Residual Risk Assessment of the Level 2 Ecological Risk Assessment Species Results

Report for the North West Slope Trawl Fishery

August 2008

EXECUTIVE SUMMARY

Since 2001, the Australian Fisheries Management Authority (AFMA) has undertaken detailed ecological risk assessments (ERAs) for all major and minor Commonwealth managed fisheries as a key part of the move towards ecosystem-based fisheries management. ERAs assess the risks that fishing poses to the ecological sustainability of the marine environment by considering the impact of fishing on all components of the marine environment. The main purpose of ERAs is to prioritise the management, research, data collection and monitoring needs for each fishery.

The ecological risk management (ERM) framework has been developed to ensure that a consistent process is followed across fisheries when responding to the ERA outcomes. This framework ties into current fishery processes and structures so that it can be easily implemented by fisheries. To support implementation of the ERM framework, AFMA will fully document the risk management strategies for each fishery. This will ensure transparency in the process and allow for easier co-ordination within and between fisheries. Using the results presented in this report, along with the results from any subsequent levels of assessment, an appropriate management response will be developed to address the high priority species as part of the ERM framework.

Due to the semi-quantitative nature of the risk assessment, the Level 2 results do not directly account for all management measures, resulting in an over-estimation of the actual risk for some species. To better encompass this, the Level 2 analysis has undergone further refinement by applying a set of residual risk guidelines.

In early 2007, the residual risk guidelines were developed in consultation with CSIRO and stakeholders to assist AFMA managers in refining the Level 2 results. They have been developed to maintain the key features of objectivity and consistency from the ERA process, and to ensure a repeatable and transparent assessment process. These guidelines take into account methodology related matters and most current management arrangements. To assist managers, a clear set of decision rules are outlined that are to be applied to individual species.

For the North West Slope Trawl Fishery (NWSTF), the results from the Level 2 PSA table are used here to determine the residual risk at this level of assessment. Overall one high risk species, the scarlet prawn, was assessed as high risk and remained high risk after applying the residual risk guidelines.

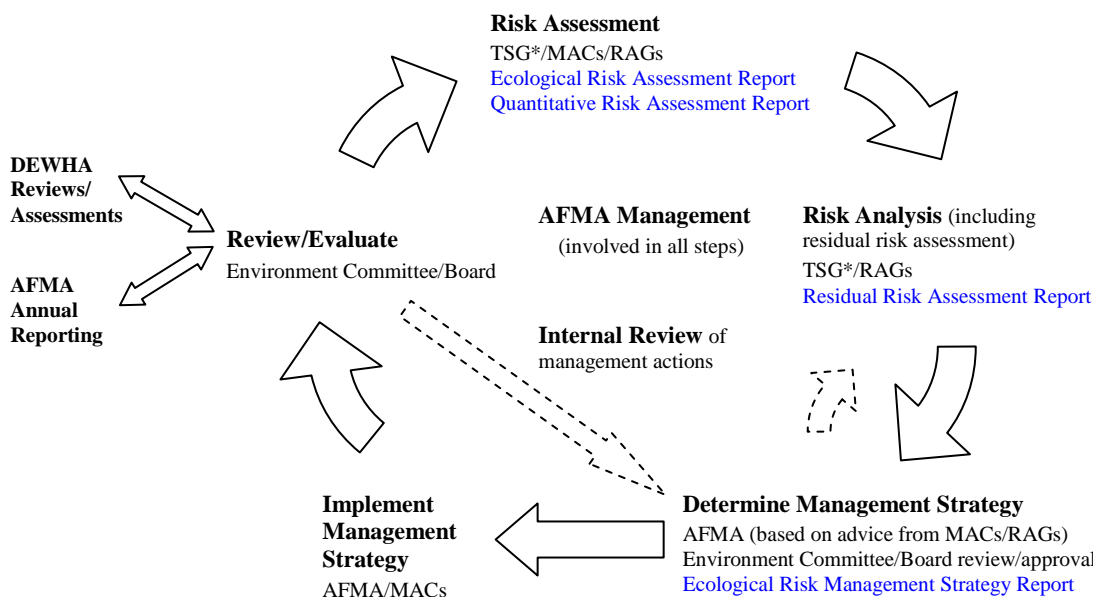# TABLE OF CONTENTS

TABLES

FIGURES

1. OVERVIEW

1.1. Ecological Risk Management Process

A key component in the Australian Fisheries Management Authority's (AFMA's) move towards ecosystem based fisheries management (EBFM) has been the undertaking of ecological risk assessments (ERAs) for all major Commonwealth managed fisheries. By assessing the impacts of fishing on all parts of the marine environment, the ERAs encompass an ecosystem-based assessment approach. The ERAs will help to prioritise research, data collection monitoring needs and management actions for fisheries and ensure that they are managed both sustainably and efficiently.

To assist with the implementation of EBFM across all fisheries AFMA has established an ecological risk management (ERM) framework (see **Figure 1**). This framework ensures that a consistent process is followed across fisheries when responding to the ERA outcomes. While this framework focuses on responding to the ERAs, it acknowledges that there are other initiatives contributing to the achievement of EBFM. The ERM framework will streamline fisheries' responses to the ERAs and incorporate other EBFM initiatives such as strategic assessment (under the *Environment Protection and Biodiversity Conservation* (EPBC) *Act 1999*), harvest strategy and bycatch and discard programs.

The Level 2 ERA residual risk process is the first step in the risk assessment and analysis phase of the ERM framework (refer to **Figure 1**). Due to the semi-quantitative nature of the level 2 ERAs, not all risk scores are an accurate representation of actual risk. The Level 2 ERA residual risk process is used to incorporate the effects of current management measures which impact on the level of risk posed by a fishery to species and adjust risk scores where appropriate. From a detailed methodology review, AFMA found that some ERAs did not include all existing management arrangements at the time of assessment. Furthermore, since the initial ERAs were conducted in 2005, the management of some fisheries has changed and additional data and information may have become available.

Risk Assessment
TSG*/MACs/RAGs
Ecological Risk Assessment Report
Quantitative Risk Assessment Report

DEWHA Reviews/ Assessments

AFMA Management
(involved in all steps)

Risk Analysis (including residual risk assessment)
TSG*/RAGs
Residual Risk Assessment Report

Review/Evaluate
Environment Committee/Board

AFMA Annual Reporting

Internal Review of management actions

Implement Management Strategy
AFMA/MACs

Determine Management Strategy
AFMA (based on advice from MACs/RAGs)
Environment Committee/Board review/approval
Ecological Risk Management Strategy Report

*TSG – Technical Support Group – currently provided by CSIRO

Figure 1 Ecological Risk Management framework

1.2. ERA Project

Since 2001, AFMA has been implementing ERAs. AFMA in collaboration with CSIRO developed the ERA methodology which has now been applied to all major Commonwealth managed fisheries. The aim of the ERA project is to assess both the direct and indirect impacts of a fishery's activity on *all* aspects of the marine ecosystem.

1.3. ERA Methodology

The ERA methodology is an adaptation of a traditional risk assessment to suit commercial fishing operations. The assessment evaluates the impact of fishing activities on all five major components of the marine ecosystem:

- target species (including bait species);
- byproduct and bycatch (discarded) species;
- threatened, endangered and protected (TEP) species;
- habitats; and
- ecological communities.

The ERA assessment adopts a hierarchical approach (refer to **Figure 2**). With every progressive level the precision increases along with confidence in the risk scores. Each of these levels is outlined in more detail below.
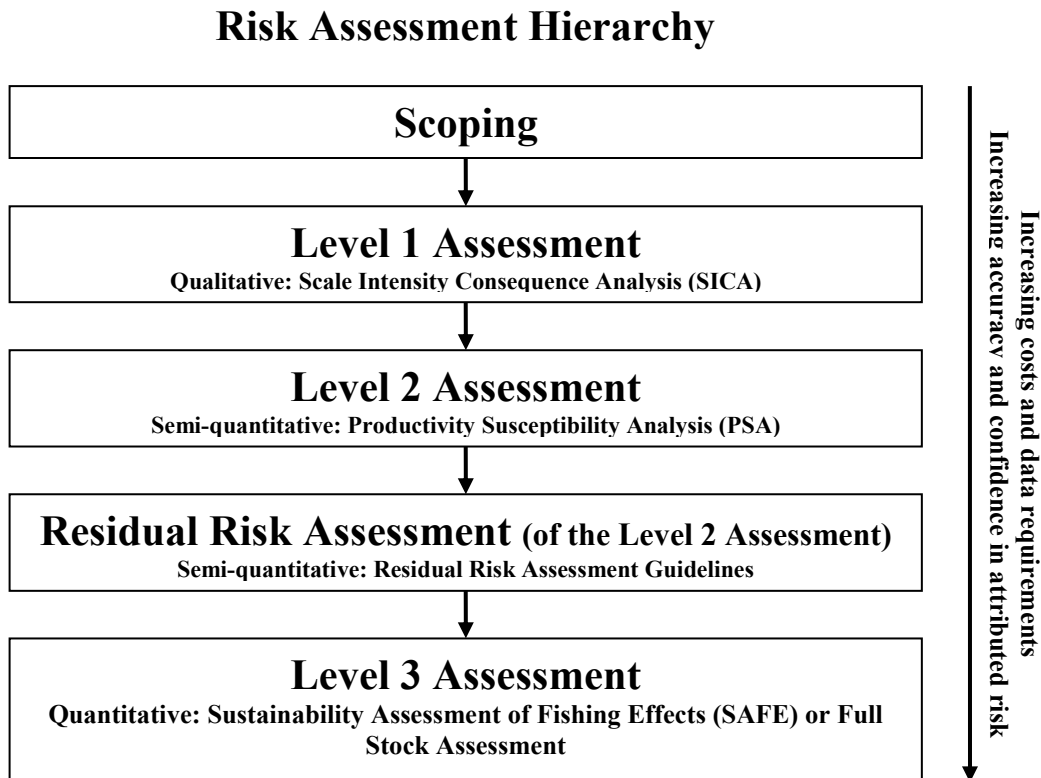
Risk Assessment Hierarchy

Figure 2 The different levels of risk assessment and the trend in confidence and cost

Scoping

At the **scoping** stage, a profile is developed for each of the fisheries being assessed. This includes gathering the information needed to complete more detailed level one and two assessments. Analysis focuses on the characteristics of the individual fishery, which may be divided into sub-fisheries based on fishing method and/or spatial coverage if this is more appropriate for assessment. At this stage, the general fishery characteristics are documented, and a list of all "units of analysis" (all species, habitat types and communities present in the fishery) is generated. Hazards and objectives for the fishery are also identified (for more detail refer to Hobday *et al.*, (2007).

Level 1 – Scale, Intensity, Consequence Analysis

Level 1 is a qualitative assessment of scale, intensity, consequence analysis **(SICA)** that identifies which hazards (activities) lead to a significant impact on any species, habitat or community. This involves an assessment of the risk posed by each identified fishing **activity** on each of the ecosystem components. At this level, analysis is conducted on whole ecosystem components (target; bycatch and byproduct; TEP species; habitats and communities), not at the individual species level. Level 1 is used as a rapid screening tool, with a "worst case" approach used to ensure only genuine low risk elements (either activities or ecosystem components) are screened out. This analysis uses the most vulnerable sub-component and the most vulnerable unit of analysis within each component (e.g. the most vulnerable species, habitat type or community). Further to this, where judgements about risk are uncertain, the highest level of risk regarded as plausible is used (for more detail refer to Hobday *et al.*, 2007).

Level 2 – Productivity Susceptibility Analysis

Level 2, the productivity susceptibility analysis **(PSA)**, is a semi-quantitative analysis of the risk posed by fishing to all individual species, habitats and communities identified in the scoping stage. PSA allows all **units** (species, habitats or communities) within any of the ecological components to be effectively and comprehensively screened for risk. Level 2 assesses the direct impact of fishing and is based on the assumption that risk to an individual unit is based on two characteristics of the unit:

- **Susceptibility:** where the extent of the impact on an ecological unit is determined by the susceptibility of the unit to the fishing activities; and
- **Productivity:** which determines the rate at which the unit can recover after potential depletion or damage by fishing activities.

For the Level 2 assessment, each unit within the ecological component is assessed for the risk it faces from the fishery. The PSA approach examines a number of **attributes** of each unit that contribute to or reflect its *susceptibility* or *productivity*. A score on a three point scale (low, medium, high) is determined for each unit for both productivity and susceptibility which combined provides a relative measure of risk for each unit. The attributes used to assess productivity and susceptibility are given in **Appendix A**. The Level 2 risk scoring system is precautionary in that, where there is no information known on a specific productivity or susceptibility attribute for a unit, it is given a default score of 'high risk'.

Level 2 ERA Residual Risk Assessment

Further information on the Level 2 ERA residual risk process is detailed later in this document.

Level 3 – Quantitative Risk Assessment

At the conclusion of the Level 2 assessment, a number of units may have been identified as being at high risk because of the activities of the fishery. At this stage a Level 3 analysis may be warranted. This can take various forms including a quantitative sustainability assessment for fishing effects (SAFE) recently developed by CSIRO to assess multiple species or a fully quantitative assessment of a specific species (similar to a standard stock assessment). Quantitative risk assessments constituting the equivalent of a Level 3 risk analysis currently exist for many species. Before proceeding to a fully quantitative Level 3 assessment, investigation of suitable existing information to further understand the risk scores for high risk units should be identified. This may help to overcome some of the constraints of the Level 2 results (outlined below) prior to proceeding to more costly Level 3 analysis for the remaining high risk units.

Constraints of Level 2 Results

The methodology used in the Level 2 assessment results in risk scores of high, medium or low to reflect potential rather than actual risk. Quantifying the actual risk for any species requires a Level 3 assessment. Due to the semi-quantitative nature of the Level 2 risk assessment, analysis does not take into account all management measures currently in place in fisheries, which may result in an over-estimate of the actual risk for some species. The management strategies that are not accounted for in the Level 2 assessment include:

- Limits to fishing effort;
- Catch limits (such as Total Allowable Catches - TACs); and
- Other controls such as seasonal closures.

Management actions or strategies that *are* accounted for in the assessment 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).

As a result, the Level 2 analysis is likely to generate more **false positives** for high risk (species assessed have a high risk when they are actually low risk) than **false negatives** (species assessed to be low vulnerability when they are actually high vulnerability). This is due to the PSA methodology adopting a **precautionary** approach to uncertainty. An example of this is when a species is missing information on its productivity and susceptibility attributes the risk score defaults to a higher risk.

In addition, TEP species are included within the assessment on the basis that they occur in the area of the fishery, whether or not there has been a recorded interaction with the fishery. For this reason there may be a higher proportion of false positives for high risk TEP species, unless there is a robust observer program that can verify that species do not interact with the fishing gear.

When AFMA reviewed the methodology using example fisheries, some additional concerns arose. Since the original ERA there is now an improved understanding of: species interaction and catch data available from log books and catch records; advances in scientific knowledge that may have become available; more resolution on the spatial distribution of species; and there may have been changes to management arrangements. Each of these issues is further described in more detail below.

Improved data

The ERA process adopts a precautionary approach. At the Level 2 analysis when a species has a missing productivity and susceptibility attributes the score defaults to a high risk category. Furthermore, species attributes that were originally calculated for the fishery may be out-of-date because additional or more precise information has become available.

Additional information

Since the time of the original ERA assessment, additional information may now be available as a result of more detailed risk assessments, such as a Level 3 analysis or population viability analysis. These results could provide a more quantitative analysis than the results from the Level 2 analysis.

Spatial assumptions

The Level 2 analysis utilises a precautionary approach when calculating susceptibility by assuming species distribution is only within the jurisdictional boundary of the fishery. While this is appropriate for species that form discrete populations or stocks, the risk score for species that do not have this spatial displacement such as pelagic and migratory species, the susceptibility scoring is not appropriately represented.

Interaction and catch data

Some species have a low to negligible level of interaction or capture. They may however still be scored high to high-medium risk irrespective of their low susceptibility, because they have a low productivity score (which raises the risk score). Considering the likelihood of the impact is low, there is little additional management that a fishery can introduce. Therefore the level of interaction or capture should be included as part of the Level 2 ERA residual risk process.

Management arrangements

As stated above, effort and catch limits for target and byproduct species are not taken into account in the ERA even though these measures may mitigate risk for some species. The Level 2 ERA residual risk process allows many of these management arrangements to be incorporated into the assessment.

Some management arrangements concerning the mitigation of bycatch have been incorporated into the initial ERA process; however, they may now be out-of-date since the initial ERA assessment. The Level 2 ERA residual risk process incorporates some of these management arrangements into the results to better represent the overall risk for a species.

There may be a beneficial overlap of a management arrangement for species that were not a target of the management plan if there is a high degree of association between two species. In some instances the initial ERA may not have considered the benefit of management arrangements between associated species.

Although seasonal, spatial and depth closures have been considered in the initial ERA, more recent spatial management measures have not been accounted for. The Level 2 ERA residual risk process will consider some of these arrangements and will bring the assessment up-to-date.

2. LEVEL 2 ERA RESIDUAL RISK PROCESS

2.1. Level 2 ERA Residual Risk

All major fisheries have been assessed to Level 2 where applicable. Before moving to a Level 3 assessment, residual risk has been assessed to account for the constraints of the Level 2 analysis. The Level 2 ERA residual risk process (**Figure 3**) incorporates some of the concepts of a Level 3 assessment and is more cost effective than a full Level 3 assessment. Furthermore, the Level 2 ERA residual risk results better represent overall risk within a fishery and will help clarify if further (Level 3) assessment is necessary.
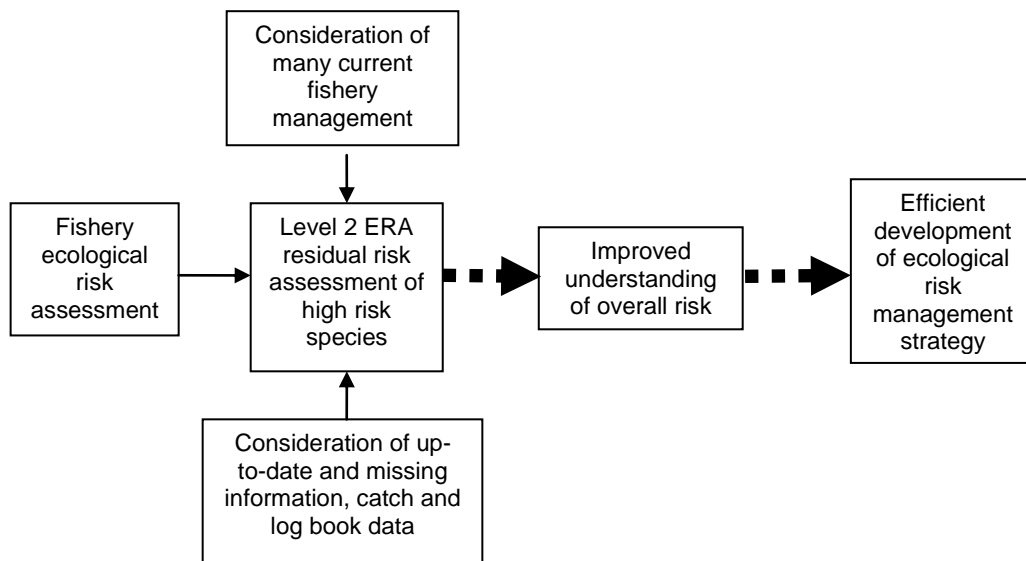

Figure 3 Flow diagram of the Level 2 ERA residual risk process

2.2. Level 2 ERA Residual Risk Process

In 2007 AFMA, with input from CSIRO and stakeholders, developed a set of guidelines to assess the residual risk for species identified as having a high potential risk based on the Level 2 analysis. The guidelines have been designed to ensure that a consistent, transparent and repeatable process is adopted across all fisheries. A summary of the guidelines is given in **Table 1**. Within each category there are clear decision rules that can be applied to a species (if relevant) to calculate Level 2 ERA residual risk. Each of the guidelines was applied on a species-by-species basis to determine the Level 2 ERA residual risk within the fishery.

When determining the Level 2 ERA residual risk, all considerations included in the calculation process must be recorded, along with the guidelines applied with a detailed justification clearly stated. This ensures that a transparent process is maintained. In review of the ERA results, the guidelines have been applied to all high priority species by managers in consultation with MAC members and experts. Broadly the application processes involved the following steps:

- Reviewing attribute and risk sores for all units, including those rated as lower risk to check for accuracy;

- Sorting the ERA result by high risk, then grouping the high risk species by role within the fishery, then by taxonomic group;

- Creating a list of all management arrangements not included in the ERA results for reference when applying the guidelines;

- Assigning each management arrangement to relevant high risk species;

- Collating spatial information from experts, observer and logbook data for all high risk species for reference when applying the guidelines;

- Deciding if and what guideline applies to each of the high risk species by conducting a species-by-species application;

- Making changes to the necessary attributes, productivity and susceptibility scores to calculate the Level 2 ERA residual risk score;

- Recording all workings, guidelines used, how they have been applied and a justification for the Level 2 ERA residual risk score (refer to Error! Reference source not found.);

- Providing preliminary Level 2 ERA residual risk results to MACs for feedback; and

- Finalising the Level 2 ERA residual risk results for release.

Before the Level 2 ERA residual risk process was applied to all fisheries the guidelines were trialled in three fisheries, the Eastern Tuna and Billfish Fishery (ETBF), Southern and Eastern Scalefish and Shark Fishery (SESSF), and the Northern Prawn Fishery (NPF). These fisheries were selected for the Level 2 ERA residual risk pilot because they are key fisheries and provide a template for other fisheries. Developments in the application of the Level 2 ERA residual risk processes are outlined in **Table 2**.

Table 1 Summary of Level 2 ERA Residual Risk Guidelines

Guideline Number	Summary
Guideline 1. Risk rating due to missing/incorrect information.	Considers if susceptibility and/or productivity attribute data for a species is missing or incorrect for the fishery assessment, and is corrected using data from a trusted source or another fishery.
Guideline 2. Additional scientific assessment.	Considers any additional rigorous scientific assessment (i.e. rapid Level 3 risk assessment, population viability analysis) that calculates the species level of risk from fishing, or considers any other scientific published assessments or results.
Guideline 3. At risk due to missing attributes.	When there are three or more missing productivity attributes, considers closely related species within a fishery that have those productivity attributes known.
Guideline 4. At risk with spatial assumptions.	Uses additional information on spatial distribution of species populations to better represent the species distribution overlap with the fishery.
Guideline 5. At risk in regards to level of interaction/capture with a zero or negligible level of susceptibility.	Considers observer or expert information to better calculate susceptibility for those species known to have a low likelihood or no record of interaction or capture with the fishery.
Guideline 6. Effort and catch management arrangements for target and byproduct species.	Considers current management arrangements based on effort and catch limits set using a scientific assessment for key species.
Guideline 7. Management arrangements to mitigate against the level of bycatch.	Considers management arrangements in place that mitigate against bycatch by the use of gear modifications, mitigation devices and catch limits.
Guideline 8. Limits on associated species through other management arrangements.	Considers the implications of management arrangements for a particular species on other associated species.
Guideline 9. Management arrangements relating to seasonal, spatial and depth closures.	Considers management arrangements based on seasonal, spatial and/or depth closures.

Table 2 Stakeholder Engagement

Guideline stage	Stakeholder interaction	Date of interaction	Stakeholder group	Summary of outcome
Draft Level 2 ERA residual risk assessment trial in SESSF	AFMA workshop	December 12th, 2006	Trial application of draft Level 2 ERA residual risk guidelines	Agreement much further work was needed
Trial Level 2 ERA residual risk assessment using draft ERA results in the ETBF, SESSF and NPF	AFMA workshop	May 21st, 2007	Fisheries managers in ETBF, SESSF and NPF and AFMA environment section	Draft Level 2 ERA results presented and application of guidelines discussed. Catalyst for major revision of multiple areas in guidelines by AFMA
Review of the draft residual risk report by the Residual Risk Review Group	Residual Risk review Group	March 13th, 2008	Fisheries managers, BRS, DEWHA & an environment NGO representatives	Reviewed the consistency of, and sought clarification on aspects of, application of the Residual Risk Guidelines across 12 major fisheries and sub fisheries.
Draft Level 2 residual risk assessment for NWSTF Fishery using final ERA results	WestMAC	November 2007	Fisheries managers, industry representatives, state member, conservation member	The draft Level 2 ERA residual risk assessment was presented and was endorsed by the MAC. Due to a lack of data and low observer coverage all high risk species were maintained as high risk species until more data can be acquired.

3. RESULTS

3.1. ERA Results

Fishery Description

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

Species Assessed

Target species:	7
Byproduct species:	16
Bycatch (discard) species:	13
TEP species:	121

Level 1 Results

The byproduct, bycatch and TEP species components were eliminated at Level 1.

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

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

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

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

Level 2 Results

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

Australian scampi, *Boschmai scampi* and velvet scampi are currently the main target species in the NWST Fishery. They are assessed at medium risk in the PSA analysis.

These species have been assessed in more detail in other analyses (Lynch and Garvey, 2005). Although catch rates have declined, they are not considered to be over-exploited at current catch levels.

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

Summary

Target species were identified as potentially at risk in the NWST Fishery, however the single high risk target species is rarely caught at present.

3.2. Level 2 ERA Residual Risk Results

The Level 2 ERA residual risk assessment summary for the NWSTF is given in **Table 3**. Overall only one target species, scarlet prawn, was assessed. A summary of this species is also given in Error! Reference source not found.. Overall no guidelines were found to be applicable and the scarlet prawn remains at high risk.

Table 3 Level 2 ERA Residual Risk Results

Taxonomic Group	Common Name	Scientific Name	Role in Fishery*	Productivity	Susceptibility	Level 2 ERA Risk Category Score	Current and Planned Management/ Assessment	Level 2 ERA Residual Risk Guideline(s) Applied	Justification	Level 2 ERA Residual Risk Score
Invertebrate	Scarlet prawn	*Aristaeopsis edwardsiana*	TA	1.43	3.00	High	Included in Harvest Strategy	None	NA	High

*Role in Fishery – TA (target), TB (target bait), BP (byproduct), DI (discard/bycatch), TEP (threatened, endangered or protected).

Table 4 Summary of Level 2 ERA Residual Risk Results

Component	Changed from high to medium	Changed from high to low	Changed from medium to low	High Residual Risk	Medium Residual Risk	Low Residual Risk
Target	0	0	0	1	4	2
Target Bait	0	0	0	0	0	0
Bycatch (discard)	0	0	0	0	0	0
Byproduct	0	0	0	0	0	0
TEP	0	0	0	0	0	0
Total	0	0	0	1	4	2

4. CONCLUSION

The purpose in applying the Level 2 ERA residual risk guidelines was to take into account any additional information and to ensure that the assessment was refined appropriately. Refinements were considered in either increasing or reducing the risk as appropriate.

Because of a lack of information and research and low observer coverage in the NWST Fishery no change was made for the single target species, the scarlet prawn, identified as high risk. It may be possible to apply the guidelines in the future as more information becomes available and as observer coverage increases.

The Level 2 ERA residual risk process brings the ERA assessment up-to-date with most of the current management initiatives within the fishery. Using the results presented here, an appropriate management response will be developed to address the high priority species as part of the ERM framework. The ERAs will be updated every five years and this will capture how effective the ERM strategy is in addressing risk to high priority species.

5. GLOSSARY

Activity	Refers to any fishing activity.
Actual risk	The real risk posed for a species from fishing activities.
Attribute	A general term for a set of properties relating to the productivity or susceptibility of a particular unit of analysis.
Availability	Used in Level 2 PSA assessment to calculate the impact on an ecological component due to a fishing activity. Considers overlap of fishing effort with a species distribution.
Bycatch	A non-target species captured in a fishery, usually of low value and often discarded (see also Byproduct). Also known as 'discard' species.
Byproduct	A non-target species captured in a fishery, but it may have value to the fisher and be retained for sale.
Catch limit	The vessel catch limit is a limit on the quantity each individual vessel can land per trip or short period of time.
Component	The marine ecosystem is broken down into five components for the risk assessment: target species (TA); byproduct (BI) and bycatch species (DI); threatened, endangered and protected species (TEP); habitats; and ecological communities.
EBFM	Ecosystem-based fisheries management considers the impact that fishing has on all of the aspects of the broader marine ecosystem, not just the target species.
Effort	The total fishing gear in use for a specified period of time.
Encounterability	Used in Level 2 PSA assessment to calculate the impact on an ecological component due to a fishing activity. 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).
EPBC Act	*Environment Protection and Biodiversity Conservation Act (Cth) 1999*
ERA	Ecological risk assessment for the effects of fishing as developed by AFMA and CSIRO.
ERM Framework	Ecological risk management process outlined by AFMA.
False negative	Species assessed to be low vulnerability when they are actually high vulnerability.
False positive	Species assessed have a high risk when they are actually low risk
Fishery	A related set of fish harvesting activities regulated by an authority (e.g. South-East Trawl Fishery).

Gear	The equipment used for fishing, e.g. gillnet, seine, longline, midwater trawl, purse seine, trap.
Level 1	The level of the ERA assessment which includes a qualitative assessment of scale, intensity, consequence analysis (SICA).
Potential risk	Possible risk as a result of fishing activities
Post Capture Mortality	Used in Level 2 PSA assessment to calculate the impact on an ecological component due to a fishing activity. Considers the condition and subsequent survival of a species that is captured and released (or discarded).
Precautionary	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 for Level 2 assessment of the ecological assessment.
Productivity	This determines the rate at which the unit can recover after potential depletion or damage by the fishing.
Residual Risk	Residual risk is broadly defined as the risk remaining after the implementation of mitigation measures.
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.
Selectivity	Used in Level 2 PSA assessment to calculate the impact on an ecological component due to a fishing activity. Considers the potential of the gear to capture or retain species.
SICA	Scale, intensity, consequence analysis for the Level 1 assessment.
Spatial management	Fisheries management that encompasses spatial arrangements such as depth closures or area closures.
Susceptibility	Used in Level 2 PSA assessment to calculate the impact on an ecological component due to a fishing activity. The extent of the impact due to the fishing activity, determined by the susceptibility of the unit to the fishing activities
Unit	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 - SUMMARY OF PRODUCTIVITY AND SUSCEPTIBILITY SCORING

Productivity

The productivity of a unit determines the rate at which the unit can recover after potential depletion or damage by fishing. The productivity score is the average of the following attributes:

1. Average age of species at maturity;
2. Average size of species at maturity;
3. Average maximum age of species;
4. Average maximum size of species;
5. Fecundity of species;
6. Reproductive strategy of species; and
7. Trophic level: organisms position in the food chain.

Susceptibility

Susceptibility is the extent of the impact on an ecological component due to a fishing activity. The susceptibility score is the product of the following attributes:

1. **Availability**: considers overlap of fishing effort with a species distribution;
2. **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);
3. **Selectivity**: considers the potential of the gear to capture or retain species; and
4. **Post Capture Mortality**: considers the condition and subsequent survival of a species that is captured and released (or discarded).

Based on the Level 2 results, if a unit is assessed at low risk from fishing, the rationale is documented and it is not assessed at a higher level. For units assessed at medium or high risk, management strategies to mitigate the risks are to be further investigated and implemented. If there are no planned or agreed management responses, the assessment moves to Level 3 (for more detail, refer to Hobday *et al.*, 2007).

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