Australian Government
Australian Fisheries Management Authority

Residual Risk Assessment

Teleost and Chondrichthyan Species

Report for the Otter Board Trawl Method of the Commonwealth Trawl Sector

2014

Box 7051, Canberra Business Centre, ACT 2610 Tel (02) 6225 5555 Fax (02) 6225 5500 AFMA Direct 1300 723 621

Contents

Executive summary

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 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.

In 2012, a quantitative Sustainability Assessment for Fishing Effects (SAFE) was completed for all teleost and chondrichthyan species for each fishing method in the Southern and Eastern Scalefish and Shark Fishery (SESSF). The otter board trawl method of the Commonwealth Trawl Sector was part of this assessment. While a SAFE 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 in place in the fishery, 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 otter board trawl method of the Commonwealth Trawl Sector, SAFE resulted in twenty-two 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, eleven of the species identified as high risk by SAFE 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 quantitative in nature, and can include assessments such as the CSIRO's sustainability assessment for fishing effects (SAFE), or stock assessments for commercially fished species.

Due to the semi-quantitative nature of the Level 2 PSA, 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.

To assist with the implementation of EBFM across all fisheries AFMA has established a process for 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.

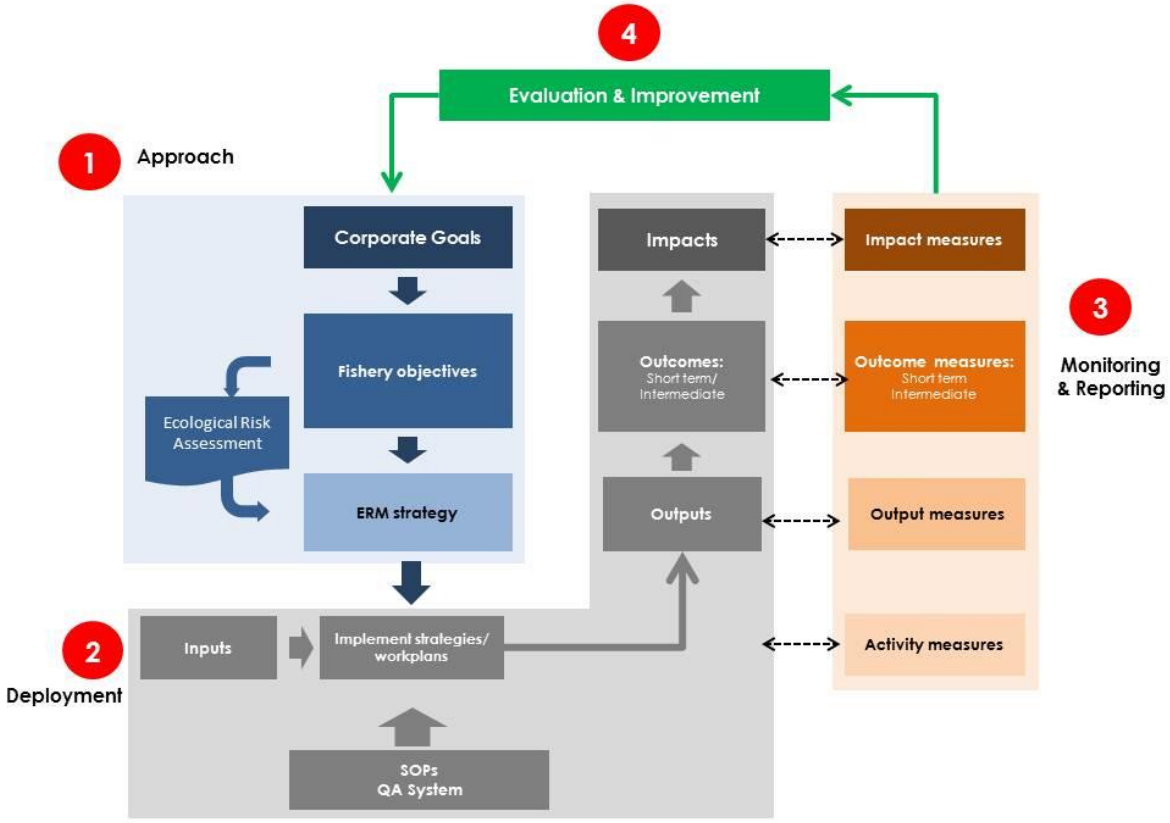

Figure 1 Ecological Risk Management Process Map

1.2 ERA 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* (2007).

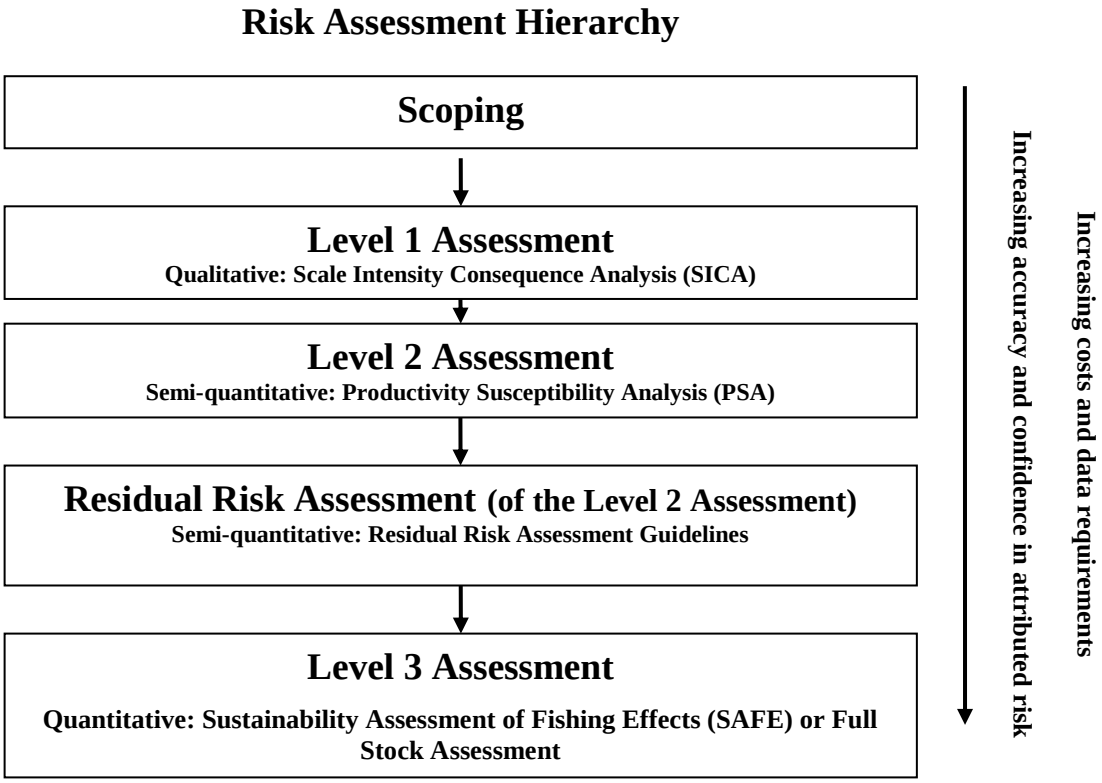

Figure 2 The different levels of risk assessment and the trend in confidence and cost

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

- **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. The level of interaction or capture is therefore included as part of the Level 2 PSA residual risk process (see below).

Constraints of Level 2 PSA

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).

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 data 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.

Level 2 PSA residual risk analysis

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 Resource Assessment Groups (RAGs) and Management Advisory Committees (MACs) and fishery 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.

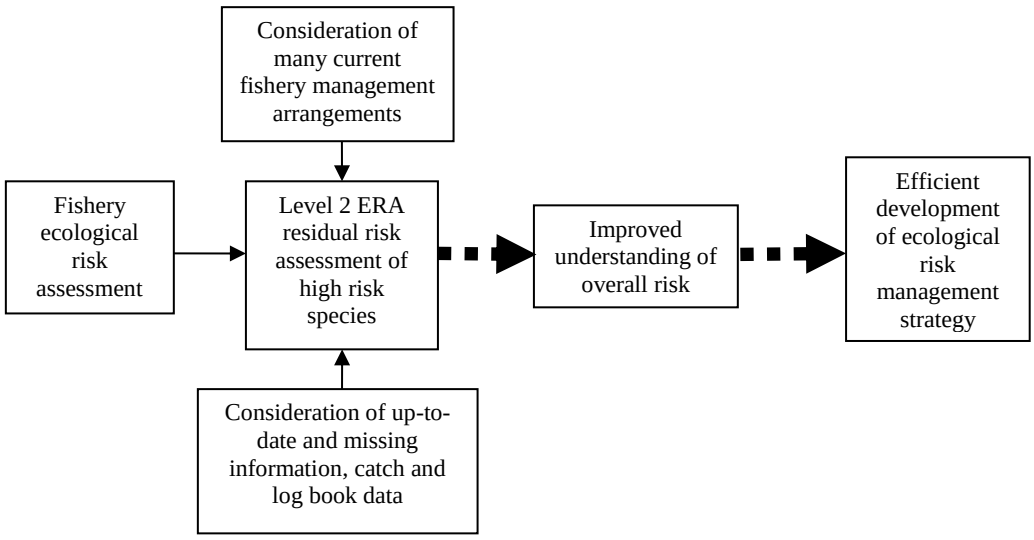

Figure 3. Flow diagram of the Level 2 ERA residual risk process

Before the Level 2 PSA 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 PSA residual risk pilot because they are key fisheries and provide a template for other fisheries. Developments in the application of the Level 2 PSA residual risk process are outlined in **Table 2**

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 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 Otter Trawl Sub-Fishery of the Commonwealth Trawl 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 chondrichthyan 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 Otter Trawl Fishery* (AFMA, 2010a) was produced. This report uses the results from the Level 2 PSA table and the residual risk guidelines to determine the residual risk rating for the species impacted by otter board trawl in the CTS.

2012

AFMA completed a residual risk analysis of Level 2 PSA results for non-teleost and non-chondrichthyan species. This assessment 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 Otter Trawl Fishery* (AFMA, 2012b). 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 was applied to all teleost and chondrichthyan species in the SESSF regardless of their Level 2 PSA scores. The result of this assessment was 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 reduced will be removed from the list of priority species to be addressed in the Ecological Risk Management strategy.

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 otter board trawl fleet forms part of the Commonwealth trawl sector (CTS) of the larger Southern and Eastern Scalefish and Shark Fishery (SESSF). The CTS covers the area of the Australian Fishing Zone extending southward from Barranjoey Point (north of Sydney) around the NSW, Victorian and Tasmanian coastlines to Cape Jervis in South Australia. The CTS is overlapped by parts of the Gillnet Hook and Trap (GHAT) sector.

The CTS is a demersal and midwater fishery which varies in fishing depth between 20 and 1300 metres. Main target species of this fishery are Blue Grenadier, Tiger Flathead, Pink Ling and Silver Warehou. Otter board operators are required to use a minimum 90 mm cod-end on their nets. The primary landing ports for the CTS are Ulladulla, Lakes Entrance, Eden, Hobart and Portland.

A Seal Excluder Device (SED) is required on freezer boats when fishing west of 148ºE.

The CTS is one of the main sources of Australian fresh fish for the Sydney and Melbourne markets. Annual fishing effort in the CTS peaked in 2001 at 112 000 hours of trawling time. After the removal of fishing concessions, as part of the $220 million Federal Government *'Securing our Fishing Future'* structural adjustment program, trawl effort declined to 58 000 hours in 2007 and has remained relatively constant.

Fishery Specifics:

Gear: Otter Trawl

≥90 mm mesh scalefish, 115 mm mesh in net mouth & wings

≥ 90 mm cod-end, single twine mesh or 102 mm double twine mesh or 90 mm double twine mesh + one of the following Bycatch Reduction Devices (BRDs):

- Single square mesh (≥90 mm) panel in upper side of codend bag (15X20 bars) OR
- A Large rotated mesh (T90) (≥90 mm) in upper codend (15X18 meshes)
- A Seal Excluder Device (SED) is required on freezer boats when fishing west of 148ºE.

Depth range: 20 m to 1300 m

Main target species: Blue Grenadier, Tiger Flathead, Silver Warehou and Pink Ling

Management: Input controls: limited entry, gear restrictions, species specific area closures

Output controls: Total Allowable Catch, Individual Transferable Quotas, trip limits

Observer program: Integrated Scientific Monitoring Program operating since the mid-1990s – collects biological information from catches at sea and in port as well as monitor TEP interactions.

Table 2 Fleet Size, Fishing Effort and Observer Input – 2007-2011. Data Source: ABARES Fish Status Reports 2008 - 2012.

Season	Fleet Size – Number of CTS Fishing Permits	Fleet Size – Number of Active Trawl Vessels	Effort - Number of Bottom Time Hours	Observer Program - Number of observed Trawl Shots
2007-2008	59	54*	57,960	342
2008-2009	59	53*	61,240	462
2009-2010	59	36	57,419	625
2010-2011	46	36	64,651	627
2011-2012	45	39	64,706	221 (sea days)

* Includes Danish seine vessels

3.1 Management arrangements introduced since last ERA

The Upper-Slope Dogfish Management Strategy has been developed by AFMA, in consultation with the fishing industry, scientific experts, conservation NGOs and other stakeholders. Revised 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 offers 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 per cent monitoring, move-on provisions and no retention of gulper sharks.

Stock rebuilding strategies have been implemented for Eastern Gemfish, School Shark and Blue Warehou since 2008. Each strategy describes management arrangements that allow for the stocks to rebuild and recover within a biologically reasonable timeframe. In addition to recommendations on TAC setting, resource assessment groups and management advisory committees have responsibility for reviewing the success of rebuilding strategies. In the event that the population is not stabilised or rebuilding under actions already implemented, the strategies outline additional progressive actions that can be taken. The Blue Warehou Strategy was updated in 2012 to include reporting requirements due to total allowable catch changes and has expanded to include the non-

trawl sectors of the SESSF. At the time of publishing, the strategies for School Shark, Blue Warehou and Eastern Gemfish are being reviewed.

The Orange Roughy Rebuilding Strategy 2015 was implemented on 1 May 2015. The strategy replaces the Orange Roughy Conservation Program 2006 (ORCP). The objective of the ORCP was to conserve Orange Roughy to ensure its long term survival in nature and recover the species to ecologically sustainable levels. Recognising progress made under the ORCP, the primary objective of the Strategy is to return all Orange Roughy stocks to levels where they can be harvested in an ecologically sustainable manner consistent with the *Commonwealth Fisheries Harvest Strategy Policy 2007* (HSP) and ultimately maximise the economic returns to the Australian community. In line with, and guided by HSP, management actions set out in the Strategy maintain low fishing mortality to support rebuilding while continuing to monitor and assess the stocks.

Since the residual risk assessment in 2010 there have been several closures in the SESSF. Closure directions for Pink Ling, Gulper Sharks, Australian Sea Lion, Deepwater Sharks and Dolphins describe areas closed to fishing with the aim of protecting vulnerable marine populations. For more information, the full closure directions can be found on the ComLaw website (www.comlaw.gov.au).

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 Otter Trawl Fishery of the Commonwealth Trawl Sector of the Southern and Eastern Scalefish and Shark Fishery* (Walker *et al*. 2007).

The marine ecosystem is divided into five *components* for the risk assessment: target species (TA); byproduct (BP) and bycatch species (BC); threatened, endangered and protected species (TEP); habitats; and ecological communities. Within those components, *units* describe the entities for which risk scores are given to. Units within the Target Species component are individual 'species'.

Number of ecological units assessed

Target species:	28
Byproduct species:	95
Bycatch (discard) species:	276
TEP species:	201
Habitats:	158
Communities:	33

No ecological components were eliminated at Level 1 (there was at least one risk score of 3 (moderate) or above for each component).

A number of hazards (activities associated with fishing) were eliminated at Level 1 (risk scores 1 or 2). Those that remain include:

- fishing (direct and indirect impacts on all 5 ecological components)
- gear loss (impact on TEP species)
- translocation of species (impact on habitats)
- discarding catch (impact on TEP species)
- navigation/steaming (impact on target species)
- activity/presence on water (impact on target species and communities)
- fishing through physical disturbance (impact on habitats and communities)

Significant hazards external to the fishery included other fisheries in the region, coastal development, and other extractive activities.

Risks to ecological components rated as major or above (risk scores 4 or 5) were all related to direct or indirect impacts from primary fishing operations. Severe impacts (risk score 5) were confined to byproduct/bycatch species.

Impacts from fishing on all components were 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

There were 600 species assessed at Level 2 using the Productivity Susceptibility Analysis (PSA). Of these, 159 were assessed to be at high risk, including 15 target species, 39 byproduct species, 99 bycatch species, and 6 TEP species. By taxa, the high risk species comprised of 58 chondrichthyans, 96 teleosts, 4 marine birds, and 1 marine mammal. Of the 159 species assessed to be at high risk, 4 had more than 3 missing attributes.

Of the 6 TEP species assessed to be at high risk, the 4 birds (Tahiti Petrel, Long-tailed Jaeger, Pacific Albatross and Chatham Albatross) were classified as high risk due to lack of information. Observer reports show that Australian Fur Seals are frequently encountered in the fishery, but overall it appears that the total population has increased in recent years (Stewardson and Knuckey, 2005). The Australian Fur Seal remains at high risk due to its low productivity and high susceptibility.

For detailed results and methodology, refer to *Ecological Risk Assessment for the Effects of Fishing: Report for the Otter Trawl Sub-Fishery of the Commonwealth Trawl Sector of the Southern and Eastern Scalefish and Shark Fishery* (Walker *et al*. 2007)

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

The 2012 Residual Risk analysis of Level 2 PSA results (AFMA, 2012b) only assessed non-teleost and non-chondrichthyan species and included the data from the 2009-2010 and 2010-2011 fishing period. The residual risk guidelines were also applied to species assessed as at high risk in the 2010 Level 2 PSA Residual Risk Analysis.

The most common guideline used was Guideline 7 which reduced the risk based on the fact that management strategies had been implemented which reduce the bycatch of some species. Overall, there was a change from nine potential high risk species prior to the assessment to four potential high risk species. These were:

- *Arctocephalus pusillus doriferus* – Australian Fur Seal / Eared Seals / Seals *(note that this has been recorded as three species)*

- *Diomedeidae (Undifferentiated)* - Albatrosses

A Seabird Management Plan became compulsory for all Otter Trawl Vessels in November 2011. Therefore the true results of the effectiveness of this plan may not become evident until the next ERA is completed.

Risk to the species above will be addressed in the Ecological Risk Management Strategy.

Level 3 Sustainability Assessment of Fishing Effects

The 2012 Sustainability Assessment of Fishing Effects (SAFE) was completed for all 447 species (90 chondrichthyan and 357 teleost) identified in the otter board trawl 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 in cost for doing a SAFE analysis for a few species and doing all species is negligible.

The assessment found that four species, all chondrichthyan, had an estimated fishing mortality rate greater than F_{crash}, the fishing mortality rate above which population extinction will occur in the long term. When uncertainty in both estimated fishing mortality rates and reference points are included in the analysis, 34 species are at least precautionary medium risk and 22 species are at least precautionary high risk. The risk scores below take a precautionary approach and consider the upper 90 per cent confidence interval to determine potential risk.

Table 3 High risk species after Level 3 SAFE analysis

Scientific Name	Common Name	Risk Score
Dipturus gudgeri	Bight Skate	Extreme High Risk
Centrophorus harrissoni	Harrison's Dogfish	Extreme High Risk
Centrophorus zeehaani	Southern Dogfish	Extreme High Risk
Dipturus australis	Common Skate	Extreme High Risk
Epigonus lenimen	Big-eyed Cardinalfish	Precautionary Extreme High Risk
Epigonus robustus	Robust Cardinalfish	Precautionary Extreme High Risk
Epigonus denticulatus	White Cardinalfish	Precautionary Extreme High Risk
Azygopus pinnifasciatus	Righteye Flounder	Precautionary Extreme High Risk
Neocyttus rhomboidalis	Spiky Oreo	Precautionary Extreme High Risk
Deania quadrispinosa	Platypus Shark	Precautionary Extreme High Risk
Dipturus canutus	Grey Skate	Precautionary Extreme High Risk
Etmopterus lucifer	Blackbelly Lantern Shark	Precautionary Extreme High Risk
Centrophorus squamosus	Nilson's Deepsea Dogfish	Precautionary Extreme High Risk
Squalus mitsukurii	Green-Eyed Dogfish	Precautionary Extreme High Risk
Centroscymnus crepidater	Deepwater Dogfish	Precautionary Extreme High Risk
Urolophus sufflavus	Yellow-backed Stingaree	Precautionary Extreme High Risk
Cephaloscyllium albipinnum	Whitefin Swell Shark	Precautionary Extreme High Risk
Galeocerdo cuvier	Tiger Shark	Precautionary Extreme High Risk
Centroscymnus plunketi	Plunket's Shark	Precautionary Extreme High Risk
Ventrifossa nigrodorsalis	Rattail	Precautionary High Risk
Trygonorrhina fasciata	Eastern Fiddler Ray	High Risk
Hydrolagus lemures	Bight Ghost Shark	High Risk

Residual risk analysis (teleost and chondrichthyans)

A summary of the residual risk assessment for the otter trawl fishery is presented in Table 5. The most common guideline used was Guideline 6 which considers catch and effort limits used to reduce risk for the following species;

- *Deania quadrispinosa* - Platypus Shark
- *Centroscymnus crepidater* - Deepwater/Golden Dogfish
- *Etmopterus lucifer* - Blackbelly Lantern Shark
- *Centroscymnus plunketi* - Plunket's Shark
- *Neocyttus rhomboidalis* - Spiky Oreo

Quota is used in the SESSF to limit catch. Platypus Shark, Deepwater/Golden Dogfish, Blackbelly Lantern Shark and Plunket's Shark are managed as a deepwater shark quota basket and are assessed as a single species group under a Tier 4 analysis. Spiky Oreo is part of the Oreo quota basket and is also assessed as a single species under a Tier 4 analysis. Quota for these species is set based on recommended biological catches as a result of the Tier 4 assessments. The risk posed to these species from fishing activities is considered when setting recommended biological catches.

Guideline 7 considers bycatch mitigation and was applied to reduce the risk for the following species:

- *Epigonus lenimen* – Bigeye Cardinalfish
- *Epigonus robustus* – Robust Cardinalfish
- *Epigonus denticulatus* – White Cardinalfish

A study of the effectiveness of bycatch mitigation measures employed in the Commonwealth Trawl Sector showed that Cardinalfish have a high rate of escapement from standard 90mm trawl cod-ends (Knuckey and Ashby, 1998; Knuckey and Ashby, 2003).

The current SESSF Gear Direction 2010 (AFMA, 2010b) mandates a minimum mesh size of 90mm in the cod-end. The Gear Direction facilitates compliance and effective use of these gear modifications. This information was not taken into consideration in the Level 3 SAFE assessment (Dr Shijie Zhou, CSIRO, *pers. comm*.).

Dr Shijie Zhou at CSIRO headed an FRDC project in 2013 titled *ERA extension to assess cumulative effects of fishing on species* (Zhou *et al*, 2013). The key difference under the updated SAFE methodology was that species distribution area was stratified into different regions so that heterogeneous density could be estimated based on data, whereas the 2012 SAFE assumed fish density was homogenous across their distribution. Gear efficiency was also estimated based on data rather than assumed, as it was in 2012. The updated

methodology resulted in two species, Bight Skate and Whitefin Swell Shark, being assessed as at low risk for otter trawl fishing in the CTS. Guideline two considers additional research, and has been applied here to reduce the risk score for Bight Skate and Whitefin Swell Shark to low.

The SESSF Resource Assessment Group (SESSFRAG) considered the Tiger Shark, *Galeocerdo cuvier*, during its March 2014 meeting. The Level 2 PSA report recognises that this species has likely been confused with *Notorynchus cepedianus*, Tasmanian Tiger Shark. There have been no recorded catches of *G. cuvier* in the otter board trawl sector since 2004, and it likely has a much lower susceptibility than is recorded in the Level 3 SAFE. Residual risk guideline 5, which considers low susceptibility and negligible catch, has been applied. The risk rating for this species has been reduced to medium.

Overall there has been a change from 22 high risk species prior to the residual risk assessment to 11 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	*Dipturus gudgeri*	Bight Skate	DI	2.43	3	High		Guideline 2 – Additional Scientific Information	This species was assessed as at low risk from commercial otter trawl fishing operations under an updated SAFE assessment (Zhou, 2012)	Low
Chondrichthyan	*Centrophorus squamosus*	Nilson's Deepsea Dogfish	DI	2.71	3	High		Guideline 2 - Additional scientific assessment	This species was assessed as at precautionary high risk from commercial fishing operations under the Level 3 SAFE assessment (Zhou, 2012)	Precautionary High Risk
Chondrichthyan	*Deania quadrispinosa*	Platypus Shark	BP	2.71	3	High	Deepwater Shark Basket TAC Tier 4 Assessment	Guideline 6 – Effort and catch management arrangements	This species was assessed as at precautionary extreme high risk from commercial fishing operations under the Level 3 SAFE assessment (Zhou, 2012) However, Level 3 SAFE analysis does not consider quota management. This species is managed as a basket quota species with an annual TAC. 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	*Centrophorus harrissoni*	Harrison's Dogfish	DI	2.57	3	High	Upper slope dogfish management strategy.	Guideline 2 - Additional scientific assessment	The *Upper Slope Dogfish Management Strategy* was implemented in October 2012, after the Level 3 SAFE assessment was conducted. The effects of this strategy are yet to be quantified, and cannot be used to downgrade the risk of Harrison's Dogfish. The effect of the plan may be considered during the next ERA. This species was assessed as at extreme high risk from commercial fishing operations under the Level 3 SAFE assessment (Zhou, 2012)	Extreme High Risk

Chondrichthyan	*Centrophorus zeehaani*	Southern Dogfish	DI	2.43	3	High	Upper slope dogfish management strategy.	Guideline 2 - Additional scientific assessment	The Upper Slope Dogfish Management Strategy was implemented in October 2012, after the Level 3 SAFE assessment was conducted. The effects of this strategy are yet to be quantified, and cannot be used to downgrade the risk of Harrison's Dogfish. The effect of the plan may be considered during the next ERA. This species was assessed as at extreme high risk from commercial fishing operations under the Level 3 SAFE assessment (Zhou, 2012)	Extreme High Risk
Chondrichthyan	*Squalus chloroculus*	Greeneye Spurdog	DI	2.43	3	High	Upper slope dogfish management strategy.	Guideline 2 - Additional scientific assessment	The Upper Slope Dogfish Management Strategy was implemented in October 2012, after the Level 3 SAFE assessment was conducted. The effects of this strategy are yet to be quantified, and cannot be used to downgrade the risk of Greeneye Spurdog. The effect of the plan may be considered during the next ERA. This species was assessed as at extreme high risk from commercial fishing operations under the Level 3 SAFE assessment (Zhou, 2012)	Extreme High Risk
Chondrichthyan	*Centroscymnus crepidater*	Deepwater/ Golden Dogfish	BP	2.57	3	High	Deepwater Shark Basket TAC Tier 4 Assessment	Guideline 6 - Effort and catch management arrangements	This species was assessed as at precautionary extreme high risk from commercial fishing operations under the Level 3 SAFE assessment (Zhou 2012) However, Level 3 SAFE analysis does not consider TACs. This species is managed as a basket quota species with a TAC of 85t (east) and 215t (west). 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	*Urolophus sufflavus*	Yellow-backed Stingaree	DI	N/A	N/A	N/A		Guideline 2 - Additional scientific assessment	This species has been added to the Level 3 SAFE assessment for 2012. This species was assessed as at precautionary extreme high risk from commercial fishing operations under the Level 3 SAFE assessment (Zhou, 2012)	Precautionary Extreme High Risk

Chondrichthyan	*Dipturus australis*	Common Skate	DI	2.29	3	High		Guideline 2 - Additional scientific assessment	This species was assessed as at extreme high risk from commercial fishing operations under the Level 3 SAFE assessment (Zhou 2012)	Extreme High Risk
Chondrichthyan	*Dipturus canutus*	Grey Skate	DI	2.14	3	High		Guideline 2 – Additional scientific assessment	This species was assessed as at precautionary extreme high risk from commercial fishing operations under the Level 3 SAFE assessment (Zhou, 2012)	Precautionary Extreme High Risk
Chondrichthyan	*Etmopterus lucifer*	Blackbelly Lantern Shark	BP	2.14	3	High	Deepwater Shark Basket TAC Tier 4 Assessment	Guideline 6 - Effort and catch management arrangements	This species was assessed as at precautionary extreme high risk from commercial fishing operations under the Level 3 SAFE assessment (Zhou, 2012) However, Level 3 SAFE analysis does not consider TACs. This species is managed as a basket quota species with a TAC of 85t (east) and 215t (west). 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	*Cephaloscyllium albipinnum*	Whitefin Swell Shark	BP	2.29	3	High		Guideline 2 – Additional Scientific Information	This species was assessed as at low risk from commercial otter trawl fishing operations under an updated SAFE assessment(Zhou, 2013)	Low
Chondrichthyan	*Galeocerdo cuvier*	Tiger Shark	BP	2.86	3	High		Guideline 5 – Low interaction/capture with low susceptibility	This species was assessed as at precautionary extreme high risk from commercial fishing operations under the Level 3 SAFE assessment (Zhou, 2012) The Level 2 PSA report recognises that this species has likely been confused with *Notorynchus cepedianus*, Tasmanian Tiger Shark. There have been no recorded catches of *G. cuvier* in the otter board trawl sector since 2004, and it likely has a much lower susceptibility than is recorded used in the Level 3 SAFE. Residual risk guideline 5, which considers low susceptibility and negligible catch, has been applied. The risk rating for this species has been reduced to medium.	Medium

Chondrichthyan	*Centroscymnus plunketi*	Plunket's Shark	BP	2.71	3	High	Deepwater Shark Basket TAC Tier 4 Assessment	Guideline 6 - Effort and catch management arrangements	This species was assessed as at precautionary extreme high risk from commercial fishing operations under the Level 3 SAFE assessment (Zhou, 2012) However, Level 3 SAFE analysis does not consider TACs. This species is managed as a basket quota species with a TAC of 85t (east) and 215t (west). 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	*Hydrolagus lemures*	Bight Ghost Shark	DI	2	3	High		Guideline 2 - Additional scientific assessment	This species was assessed as at high risk from commercial fishing operations under the Level 3 SAFE assessment (Zhou, 2012)	High Risk
Chondrichthyan	*Trygonorrhina fasciata*	Eastern Fiddler Ray	DI	2.29	1.89	Med		Guideline 2 - Additional scientific assessment	This species was assessed as at high risk from commercial fishing operations under the Level 3 SAFE assessment (Zhou, 2012)	High Risk
Teleost	*Epigonus lenimen*	Big-eyed Cardinalfish	DI	2	3	High		Guideline 7 and expert override	A study of the effectiveness of bycatch mitigation measures employed in the SETF showed that Cardinalfish have a high rate of escapement from standard 90mm trawl cod-ends (Knuckey and Ashby, 1998; Knuckey and Ashby, 2003). This information was not taken into consideration in the SAFE. The current SESSF Gear Direction 2010 (first introduced in 2005) mandates a minimum mesh size of 90mm in the cod-end. The Gear Direction facilitates compliance and effective use of these gear modifications. As a result, the susceptibility risk score has been reduced to 2 giving an overall risk category of medium. (**See note 2)**	Medium

Teleost	*Epigonus robustus*	Robust Cardinalfish	DI	2	3	High		Guideline 7 and expert override	A study of the effectiveness of bycatch mitigation measures employed in the SETF showed that Cardinalfish have a high rate of escapement from standard 90mm trawl cod-ends (Knuckey and Ashby, 2003). This information was not taken into consideration in the Level 3 SAFE. The current SESSF Gear Direction 2010 (first introduced in 2005) mandates a minimum mesh size of 90mm in the cod-end. The Gear Direction facilitates compliance and effective use of these gear modifications. As a result, the susceptibility risk score has been reduced to 2 giving an overall risk category of medium. (**See note 2)**	Medium
Teleost	*Epigonus denticulatus*	White Cardinalfish	DI	2	3	High		Guideline 7 and expert override	A study of the effectiveness of bycatch mitigation measures employed in the SETF showed that Cardinalfish have a high rate of escapement from standard 90mm trawl cod-ends (Knuckey and Ashby, 2003). This information was not taken into consideration in the Level 3 SAFE. The current SESSF Gear Direction 2010 (first introduced in 2005) mandates a minimum mesh size of 90mm in the cod-end. The Gear Direction facilitates compliance and effective use of these gear modifications. As a result, the susceptibility risk score has been reduced to 2 giving an overall risk category of medium. (**See note 2)**	Medium
Teleost	*Azygopus pinnifasciatus*	Righteye Flounder	DI	1.29	3	High		Guideline 2 - Additional scientific assessment	This species was assessed as at precautionary extreme high risk from commercial fishing operations under the Level 3 SAFE assessment (Zhou, 2012)	Precautionary Extreme High Risk
Teleost	*Ventrifossa nigrodorsalis*	Rattail	DI	1.86	3	High		Guideline 2 - Additional scientific assessment	This species was assessed as at precautionary high risk from commercial fishing operations under the Level 3 SAFE assessment (Zhou, 2012)	Precautionary High Risk

Teleost	*Neocyttus rhomboidalis*	Spiky Oreo	BP	2	3	High	Oreo TAC Tier 4 Assessment	Guideline 6 - Effort and catch management arrangements	This species was assessed as at precautionary extreme high risk from commercial fishing operations under the Level 3 SAFE assessment (Zhou, 2012) However, Level 3 SAFE analysis does not consider TACs. This species is managed as a basket quota species with a TAC of 132 t. 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

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 the 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	0	0	0
BP	4	0	0	2	4	0
DI	5	2	0	9	5	2
Total	9	2	0	11	9	0

6. 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 SAFE analysis. In 2012 however, all teleost and chondrichthyan species were subject to a SAFE. While this is considered as a high level and quantitative assessment, there are still some management arrangements, such as catch limits and interaction rates which are not considered. For example, SAFE 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 22 species assessed as high risk under the SAFE. After application of the residual risk guidelines, nine species had the risk scored reduced to medium and two species to low. Five species of deepwater shark had their risk scores reduced using Guideline 6, which considers the deepwater shark TAC. Three species of Cardinalfish had their risk scores reduced using Guideline 7, which considers bycatch mitigation strategies. Two chondrichthyan species had their risk score reduced to low using guideline two, which considers additional research. The Tiger Shark, *Galeocerdo cuvier*, had its risk score reduced to medium after application of residual risk guideline 5, which considers low interaction and susceptibility.

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 will be updated periodically and this will capture how effective the ERM response to high risk species has been.

7. Consultation and clearance

The residual risk analysis commenced in October 2013 and was finalised in December 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. 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. Risk scores for Bight Skate and Whitefin Swell Shark were adjusted in November 2014 when AFMA became aware of an updated SAFE for these species. Final clearance has been given 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	A risk assessment process whereby the productivity and susceptibility attributes of a species are used to calculate risk scores at a species level.
Residual Risk	In the context of this document residual risk means the residual risk after the Level 2 PSA assessment as well as after the Level 3 SAFE.
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: organism's 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.

REFERENCES

Australian Fisheries Management Authority, 2010a. Residual Risk Assessment of the Level 2 Ecological Risk Assessment Species Results: Report for the Otter Trawl Fishery. Australian Fisheries Management Authority, Canberra.

Australian Fisheries Management Authority, 2010b. *Southern and Eastern Scalefish and Shark Fishery (Minimum Gear Requirements) Direction 2010*, Federal Register of Legislative Instruments F2010L01820. Australian Fisheries Management Authority, Canberra, viewed 16 May 2012.

Australian Fisheries Management Authority, 2012a. *Southern and Eastern Scalefish and Shark Fishery, Management Arrangements Booklet*. Australian Fisheries Management Authority, Canberra.

Australian Fisheries Management Authority, 2012b. *Residual Risk Assessment of the Level 2 Ecological Risk Assessment for Non-Teleost and Non-Chondrichthyans: Report for the Otter Trawl Fishery*. Australian Fisheries Management Authority, Canberra.

Hobday, A.J., Smith, A. and Stobutzki, I., 2004. *Ecological risk Assessment for Australian Commonwealth Fisheries. Final Report Stage 1. Hazard identification and preliminary risk assessment. Report Number R01/0934*. CSIRO Marine Research.

Hobday, A.J., Smith, A., Webb, H., Daley, R., Wayte, S., Bulman, C., Dowdney, J., Williams, A., Sporcic, M., Dambacher, J., Fuller, M. and Walker, T., 2007. *Ecological Risk Assessment for Effects of Fishing: Methodology, Report Ro4/1072*. Australian Fisheries Management Authority, Canberra.

Knuckey, I.A. and Ashby, C. (1998) *Effects of Trawling Subprogram: Maximising yields and reducing discards in the South East Trawl Fishery through gear development and evaluation.* FRDC Project 1998/204. Fisheries Victoria – Fisheries Research Branch 279pp.

Knuckey, I.A. and Ashby, C. (2003) *Bycatch Reduction in Australia's South East Trawl Fishery: Letting the Message Get Through as Well as the Fish*. Marine and Fisheries Research Institute, Queenscliff.

Smith, A.D.M., Hobday, A.J., Webb, H., Daley, R., Wayte, S., Bulman, C., Dowdney, J., Williams, A., Sporcic, M., Dambacher, J., Fuller, M., Furlani, D., Griffiths, S., Kenyon, R. and Walker, T., 2007. *Ecological Risk Assessment for the Effects of Fishing: Final Report R04/1072*. Final Report for the Australian Fisheries Management Authority, Canberra.

Stewardson, C.L. and Knuckey, I.A. (2005). South East Trawl Fishery: Seal Bycatch Guidelines for Reporting and Data Collection. Bureau of Rural Sciences, Canberra, 20 p.

Walker, T., Dowdney, J., Williams, A., Fuller, M., Webb, H., Bulman, C., Sporcic, M., Wayte, S., 2007. *Ecological Risk Assessment for the Effects of Fishing: Report for the Otter Trawl Fishery of the Commonwealth Trawl Sector of the Southern and Eastern Scalefish and Shark Fishery.* Report for the Australian Fisheries Management Authority, Canberra.

Wilson, D., Curtotti, R., Begg, G. and Phillips, K. (eds) 2009. *Fishery Status Reports 2008: Status of Fish Stocks and Fisheries Managed by the Australian Government*, Bureau of Rural Sciences & Australian Bureau of Agricultural and Resource Economics, Canberra.

Wilson D, Curtotti R, Begg G & Phillips K (eds) 2009, *Fishery Status Reports 2008: Status of fish stocks and fisheries managed by the Australian Government*, Bereau of Rural Sciences & Australian Bereau of Agricultural and Resource Economics, Canberra.

Woodhams, J., Stobutzki, I., Vieira, S., Curtotti, R. and Begg, G.A. (eds), 2011. *Fishery Status Reports 2010: Status of Fish Stocks and Fisheries Managed by the Australian Government*. Australian Bureau of Agricultural and Resource Economics and Sciences, Canberra.

Woodhams, J, Vieira, S & Stobutzki, I (eds) 2013, *Fishery status reports 2012*, Australian Bereau of Agricultural and Resource Economics and Sciences, Canberra.

Zhou, S., Smith, A.D.M., and Fuller, M., 2007. *Rapid Quantitative Risk Assessment for Bycatch Species in Major Commonwealth Fisheries*. Final Report on AFMA project. CSIRO Cleveland.

Zhou, S., Fuller, M. and Daley, R., 2012. *Sustainability Assessment of Fish Species Potentially Impacted in the Southern and Eastern Scalefish and Shark Fishery: 2007-2010*. Report to the Australia Fisheries Management Authority, Canberra.

Zhou, S., Daley, R., Fuller, M., Bullman, C., Hobday, A., Courtney, T., Ryan, P and Ferrel, D., 2013. *ERA extension to assess cumulative effects of fishing on species.* Fisheries Research and Development Cooporation.