientific Name	Common Name	Average logbook catch (kg) (2001-04)	Missing > 3 attributes (Y/N)	Number of missing productivity attributes (out of 7)	Number of missing susceptibility attributes (out of 5)	Productivity (additive) 1- low risk, 3 - high risk	Susceptibility (mult) 1- low risk, 3 - high risk	2D risk value (P&S) 1.41- low risk, 4.24 - high risk	Susceptibility override used?	PSA risk category	PSA risk category crusctacean	High/Med risk category (Refer 2.4.8)	Comments
171	Pentaceros decacanthus	big-spined boarfish	824	N	3	0	2	2.33	3.07	N	Med	Med	Widely distributed	High risk with smaller mesh due to small size at maturity
1038	Polyprion oxygeneios	Hapuku	93	N	0	0	2	2.33	3.07	N	Med	Med	Widely distributed	
600	Etelis carbunculus	Ruby snapper; Northwest Ruby Fish	21395	N	0	0	1.57	2.33	2.81	N	Med	Med	Widely distributed	
113	Neoplatycephalus conatus	Deepwater Flathead	25405	N	0	0	1.29	2.33	2.66	N	Med	Med	Widely distributed	Additional information on distribution: endemic to southern Australia
561	Hoplostethus atlanticus	Orange roughy	39220	N	0	0	2	1.67	2.6	N	Low	Low		
132	Epinephelus septemfasciatus	bar cod	0	N	0	0	1.71	1.44	2.24	N	Low	Low		
682	Pristipomoides filamentosus	Rosy Jobfish / King Snapper	615	N	0	0	1.43	1.67	2.2	N	Low	Low		
68	Centroberyx gerrardi	bight redfish	362	N	1	0	1.57	1.44	2.13	N	Low	Low		
539	Chelidonichthys Kumu	Red Gurnard	1210	N	0	0	1.29	1.44	1.93	N	Low	Low		

Byproduct species *WDW finfish and crusteacean trawl fishery*

ERA species ID	Scientific Name	Common Name	Average logbook catch (kg) (2001-04)	Missing > 3 attributes (Y/N)	Number of missing productivity attributes (out of 7)	Number of missing susceptibility attributes (out of 5)	Productivity (additive) 1- low risk, 3 - high risk	Susceptibility (mult) 1- low risk, 3 - high risk	2D risk value (P&S) 1.41- low risk, 4.24 - high risk	Susceptibility override used?	PSA risk category	PSA risk category crusctacean	High/Med risk category (Refer 2.4.8)	Comments
Chondrichthyan														
371	Centrophorus moluccensis (west)	Endeavour Dogfish	2,102	N	0	0	2.57	3.00	3.95	N	High	High	*Other	Additional information on distribution: widely distributed outside of the fishery (Last and Stevens 1994) but high availability within the fishery ; only at high risk if separate stock in Southern Australia - possible, temperate
936	Galeorhinus galeus	School Shark, Tope shark	162	N	0	0	2.57	3.00	3.95	N	High	High	Widely distributed	Additional information on distribution: widely distributed outside of the fishery (Last and Stevens 1994) but high availability within the fishery. Local stocks in SE Australia are overfished
1079	Squalus mitsukurii	Green-Eyed Dogfish	0	N	0	0	2.43	3.00	3.86	N	High	High	Widely distributed	Additional information on distribution: Now thought to be endemic to southern Australia (P.Last pers.comm.) high effort overlap

ERA species ID	Scientific Name	Common Name	Average logbook catch (kg) (2001-04)	Missing > 3 attributes (Y/N)	Number of missing productivity attributes (out of 7)	Number of missing susceptibility attributes (out of 5)	Productivity (additive) 1- low risk, 3 - high risk	Susceptibility (mult) 1- low risk, 3 - high risk	2D risk value (P&S) 1.41- low risk, 4.24 - high risk	Susceptibility override used?	PSA risk category	PSA risk category crusctacean	High/Med risk category (Refer 2.4.8)	Comments
668	Squatina tergocellata	ornate angel shark	442	N	0	0	2.43	3.00	3.86	N	High	High	Widely distributed	Additional information on distribution: endemic to Australia; from Port Lincoln (SA) to Geraldton (WA)
534	Chimaera sp. E [in Last & Stevens, 1994]	whitefin chimaera	0	N	3	0	2.29	3.00	3.77	N	High	High	*Other	Additional information on distribution: only known from northern WA
955	Hydrolagus lemures	bight ghost shark	0	N	0	0	2.00	3.00	3.61	N	High	High	*Other	Additional information on distribution: restricted to Australia: Cairns (Qld) to Exmouth Gulf (WA), excluding Tasmania
609	Deania quadrispinosa	Platypus Shark	0	N	0	0	2.71	2.33	3.58	N	High	High	*Other	Additional information on distribution: dsn NZ, southern Africa, southern Aust outside of the fishery (Last and Stevens 1994) but high availability within the fishery; only at high risk if separate stock in Southern Australia, possible

ERA species ID	Scientific Name	Common Name	Average logbook catch (kg) (2001-04)	Missing > 3 attributes (Y/N)	Number of missing productivity attributes (out of 7)	Number of missing susceptibility attributes (out of 5)	Productivity (additive) 1- low risk, 3 - high risk	Susceptibility (mult) 1- low risk, 3 - high risk	2D risk value (P&S) 1.41- low risk, 4.24 - high risk	Susceptibility override used?	PSA risk category	PSA risk category crusctacean	High/Med risk category (Refer 2.4.8)	Comments
808	Carcharhinus obscurus	Dusky Shark	0	N	0	0	3.00	1.67	3.43	N	High	High	Low overlap	Additional information on distribution: widely distributed outside of the fishery (Last and Stevens 1994) but high availability within the fishery; only at high risk if separate stock in Southern Australia
2705	Chimaera sp. C [in Last & Stevens, 1994]	longspine chimaera	0	Y	4	0	2.43	2.33	3.37	N	High	High	Missing data	Additional information on distribution: east and west of Australia, in warm temperate/tropical waters
604	Deania calcea	Brier Shark	0	N	0	0	2.71	1.67	3.19	N	High	High	Low overlap	Additional information on distribution: widespread outside of the fishery (Last and Stevens 1994) but high availability within the fishery; only at high risk if separate stock in Southern Australia, possible
866	Rhizoprionodon acutus	Milk shark	0	N	0	0	2.14	2.33	3.17	N	Med	Med	*Other	
535	Carcharhinus brachyurus	Bronze Whaler	8	N	0	0	2.86	1.22	3.11	N	Med	Med	Widely distributed	

ERA species ID	Scientific Name	Common Name	Average logbook catch (kg) (2001-04)	Missing > 3 attributes (Y/N)	Number of missing productivity attributes (out of 7)	Number of missing susceptibility attributes (out of 5)	Productivity (additive) 1- low risk, 3 - high risk	Susceptibility (mult) 1- low risk, 3 - high risk	2D risk value (P&S) 1.41- low risk, 4.24 - high risk	Susceptibility override used?	PSA risk category	PSA risk category crusctacean	High/Med risk category (Refer 2.4.8)	Comments
1040	Pristiophorus cirratus	common saw shark	399	N	0	0	2.43	1.67	2.95	N	Med	Med	Low overlap	
786	Chimaera sp. A [in Last & Stevens, 1994]	southern chimaera	0	N	2	0	2.29	1.67	2.83	N	Med	Med	Low overlap	
619	Carcharhinus dussumieri	Whitecheek shark	0	N	0	0	2.29	1.44	2.70	N	Med	Med	Low overlap	
999	Mustelus antarcticus	Gummy Shark	500	N	0	0	2.29	1.22	2.59	N	Low	Low		
630	Carcharhinus sorrah	Sorrah shark	0	N	0	0	2.14	1.22	2.47	N	Low	Low		
286	Callorhinchus milii	Elephantfish	112	N	0	0	1.71	1.44	2.24	N	Low	Low		
Invertebrate														
1352	Hypothalassia acerba	champagne crab	0	Y	4	0	2.29	2.33	3.27	N	High	High	Missing data	missing productivity info
1347	Chaceon bicolor	crystal crab	119	N	3	0	2.00	1.67	2.60	N	Low	Med		Medium risk with smaller mesh due to small size at maturity
1334	Metanephrops neptunus	Neptune scampi, neppie scampi, neptune l	0	N	1	0	1.71	1.67	2.39	N	Low	Low		
2212	Metanephrops sibogae	Siboga scampi	0	N	1	0	1.71	1.67	2.39	N	Low	Low		
2287	Nephrosis serrata	Deep-sea scampi	0	N	1	0	1.71	1.67	2.39	N	Low	Low		
2288	Nephrosis stewarti	Stewart's scampi	0	N	1	0	1.71	1.67	2.39	N	Low	Low		
465	Pseudocarcinus gigas	Giant crab	6	N	1	0	1.71	1.30	2.15	N	Low	Low		

ERA species ID	Scientific Name	Common Name	Average logbook catch (kg) (2001-04)	Missing > 3 attributes (Y/N)	Number of missing productivity attributes (out of 7)	Number of missing susceptibility attributes (out of 5)	Productivity (additive) 1- low risk, 3 - high risk	Susceptibility (mult) 1- low risk, 3 - high risk	2D risk value (P&S) 1.41- low risk, 4.24 - high risk	Susceptibility override used?	PSA risk category	PSA risk category crusctacean	High/Med risk category (Refer 2.4.8)	Comments
11	Nototodarus gouldi	Arrow Squid	910	N	0	0	1.43	1.22	1.88	N	Low	Low		
24	Thenus orientalis	BUG	0	N	0	0	1.29	1.07	1.68	N	Low	Low		
Teleost														
658	Plagiogeneion macrolepis	bigscale rubyfish	0	N	3	0	2.00	3.00	3.61	N	High	High	*Other	Additional information on distribution: restricted to Great Australian Bight and south-west WA
592	Dannevigia tusca	Australian Tusk	41	N	1	0	1.71	3.00	3.46	N	High	High	Widely distributed	Additional information on distribution: dsn restricted to southern Australia
1012	Nemadactylus macropterus	Jackass Morwong	62	N	0	0	1.43	3.00	3.32	N	High	High	Widely distributed	Additional information on distribution: widely distributed outside of the fishery (Rees *et al* 1999) but high availability within the fishery ;only at high risk if separate stock in South Western Australia

ERA species ID	Scientific Name	Common Name	Average logbook catch (kg) (2001-04)	Missing > 3 attributes (Y/N)	Number of missing productivity attributes (out of 7)	Number of missing susceptibility attributes (out of 5)	Productivity (additive) 1- low risk, 3 - high risk	Susceptibility (mult) 1- low risk, 3 - high risk	2D risk value (P&S) 1.41- low risk, 4.24 - high risk	Susceptibility override used?	PSA risk category	PSA risk category crusctacean	High/Med risk category (Refer 2.4.8)	Comments
169	Paristiopterus gallipavo	Yellow-Spotted Boarfish	41	N	3	0	2.29	2.33	3.27	Y	High	High	Widely distributed	Expert override :mainly a shelf species (Alan Williams pers comm). Encounterability reduced to medium. Additional information on distribution: Endemic to Australia. Eastern SA to central coast of WA.
233	Nelusetta ayraudi	Chinaman-Leatherjacket	64	N	0	0	1.29	3.00	3.26	N	High	High	Widely distributed	Additional information on distribution: endemic to Australia - central coast of WA to southern Queensland
933	Genypterus blacodes	Ling	0	N	1	0	2.14	2.33	3.17	N	Med	Med	Widely distributed	
175	Oplegnathus woodwardi	Knifejaw	124	N	3	0	2.14	2.33	3.17	N	Med	Med	Widely distributed	Additional information on distribution: restricted to southern Australia
173	Pseudopentaceros richardsoni	Richardson's Boarfish /Southern	1,169	N	3	0	2.14	2.33	3.17	N	Med	Med	Widely distributed	

ERA species ID	Scientific Name	Common Name	Average logbook catch (kg) (2001-04)	Missing > 3 attributes (Y/N)	Number of missing productivity attributes (out of 7)	Number of missing susceptibility attributes (out of 5)	Productivity (additive) 1- low risk, 3 - high risk	Susceptibility (mult) 1- low risk, 3 - high risk	2D risk value (P&S) 1.41- low risk, 4.24 - high risk	Susceptibility override used?	PSA risk category	PSA risk category crusctacean	High/Med risk category (Refer 2.4.8)	Comments
958	Hyperoglyphe antarctica	Blue Eye Trevalla	0	N	0	0	2.00	2.33	3.07	Y	Med	Med	Widely distributed	Expert override :mostly inaccessible (Alan Williams pers comm). Encounterability reduced to medium. Additional information on distribution :widely distributed outside of the fishery (Rees *et al* 1999) but high availability within the fishery. Fully fished in S.E. fishery
596	Plagiogeneion rubiginosus	Ruby Fish	0	N	3	0	2.00	2.33	3.07	N	Med	Med	*Other	
282	Beryx splendens	Alfonsino	1,086	N	1	0	1.71	2.33	2.90	Y	Med	Med	Widely distributed	Expert override : rocky bottom species (Alan Williams pers comm). Encounterability reduced to medium. Additional information on distribution : widely distributed outside of the fishery (Rees *et al* 1999) but high availability within the fishery only at high risk if separate stock in south Western Australia
215	Centrolophus niger	Rudderfish	0	N	0	0	1.71	2.33	2.90	N	Med	Med	*Other	

ERA species ID	Scientific Name	Common Name	Average logbook catch (kg) (2001-04)	Missing > 3 attributes (Y/N)	Number of missing productivity attributes (out of 7)	Number of missing susceptibility attributes (out of 5)	Productivity (additive) 1- low risk, 3 - high risk	Susceptibility (mult) 1- low risk, 3 - high risk	2D risk value (P&S) 1.41- low risk, 4.24 - high risk	Susceptibility override used?	PSA risk category	PSA risk category crusctacean	High/Med risk category (Refer 2.4.8)	Comments
982	Macruronus novaezelandiae	Blue Grenadier	0	N	0	0	1.71	2.33	2.90	N	Med	Med	Widely distributed	
997	Mora moro	Ribaldo	608	N	2	0	1.71	2.33	2.90	N	Med	Med	Widely distributed	
158	Pagrus auratus	Snapper/Squirefish	226	N	0	0	1.71	2.33	2.90	N	Med	Med	Widely distributed	
136	Priacanthus macracanthus	bigeye	0	N	1	0	1.71	2.33	2.90	N	Med	Med	*Other	
147	Rachycentron canadum	cobia	2	N	0	0	1.71	2.33	2.90	N	Med	Med	Spatial uncertainty	
591	Seriola dumerili	Eye Streak Kingfish/ Amberjack	2,592	N	0	0	1.71	2.33	2.90	Y	Med	Med	Spatial uncertainty	Expert override :mostly pelagic (Alan Williams pers comm). Encounterability reduced to medium. Additional information on distribution :No fishery overlap info available. Widely distributed;only at high risk if separate stock in South Western Australia
163	Protonibea diacanthus	banded/spotted croaker	0	N	0	0	1.57	2.33	2.81	N	Med	Med	Widely distributed	

ERA species ID	Scientific Name	Common Name	Average logbook catch (kg) (2001-04)	Missing > 3 attributes (Y/N)	Number of missing productivity attributes (out of 7)	Number of missing susceptibility attributes (out of 5)	Productivity (additive) 1- low risk, 3 - high risk	Susceptibility (mult) 1- low risk, 3 - high risk	2D risk value (P&S) 1.41- low risk, 4.24 - high risk	Susceptibility override used?	PSA risk category	PSA risk category crusctacean	High/Med risk category (Refer 2.4.8)	Comments
1087	Thyrsites atun	Barracouta	380	N	0	0	1.57	2.33	2.81	Y	Med	Med	Widely distributed	Expert override :benthopleagic on shelf (Ross Daley pers comm). Encounterability reduced to medium. Additional information on distribution :Widely distributed outside of the fishery (Rees *et al* 1999) but high availability within the fishery;only at high risk if separate stock in south Western Australia
84	Metavelifer multiradiatus	veilfin	0	N	3	0	2.00	1.89	2.75	N	Med	Med	Widely distributed	
593	Elagatis bipinnulata	rainbow runner	0	N	0	0	1.43	2.33	2.74	N	Med	Med	Widely distributed	
2706	Pristipomoides typus	threadfin snapper;sharptooth snapper	0	N	0	0	1.43	2.33	2.74	N	Med	Med	*Other	
97	Scorpaena papillosa	Red Rock Cod	8	N	1	0	1.43	2.33	2.74	N	Med	Med	Widely distributed	
848	Diretmichthys parini	parins spinyfin	0	N	3	0	2.14	1.67	2.71	N	Med	Med	Low overlap	
71	Cyttus traversi	King Dory	36	N	0	0	1.29	2.33	2.66	N	Med	Med	Widely distributed	
670	Sargocentron rubrum	Red Squirrel Fish	100	N	0	0	1.29	2.33	2.66	N	Med	Med	Widely distributed	

ERA species ID	Scientific Name	Common Name	Average logbook catch (kg) (2001-04)	Missing > 3 attributes (Y/N)	Number of missing productivity attributes (out of 7)	Number of missing susceptibility attributes (out of 5)	Productivity (additive) 1- low risk, 3 - high risk	Susceptibility (mult) 1- low risk, 3 - high risk	2D risk value (P&S) 1.41- low risk, 4.24 - high risk	Susceptibility override used?	PSA risk category	PSA risk category crusctacean	High/Med risk category (Refer 2.4.8)	Comments
1013	Neocyttus rhomboidalis	Spiky Oreo	181	N	0	0	2.00	1.67	2.60	N	Low	Low		
82	Allocyttus niger	Black Oreo	12	N	0	0	1.86	1.67	2.50	N	Low	Low		
631	Pseudocyttus maculatus	Smooth oreo	1,044	N	0	0	1.86	1.67	2.50	N	Low	Low		
597	Aphareus rutilans	rusty jobfish	448	N	0	0	1.57	1.89	2.46	N	Low	Low		
888	Gephyroberyx darwinii	darwin's roughy	412	N	0	0	1.57	1.89	2.46	N	Low	Med		Medium risk with smaller mesh due to small size at maturity
332	Centroberyx affinis	Redfish	278	N	1	0	1.71	1.67	2.39	N	Low	Low		
204	Ruvettus pretiosus	Oilfish	2	N	0	0	1.71	1.67	2.39	N	Low	Low		
693	Glaucosoma hebraicum	West Australian dhufish	0	N	0	0	1.86	1.44	2.35	N	Low	Low		
941	Helicolenus percoides	Ocean Perch - inshore	16	N	0	0	1.86	1.44	2.35	N	Low	Low		
420	Epinephelus lanceolatus	rock cod	0	N	0	0	2.00	1.22	2.34	N	Low	Low		
185	Bodianus vulpinus	Pigfish	6	N	0	0	1.29	1.89	2.28	N	Low	Med		Medium risk with smaller mesh due to small size at maturity
109	Pterygotrigla polyommata	Latchet	772	N	0	0	1.29	1.89	2.28	N	Low	Low		
162	Argyrosomus hololepidotus	Jewfish	1	N	0	0	1.71	1.44	2.24	N	Low	Low		
723	Etelis coruscans	sea perch/snapper	1,135	N	0	0	1.71	1.44	2.24	N	Low	Low		
181	Latridopsis forsteri	Bastard Trumpeter	3	N	0	0	1.71	1.44	2.24	N	Low	Low		
599	Lutjanus sebae	Red Emperor	0	N	0	0	1.71	1.44	2.24	N	Low	Low		

ERA species ID	Scientific Name	Common Name	Average logbook catch (kg) (2001-04)	Missing > 3 attributes (Y/N)	Number of missing productivity attributes (out of 7)	Number of missing susceptibility attributes (out of 5)	Productivity (additive) 1- low risk, 3 - high risk	Susceptibility (mult) 1- low risk, 3 - high risk	2D risk value (P&S) 1.41- low risk, 4.24 - high risk	Susceptibility override used?	PSA risk category	PSA risk category crusctacean	High/Med risk category (Refer 2.4.8)	Comments
620	Scomberomorus commerson	Spanish Mackerel	38	N	0	0	1.71	1.44	2.24	N	Low	Low		
62	Thunnus obesus	Bigeye Tuna	0	N	0	0	1.71	1.44	2.24	N	Low	Low		
1546	Lutjanus russelli [The eastern form]	[a tropical snapper]	0	N	0	0	1.43	1.67	2.20	N	Low	Low		
218	Schedophilus labyrinthica	ocean blue-eye	25	N	0	0	1.43	1.67	2.20	N	Low	Low		
1069	Seriolella punctata	Spotted Warehou	2	N	0	0	1.43	1.67	2.20	N	Low	Low		
209	Trichiurus lepturus	smallhead hairtail	2	N	0	0	1.43	1.67	2.20	N	Low	Low		
690	Epinephelus radiatus	Oblique-banded Grouper /Radiant cod	1,826	N	0	0	1.57	1.44	2.13	N	Low	Low		
667	Glaucosoma buergeri	Northern Jewfish	58	N	0	0	1.57	1.44	2.13	N	Low	Low		
746	Priacanthus hamrur	bigeye	0	N	1	0	1.57	1.44	2.13	N	Low	Low		
150	Pseudocaranx dentex	Silver Trevally	40	N	0	0	1.57	1.44	2.13	N	Low	Low		
211	Sarda australis	australian bonito	8	N	0	0	1.57	1.44	2.13	N	Low	Low		
684	Lutjanus malabaricus	Scarlet Sea Perch / Large Mouth Nannygai	0	N	0	0	1.71	1.22	2.11	N	Low	Low		
148	Seriola lalandi	Yellowtail Kingfish	122	N	0	0	1.71	1.22	2.11	N	Low	Low		
214	Cyttus australis	Silver dory	0	N	0	0	1.29	1.67	2.10	N	Low	Low		
1068	Seriolella brama	Blue Warehou	16	N	0	0	1.29	1.67	2.10	N	Low	Low		
217	Seriolella caerulea	White Trevalla	500	N	0	0	1.29	1.67	2.10	N	Low	Low		
1088	Trachurus declivis	Jack Mackerel	0	N	0	0	1.29	1.67	2.10	N	Low	Low		
70	Cleidopus gloriamaris	pineapple fish	13	N	1	0	1.57	1.30	2.04	N	Low	Low		
671	Neatypus obliquus	Footballer Sweep	1	N	0	0	1.43	1.44	2.03	N	Low	Low		

ERA species ID	Scientific Name	Common Name	Average logbook catch (kg) (2001-04)	Missing > 3 attributes (Y/N)	Number of missing productivity attributes (out of 7)	Number of missing susceptibility attributes (out of 5)	Productivity (additive) 1- low risk, 3 - high risk	Susceptibility (mult) 1- low risk, 3 - high risk	2D risk value (P&S) 1.41- low risk, 4.24 - high risk	Susceptibility override used?	PSA risk category	PSA risk category crusctacean	High/Med risk category (Refer 2.4.8)	Comments
178	Nemadactylus valenciennesi	queen snapper	8	N	0	0	1.43	1.44	2.03	N	Low	Low		
598	Pristipomoides multidens	Gold Band Snapper	0	N	0	0	1.43	1.44	2.03	N	Low	Low		
72	Zeus faber	John Dory	66	N	0	0	1.43	1.44	2.03	N	Low	Low		
615	Achoerodus viridis	Eastern Blue Groper	0	N	0	0	1.57	1.22	1.99	N	Low	Low		
749	Priacanthus tayenus	bigeye	0	N	1	0	1.57	1.22	1.99	N	Low	Low		
123	Lepidoperca pulchella	Orange Perch	228	N	0	0	1.29	1.44	1.93	N	Low	Low		
873	Scomber scombrus	Atlantic mackerel	10	N	0	0	1.29	1.44	1.93	N	Low	Low		
444	Epinephelus multinotatus	white-spotted rock cod	0	N	0	0	1.43	1.22	1.88	N	Low	Low		
1380	Lutjanus sp. (in Yearsley, Last & Ward, 1999) [The western form]	Russell's snapper	0	N	0	0	1.43	1.22	1.88	N	Low	Low		
607	Scorpis lineolata	Sweep	17	N	0	0	1.43	1.22	1.88	N	Low	Low		
210	Scomber australasicus	Blue Mackerel	12	N	0	0	1.29	1.22	1.77	N	Low	Low		

Bycatch species *WDW finfish and crusteacean trawl fishery*

ERA species ID	Scientific Name	Common Name	Average logbook catch (kg) (2001-04)	Missing > 3 attributes (Y/N)	Number of missing productivity attributes (out of 7)	Number of missing susceptibility attributes (out of 5)	Productivity (additive) 1- low risk, 3 - high risk	Susceptibility (mult) 1- low risk, 3 - high risk	2D risk value (P&S) 1.41- low risk, 4.24 - high risk	Susceptibility override used?	PSA risk category	PSA risk category crusctacean	High/Med risk category (Refer 2.4.8)	Comments
Chondrichthyan														
1078	Squalus megalops	Piked Dogfish	279	N	0	0	2.29	3	3.77	N	High	High	Widely distributed	Additional information on distribution: probably an Australian endemic: Townsville (Qld) to Carnarvon (WA)
179	Alopias vulpinus	Thintail Thresher Shark, thresher shark	30	N	0	0	2.57	1.44	2.95	N	Med	Med	Widely distributed	
60	Notorynchus cepedianus	Broadnose sevengill shark	0	N	0	0	2.57	1.44	2.95	N	Med	Med	Widely distributed	
853	Manta birostris	Manta Ray	0	N	0	0	2.43	1.67	2.95	N	Med	Med	Widely distributed	
964	Isurus oxyrinchus	Shortfinned Mako or Blue Pointer	0	N	0	0	2.43	1.44	2.83	N	Med	Med	Widely distributed	
Teleost														
686	Satyrichthys cf moluccense	Armoured Gurnard	732	Y	4	0	2.57	1.67	3.06	N	Med	Med	Missing data	
691	Dentex tumifrons	Yellowback bream	42	N	0	0	1.29	2.33	2.66	N	Med	Med	Widely distributed	High risk with smaller mesh due to small size at maturity
86	Trachipterus arawatae	Ribbon or Dealfish	0	N	2	0	2	1.67	2.6	N	Low	Low		
252	Mola mola	ocean sunfish	0	N	1	0	2.29	1.22	2.59	N	Low	Low		
208	Lepidopus caudatus	Southern Frostfish	1	N	1	0	1.71	1.67	2.39	N	Low	Low		
654	Carangoides caeruleopinnatus	trevally	0	N	0	0	1.43	1.44	2.03	N	Low	Low		
657	Carangoides chrysophrys	trevally	0	N	0	0	1.43	1.22	1.88	N	Low	Low		

Expert overrides are from Alan Williams and Ross Daley , CSIRO Marine and Atmospheric Research.

The following table contains only species where risk category varies with the crustacean mesh size. In this table the susceptibility and risk values are those calculated for the crustacean mesh size

ERA Species ID	Scientific name	Common name	average logbook catch (kg) 2001-04	Missing > 3 attributes (Y/N)	Number of missing productivity attributes (out of 7)	Number of missing susceptibility attributes (out of 4)	Productivity (additive) 1- low risk, 3 - high	Susceptibility (mult) 1- low risk, 3 - high	Overall risk score 1.41- low , 4.24 - high	override used?	Risk category finfish	Risk category crustacean	Comments
1347	Chaceon bicolor	crystal crab	119	N	3	0	2.00	2.33	3.07	N	Low	Med	Medium risk with smaller mesh due to small size at maturity
888	Gephyroberyx darwinii	darwin's roughy	412	N	0	0	1.57	2.33	2.81	N	Low	Med	Medium risk with smaller mesh due to small size at maturity
185	Bodianus vulpinus	Pigfish	6	N	0	0	1.29	2.33	2.66	N	Low	Med	Medium risk with smaller mesh due to small size at maturity
691	Dentex tumifrons	Yellowback bream	42	N	0	0	1.29	3.00	3.26	N	Med	High	High risk with smaller mesh due to small size at maturity
1339	Ibacus alticrenatus	Deepwater bug; Wollongong bug	0	Y	4	0	2.29	1.44	2.70	N	Low	Med	Medium risk with smaller mesh due to small size at maturity
1340	Ibacus pubescens	Western balmain bug; Bugs	0	N	2	0	1.86	2.33	2.98	N	Low	Med	Medium risk with smaller mesh due to small size at maturity
171	Pentaceros decacanthus	big-spined boarfish	824	N	3	0	2.00	3.00	3.61	N	Med	High	High risk with smaller mesh due to small size at maturity

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).

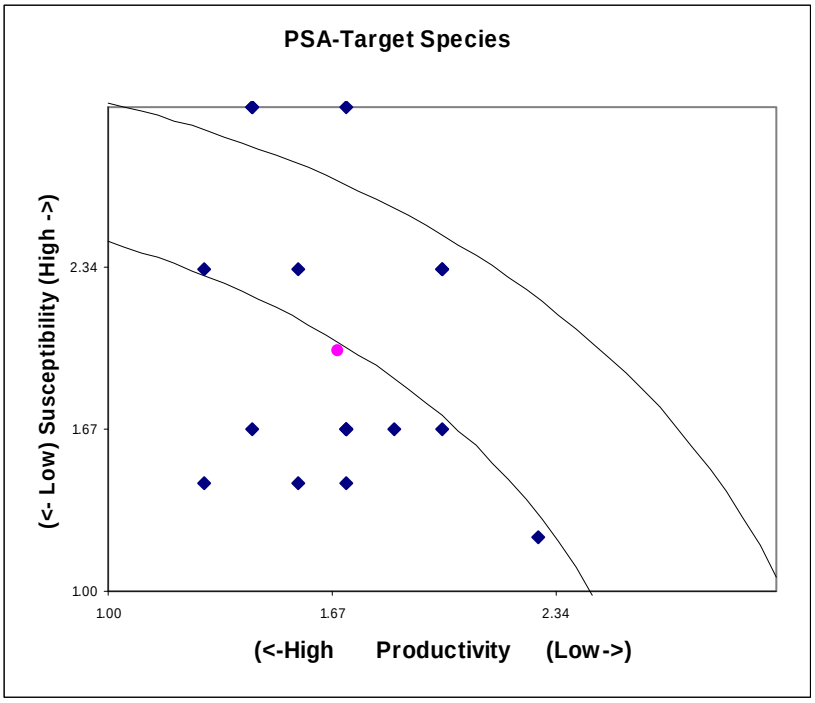
Record #	ERA habitat #	Sub-biome	Feature	Habitat Name	SGF Score	Productivity score (Average)	Susceptibility score (Multiplicative)	Overall Risk Value (P&Sm)	Overall Risk Ranking (2D multiplicative)	Risk Ranking Override	Rational for Risk Ranking Override
2197	221	mid-slope	Slope	Mud, irregular, crinoids/ seawhips	005	3.00	2.04	3.63	High		
2198	222	mid-slope	Slope	Mud, flat, solitary	007	3.00	2.04	3.63	High		
2201	228	mid-slope	Slope	Fine sediments, unrippled, solitary	107	3.00	2.04	3.63	High		
2203	232	mid-slope	Slope	Fine sediments, subcrop, octocorals	155	3.00	1.89	3.55	High		
2204	243	mid-slope	Slope	Gravel, irregular, low encrustings	336	3.00	1.93	3.57	High	leave here	same as SET OT
2206	245	mid-slope	Slope	boulders and slabs, subcropping, octocorals	455	3.00	2.07	3.64	High		
2208	249	mid-slope	Seamount	Igneous rock, rubble bank, octocorals	545	3.00	2.30	3.78	High		
2210	213	mid-slope	Seamount	Igneous rock (?), low outcrop, octocorals	575	3.00	2.30	3.78	High		
2211	157	mid-slope	Slope	Igneous rock, high outcrop, octocorals	595	3.00	1.67	3.43	High	Low	low encounterability
2212	165	mid-slope	Slope	Sedimentary rock, subcrop, octocorals	655	3.00	1.89	3.55	High		
2213	252	mid-slope	Slope	Sedimentary rock, subcrop, small encrustors	656	3.00	1.71	3.45	High	leave here	same as SET OT
2170	227	upper slope	Slope	Fine sediments, unrippled, large sponges	101	3.00	2.30	3.78	High		
2171	078	upper slope	Slope	Fine sediments, unrippled, Solitary epifauna	107	3.00	2.30	3.78	High		
2173	231	upper slope	Slope	Fine sediments, irregular, glass sponge (stalked)	137	3.00	2.30	3.78	High		
2175	236	upper slope	Slope	Coarse sediments, rippled, solitary epifauna	217	3.00	2.30	3.78	High		
2177	237	upper slope	Slope	Coarse sediments, wave rippled, bryozoan turf	226	3.00	2.07	3.64	High		
2178	238	upper slope	Slope	Coarse sediments, irregular, octocorals (matrix of solsomalia – dead corals)	235	3.00	2.30	3.78	High		
2179	239	upper slope	Slope	Coarse sediments, subcrop, large sponges	251	3.00	2.14	3.69	High		
2180	240	upper slope	Slope	Sedimentary rock, subcrop, octocorals	255	3.00	2.14	3.69	High		
2181	241	upper slope	Slope	Coarse sediments, subcrop, low encrusting community (ascidians)	256	3.00	1.93	3.57	High		
2184	036	upper slope	Slope	Sedimentary rock, subcrop, small encrustors	656	3.00	1.93	3.57	High		

Record #	ERA habitat #	Sub-biome	Feature	Habitat Name	SGF Score	Productivity score (Average)	Susceptibility score (Multiplicative)	Overall Risk Value (P&Sm)	Overall Risk Ranking (2D multiplicative)	Risk Ranking Override	Rational for Risk Ranking Override
				(hydroids?)							
2185	256	upper slope	Slope	Sedimentary rock, outcrop, octocorals	665	3.00	2.04	3.63	High	Low	low encounterability
2186	035	upper slope	Slope	Sedimentary rock, outcrop, small encrustors	666	3.00	1.83	3.51	High	Low	low encounterability
2188	145	upper slope	Canyon	Sedimentary rock, low outcrops on steep slope, large sponges	671	3.00	2.42	3.86	High	Low	low encounterability
2189	071	upper slope	Shelf break	Sedimentary rock, low outcrop, small encrustors	676	3.00	2.07	3.64	High	Low	low encounterability
2190	261	upper slope	Slope	Sedimentary rock, outcrop, sedentary (anemones)	677	3.00	2.04	3.63	High	Low	low encounterability
2191	264	upper slope	Slope	Sedimentary rock, high outcrop, octocorals	683	3.00	1.89	3.55	High	Low	low encounterability
2195	269	upper slope	Slope	Sedimentary rock, high outcrop, octocorals	695	3.00	1.89	3.55	High	Low	low encounterability
2196	270	upper slope	Slope	Sedimentary rock, high outcrop, solitary epifauna	697	3.00	1.89	3.55	High	Low	low encounterability
2199	159	mid-slope	Slope	Mud, irregular, bioturbators	039	2.00	1.83	2.71	Med		
2200	156	mid-slope	Slope	Fine sediments, unripped, no fauna	100	2.00	1.83	2.71	Low	Low	low productivity but also low risk
2202	230	mid-slope	Slope	Fine sediments, irregular, no fauna	130	2.00	1.83	2.71	Low	Low	low productivity but also low risk
2205	244	mid-slope	Slope	Igneous boulder, rubble bank, no fauna	440	2.00	1.89	2.75	Low	Low	low productivity but also low risk
2209	250	mid-slope	Seamount	Igneous rock, low outcrop, no fauna	570	2.00	2.07	2.88	Med	leave here	ranked here because Seamount
2214	253	mid-slope	Slope	Consolidated rock conglomerate, subcrop, bioturbators	659	2.00	1.71	2.63	Med		
2141	202	upper slope	Slope	mud, unrippled, no fauna	000	2.00	2.07	2.88	Med		
2169	141	upper slope	Slope	mud, unrippled, bioturbators	009	2.00	2.07	2.88	Med		
2172	133	upper slope	Slope	Fine sediments, current rippled, no fauna	110	2.00	2.07	2.88	Med		
2174	041	upper slope	Slope	Fine sediments, irregular, bioturbators	139	2.00	2.07	2.88	Med		
2175	235	upper slope	Slope	Coarse sediments, rippled, no fauna	210	2.00	2.19	2.96	Med		
2176	072	upper slope	Slope	Coarse sediments, rippled, bioturbators	239	2.00	2.07	2.88	Med		
2182	247	upper slope	Slope	boulders, low outcrop, no fauna	470	2.00	2.04	2.85	Med		
2183	251	upper slope	Slope	Sedimentary rock, subcrop, no fauna	650	2.00	1.93	2.78	Med		

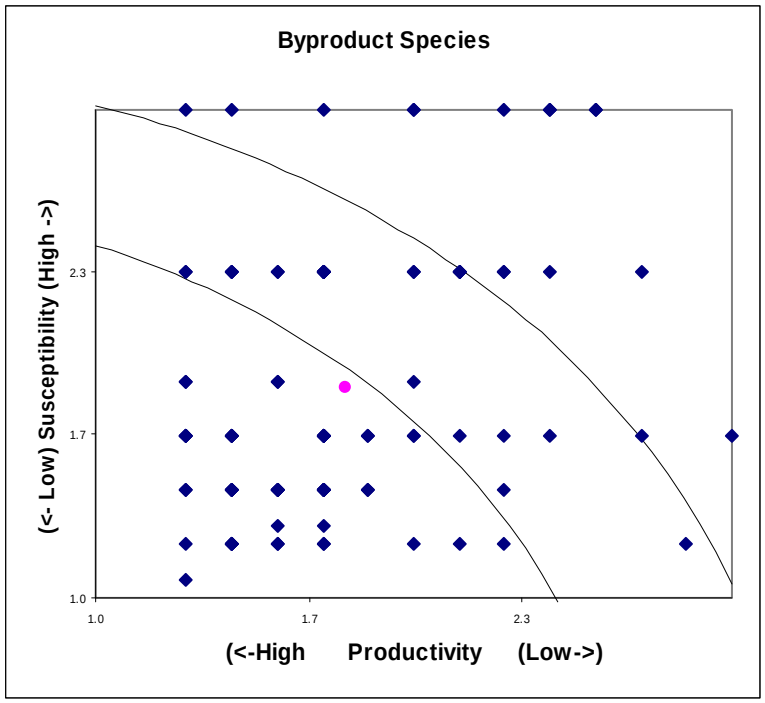
Record #	ERA habitat #	Sub-biome	Feature	Habitat Name	SGF Score	Productivity score (Average)	Susceptibility score (Multiplicative)	Overall Risk Value (P&Sm)	Overall Risk Ranking (2D multiplicative)	Risk Ranking Override	Rational for Risk Ranking Override
2187	257	upper slope	Shelf break	Sedimentary rock, low outcrop, no fauna	670	2.00	2.07	2.88	Med		
2194	267	upper slope	Slope	Sedimentary rock (mudstone?), high outcrop, small sponges	692	2.00	1.80	2.69	Med	Low	low encounterability
2207	248	mid-slope	Slope	Igneous rock, rubble bank, no fauna	540	2.00	1.62	2.58	Low		
2215	262	mid-slope	Slope	sedimentary/mudstone, high outcrop, no fauna	680	2.00	1.59	2.56	Low		
2193	265	upper slope	Slope	Sedimentary rock (mudstone?), high outcrop, no fauna	690	2.00	1.71	2.63	Low		

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

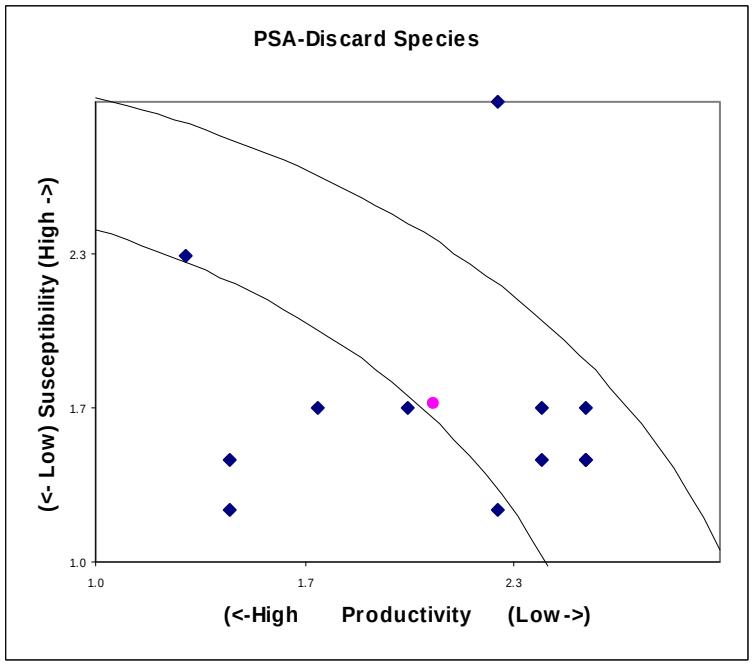
The average productivity and susceptibility scores for each unit of analysis (e.g. for each species) are then used to place the individual units of analysis on 2D plots (as below). The relative position of the units on the plot will determine relative risk at the unit level as per PSA plot below. The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



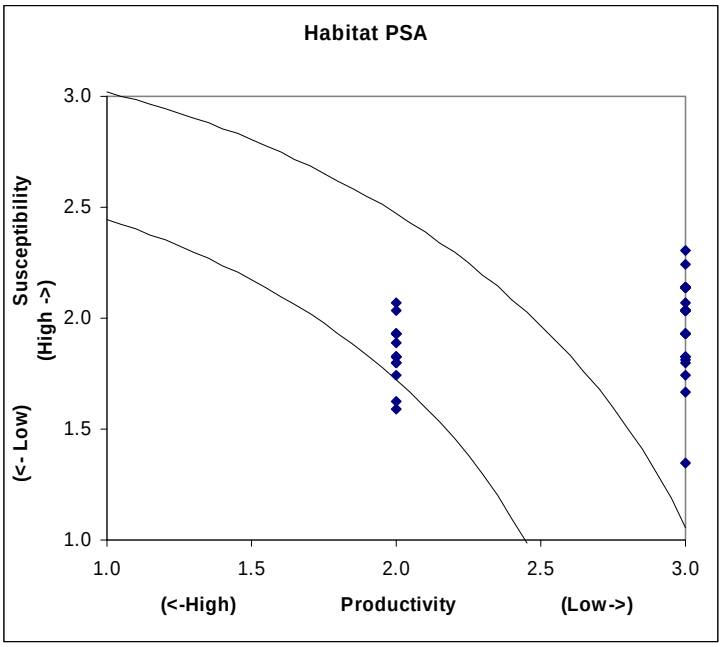
PSA plot for target species



PSA plot for byproduct species



PSA plot for discards/bycatch 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)**.

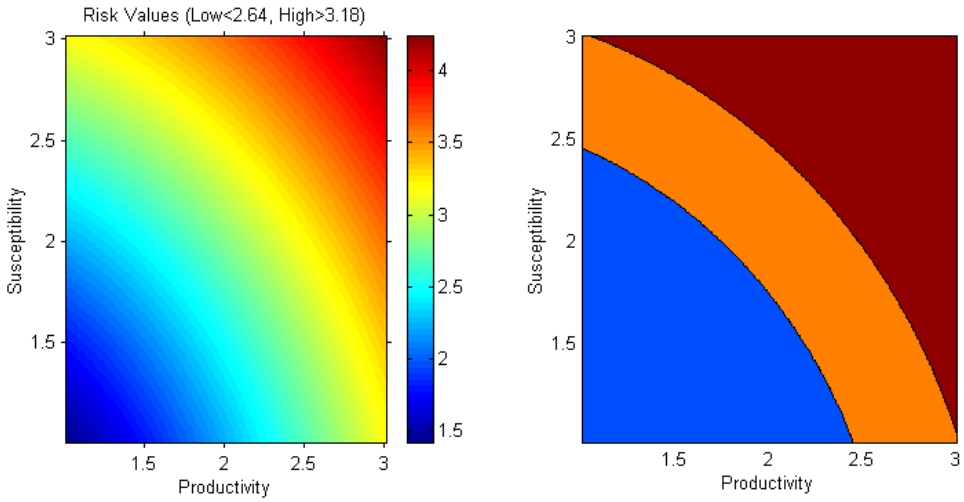


Figure 17. Overall risk values in the PSA plot. Left panel. Colour map of the distribution of the euclidean overall risk values. Right panel. The PSA plot contoured to show the low risk (blue), medium risk (orange) and high risk (red) values.

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 from 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.

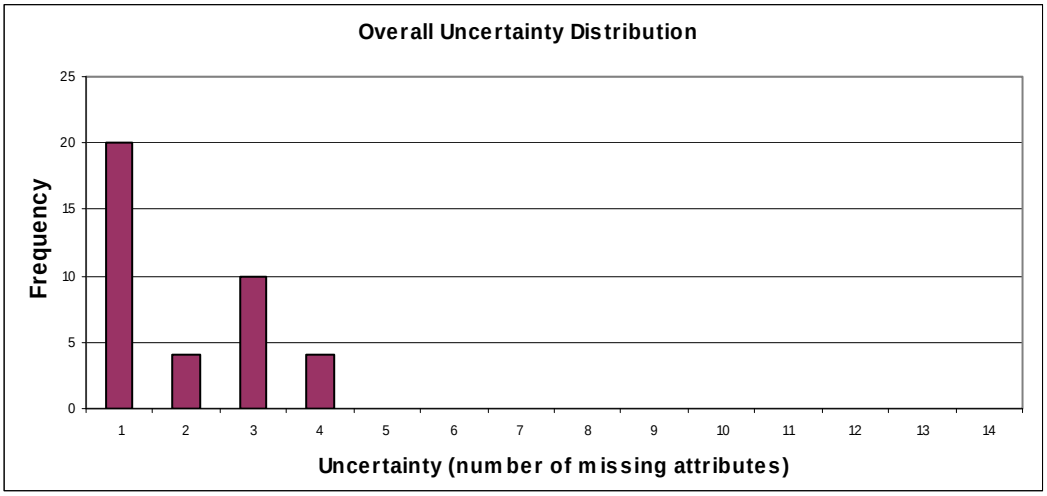
The validity of the ranking can also be examined by comparing the results with those from other data sources or modelling approaches that have already been undertaken in specific fisheries. For example, the PSA results of the individual species (target, byproduct and bycatch and TEP) can be compared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

<u>Availability of information</u>
The ability to score each species based on information on each attribute varied between the attributes (as per summary below). With regard to the productivity attributes, fecundity was missing in 20% of species, and so the most conservative score was used, while information on maximum size 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	112	109	103	129	129	127	120
n species scores with attribute unknown, (conservative score used)	17	20	26	0	0	2	9
% unknown information	13	16	20	0	0	2	7
Susceptibility Attributes	Availability	Encounterability		Selectivity	PCM		
		Bathymetry overlap	Habitat				
Total species scores for attribute	129	129	129	129	129		
n species scores with attribute unknown, (conservative score used)	0	0	0	0	0		
% unknown information	0	0	0	0	0		

Each species considered in the analysis had information for an average of 6.4 (91%) productivity attributes and all (100%) susceptibility attributes. This meant that, on average, conservative scores were used for less than 8% of the attributes for a single species. Species had missing information for between 0 and 4 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.

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: The attributes selected for productivity and susceptibility were not strongly correlated (as per correlation matrix below for Productivity and Susceptibility). The strongest productivity attribute correlation was between fecundity and reproductive strategy, while the strongest susceptibility correlation was between encounterability and availability. This correlation analysis suggests that each attribute was "measuring" a different aspect of the species characteristics and all attributes were suitable for inclusion in the PSA.

	Age at maturity	Max age	Fecundity	Max size	Min size at maturity	Reproductive strategy	Trophic level
Age at maturity	X						
Max age	0.52	X					
Fecundity	0.52	0.08	X				
Max size	-0.07	0.00	0.02	X			
Min size at maturity	0.16	0.12	0.24	0.70	X		
Reproductive strategy	0.30	0.09	0.60	0.24	0.37	X	
Trophic level	-0.14	-0.02	-0.01	0.30	0.22	0.23	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	0.28	X		
Selectivity	-0.27	-0.23	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 low 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)	-	0.09	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.

Productivity and susceptibility risk values for Species

The average productivity score for all species was [1.79 ± 0.12] (mean ± SD of scores calculated using n-1 attributes) and the mean susceptibility score was 1.86 (as per summary of average productivity and susceptibility scores as below). Individual scores are shown in the table in section 2.42: Summary of PSA results. The small variation in the average of the boot-strapped values (using n-1 attributes), indicates the productivity and susceptibility scores are robust to elimination of a single attribute. Information for a single attribute does not have a disproportionately large effect on the productivity and susceptibility scores. Information was missing for an average of 0.57 attributes out of 12 possible for each species.

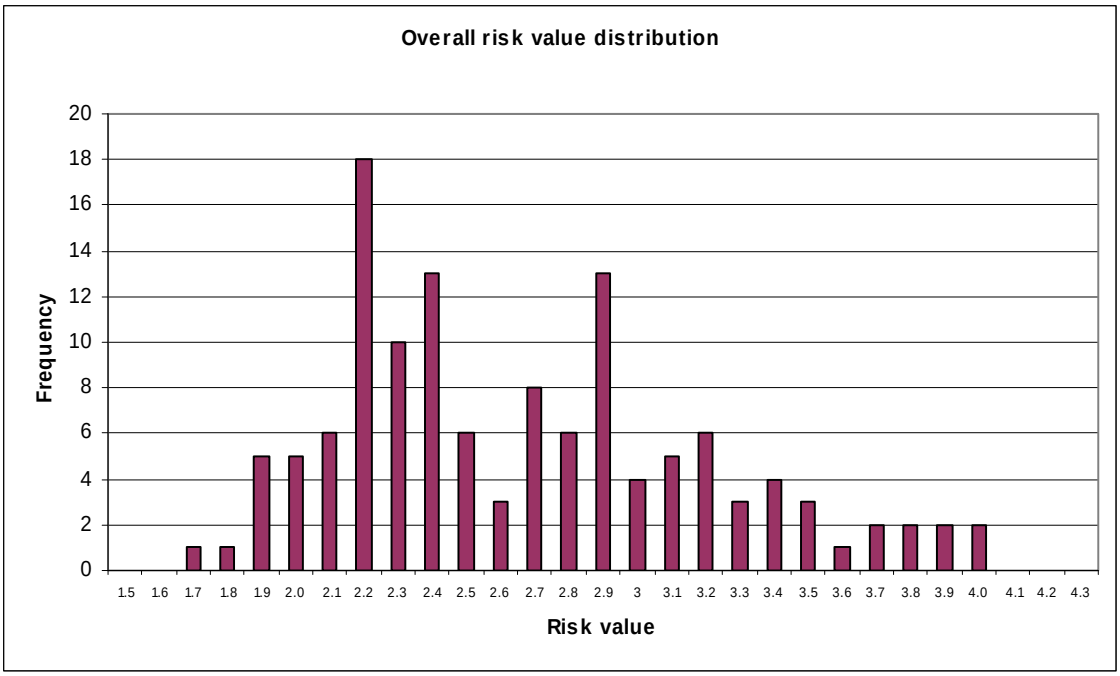
Productivity and susceptibility risk values for habitat units.

The average productivity score for all habitats was 2.6 and the mean susceptibility score was 1.91 (as per summary of average productivity and susceptibility scores as below). Individual scores are shown in the table in section 2.42: Summary of PSA results.

Overall Risk Values for Species

The overall risk values (euclidean distance on the PSA plot) could fall between 1 and 4.24 (scores of 1&1 and 3&3 for both productivity and susceptibility respectively). The mean observed overall risk score was 2.62, with a range of [1.68 – 3.95]**.**

The actual values for each species are shown in the table in section 2.42: Summary of PSA results. A total of 20 species (16%) were classed as high risk, 37 (29%) were in the medium risk category, and 72 (56%) in the low risk category**.**

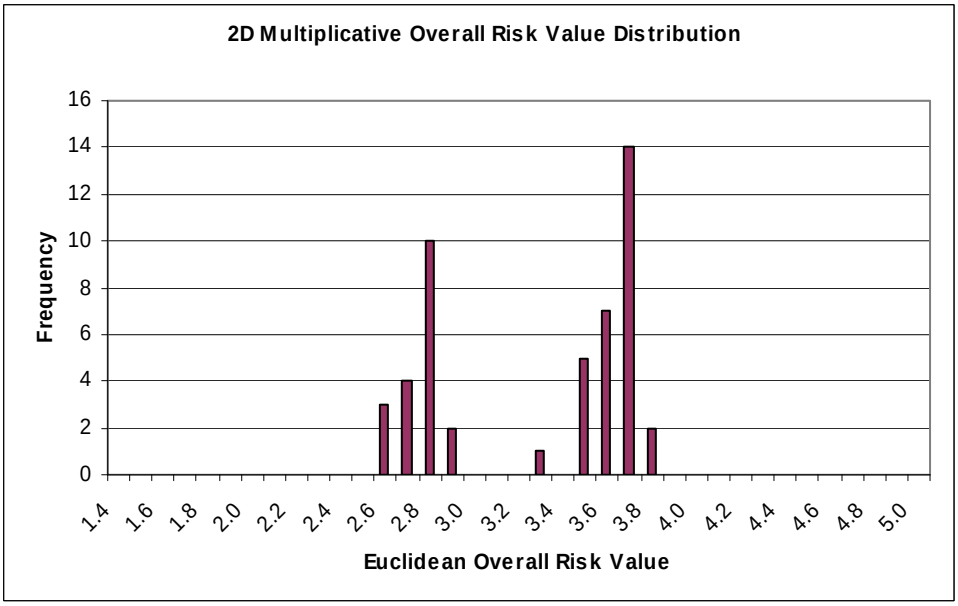


Frequency distribution of the overall risk values generated for the 129 species in the WDWTF PSA.

Overall Risk Values for Habitats

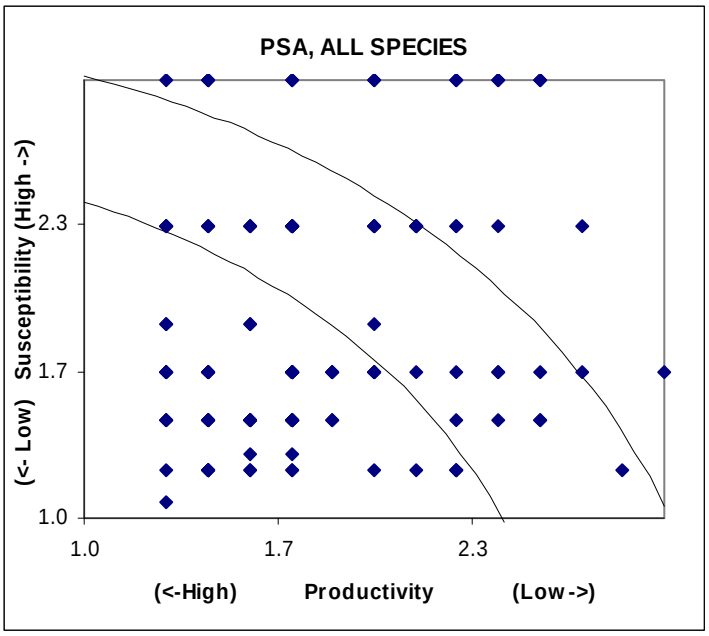
The overall risk values (euclidean distance on the PSA plot) could fall between 1 and 4.24 (scores of 1&1 and 3&3 for both productivity and susceptibility respectively). The mean observed overall risk score was 3.24, with a range of 2.56- 3.78**.**

The actual values for each habitat are shown in the table in section 2.42: Summary of PSA results. A total of 20 (42%) habitats were classed as high risk, 12 (25%) as medium risk and 16 (33%) as low risk.



Frequency distribution of the overall risk values generated for the 48 habitat types in the WDWTF PSA.

The distribution of the overall risk values of all species is shown on the PSA plot below.



PSA plot for all species in the WDWTF. Species in the upper right of the plot are at highest risk.

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

All attributes are treated equally in the PSA; however, information on some attributes may be of low quality.

2.4.6 Evaluation of the PSA results (Step 6)

Species Components:
The Level 2 (or PSA) analysis of the species in the Western Deepwater Trawl Fishery was presented to, and reviewed by, WESTMAC members at a meeting in Fremantle on 7 March 2006. Following discussion at that meeting, some changes were made to the analysis. The changes for individual species are detailed in Document L2.1 in the appendix. The PSA methodology has since been reviewed and revised. The following results reflect the revised methodology (as at 30 April 2006), as well as the changes for individual species.

Overall

For the WDWTF, the TEP species component was assessed in Level 1 to be at low risk from the fishery activities. This component is therefore excluded from further analysis. The other components were assessed to be at potential risk from fishery activities, so are assessed at the next level.

A total of 129 target, byproduct and discard species were considered. For most species there was little missing data. The average number of missing attributes was 0.66 out of a possible 12. Of the 129 species assessed at Level 2, expert over rides were used on five species. Of the 20 species assessed to be at high risk, two had more than three missing attributes.

Operators in this fishery use different mesh size depending on whether finfish (90 mm) or crustaceans (45 mm) are being targeted. This will change the selectivity of the gear. To take this into account the PSA has been run separately for the 2 mesh sizes. This involves a change to only one of the 12 attributes (selectivity) used in the PSA, so little difference is observed in the overall results. Any changes in individual species' risk categories are highlighted on the species summary list in section 2.4.2.

Summary of average productivity, susceptibility and overall risk scores.

Component	Measure	Finfish gear	Crustacean gear
All species	Number of species	129	
	Average of productivity total	1.79	
	Average of susceptibility total	1.86	1.90
	Average of overall risk value	2.62	2.65
	Average number of missing attributes	0.66	
Target species	Number of species	17	
	Average of productivity total	1.69	
	Average of susceptibility total	1.99	2.08
	Average of overall risk value	2.65	2.72
	Average number of missing attributes	0.76	
Byproduct species	Number of species	100	
	Average of productivity total	1.77	
	Average of susceptibility total	1.86	1.89
	Average of overall risk value	2.60	2.62
	Average number of missing attributes	0.53	
Discard species	Number of species	12	
	Average of productivity total	2.08	
	Average of susceptibility total	1.69	1.74
	Average of overall risk value	2.72	2.77
	Average number of missing attributes	0.67	

PSA risk categories for each species component for the finfish gear.

Risk Category	High	Medium	Low	Total
Target species	3	4	10	17
Byproduct species	16	27	57	100
Discard species	1	6	5	12
Total	20	37	72	129

PSA risk categories for each species component for the crustacean gear.

Risk Category	High	Medium	Low	Total
Target species	4	5	8	17
Byproduct species	16	30	54	100
Discard species	2	5	5	12
Total	22	40	67	129

PSA risk categories for each taxon for the finfish gear.

Risk Category	High	Medium	Low	Total
Chondrichthyan	11	9	3	23
Invertebrate	1	0	13	14
Teleost	8	28	56	92
Total	20	37	72	129

PSA risk categories for each taxon for the crustacean gear.

Risk Category	High	Medium	Low	Total
Chondrichthyan	11	9	3	23
Invertebrate	1	3	10	14
Teleost	10	28	54	92
Total	22	40	67	129

Target species

Finfish gear
Three target species are classified as high risk, four as medium risk, and ten as low risk. There was very little missing data.

The following species are classified as high risk: gemfish, tang snapper and mirror dory. The high risk species have a high proportion of their core range overlapping with recent fishery effort, live in habitats where they are likely to encounter the gear, and are the right size to be selected by the gear, leading to a high susceptibility score. Gemfish are restricted in distribution to southern Australia and NZ, and do form separate stocks east and west of Tasmania. The eastern gemfish stock is severely depleted. Gemfish are also

targeted in the Great Australian Bight trawl fishery. Tang snapper and mirror dory are widely distributed, so are only likely to be at high risk if they form separate stocks in the area of the WDWTF.

These species are classified as medium risk: deepwater flathead, big-spined boarfish, hapuku and ruby snapper.

These species are classified as low risk: Australiensis scampi, Boschmai scampi, velvet scampi, western Balmain bug, deepwater bug, orange roughy, Bight redfish, rosy jobfish, bar cod and red gurnard. Orange roughy comes out at low current risk because most of the effort is currently focused on the upper slope rather than the mid slope.

Crustacean gear
Four target species are classified as high risk, five as medium risk, and eight as low risk. There was very little missing data.

When crustacean gear is used, one more target species is classified as high risk: big-spined boarfish. Big-spined boarfish have a small size at maturity, so their susceptibility is higher with the smaller crustacean mesh size. The risk for deepwater bug and western Balmain bug changes from low to medium when crustacean gear is used, as they have a higher selectivity with the smaller mesh size.

Byproduct species

Finfish gear
Of the 100 byproduct species, 16 are classified as high risk, 27 as medium risk and 57 as low risk.

Ten of the high risk species are chondrichthyan species with high susceptibility and low productivity. Three of these are restricted to southern or western Australia – green-eyed dogfish, ornate angel shark, and whitefin chimaera. Two species are restricted to Australian waters, and the other five are more widely distributed, so they are only likely to be at high risk if they form local stocks in the area of the fishery. All of the high risk species have significant depth overlap with the fishery, although several species also occur on the shelf where they are not at risk from the WTBF. The high risk chondrichthyans of most concern include the following:

- Endeavour dogfish; core depth range 300-500m; caught in substantial quantities; of conservation concern in other parts of its range.
- Green eyed dogfish; core depth range 180-480m; rarely caught; stocks in the GAB are under pressure and stock structure may overlap with WTBF.
- Ornate angel shark (may be Australian angel shark); core depth range 50-400m; substantial catches and endemic to SW Australia.
- Whitefin chimaera; core depth range 390-820m; low catches but endemic to northern WA.
- Dusky shark; overlaps from shelf to upper slope; of conservation concern in WA fishery and flagged at potential high risk in GABTF. Rarely caught but concern about cumulative impacts.

- Brier shark; core depth range 480-930m; not currently targeted at these depths, but at risk if targeted.

Four of the high risk byproduct species are teleosts which score high risk because of high susceptibility. These species all have a high proportion of their range in this fishery overlapping with effort, live in habitats where they are likely to be encountered by the gear, and are the right size to be selected by the gear. Two of these species are restricted to southern or western Australia: bigscale rubyfish and Australian tusk. The other two species have a wider distribution, and would be of concern if they formed local stocks in the area of the fishery. Another high risk teleost species (yellow-spotted boarfish) has several missing productivity attributes, and may not be in this category if all attributes were known. The high risk teleosts of most concern include:

- Bigscale rubyfish (bonnetmouth?); core depth range 180-370m; low catches but endemic to GAB and SW WA.
- Australian tusk; core depth range 100-320m; minor catches; restricted to southern Australia.

The other high risk byproduct species is champagne crab, which most likely falls into this category because it has 4 missing attributes.

Crustacean gear
Of the 100 byproduct species, 16 are classified as high risk, 30 as medium risk and 54 as low risk.

Crystal crab (or snow crab), Darwin's roughy and pigfish change from low to medium risk when crustacean gear is used, as they have a higher selectivity score with the smaller mesh size.

Discard species

Finfish gear
Of the 12 discard species, 1 is classified as high risk, 6 as medium risk and 5 as low risk.

The high risk species is piked dogfish, which has a high proportion of its range in this fishery overlapping with recent effort (core depth range 100-330m). It is an Australian endemic distributed from Townsville (Qld) around the south coast to Carnarvon (WA).

Crustacean gear
Of the 12 discard species, 2 are classified as high risk, 5 as medium risk and 5 as low risk.

Yellowback bream changes from medium to high risk when crustacean gear is used, as it has a higher selectivity with the smaller mesh size.

Habitat Component:

Overall

A total of 48 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 2.4.2 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	48
	Average of productivity total	2.60
	Average of susceptibility total	2.00
	Average of overall risk value	3.30
	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	18	11	29
Medium	0	0	0	10	6	16
Low	0	0	0	1	2	3
Total	0	0	0	29	19	48
	Not in fishery	Not in fishery	Not in fishery			

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	10	10	20
Medium	0	0	0	9	3	12
Low	0	0	0	10	6	16
Total	0	0	0	29	19	48
	Not in fishery	Not in fishery	Not in fishery			

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

Risk Category	High	Medium	Low	Total
Total Habitats	20	12	16	48

Habitats of the mid-slope were scored mostly at high risk (10) or medium risk (10); none were considered low risk. On the upper slope, 10 are classified as high risk, 9 at medium and 10 at low risk. No continental shelf habitats were scored because the minimum operating depth of the fishery is 200 m.

Discussion

The large size and wide depth range of the fishery area (~1,000 n.m. north to south, 200-~1,500 m depths) and the availability of seabed habitat data from a recent (late-2005) CSIRO survey of deep benthic biodiversity off WA, resulted in many different habitat types (48) being identified and assessed. This has the effect of including 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 WDWT is 20 (42%) high, 12 (25%) medium and 16 (33%) low. High, medium and low risk habitat types were identified on both the mid- and upper continental slope.

Factors contributing to the high risk ranking of 20 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,

- 10 high risk mid-slope habitats included 5 categories each of 'hard' and 'soft' bottom types. Hard types are low-relief, hard metamorphic rock, softer sedimentary rock or cobbles in the form of debris flows with large, erect or delicate epifauna consisting of octocorals and encrusting animals. Outcropping rocky habitats with vulnerable fauna (particularly large erect types) were down-ranked from high to low risk because of low accessibility (encounterability), except for two seamount habitats characterized by rocky outcrops that attracted a default of high risk. Five types of soft bottom habitats are muds, fine sediments or gravel characterized by large, erect or delicate epifauna (seawhips, octocorals, solitary fauna and low encrusting types).

- 10 high risk habitats on the upper slope included 2 types of low-relief hard bottom and 8 soft bottom habitats characterized variously by large sponges, glass sponges, octocorals, solitary or low/encrusting animals. In addition, 8 outcropping rocky habitats with large erect and encrusting faunal types were down-ranked from high to low risk because of low accessibility (encounterability).

Factors contributing to the medium risk ranking of 12 habitats are largely the same as for high risk types, although only habitats with bioturbating (burrowing) fauna score at medium risk. Sixteen habitat types scored at low risk. These are mostly down-ranked from high risk based on their low encounterability by bottom trawling. While there is uncertainty about the degree of ruggedness that prevents trawl access using new technology, images show these habitats would make trawl access very difficult – having

either high relief (> ~0.5 to 1 m) or undercuts or are on steep slopes, or a combination of the above.

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.

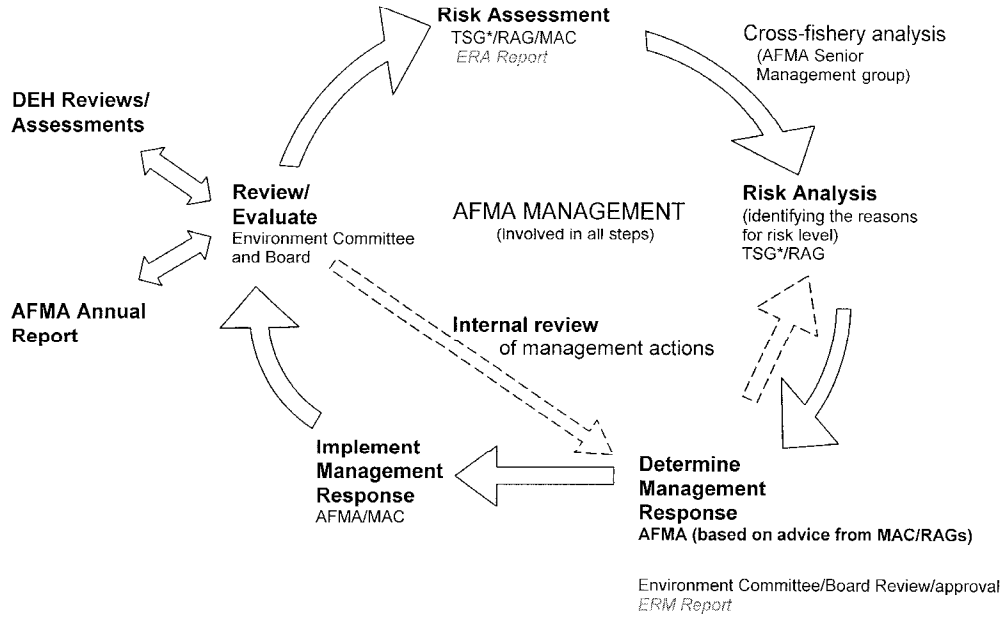
For example, if in a Level 2 analysis of habitat types, two of seven habitat types were determined to be at risk from the sub-fishery, only those two habitat types would be considered at Level 3.

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.

Finfish

Of the 20 species classified as high risk in the WDWT fishery, 2 had missing data (Category 1), 11 are widely distributed outside the fishery (Category 2A), and 2 had low overlap inside the fishery (Category 2B). There were 5 other high risk species.

High risk Category	Description	Total
Category 1	High risk - Missing data for more that 3 attributes	2
Category 2A	High risk - Widely distributed outside fishery	11
Category 2B	High risk - Low overlap inside fishery	2
Category 3	High risk - One susceptibility attribute scored low	0
Category 4	High risk - Spatial uncertainty	0
Other	High risk -other	5
	Total High	20

Crustaceans

Of the 20 species classified as high risk in the WDWT fishery, 2 had missing data (Category 1), 11 are widely distributed outside the fishery (Category 2A), and 2 had low overlap inside the fishery (Category 2B). There were 5 other high risk species.

High risk Category	Description	Total

Category 1	High risk - Missing data for more that 3 attributes	2
Category 2A	High risk - Widely distributed outside fishery	11
Category 2B	High risk - Low overlap inside fishery	2
Category 3	High risk - One susceptibility attribute scored low	0
Category 4	High risk - Spatial uncertainty	0
Other	High risk -other	5
	Total High	20

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

Ruby snapper was assessed at Level 3 in 2002 (Dichmont *et al*, 2002), although lack of data for the analysis meant that the results were inconclusive. The analysis did show that CPUE of ruby snapper appears to be declining, which prompted concerns over the sustainability of the species.

None of the other species in the WDWTF have been assessed at Level 3. Some have had Level 3 assessments of their stocks in other fisheries (orange roughy, gemfish, jackass morwong, ling), but these species are likely to form separate stocks in the WDWTF.

3. General discussion and research implications

The Western Deepwater Trawl Fishery operates in deepwater (greater than 200m) off the west coast of Western Australia, between Cape Leeuwin and North West Cape. It is a mixed fish and crustacean demersal trawl fishery, with low productivity and a high diversity of species taken in small volumes.

Important commercial fishes include orange roughy, mirror dory, gemfish, deepwater flathead, ruby snapper and Tang's snapper. In the past scampi (*Metanephrops spp.*) has been targeted in 300-500m of water and recently bugs (*Ibacus spp.*) have formed an important and growing component of the catch. Both demersal fish trawl gear and crustacean gear is used. The crustacean gear is only suitable for trawling on soft substrates.

3.1 Level 1

The SICA analysis identified four components at potential risk from the fishery – the target species, bycatch/byproduct species, habitats and communities. With the exception of communities these have all been assessed further at Level 2 using the PSA analysis. The main hazard identified to be of concern at Level 1 was direct impact of fishing. Additional impacts on habitats came from direct impact without capture, and disturbing physical processes, both associated directly with fishing. Target and byproduct/bycatch species and habitats were considered to be potentially at major risk from the fishery (risk score 4). No components were assessed to be potentially at severe risk (risk score 5).

The WDWTF is immediately adjacent to the western border of the Great Australian Bight Trawl fishery, which targets some of the same species. An investigation into the extent and significance of potential stock sharing impacts would be useful.

Due to the offshore nature of the WDWTF and the low level of fishing effort, interactions with TEP species are likely to be rare in this fishery. It would, however, be preferable for an observer program to verify the frequency of interaction with TEP species. Such a program might also extend the list of discard species, which is quite short for a trawl fishery.

3.2 Level 2

Of the 129 species assessed, 20 were found to be at high risk, with 16 of these in the byproduct and bycatch categories. Two additional species were at high risk when the fishery uses the crustacean nets. Twenty (20) of the 48 habitats assessed were also found to be at high risk from trawling.

3.2.1 Species at risk

Of the list of species rated as high risk from the PSA analyses, the authors consider that at least 12 species need further evaluation or management response. This expert

judgment is based on taxonomy/identification, distribution, stock structure, movements, conservation status and overlap with this/other fisheries as discussed below (sorted taxa and risk category). These and other high risk species are discussed further below.

Species	*Risk Category*	*Role*
Chondrichthyans		
• Endeavour Dogfish	*Other	Byproduct
• Whitefin chimaera	*Other	Byproduct
• Longspine chimaera	Missing data	Byproduct
• Ornate angel shark	Widely distributed	Byproduct
• Green-Eyed Dogfish	Widely distributed	Byproduct
• School Shark, Tope shark	Widely distributed	Byproduct
Teleosts:		
• Big-spined boarfish	Widely distributed	Target
• Gemfish	Widely distributed	Target
• Mirror dory	Widely distributed	Target
• Chinaman-Leatherjacket	Widely distributed	Byproduct
• Australian Tusk	Widely distributed	Byproduct
• Yellow-Spotted Boarfish	Widely distributed	Byproduct

Three of the target species were assessed to be at potentially high risk: gemfish, tang snapper and mirror dory. Catches of these species are currently at fairly low levels in the WDWTF, but gemfish and mirror dory are also caught in the adjacent GAB trawl fishery.

The majority of species judged to be at high risk were byproduct species (16). The majority of these (10) are chondrichthyan (shark and ray) species which generally have low productivity. Some within this group are likely to be false positives, especially those with wide distributions. However, there remain six chondrichthyan species that are endemic to southern/western Australia and that are highly susceptible to capture by trawling. Several of these are of concern because of cumulative impacts of fishing across several fisheries. A more detailed risk analysis of chondrichthyan species in southern Australia is being undertaken currently within an FRDC project (FRDC 202/033), and results from this study, available shortly, should be considered.

Three of the five high risk byproduct teleost species are widely distributed and would only be at risk from the WDWT fishery if they constituted local stocks within the range of the fishery. Further information on stock structure for this group would be valuable in assessing risk. The other two high risk teleost species could genuinely be at high risk, mainly due to restricted southern/western distribution and high susceptibility to the gear. One of these, longspine chimaera, is missing several productivity attributes. More detailed analysis of logbook and observer data for these species is warranted, as well as a search for any information on relative or absolute abundance from surveys or from catch records from other fisheries in the area.

Examination of core depth ranges, both for the larger set of high risk species, and for the more restricted set, shows that these species are found at a range of depths across the upper and mid slope. Since spatial management (use of seasonal and permanent spatial closures) may be the best way to mitigate risks for many of these species, a more detailed analysis of the spatial and seasonal distribution of catches (based on logbook and survey data) would be worthwhile. Study of habitat associations of high risk species may also be informative for selection of mitigation measures, and may indicate natural spatial refuges from trawling (and hence lower levels of risk).

In considering spatial management for protection of high risk species, a key concern is the mobility of species and their movement into and out of protected areas (be they natural refuges or areas closed to fishing by MPAs or fishery closures).

Finally, much of the uncertainty in translating species identified by Level 2 analyses as potentially high risk into actual risk categories stems from the lack of data on abundance of these species (against which to judge the sustainability of catches). Some form of fishery independent surveys for the WTBF, perhaps in association with an observer program, should take into account the needs for such data for by-product and discard species currently assessed as potentially high risk.

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) (unpublished data from a recent survey) are scored at medium risk, acknowledging both a potentially deleterious impact from trawling and the vast expanses of these habitats that exist in the WDWTF with very low trawl fishing effort.

The best options available for managing (the users of) benthic habitats assessed as high risk are likely to involve regulating access through long-term or permanent spatial closures. These can be gear-specific to acknowledge the highly different levels of risk from different gears, but also need to take account of cumulative effects of different sub-fisheries. Long term or permanent spatial closures acknowledge that habitat protection requires a different response than short term regulation of access, such as seasonal closures to protect spawning stocks.

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 WDWTF provides only an evaluation of what habitats exist at a relevant level of detail for 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). 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 in some cases. An example of unused data is the recent CSIRO survey. This shows 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 few immediate needs to protect fishery habitat. These include the vast scale of the fishery, low effort during a developing phase, extensive tracts of inaccessible bottom and a rapidly developing program to implement offshore MPAs. One exception, however, are habitats of seamounts that are widely recognized as being hotspots for both fishery production and biodiversity value. No substantial seamount features have been identified in the WDWTF, but this may change with further exploration (and may miss being considered by the MPA process). 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 Community assemblages at risk

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

3.3 Key Uncertainties / Recommendations for Research and Monitoring

In assessing risk to byproduct, bycatch and TEP species, it is not possible to assess absolute risk without supplementary information on either abundance or total mortality rates, and such data are not available for the vast majority of such species. However examination of trends in CPUE from logbook data may prove to be useful. Examination of spatial and temporal patterns in catches is also warranted.

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.

Research recommendations arising from this assessment include:

- Development of an observer program to help document interactions with TEP species and improve assessment of by-catch species. Consider development of an industry based fishery independent survey in conjunction with the observer program. Start to document fishery habitats – how much and where.
- Studies of stock structure – especially links to GAB and NW Slope fisheries.
- Examine spatial and temporal trends in catches and CPUE for higher risk species.

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Glossary of Terms

Assemblage	A subset of the species in the community that can be easily recognized and studied. For example, the set of sharks and rays in a community is the Chondrichthyan assemblage.
Attribute	A general term for a set of properties relating to the productivity or susceptibility of a particular unit of analysis.
Bycatch species	A non-target species captured in a fishery, usually of low value and often discarded (see also Byproduct).
Byproduct species	A non-target species captured in a fishery, but it may have value to the fisher and be retained for sale.
Community	A complete set of interacting species.
Component	A major area of relevance to fisheries with regard to ecological risk assessment (e.g. target species, bycatch and byproduct species, threatened and endangered species, habitats, and communities).
Component model	A conceptual description of the impacts of fishing activities (hazards) on components and sub-components, linked through the processes and resources that determine the level of a component.
Consequence	The effect of an activity on achieving the operational objective for a sub-component.
Core objective	The overall aim of management for a component.
End point	A term used in risk assessment to denote the object of the assessment; equivalent to component or sub-component in ERAEF
Ecosystem	The spatially explicit association of abiotic and biotic elements within which there is a flow of resources, such as nutrients, biomass or energy (Crooks, 2002).
External factor	Factors other than fishing that affect achievement of operational objectives for components and sub-components.
Fishery method	A technique or set of equipment used to harvest fish in a fishery (e.g. long-lining, purse-seining, trawling).
Fishery	A related set of fish harvesting activities regulated by an authority (e.g. South-East Trawl Fishery).
Habitat	The place where fauna or flora complete all or a portion of their life cycle.
Hazard identification	The identification of activities (hazards) that may impact the components of interest.
Indicator	Used to monitor the effect of an activity on a sub-component. An indicator is something that can be measured, such as biomass or abundance.
Likelihood	The chance that a sub-component will be affected by an activity.

Operational objective	A measurable objective for a component or sub-component (typically expressed as “the level of X does not fall outside acceptable bounds”)
Precautionary approach	The approach whereby, if there is uncertainty about the outcome of an action, the benefit of the doubt should be given to the biological entity (such as species, habitat or community).
PSA	Productivity-Susceptibility Analysis. Used at Level 2 in the ERAEF methodology.
Scoping	A general step in an ERA or the first step in the ERAEF involving the identification of the fishery history, management, methods, scope and activities.
SICA	Scale, Impact, Consequence Analysis. Used at Level 1 in the ERAEF methodology.
Sub-component	A more detailed aspect of a component. For example, within the target species component, the sub-components include the population size, geographic range, and the age/size/sex structure.
Sub-fishery	A subdivision of the fishery on the basis of the gear or areal extent of the fishery. Ecological risk is assessed separately for each sub-fishery within a fishery.
Sustainability	Ability to be maintained indefinitely
Target species	A species or group of species whose capture is the goal of a fishery, sub-fishery, or fishing operation.
Trophic position	Location of an individual organism or species within a 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
28-09-2006	Collated comments forwarded by AFMA	In the level 2 summary of species PSA results table the values only correspond with the finfish method. Where susceptibility is different for the different mesh size in the crustacean method there is no value for risk or susceptibility etc.	Added table with values for crustacean mesh size for species where risk category was different with different mesh size.

Appendix B: PSA results summary of stakeholder discussions

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

The following species were discussed at the WESTMAC meeting in Fremantle on 7 March 2006. All high risk species were discussed.

Taxa name	Scientific name	Common name	PSA risk rank	Role in fishery	Comments from WESTMAC meeting on 7 March 2006, and follow-up	Action	Outcome	Possible management response
Chondrichthyan	*Centrophorus moluccensis (west)*	Endeavour Dogfish	H	BP	Distribution queried, but is in area and depths of fishery according to literature	none	none	
Chondrichthyan	*Chimaera sp. E*	Whitefin Chimaera	H	BP	Change common name from marbled ghostshark. Check missing info	Max size added	Reduced risk value, but still high	Identify catch to species level in logbook to verify species
Chondrichthyan	*Chimaera sp. C*	Longspine Chimaera	H	BP	Check missing info	More info added	Reduced risk value, but still high	
Chondrichthyan	*Carcharhinus obscurus*	Dusky shark	H	BP	Mostly misidentified as bronze whalers	Add to species list	High risk	Improve species identification
Chondrichthyan	*Galeorhinus galeus*	School shark	H	BP	Query re veracity of logbook records – AFMA to check. Distribution queried, but is in area and depths of fishery according to literature	none	none	AFMA to check logbook record
Chondrichthyan	*Squalus mitsukurii*	Green-eyed dogfish	H	BP	Confusion re species	none	none	Improve species identification/ observers or cameras
Chondrichthyan	*Squatina tergocellata*	Ornate angel shark	H	BP	Widely spread, but more common on outer shelf. Does occur in depths of fishery according to literature.	none	none	Check depths at which caught in state, GAB and SET fishery
Chondrichthyan	*Pristiophorus cirratus*	Common saw shark	M	BP	Common in shallower waters in the GAB.	none	none	Check depths at which caught in state, GAB and SET fishery

Taxa name	Scientific name	Common name	PSA risk rank	Role in fishery	Comments from WESTMAC meeting on 7 March 2006, and follow-up	Action	Outcome	Possible management response
Chondrichthyan	*Deania calcea*	Brier shark	H	BP		none	none	Monitor catches
Invertebrate	*Hypothalassia acerba*	Champagne crab	H	BP	Changed scientific name from *H. armata* to *H. acerba*. Ross Gould provided extra info.	Added some size info	Reduced risk value, but still high (still missing info)	Obtain more info, including state catch information
Invertebrate	*Chaceon bicolor*	Crystal/snow crab	L/M	BP	Becomes medium risk with smaller mesh. This is because selectivity increases from medium to high (M:species size is between mesh size and 2xmesh size)	Checked size info	Still low with finfish and medium with crustacean gear	Collect missing productivity info
Teleost	*Paristiopterus gallipavo*	Yellow-Spotted Boarfish	H	BP	Industry not sure what this species is			Improve species identification
Teleost	*Oplegnathus woodwardi*	Knifejaw	H	BP	Query re dsn – is mostly in shallower depths. Checked depth dsn and is OK according to literature	none	none	Could get better info on depths by looking at GAB, GHAT or State fisheries
Teleost	*Hyperoglyphe antarctica*	Blue eye trevalla	H	BP	Not recorded as caught in fishery in last 4 years. Usually taken by State line fishery			If can verify that not caught, remove from species list
Teleost	*Diretmichthys parini*	Parins spinyfin	M	BP	Not caught according to industry			If can verify that not caught, remove from species list
Teleost	*Beryx splendens*	Alfonsino	H	BP	Only caught in this fishery if specifically targeted on pinnacles			Restrict fishing on pinnacles ?

Taxa name	Scientific name	Common name	PSA risk rank	Role in fishery	Comments from WESTMAC meeting on 7 March 2006, and follow-up	Action	Outcome	Possible management response
Teleost	*Dannevigia tusca*	Australian Tusk	H	BP	Industry not sure what this species is			Check logbook to see where and when caught. Set threshold catch trigger. Response required if catch above trigger level
Teleost	*Nemadactylus macropterus*	Jackass morwong	H	BP	Query re dsn – is mostly in shallower depths. Checked depth dsn – core depth is 50-250 m according to SEF guide.	Changed depth dsn to 50-250	Risk changed from high to medium	
Teleost	*Nelusetta ayraudi*	Chinaman leatherjacket	H	BP	Query re dsn – is mostly in shallower depths. Checked depth dsn and is OK according to literature	none	none	Could get better info on depths by looking at GAB, GHAT or State fisheries
Teleost	*Pristipomoides typus*	sharptooth snapper	H	BP	Shallow water species	Fill in some missing info	Risk changed from high to medium	
Chondrichthyan	*Squalus megalops*	Piked dogfish	H	DI	Query re dsn – is mostly in shallower depths. Checked depth dsn and is OK according to literature	none	none	Could get better info on depths by looking at GAB, GHAT or State fisheries
Teleost	*Rexea solandri*	Gemfish	H	TA	Preferable not to catch juveniles – could they be a smaller species ?	none	none	Monitor catch
Teleost	*Lipocheilus carnolabrum*	Tang snapper	H	TA				Monitor cpue. Analyse historical data
Teleost	*Zenopsis nebulosus*	Mirror dory	H	TA	Difficulty with cpue analysis because need specific net to catch			Cpue analysis
Teleost	*Neoplatycephalus conatus*	Deepwater flathead	M	TA	Query re dsn – is mostly in shallower depths. Checked depth dsn – core depth is 100-200 m according to SEF guide.	Changed depth dsn to 100-200	Risk changed from high to medium	

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

Table 5B. Bycatch and Byproduct species. Description of consequences for each component and each sub-component. Use table as a guide for scoring the level of consequence for bycatch/byproduct species.

(Modified from Fletcher *et al*. 2002)

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

Sub-component	Score/level					
	1 Negligible	2 Minor	3 Moderate	4 Major	5 Severe	6 Intolerable
	variability for this population.	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 variability for this	**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,	**5. Reproductive capacity** Change in reproductive capacity adversely affecting long-term recruitment dynamics. Time to recovery up to 5	**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 dynamics. Time to recovery > 100 generations free from

Sub-component	Score/level					
	1 Negligible	2 Minor	3 Moderate	4 Major	5 Severe	6 Intolerable
	population.		long-term recruitment dynamics not adversely damaged.	generations free from impact.	recovery up to 10 generations free from impact.	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/increasing 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/increasing outside of historical range and/or allowed/facilitated new species to appear. Recovery period measured in years to decades.	4. Trophic/size structure Changes in mean trophic level. Ecosystem function severely altered and some function or components are missing and new groups present. Recovery period measured in years to decades.	4. Trophic/size structure Ecosystem function catastrophically altered as a result of changes in mean trophic level, total collapse of ecosystem processes. Recovery period measured in decades to centuries.
Bio-geochemical cycles	5. Bio- and geochemical cycles Interactions which	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.