Australian Government
Australian Fisheries Management Authority

Residual Risk Assessment

Teleost and Chondrichthyan Species

Report for the Shark Gillnet Method of the Gillnet Hook and Trap Sector

2014

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Executive Summary

The Australian Fisheries Management Authority (AFMA) has undertaken detailed ecological risk assessments (ERAs) for all major 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 management processes and structures so that it can be easily implemented in 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, appropriate management arrangements will be developed to address the high risk species as part of the ERM framework.

In early 2007, the residual risk guidelines were developed in consultation with the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and stakeholders to assist AFMA managers in refining the Level 2 Productivity Susceptibility Analysis (PSA) 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.

A quantitative Sustainability Assessment of Fishing Effects (SAFE) analysis was completed for all teleost and chondrichthyan species for each fishing method in the Southern and Eastern Scalefish and Shark Fishery (SESSF). The shark gillnet method of the SESSF was part of this assessment. While SAFE analysis is the most quantitative method for assessing potential risk posed to a species by fishing activity, the results do not directly account for all management measures, resulting in an over-estimation of the actual risk, or false-positives, for some species. AFMA has consulted with CSIRO and agreed that it would be appropriate to apply residual risk guidelines and expert overrides to some of those risk scores. This allows management measures and interaction levels to be taken into account to determine the risk level.

For the shark gillnet sector of the gillnet hook and trap fishery, SAFE analysis resulted in seven chondrichthyan species being classified as high risk. Residual risk guidelines have been applied to the Level 2 PSA results for these species to determine the residual risk at this level of assessment. After application of the residual risk guidelines, six of the species identified as

high risk during SAFE analysis remain high. Using these results, an appropriate management strategy will be developed to address the high risk species as a part of AFMA's ERM framework.

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 provide information to assist the decision making process so that they can be managed both sustainably and efficiently.

The ERA process is hierarchical, and currently includes three levels of assessment. The lowest level is a Level 1 assessment, which is a qualitative assessment that broadly looks at which hazards (activities) could lead to a significant impact on species, habitats or communities. The next level (Level 2) is a semi-quantitative analysis based on the assumption that risk to a species, habitat or community is based on its susceptibility to fishing, and the rate at which the unit can recover after an impact. Level 2 ERA has been completed for all major Commonwealth fisheries. The final Level 3 is a quantitative assessment, and can include assessments such as the CSIRO's sustainability assessment for fishing effects (SAFE), or stock assessments for commercially fished species.

To assist with the implementation of EBFM across all fisheries AFMA has established a process fir implementing ecological risk management (ERM) (see Figure 1). This process ensures that a consistent process is followed across fisheries when responding to the ERA outcomes. While this focuses on responding to the results of ERAs, it acknowledges that there are other initiatives contributing to the achievement of EBFM. The ERM framework will streamline fisheries' responses to the results of ERAs and incorporate other initiatives such as bycatch and discard programs and species-specific management arrangements.

Due to the semi-quantitative nature of the Level 2 Productivity Susceptibility Analysis, not all risk scores are an accurate representation of actual risk. To account for this and to ensure management effort is not unnecessarily expended on 'false positives', an additional step called a residual risk assessment is included in the ERA process. The residual risk assessment is used to account for current management measures which reduce the level of risk posed by a fishery to species, and adjust risk scores where appropriate. During a detailed review of the ERA methodology, AFMA found that some ERAs did not include all existing management arrangements at the time of assessment. Furthermore, since the initial ERAs were completed in 2007, the management of some fisheries has changed and additional data and information may have become available to provide further detail on the actual level of risk of fishing on a species, habitat or community.

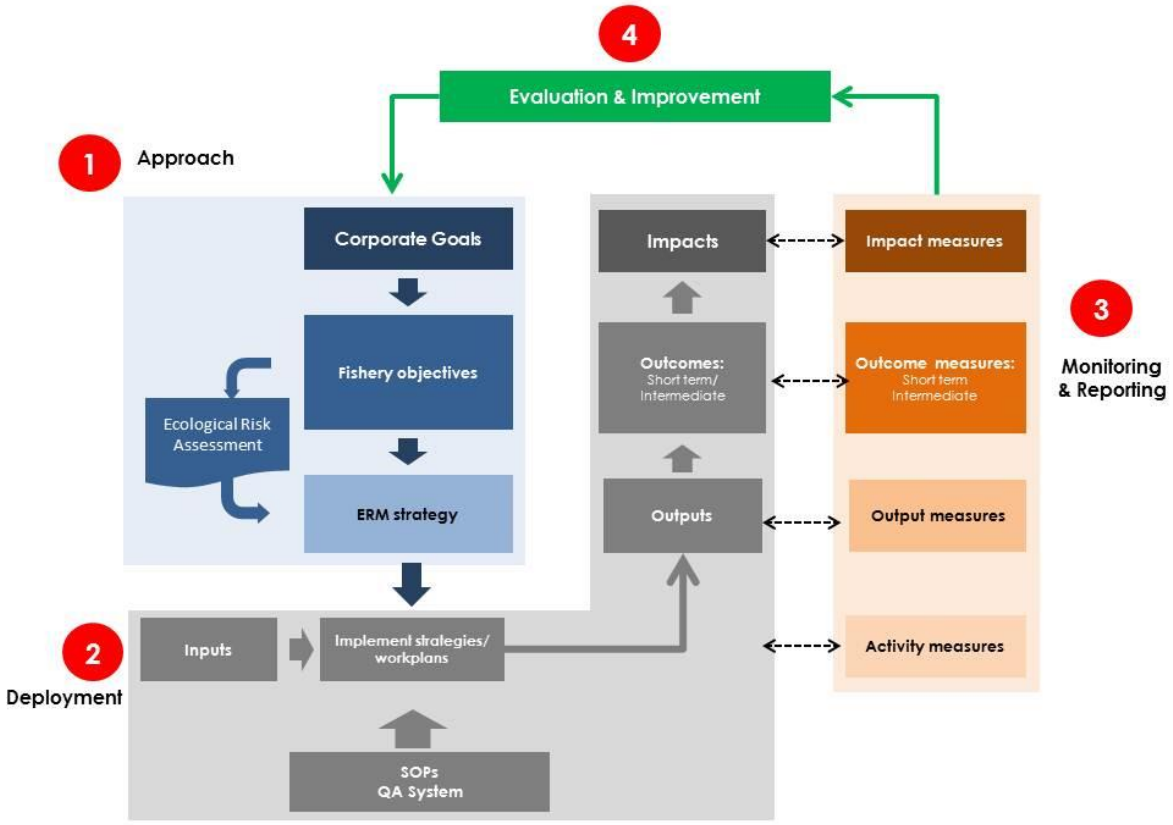

Figure 1 Ecological Risk Management Framework

1.2 Ecological Risk Assessment Methodology

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

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

The ERA assessment adopts a hierarchical approach (**Figure 2**). With every progressive level, the precision increases along with confidence in the risk scores (noting that not all components of a system progress all the way through the assessment hierarchy). The Level 2 PSA, residual risk assessment and SAFE assessments are detailed below. For the full ERA methodology, including Scoping and Level 1 Scale, Intensity, Consequence, Analysis (SICA), please refer to *Ecological Risk Assessment for Effects of Fishing: Methodology* (Hobday *et al*, 2007).

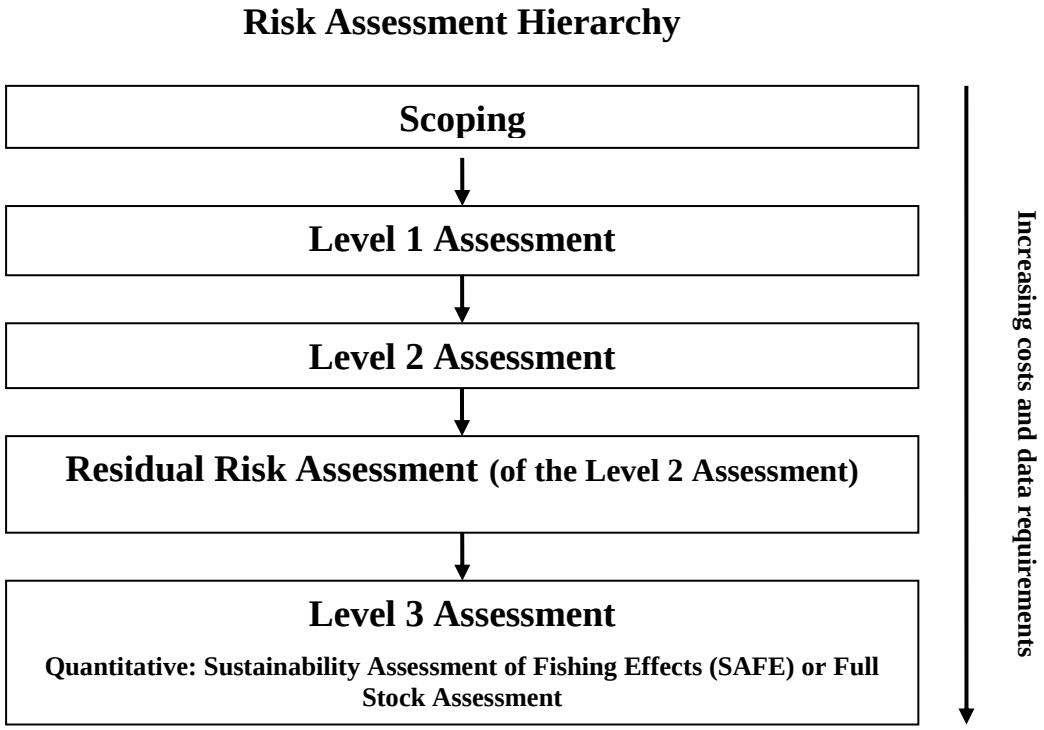

Figure 2 The different levels of risk assessment and the trend in confidence and cost

Level 2 – Productivity Susceptibility Analysis (PSA)

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

- **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.

The Level 2 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 PSA 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'.

The Level 2 PSA 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 extend beyond the boundary of the fishery such as pelagic and migratory species is not.

Some species have a low to negligible level of interaction with the fishing gear. Species with very low biological productivity may, however, still be scored high or medium risk irrespective of their low susceptibility. Considering the likelihood of interaction is already low there is little additional management that a fishery can introduce to mitigate the risk. Therefore the level of interaction or capture should be included as part of the Level 2 PSA residual risk process.

Constraints of Level 2 PSA results

The methodology used in the Level 2 PSA assessment results in risk scores of high, medium or low to reflect potential rather than actual risk. Due to the semi-quantitative nature of the Level 2 PSA risk assessment, analysis does not take into account all management measures currently in place in fisheries, which may result in an over-estimate, or false-positive, 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)
- 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)
- handling practices that may affect the survival of species after capture (post capture mortality).

However, it may be the case that not *all* management actions are considered. As a result, the Level 2 PSA is intentionally designed 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 Level 2 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. Regardless of their risk scores, AFMA will take all reasonable steps to minimise any future interactions with TEP species through the ERM strategy.

When AFMA reviewed the methodology using example fisheries in 2007, some additional concerns arose. Since the original Level 2 PSA results were produced there is now an improved understanding of: new or updated catch data available from log books and catch records; advances in scientific knowledge that may have become available; and more resolution on the spatial distribution of species etc. Each of these issues is discussed below.

Level 2 residual risk assessment of PSA results

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 PSA. Before moving to a Level 3 assessment, the residual risks are assessed to account for some of the constraints of the Level 2 PSA assessment (mentioned above). The Level 2 PSA residual risk process 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 PSA residual risk results more accurately represent overall risk within a fishery and will help clarify if further (Level 3) assessment is necessary.

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 PSA residual risk. Each of the guidelines is applied on a species-by-species basis to determine the Level 2 PSA residual risk within the fishery.

When determining the Level 2 PSA 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 are applied to all high risk species by managers in consultation with MAC members and experts. Broadly the application processes involved the following steps:

- Sorting the ERA result by high risk, then grouping the high risk species by role (e.g. target, byproduct or discarded species) 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.
- 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 PSA residual risk score.
- Recording all workings, guidelines used, how they have been applied and a justification for the Level 2 PSA residual risk score.
- Providing preliminary Level 2 PSA residual risk results to RAGs and MACs for feedback.
- Finalising the Level 2 PSA residual risk results for release.

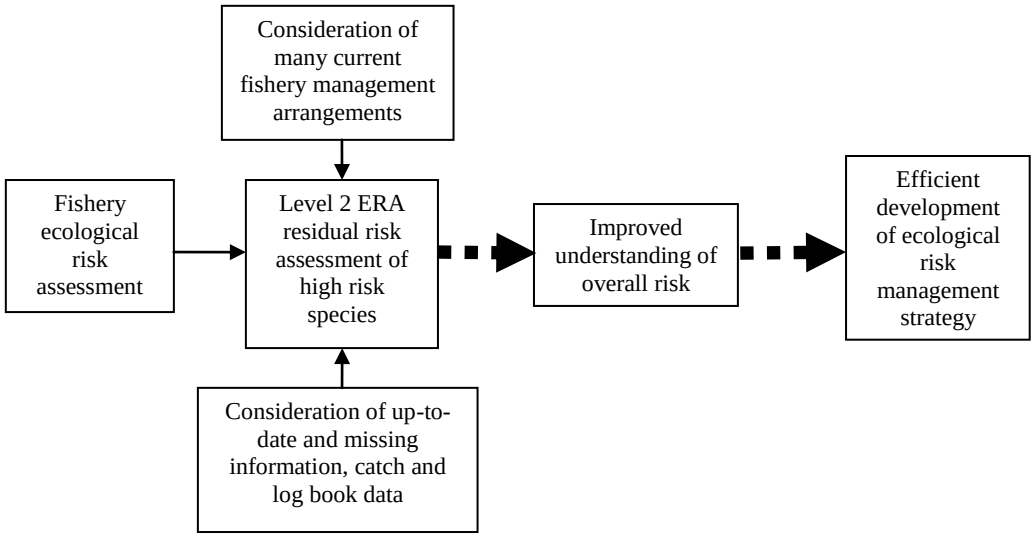

Figure 3. Flow diagram of the Level 2 ERA residual risk process

Level 3 – Quantitative risk assessment

At the conclusion of the Level 2 PSA 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) 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 resulting from the Level 2 assessment for high risk units should be identified. This may help to overcome some of the constraints of the Level 2 PSA results (outlined below) prior to proceeding to more costly Level 3 analysis for the remaining high risk units.

The Level 3 SAFE assessments that have been produced have only been applied to teleost and chondrichthyan species as it is difficult to obtain essential growth parameters for other

species. Therefore, no Level 3 SAFE data exists for non-teleost and non-chondrichthyan species. For these species, the Level 2 PSA residual risk analysis is the highest level of assessment currently completed.

1.3 ERA milestones and previous ERA assessments

2001

Funding was received to invest into ecological risk assessments (ERA's). The methodology was developed to be applied to Australian Commonwealth fisheries across 6 years in 2 stages. The first stage (Hobday *et al*. 2004) occurred between 2001 and 2004 and developed the basic methods and approach and applied them to several fisheries managed by the Australian Fisheries Management Authority (AFMA). Stage 2 (Smith *et al.* 2007) occurred between 2004 and 2007 and extended the Ecological Risk Assessment (ERA) methods, particularly for Level 2 PSA assessments, and applied the methods to 31 sub-fisheries within 13 of AFMA's managed fisheries.

2007

The report *Ecological Risk Assessment for Effects of Fishing: Report for the Shark Gillnet Sub-Fishery of the Commonwealth Gillnet Hook and Trap Sector of the Southern and Eastern Scalefish and Shark Fishery* (Walker *et al.* 2007) was produced. This report completes 4 stages of the ERA method: Scoping, Level 1, Level 2 and a model based Level 3 analysis.

The residual risk guidelines were developed in consultation with CSIRO and stakeholders to assist AFMA managers in refining the Level 2 PSA results. They were developed to maintain the key features of objectivity and consistency from the ERA process, and to ensure a repeatable and transparent assessment process.

The Level 3 Sustainability Assessment for Fishing Effects (SAFE) method was initially developed for the SESSF in 2007 and applied to teleost and chondrichtyan species impacted by five fishing methods across the SESSF: otter board trawl and Danish seine in the Commonwealth Trawl Sector, otter board trawl in the Great Australian Bight trawl sector, shark gillnet and scalefish automatic longline in the Gillnet, Hook and Trap Sector (Zhou *et al*. 2007).

2010

The report *Residual Risk Assessment of the Level 2 Ecological Risk Assessment Species Results: Report for the Gillnet Sector of the Gillnet Hook and Trap Fishery* (AFMA, 2010b) was produced. This report uses the results from the Level 2 PSA table and the Residual Risk Guidelines to determine the residual risk category for the species of the Gillnet sub-fishery.

2012

Level 2 PSA residual risk assessment of the non-teleost and non-chondrichthyan species (AFMA 2012b) focussed on species assessed as at high risk in the *2010 Residual Risk*

Assessment of the Level 2 Ecological Risk Assessment Species Results: Report for the Gillnet Sector of the Gillnet Hook and Trap Fishery (AFMA, 2010b). The aim was to assess whether the ERM framework had been successful in reducing the risk the fishery poses upon the species. This was also a Level 2 PSA Residual Risk analysis of the non-teleost and non-chondrichthyan species that had been caught or interacted with in the time since the previous ERA was completed

The Level 3 SAFE methodology was updated to include the most recent fishery distribution and effort data, new species from logbook and observer data and the introduction of the Danish seine method into the Great Australian Bight trawl sector (GABT). The analysis was applied to all teleost and chondrichthyan species for six major methods in the SESSF: otter board trawl in the Commonwealth trawl sector, otter board trawl in the Great Australian Bight trawl sector, Danish seine in the Commonwealth trawl sector, shark gillnet in the gillnet, hook and trap sector, automatic longline in the gillnet, hook and trap sector, and Danish seine in the Great Australian Bight trawl sector (Zhou *et al.* 2012). The results of this assessment are the basis of this residual risk assessment.

2. 2014 Residual risk analysis

In 2012 a Level 3 SAFE analysis was applied to all teleost and chondrichthyan species in the SESSF regardless of their Level 2 PSA scores. The result of this assessment is a list of high risk species. Without application of the residual risk guidelines, it is likely that a number of the high risk species are false-positives, as management arrangements and bycatch mitigation strategies have not been considered. AFMA has consulted with CSIRO and agreed that it would be appropriate to apply residual risk guidelines and expert overrides to some of those risk scores. This allows management measures and interaction levels to be taken into account to determine the risk level.

As part of the ERA reassessment for the Southern and Eastern Scalefish and Shark Fishery (SESSF) AFMA has applied the residual risk guidelines to all species assessed as high risk in the 2012 SAFE assessment.

AFMA has applied the following methodology:

1. For all species scored as high risk in the 2012 SAFE analysis, record the Level 2 PSA risk score from 2007. The productivity and susceptibility scores are unlikely to have changed.

2. Apply the residual risk guidelines to the Level 2 PSA risk scores from 2007.

3. Those species which have had their risk scores downgraded will be removed from the list of priority species to be addressed in the Ecological Risk Management response.

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.

3. Fishery Description

The shark gillnet sector forms part of the gillnet hook and trap sector (GHAT) of the larger Southern and Eastern Scalefish and Shark Fishery (SESSF). The GHAT covers an area from the New South Wales/Victorian border to the South Australian/Western Australian border including waters around Tasmania; from the low water mark to the extent of the Australian Fishing Zone (AFZ).

The shark gillnet sector sets demersal gillnets to target Gummy Shark. Current management arrangements restrict all gillnet operations to waters shallower than 183 m to protect large School Shark found in deeper waters. Gillnet operators in the GHAT are permitted to use up to 6 000 metres (outside 3 nm) with the exception of waters adjacent to South Australia where the maximum gillnet length is 4 200 metres. All mesh sizes must be greater than or equal to 15 centimetres and less than or equal to 16.5 centimetres (6-6½ inches).

The shark fishery has traditionally supplied fish for local markets with a large proportion of the catch sold in southern Australia. The fishing license buy back, as part of the $220 million Federal Government '*Securing our Fishing Future*' Package, bought out 26 of the 88 permits.

Fishery specifics:

Gear:	Demersal gillnet
	Monofilament with a maximum length of 6,000 metres with the exception of waters adjacent to South Australia where the maximum gillnet length is 4,200 metres.
Depth range:	10 m to 183 m (96% of gummy shark taken <80 m)
Main target species:	Gummy Shark
Management:	Input Controls: Gear restrictions, spatial closures
	Output Controls: Individual transferable quotas for the four main species; trigger limits for bycatch species
Observer program:	In place since 2007; observer or camera coverage levels are 100% in South Australia and 10% in the remainder of the area being fished, scientific surveys conducted 1973-76, 1986-87, 1998-01 and 2007-2008.

Table 2 Fleet Size, Fishing Effort and Observer Input – 2007-2011. Data Source: ABARES Fish Status Reports 2008 and 2010.

	Fleet Size – Number of Active Gillnet Vessels	Effort - Number of Lifts Per Year (km)	Observer Program - Number of Lifts (km)
2007-2008 Season	66	34,870	154
2008-2009 Season	62	35,163	155
2009-2010 Season	63	37,396	1,015
2010-2011 Season	59	40,226	2097
2011-2012 Season	45	34,264	2,184

3.1 Management arrangements introduced since last ERA

In June 2010 AFMA implemented the Australian Sea Lion Management Strategy (AFMA 2010a). The Strategy was developed to reduce and monitor the interactions between Australian Sea Lions and gillnets used by Commonwealth shark fishers in the area of the fishery off South Australia. The measures implemented under the Strategy included formal closures around more than 40 Australian Sea Lion colonies in South Australian waters; the setting of Australian Sea Lion mortality limits that trigger additional closures if unacceptable levels of ongoing Australian Sea Lion interaction occur; and a review of gillnet fishing practices.

On 1 May 2011 additional areas of the fishery were closed to fishing by gillnets, the use of hooks by affected eligible gillnet concession holders was allowed in the closed areas and the Australian Sea Lion Management Zone and mandatory monitoring through onboard observers or electronic monitoring of all fishing operations using gillnets in the areas of waters adjacent to the closed areas was implemented.

On 21 December 2011 AFMA approved the recommendations to reduce the trigger limits. The revised triggers means that if a trigger limit is reached in a zone, that zone will be closed to gillnetting for a period of 18 months, or if the overall trigger limit is reached, the overall ASL Management Zone will be closed to gillnetting for a period of 18 months.

On 1 May 2011, AFMA introduced a direction to limit School Shark catches and targeting in the SESSF. The direction implemented the 20 per cent School Shark to Gummy Shark catch ratio rule which was agreed to by industry through a series of workshops in 2010 and subsequently supported by the Southern Eastern Management Advisory Committee and Commission. This rule limits catches of School Shark to 20 per cent of an operator's Gummy Shark holdings i.e. quota holdings (caught or uncaught) of Gummy Shark must be

five times greater than the amount of School Shark caught. If operators are above the ratio for a given reconciliation period, they must lease or buy more Gummy Shark quota to bring them under the ratio.

On 22 September 2011, AFMA closed an area of the fishery off South Australia to gillnetting, established a zone adjacent to the closed area with mandatory monitoring while fishing with gillnets, and allowed for the use of hooks by affected gillnet concession holders in both the closed area and monitoring zone. This closure was revoked on the implementation of AFMA's Dolphin Strategy on 8 September 2014.

The Dolphin Strategy aims to reduce bycatch of dolphins in Commonwealth managed gillnet fisheries through the implementation of an individual responsibility framework. This framework holds operators to be individually responsible for interactions with protected species, and enables AFMA to respond at an individual boat level.

The Upper-Slope Dogfish Management Strategy has been developed by AFMA, in consultation with the fishing industry, scientific experts, conservation NGOs and other stakeholders. Updated in October 2012, the objectives of the strategy are to rebuild the populations of Harrison's Dogfish (*Centrophorus harissoni)*, and Southern Dogfish (*C. zeehaani).* The strategy also offer some level of protection for Greeneye Spurdog (*Squalus chloroculus*) and Endeavour Dogfish (*Centrophorus moluccensis*). The strategy relies on a network of spatial closures supplemented by a range of operational measures including regulated handling practices, 100% monitoring, move-on provisions and no retention of gulper sharks.

4. Results

Level 1 Scale Intensity Consequence Analysis

The following results are derived from the Level 1 assessment undertaken in the *Ecological Risk Assessment for Effects of Fishing: Report for the Shark Gillnet Sub-Fishery of the Commonwealth Gillnet Hook and Trap Sector of the Southern and Eastern Scalefish and Shark Fishery* (Walker *et al.* 2007):

Number of ecological units assessed

Target species:	1
Byproduct species:	80
Discard species:	56
TEP species:	192
Habitats:	102 (98 demersal, 4 pelagic)
Communities:	11 (9 demersal, 2 pelagic)

Most activities associated with within-fishery hazards (direct impacts) are eliminated at Level 1 (risk scores 1 or 2). Three remaining activities include:

- 'fishing' associated with capture direct impact (for target species, byproduct & bycatch species, TEP species, and habitat components)
- 'incidental behaviour' associated with capture direct impact (for TEP species component)
- 'fishing' associated with non-capture direct impact (for habitats component).

Four activities associated with external hazards also remain:

- 'other capture fishery methods' (habitats and communities components),
- 'coastal development' (byproduct & bycatch species)
- 'other extractive activities' (byproduct & bycatch species component)
- 'other anthropogenic activities' (TEP species component)

There is only one severe consequence (risk score 5) associated with within-fishery activities; this is 'fishing' from capture direct impact on the byproduct and bycatch species component. All other activities with consequence scores rated as major or severe (risk scores 4 or 5, respectively) are associated with external hazards.

Three components (target species, byproduct and bycatch species and TEP species) have within-fishery activities with consequences rated as moderate or above and are therefore assessed in more detail at Level 2.

For more detail regarding scoring refer to the *Ecological Risk Assessment for Effects of Fishing: Methodology* (Hobday *et al*., 2007).

Level 2 Productivity Susceptibility Analysis

329 species are assessed under the Level 2 Productivity Susceptibility Analysis (PSA). Of these, 21 were assessed to be at high risk (1 target species, 11 byproduct species, 3 bycatch species and 5 TEP species). By taxa, the high risk species comprise 16 chondrichthyans (sharks, rays and chimaeras), and 5 marine mammals. Of the 329 species assessed at Level 2, expert over rides were used on 151 species (mainly marine birds, mammals and reptiles in the TEP component). Of the 21 species assessed at high risk, only one (byproduct) species had more than three missing attributes.

The five seal TEP species assessed as high risk are the Australian Fur Seal, New Zealand Fur Seal, Australian Sea Lion, Leopard Seal, and Southern Elephant Seal. The Australian Sea Lion is of greatest concern because of its small population size (approx 10,000 – 12,000 individuals) and complex separate breeding populations in southern Australia. There are 47 out of the known 73 breeding locations for Australian Sea Lions in South

Australia (Goldsworthy et. al., 2007) where 80 per cent of the species population occurs. The Australian Fur Seal and New Zealand Fur Seal, however, have much larger populations that appear to be increasing. The Leopard Seal and Southern Elephant Seal are distributed over a very wide geographic range, with only very small proportions of their populations occurring within the range of the shark gillnet sub-fishery.

Of the TEP species assessed at Level 2 (PSA Analysis), five marine mammals were assessed as high risk, one marine mammal was assessed as medium risk, four marine birds were assessed to be at medium risk and one marine bird was assessed to be at low risk.

For detailed results and methodology refer to *Ecological Risk Assessment for the Effects of Fishing: Report for the Shark Gillnet component of the Gillnet Hook and Trap Sector of the Southern and Eastern Scalefish and Shark Fishery* (Walker *et al*, 2007).

Level 2 PSA residual risk (non-teleost and non-chondrichthyans)

For the 2012 Level 2 Residual Risk ERA, the residual risk process and guidelines were applied only to non-teleost and non-chondrichthyan species caught or interacted with in the 2009-2010 period and the 2010-2011 period. The residual risk process and guidelines were also applied to the non-teleost and non-chondrichthyan species assessed as at high risk in the 2010 ERA (AFMA 2010b). This is to take into account the quantity of the species/number of individuals caught over the period specified and to potentially identify trends.

The most common guideline used was guideline 5 which reduced risk based on the fact that the level of interaction/capture of this species has zero or negligible effect. Overall there was a change from five high risk marine mammal species prior to the Level 2 PSA residual risk assessment to four high risk species.

Level 3 Sustainability Assessment of Fishing Effects

The 2012 SAFE assessment was completed for all 195 species (40 chondrichthyan and 155 teleost) identified in the shark gillnet fishery regardless of their Level 2 PSA risk score. This is because:

- changes to biological reference points for teleosts and chondrichthyans are likely to affect previous risk scores
- the objective was to assess impact in more recent years because fishing effort and distribution may have changed
- the difference costs for doing a SAFE analysis for a few species and doing all species is negligible.

The assessment found that 5 species, all chondrichthyan, had an estimated fishing mortality rate greater than F_{msm}, the maximum sustainable mortality rate. When uncertainty in both estimated fishing mortality rates and reference points are included in the analysis, 7 species are at least precautionary high risk.

Table 3 High risk species after Level 3 SAFE analysis

Scientific Name	Common Name	Risk Score
Carcharhinus brachyurus	Bronze Whaler	Extreme High Risk
Carcharodon carcharias	White Shark	Extreme High Risk
Furgaleus macki	Whiskery Shark	Precautionary Extreme High Risk
Sphyrna zygaena	Smooth Hammerhead	Precautionary Extreme High Risk
Galeorhinus galeus	School Shark	Precautionary Extreme High Risk
Pristiophorus cirratus	Common Sawshark	Precautionary High Risk
Notorynchus cepedianus	Broadnose Shark	Precautionary High Risk

4.5 Residual risk analysis (teleost and chondrichthyans)

The residual risk summary for the shark gillnet fishery is summarised in table 5. Guideline 6 was used to reduce risk for the Common Sawshark. This species is managed as a quota species and has a TAC of 339 t. School Shark is also subject to a full stock assessment under the SESSF Harvest Strategy as a Tier 1 species and has a TAC of 215 t. The most recent stock assessment for School Shark, completed in 2009, resulted in a biomass estimate below the limit reference point. This means that there can be no targeted fishing for School Shark and the RBC is 0 tonnes. However, in 2012 a School Shark Workshop found that the 2009 assessment could not be relied upon for estimates of stock status. This was primarily because the index of abundance for School Shark is based on catch and effort data which is not reliable as School Shark are actively avoided by fishers. Work is now being undertaken to develop a reliable index of abundance. Without a reliable estimate of biomass, the risk score cannot be reduced.

Overall there has been a change from 7 high risk species prior to the residual risk assessment to 6 high risk species.

Table 4 Residual Risk guidelines applied to species assessed as high risk after SAFE analysis.

Taxonomic Group	Scientific Name	Common Name	Role in Fishery	Productivity	Susceptibility	Level 2 PSA Risk Score	Current and Planned Management Assessment	Level 2 ERA Residual Risk Guideline(s) Applied	Justification	Level 2 Residual Risk Score
Chondrichthyan	*Carcharhinus brachyurus*	Bronze Whaler	BP	2.86	3	High	Spatial management such as the closure inside 3nm off Victoria, closures in South Australia, shark pupping closures in Tasmania, the 183m depth closure and the 130m depth closure off Tasmania offer some protection for this species.	Guideline 2 – Additional Scientific Assessment	Average annual catch reported in Catch Disposal records for this species for 2007-2012 is approximately 20.1t. Note that there are identification issues between *C. brachyurus* and *C. obscurus* (Dusky Shark) with the latter never recorded in logbooks. It is likely that a portion of the catch reported under *C. brachyurus* is in fact *C. obscurus* This species was assessed as extreme high risk from commercial fishing operations under the Level 3 SAFE assessment. (Zhou 2012)	Extreme High
Chondrichthyan	*Sphyrna zygaena*	Smooth Hammerhead	BP	2.71	3	High	Spatial closures, gillnet mesh size restrictions and the predominately pelagic nature of these sharks limit the annual catch. SharkRAG have developed an upper reference limit of 10 t against which to monitor catches.	Guideline 2 – Additional Scientific Assessment	Average annual catch reported in Catch Disposal records for this species for 2008-2012 is approximately 7.3t. This species was assessed as precautionary extreme high risk from commercial fishing operations under the Level 3 SAFE assessment. (Zhou 2012).	Precautionary Extreme High Risk

Chondrichthyan	*Carcharodon carcharias*	White Shark	TEP	2.86	2.33	High	Spatial closures such as the 183m depth closure and around seal colonies provide some protection to White Sharks as seals make up a large portion of their diet. There has been a closure to shark gillnetting and long-lining in ocean waters within 3 nm of the Victorian coast since 1988.	Guideline 2 – Additional Scientific Assessment	White Sharks are a TEP species and it is illegal for operators to retain those caught. Many White Sharks caught in the gillnet sector are returned alive (logbook information) as most commonly they are entangled in the headrope as opposed to enmeshed. This species was assessed as extreme high risk from commercial fishing operations under the Level 3 SAFE assessment. (Zhou 2012)	Extreme High Risk
Chondrichthyan	*Notorynchus cepedianus*	Broadnose Shark	BP	2.57	2.33	High	Spatial closures in coastal waters such as Victoria and South Australian provide some protection for this species. SharkRAG have developed an upper reference limit of 70 t and a lower reference limit of 20t against which to monitor catches.	Guideline 2 – Additional Scientific Assessment	Average annual catch reported in logbooks between 2008-2012 is approximately 35.2t per year. Surveys conducted by Dr Walker suggest population of this species is increasing. Dr Walker of the view that this is the result of the current size selectivity of 6 inch gillnets (*pers comms*). The historic shark fishery was mainly shark hook which used to catch large breeding females. Since gillnets have become the predominant method, only the smaller size classes are selected and the breeding age animals remain unfished. This species was assessed as precautionary high risk from commercial fishing operations under the Level 3 SAFE assessment. (Zhou 2012).	Precautionary High

Chondrichthyan	*Furgaleus macki*	Whiskery Shark	BP	2.57	3	High	Western Australia has had a 2 month seasonal closure (mid-Aug to mid-Sept) in place since 2006/07. WA Fisheries have capped fishing effort at 2001/02 levels and a conversion to hourly gear units as a management tool was implemented for the 2009/10 fishing	Guideline 2 – Additional Scientific Assessment	Average annual catch across the SESSF is approximately 29 tonnes, 96.5% of which is caught in the gillnet sector. Catches of this species have been recorded as far east as Bass Strait in recent years, possibly pointing to a recovery of the stock. WA Fisheries conducted a stock assessment on this species in 2007. This assessment has shown the stock to be recovering and breeding stock levels are currently inadequate but recovering (WA State of the Fisheries Report 2007/08 – McAuley 2008). This species was assessed as precautionary extreme high risk from commercial fishing operations under the Level 3 SAFE assessment. (Zhou 2012)	Precautionary Extreme High Risk
Chondrichthyan	Pristiophorus cirratus	Common Sawshark	BP	2.43	3	High	Sawshark TAC 339t Tier 4 Assessment	Guideline 6 – Effort and catch management	This species was assessed as precautionary high risk from commercial fishing operations under the Level 3 SAFE assessment. (Zhou 2012). Average annual catch in the gillnet fishery is approximately 103t with a cumulative catch of approximately 220t across the SESSF. The TAC has been determined through a scientific Tier 4 assessment, and there is confidence of a high level of compliance in the fishery. The overall risk rating for this species has therefor been reduced to medium (**see note 1)**.	Medium

Chondrichthyan	*Galeorhinus galeus*	School Shark	BP	2.57	3	High	Bycatch TAC set at 215t Tier 1 Assessment Formal stock rebuilding strategy. Spatial management designed to promote stock rebuilding. Closure inside 3nm off Victoria, closures in South Australia, pupping closures in Tasmania, 183m depth closure and the 130m depth closure off Tasmania. 20% Catch ratio of School Shark to Gummy Shark	Guideline 6 – Effort and catch management	The most recent stock assessment for School Shark, completed in 2009, resulted in a biomass estimate below the limit reference point. This means that there can be no targeted fishing for School Shark and the RBC is 0 tonnes. However, in 2012 a School Shark Workshop found that the 2009 assessment could not be relied upon for estimates of stock status, primarily because the index of abundance for School Shark was not reliable. Work is now being undertaken to develop a reliable index of abundance. Without a reliable estimate of biomass, the risk score can not be reduced. This species was assessed as precautionary high risk from commercial fishing operations under the Level 3 SAFE assessment. (Zhou 2012).	Precautionary High Risk

*Role in Fishery – TEP (Threatened, Endangered or Protected)

Notes for Table 4

1	Dr Shijie Zhou and Dr Tony Smith of CSIRO have provided comment that it is appropriate a species covered by TAC (species specific or basket) should have it's overall risk rating reduced. TACs are set based on scientific tiered assessments and are effective at mitigating risk.
2	Level 2 PSA risk score has been derived using the formula. Risk = $\sqrt{P^2 + S^2}$, where *P* is the productivity risk score and *S* the susceptibility risk score. The risk categories are defined as follows: **High risk:** risk score >3.18 **Medium risk:** 2.64 < risk score < 3.18 **Low risk:** risk score < 2.64.

Table 5 Summary of Residual Risk Results for Teleost and Chondrichthyan Species

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
TEP	0	0	0	1	0	0
BP	1	0	0	5	1	0
DI	0	0	0	0	0	0
Total	1	0	0	6	1	0

5. Conclusion

The methodology used for this 2014 residual risk assessment has been adapted to suit a change in the SAFE assessment process. When first developed, the ERA methodology dictated that only those teleost and chondrichthyan species which were scored as high risk after the Level 2 PSA analysis would progress to the Level 3 SAFE analysis. In 2012, however, all teleost and chondrichthyan species were subject to a SAFE analysis. While this is considered as a high level and fully quantitative assessment, there are still some management arrangements, such as catch limits and interaction rates which are not considered. For example, SAFE analysis considers fishing effort but not catch rates. After consultation with CSIRO, it was considered appropriate to apply residual risk guidelines, consistent with Level 2 PSA residual risk assessment, to the species assessed as high risk after the SAFE analysis.

Overall there were 7 species assessed as high risk after the SAFE analysis. After application of the residual risk guidelines, the Common Sawshark was considered to be at medium risk after application of guideline 6 which considers limits on catch and effort. The Common Sawshark has a TAC of 339t and is assessed as a tier 4 species. Despite several management arrangements, not all species could have their risk scores reduced, and these management arrangements have been noted. Notably, the School Shark is managed as a Tier 1 species with a TAC of 215t. However, there were uncertainties surrounding the index of abundance in the most recent stock assessment. Without reliable estimates of biomass the risk score could not be reduced.

The 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 strategy will be developed to address the high risk species as part of the ERM framework. The ERA's will be updated periodically and this will capture how effective the ERM response to high risk species has been.

6. Consultation and clearance

The residual risk analysis commenced in October 2013 and was finalised in June 2014. As part of the consultation process AFMA sought advice on application of residual risk guidelines from CSIRO and presented preliminary results to relevant resource assessment groups (RAGS) for comment. The final results were presented at the March 2014 meeting of the Southern and Eastern Scalefish and Shark RAG which includes representatives from industry, science and management. Final clearance has been approved by George Day, Senior Manager of Demersal and Midwater Fisheries at AFMA.

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	That part of fisher's catch which is returned to the sea either because it has no commercial value or regulations preclude it from being retained and; That part of the catch that does not reach the deck of the fishing vessel but is affected by the interaction with the fishing gear.
Byproduct	A non-target species captured in a fishery that has 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 risk when they are actually high risk.
False positive	Species assessed to 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, Danish seine, pelagic longline, midwater trawl, purse seine, trap etc.
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 risk, risk is assumed to be high, unless there is advice to the contrary.
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.
Level 2 PSA	
Residual Risk	In the context of this document residual risk means the residual risk after the Level 2 PSA assessment.
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 affect of the fishing activities on the unit.
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".

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).

For non-teleost and non-chondrichthyan species, 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, residual risk guidelines are applied which consider things such as catch levels and management strategies to mitigate the risks (for more detail, refer to Hobday *et al.*, 2007).

In the most recent assessment, all teleost and chondrichthyan species were assessed via Level 3 SAFE assessment, regardless of their Level 2 PSA scores. A revitalisation project is currently underway between AFMA, CSIRO and various stakeholders to review the ERA methodology and bring it up to date with current fisheries management frameworks.

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