



Australian Government

Australian Fisheries Management Authority

 Residual Risk Assessment of the
Level 2 Ecological Risk Assessment
Species Results
Report for the Eastern Tuna and Billfish Fishery



March 2009



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 by fisheries. To support implementation of the ERM framework, AFMA will fully document the risk management 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 priority species as part of the ERM framework.

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

In early 2007, the residual risk guidelines were developed in consultation with CSIRO and stakeholders to assist AFMA managers in refining the Level 2 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 the most current management arrangements. To assist managers, a clear set of decision rules are outlined that are to be applied to individual species.

For the Eastern Tuna and Billfish fishery, the results from the Level 2 PSA table are used here to determine the residual risk for the fishery. Overall 34 species from a total of 390 assessed were deemed to be high risk. There has been a change from 34 high risk species prior to the residual risk assessment to five high residual risk species. These included two byproduct shark species and three threatened, endangered and protected (TEP) species including two whales and a turtle. The two primary reasons behind changes in risk were because of a zero observed interaction with the species and compliance with the statutory Threat Abatement Plan (TAP) for the incidental catch of seabirds.



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1. OVERVIEW

1.1. Ecological Risk Management Process

A key component in the Australian Fisheries Management Authority's (AFMA's) implementation of the ecological component of ESD 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.

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

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



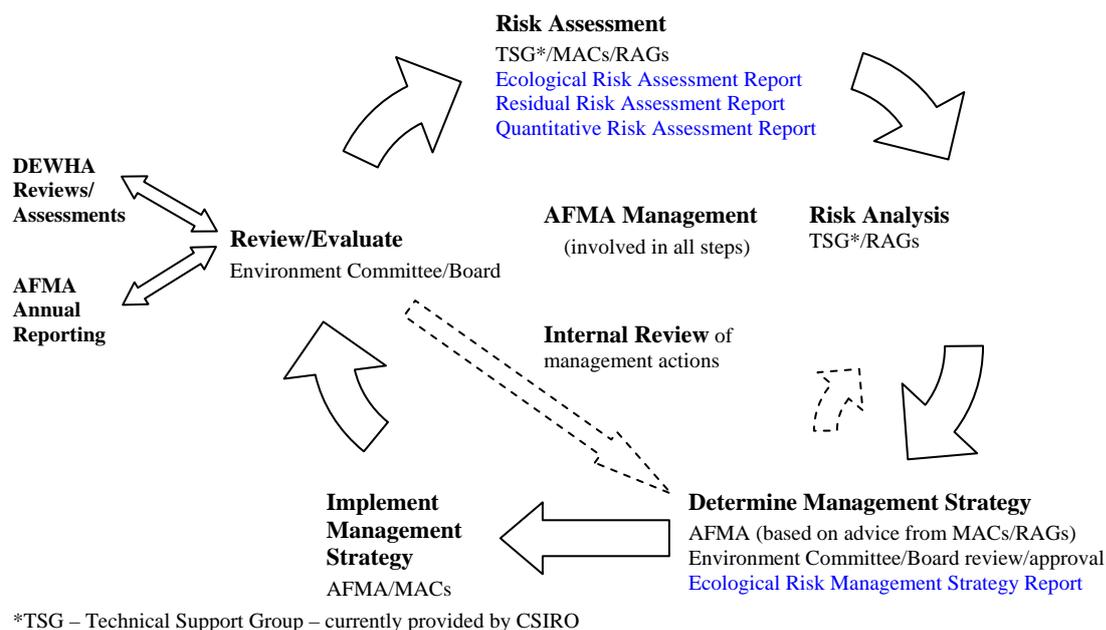


Figure 1 Ecological Risk Management framework

1.2. ERA Project

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

1.3. ERA Methodology

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

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

The ERA assessment adopts a hierarchical approach (refer to **Figure 2**). With every progressive level, the precision increases along with confidence in the risk scores (noting that not all components progress all the way through the assessment hierarchy). Each of these levels is outlined in more detail below.



Risk Assessment Hierarchy

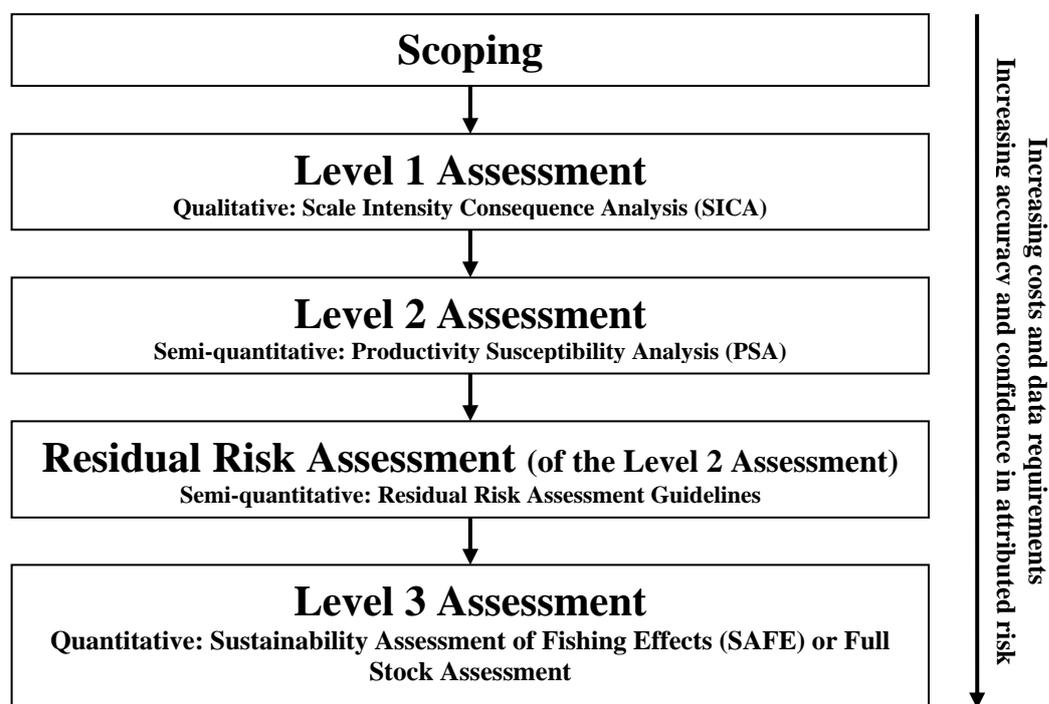


Figure 2 The different levels of risk assessment and the trend in confidence and cost

Scoping

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

Level 1 – Scale, Intensity, Consequence Analysis

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



Level 2 – Productivity Susceptibility Analysis

Level 2 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) within any of the ecological components 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 of the unit:

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

For the Level 2 assessment, each unit within the ecological component is assessed for the risk it faces from the fishery. The 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 is 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'.

Level 2 PSA Residual Risk Assessment

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

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) recently developed by CSIRO to assess multiple species or a fully quantitative assessment of a specific species (similar to a standard stock assessment). Quantitative risk assessments constituting the equivalent of a Level 3 risk analysis currently exist for many species. Before proceeding to a fully quantitative Level 3 assessment, investigation of suitable existing information to further understand the risk scores for high risk units should be identified. This may help to overcome some of the constraints of the Level 2 PSA results (outlined below) prior to proceeding to more costly Level 3 analysis for the remaining high risk units.

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. Quantifying the actual risk for any species requires a Level 3 assessment. 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 of the actual risk for some species. The management arrangements that are not accounted for in the Level 2 assessment include:

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



Management arrangements that *are* accounted for in the assessment include:

- Spatial management that limits the range of the fishery (affecting availability);
- Gear limits that affect the size of animals that are captured (selectivity); and
- Handling practices that may affect the survival of species after capture (post capture mortality).

As a result, the Level 2 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.

When AFMA reviewed the methodology using example fisheries, 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.



Improved data

The ERA process adopts a precautionary approach if there is uncertainty about an attribute the higher risk score is used. At the Level 2 PSA when a species is missing either a productivity or susceptibility attribute the score defaults to a high risk category. Furthermore, species attributes that were originally calculated for the fishery may be out-of-date because additional or more precise information has become available.

Additional information

Since the time of the original ERA assessment, additional information may now be available as a result of other investigations and research etc.

Spatial assumptions

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.

Interaction and catch data

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 that 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.

Management arrangements

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

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

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

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



2. LEVEL 2 ERA RESIDUAL RISK PROCESS

2.1. Level 2 ERA Residual Risk

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

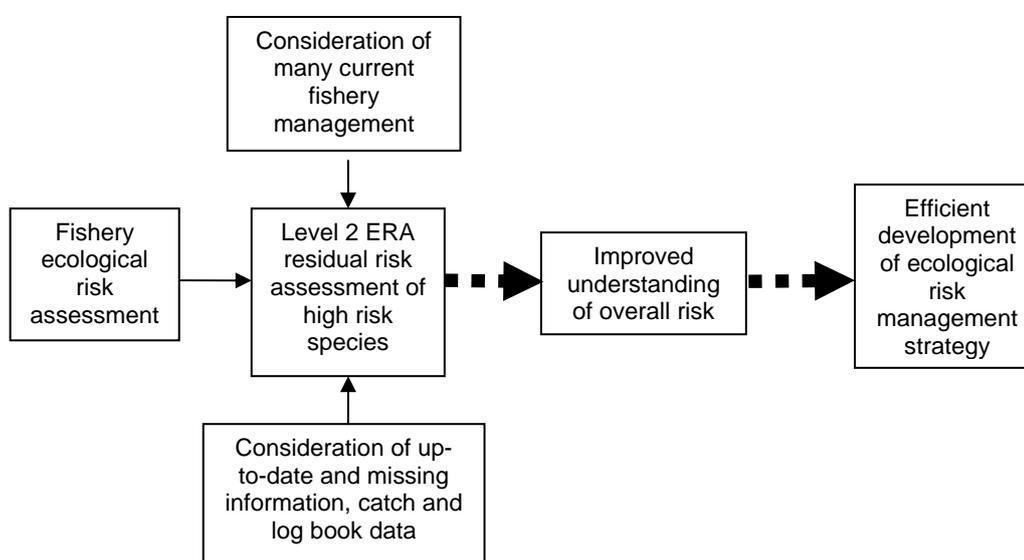


Figure 3 Flow diagram of the Level 2 ERA residual risk process

2.2. Level 2 PSA Residual Risk Process

In 2007 AFMA, with input from CSIRO and stakeholders, developed a set of guidelines to assess the residual risk for species identified as having a high potential risk based on the Level 2 analysis. The guidelines have been designed to ensure that a consistent, transparent and repeatable process is adopted across all fisheries. A summary of the guidelines is given in **Table 1**. Within each category there are clear decision rules that can be applied to a species (if relevant) to calculate Level 2 PSA residual risk. Each of the guidelines was 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 have been 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 within the fishery, then by taxonomic group;
- Creating a list of all management arrangements not included in the Level 2 PSA results for reference when applying the guidelines;
- Considering each management arrangement to relevant high risk species;
- Collating spatial information from experts, observer and logbook data for all high risk species for reference when applying the guidelines;
- Deciding if and what guideline applies to each of the high risk species by conducting a species-by-species application;
- Making changes to the necessary attributes, productivity and susceptibility scores to calculate the Level 2 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 MACs for feedback; and
- Finalising the Level 2 PSA residual risk results for release.

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**.

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 Number	Summary
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.

* For the complete Residual Risk Guidelines, refer to
http://www.afma.gov.au/environment/eco_based/eras/reports.htm

Table 2 Stakeholder Engagement

Guideline stage	Stakeholder interaction	Date of interaction	Stakeholder group	Summary of outcome
Draft Level 2 ERA residual risk assessment trial in SESSF	AFMA workshop	December 12 th , 2006	Trial application of draft Level 2 ERA residual risk guidelines	Agreement much further work was needed
Trial assessment of residual risk guidelines using CSIRO draft ERA results	AFMA workshop	21 May 2007	Fisheries managers in ETBF, with consultation with members of MACs and RAGs	Draft level 2 ERA results presented and application of guidelines discussed. Catalyst for major revision of multiple areas in guidelines by AFMA
CSIRO interim final ERA results available and draft residual risk guidelines are applied	Bycatch Working Group and ETMAC 69	18-20 June 2007	ETMAC members and bycatch working group members	Industry through the MAC and bycatch subcommittee provided feedback on draft residual risk guidelines and assisted refinement of ERA/ERM outcomes.
CSIRO final ERA results available and application of draft residual risk guidelines continues	AFMA Emails	Late June 2007	Scientific experts on marine mammals, birds and turtles	Provided information on biological attributes, spatial distributions and population dynamics for species residual risk assessment
Application of final residual risk guidelines is completed	Residual Risk Working Group	10 July 2007	Residual risk working group members from MAC	Applied guidelines to example species (swordfish, whale, turtle, shearwater & shark). Following discussion AFMA later revised residual risk assessment of species and provided updated results to group.
Presentation of residual risk results for ETBF species	ETRAG	19 July 2007	ETRAG members	Noted the application of residual risk guidelines to the ETBF and requested more time to examine the process and be provided with a copy of the finalised residual risk report
Preparation of draft ERA residual risk report for ETBF	ETMAC 70	15-16 November 2007	ETMAC members	Presented with draft residual risk report with final ERA results for the ETBF. Comment sought



Further drafting of the ERA residual risk report for the ETBF	Provided out-of-session to ETMAC 71-72	April 2008	ETMAC members	from MAC on the report. Presented with updated version of residual risk report which had a change to 8 high residual risk species. No further comments were received.
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3. RESULTS

3.1. ERA Results

Overall 34 species from a total of 390 assessed were deemed to be high risk in the ETBF. These included one target species, three bycatch/byproduct species and 30 TEP species. There has been a change from 34 high risk species prior to the residual risk assessment to five high residual risk species. These included two bycatch/byproduct shark species and three protected species: two whales and a turtle.

The two primary reasons behind changes in risk were because of a zero observed interaction with the species and the fact that the fishery is meeting (exceeding) targets set under the statutory Threat Abatement Plan (TAP) for the incidental catch of seabirds.

Fishery Description

Gear:	Pelagic longline, minor line (handline, troll, rod and reel)
Area:	The ETBF extends from Cape York, Queensland, to the South Australian/Victorian border. Since July 2002 the fishery has also included the area of the high seas within the Convention on the Conservation and Management of Highly Migratory Fish Stocks in the Western Central Pacific Ocean. Major ports used by the fleet include Cairns, Mooloolaba, Sydney and Ulladulla.
Depth range:	>200m
Fleet size:	92 active vessels in 2005/06
Effort:	9.33 million hooks set on 8,976 shots in 2005/06.
Landings:	Retained catch (in tonnes) for 2005/06 was 1,524 for yellowfin tuna, 555 for bigeye tuna, 1,447 for broadbill swordfish, 506 for striped marlin, 1,584 for albacore tuna, 114 for sharks and 561 for other species. Total of 6,291 tonnes retained.
Discard rate:	Observed discard rate for target species in 2005/06 was 5% for yellowfin tuna, 2% for albacore tuna, 5% for broadbill swordfish, 12% for bigeye tuna and 6% for striped marlin. Lancetfish, sunfish and snake mackerel have the highest discard rates where almost 100% of those caught were not kept in 2005/06.
Main target species:	Yellowfin tuna (<i>Thunnus albacares</i>), bigeye tuna (<i>T. obesus</i>), albacore tuna (<i>T. alalunga</i>), broadbill swordfish (<i>Xiphias gladius</i>) and striped marlin (<i>Tetrapturus audax</i>).
Management:	AFMA manages the commercial sector through a system of input and output controls, including limited entry, zoning, spatial closures, bycatch provisions, gear restrictions and total allowable catch



arrangements. SFRs are being implemented, which will be based on a system of individual tradeable effort units (hooks)

Observer program: An AFMA run observer program for the ETBF began in September 2001 with a target of covering 6% of the fishery. In 2003 this was revised to 5.1% which was considered by CSIRO a representative sample of the fishing effort. The current level of observer coverage in the fishery is around 8.5%.

Ecological Units Assessed

Target species:	5
Target species/Bait:	3
By-product/Bycatch species:	44 and 54 respectively
TEP species:	284
Habitats:	274 (264 benthic, 10 pelagic)
Communities:	64 (55 demersal, 9 pelagic)

Level 1 Results

Habitats were eliminated at Level 1 –no risk scores were greater than 2. There was at least one risk score of 3 (moderate) or above for each of the other components.

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

- Fishing (direct impacts on all ecological components except habitats,
- Fishing without capture (direct impact on protected species),
- Translocation of species (impact on all components except habitats)
- On board processing (impact on protected species), and
- Discarding catch (impact on protected species).

Significant external hazards included impacts from other fisheries in the region.

Risks rated as major (risk score 4) included direct impacts from primary fishing operations on target species, and disease introduction through imported bait on target species and communities. Severe impacts (risk score 5) were confined to direct and indirect impacts on TEP species.

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

Level 2 Results

Species

A total of 390 species were assessed at Level 2 using the PSA analysis. Of these, 34 were assessed to be at high risk, including 1 target species (broad billed swordfish), 3 byproduct species, 0 bycatch species, and 30 TEP species. By taxa, the high risk species comprised 1 teleost, 4 chondrichthyans, 23 marine birds, 5 marine mammals, and 1 marine reptile (turtle). Of the 390 species assessed, over rides were used on 145 species.



Of the 34 species assessed to be at high risk, four species had more than 3 missing attributes.

The five target species are managed through a system of effort limits (number of hook deployments) modified by spatial “usage rates” that allows some direction of effort away from depleted areas.

Of the 44 byproduct species, three chondrichthyan species (longfin mako, porbeagle and dusky shark) were identified at high risk. None of these three high risk species are currently subject to explicit management controls. Logbooks show that dusky shark are caught in considerable numbers, and it is likely that many bronze whalers in the logbooks are in fact mis-identified dusky sharks. Of the 56 bycatch species, none were assessed to be at high risk.

The main ecological sustainability issue for species appears to be catches of protected species, in particular seabirds, leatherback turtles, and perhaps to a lesser extent, marine mammals. Seabirds are attracted to fishing vessels by discarded offal and baits and on occasion ingest baited hooks during the setting or, less commonly, hauling of the longline.

Oceanic longline fishing is listed as a key threatening process for seabirds under the *EPBC Act 1999* requiring the development of a Threat Abatement Plan (TAP). The current TAP (2006) requires the ETBF to significantly reduce the bycatch of seabirds in oceanic longline operations and maintain a bycatch rate of less than 0.05 birds per 1000 hooks in all fishing areas (by 5 degree latitudinal bands) and all seasons (1 September – 30 April; 1 May – 31 August).

AFMA has implemented fishing permit conditions that are designed to avoid the capture of seabirds. Conditions to fish south of 25°S include the mandatory use of bird scaring tori lines to scare birds away from the line and weighted swivels to sink the line out of reach of birds.

In 2006 and 2008 a number of bird interactions were recorded in a relatively small part of the fishery. In both years fishing in the area of high bird interactions was restricted to night setting and mitigation measures were reviewed. The captures in winter season of 2008 resulted in a bird interaction rate of 0.06 birds per 1000 hooks in the area between 30° -35° S, in excess of the TAP trigger limit. The fishery has remained closed to daylight setting in this area.

The responses to interactions with seabirds are mandated in the TAP and AFMA and the fishing industry have proven the current TAP is capable of minimising interactions and dealing with the occurrence of any unusual issues.

Capture of marine mammals is less of an issue than seabirds, but some smaller species of whale are occasionally caught, though many survive capture. Improved species identification for sightings and gear interactions by observers would help reduce uncertainty for this group. Concerns remain for risk to turtle species, many of which are caught in longline operations, though many appear to survive capture. Risk to turtles is likely to be higher from trawling, but the data summaries show that some leatherback turtles are caught and killed each year by ETBF longline operations. The species of most conservation concern (loggerhead turtles) is also captured routinely, but no deaths have been recorded by observers to date.



Habitats

The habitat component did not require assessment at Level 2 for the ETBF longline sub-fishery.

Communities

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

Summary

Sustainability of both target and non-target catch is an important issue for the ETBF longline sector. The high risk target species, swordfish, is now under an interim quota. The non-target group at highest risk is undoubtedly seabirds, and this issue is being addressed through the Threat Abatement Plan and subsequent processes. Some species of turtles may also be at risk from capture, and interactions with marine mammals should continue to be monitored. While two species of chondrichthyans (longfin mako and dusky shark) were a high risk, this is a taxa group that will require increased focus and monitoring. The Level 1 analysis also identified disease risk from imported bait as a potential issue.

3.2. Level 2 PSA Residual Risk Results

The residual risk assessment summary for the ETBF is given in Table 4. Overall 34 species were assessed: one target species, three bycatch/byproduct species and 30 TEP species. A summary of the number of species in each category of risk and the guidelines used for each component are given in Table 3. The most common guidelines used were Guidelines 5 and 7. Overall there has been a change from 34 high risk species prior to the residual risk assessment to five high residual risk species.



Table 3 Level 2 PSA Residual Risk Results

Taxonomic Group	Common Name	Scientific Name	Role in Fishery*	Productivity	Susceptibility	Level 2 ERA Risk Category Score	Current and Planned Management/ Assessment	Level 2 ERA Residual Risk Guideline(s) Applied	Justification	Level 2 ERA Residual Risk Score
Chondrichthyan	Longfin Mako	<i>Isurus paucus</i>	BP	2.71	2.33	High 3.58	Ban of wire traces A 20 shark trip limit to reduce targeting.	Guideline 7	ETBF has had a shark trip limit in place since 2000 that authorises the take of 20 sharks per trip. However there is no limit on number of trips that can be undertaken and it wasn't developed through a scientific assessment: therefore there was no change in risk score. Big sharks are often released alive from pelagic longline operations in the ETBF. Typical practice for fisher's is to cut off sharks at the waterline well before they reach the deck of the boat. Wire Trace was banned across entire ETBF in July 2005. Prior to the ban wire was used by up to 40% of operators or maximums of 25 and 22 boats for the years 2000 and 2002. Research conducted off north-eastern Australia comparing the catch rates of nylon monofilament traces to wire traces found that	High 3.31

Taxonomic Group	Common Name	Scientific Name	Role in Fishery*	Productivity	Susceptibility	Level 2 ERA Risk Category Score	Current and Planned Management/ Assessment	Level 2 ERA Residual Risk Guideline(s) Applied	Justification	Level 2 ERA Residual Risk Score
									the catch rates of sharks using mono were 30% less than when using wire. Therefore reduce selectivity of sharks to capture.	
Chondrichthyan	Porbeagle Shark	<i>Lamna nasus</i>	BP	2.71	1.67	High 3.19	Ban of wire traces A 20 shark trip limit to reduce targeting.	Guideline 7	As above	Medium 3.07
Chondrichthyan	Dusky Shark	<i>Carcharhinus obscurus</i>	BP	3	1.67	High 3.43	Ban of wire traces A 20 shark trip limit to reduce targeting.	Guideline 7	As above	High 3.33
Chondrichthyan	White Shark	<i>Carcharodon carcharias</i>	TEP	2.86	1.44	High 3.20	Ban of wire traces	Guideline 5 Guideline 7	There is an effective level of observer coverage in the ETBF. CSIRO in 2003 recommended 5.1% as an effective level of coverage in the ETBF but this has since been exceeded with a revised target of 8.5% for the fishery due to increased coverage during SBT season. The TAP also requires 5% coverage in 5° latitude bands in the ETBF. Total observer interaction data for this species was 4 (which was considered minimal in light of none being hooked) with a	Medium 3.14

Taxonomic Group	Common Name	Scientific Name	Role in Fishery*	Productivity	Susceptibility	Level 2 ERA Risk Category Score	Current and Planned Management/ Assessment	Level 2 ERA Residual Risk Guideline(s) Applied	Justification	Level 2 ERA Residual Risk Score
									negligible level of cryptic mortality. Species has a low susceptibility of 1.44 so reduce risk score from high to medium. Wire Trace was banned across entire ETBF in July 2005. Prior to the ban wire was used by up to 40% of operators or maximums of 25 and 22 boats for the years 2000 and 2002. Research conducted off north-eastern Australia comparing the catch rates of nylon monofilament traces to wire traces found that the catch rates of sharks using mono were 30% less than when using wire. Therefore reduce selectivity of sharks to capture.	
Teleost	Broad Billed Swordfish	<i>Xiphias gladius</i>	TA	1.86	3.00	High 3.53	TAC of 1,400t implemented 1 January 2006	Guideline 6	In response to localised depletion, broadbill swordfish is under a competitive TAC of 1,400t. The TAC was developed scientifically using CPUE and annual catch data. The scientific models suggest this limit is precautionary (Kolody 2006). This limit is	Medium 3.18

Taxonomic Group	Common Name	Scientific Name	Role in Fishery*	Productivity	Susceptibility	Level 2 ERA Risk Category Score	Current and Planned Management/ Assessment	Level 2 ERA Residual Risk Guideline(s) Applied	Justification	Level 2 ERA Residual Risk Score
									<p>designed to improve the status of the stock over a 5 year period. In managing this TAC trigger limits have been set that apply to the total catch of broadbill for a specified period of time. If this trigger limit is reached within a specified period, all operators will be subject to a 10 fish bycatch limit.</p> <p>Kolody (2008) suggests that in broad terms we are above the associated MSY reference points and that the status of the stock has improved since the 2006 assessment.</p>	
Marine Bird	Buller's Albatross	<i>Thalassarche bulleri</i>	TEP	2.43	2.33	High 3.37	Species is subject to a TAP	Guideline 7	<p>Species has a TAP in place which seeks to ensure the fishery does not exceed a catch rate of 0.05 birds per 1000 hooks. Mitigation measures such as tori line use, line-weighting, no offal discharge and using thawed bait have reduced seabird catch. These reduce the encounterability of seabirds to hooks. In 2006 and 2008 a number of bird</p>	Medium 2.83

Taxonomic Group	Common Name	Scientific Name	Role in Fishery*	Productivity	Susceptibility	Level 2 ERA Risk Category Score	Current and Planned Management/ Assessment	Level 2 ERA Residual Risk Guideline(s) Applied	Justification	Level 2 ERA Residual Risk Score
						High 3.37			interactions were recorded in a relatively small part of the fishery. In both years fishing in the area of high bird interactions was restricted to night setting and mitigation measures were reviewed. The captures in winter season of 2008 resulted in a bird interaction rate of 0.06 birds per 1000 hooks in the area between 30° - 35° S, in excess of the TAP trigger limit. The fishery has remained closed to daylight setting in this area. In every season the fishery as a whole has remained below the TAP level of 0.05 birds per 1000 hooks. The responses to interactions with seabirds are mandated in the TAP and AFMA and the fishing industry have proven the current TAP is capable of minimising interactions and dealing with the occurrence of any unusual issues.	Medium 2.83
Marine Bird	Shy Albatross	<i>Thalassarche cauta</i>	TEP	2.43	2.33	High 3.37	Species is subject to a	Guideline 7	As above	Medium 2.83

Taxonomic Group	Common Name	Scientific Name	Role in Fishery*	Productivity	Susceptibility	Level 2 ERA Risk Category Score	Current and Planned Management/ Assessment	Level 2 ERA Residual Risk Guideline(s) Applied	Justification	Level 2 ERA Residual Risk Score
							TAP			
Marine Bird	Yellow-nosed Atlantic Albatross	<i>Thalassarche chlororhynchos</i>	TEP	2.29	2.33	High 3.27	Species is subject to a TAP	Guideline 7	As above	Medium 2.70
Marine Bird	Grey-headed Albatross	<i>Thalassarche chrysostoma</i>	TEP	2.43	2.33	High 3.37	Species is subject to a TAP	Guideline 7	As above	Medium 2.83
Marine Bird	Southern Royal Albatross	<i>Diomedea epomophora</i>	TEP	2.57	3.00	High 3.95	Species is subject to a TAP	Guideline 7	As above	Medium 3.06
Marine Bird	Wandering Albatross	<i>Diomedea exulans</i>	TEP	2.57	3.00	High 3.95	Species is subject to a TAP	Guideline 7	As above	Medium 3.06
Marine Bird	Black-browed Albatross	<i>Thalassarche melanophrys</i>	TEP	2.43	2.33	High 3.37	Species is subject to a TAP	Guideline 7	As above	Medium 2.83
Marine Bird	Sooty Albatross	<i>Phoebastria fusca</i>	TEP	2.29	2.33	High 3.27	Species is subject to a TAP	Guideline 7	As above	Medium 2.70
Marine Bird	Salvin's Albatross	<i>Thalassarche salvini</i>	TEP	2.57	2.33	High 3.47		Guideline 3	This species has 3 missing productivity attributes (Average Max Age, Average Age at Maturity and Trophic Level). There are closely related species from the genus <i>Thalassarche</i> including Shy Albatross, White-capped Albatross and Campbell Albatross. The attribute risk scores from these three species were the same for the missing productivity attributes and were therefore borrowed for this species.	Medium 2.83

Taxonomic Group	Common Name	Scientific Name	Role in Fishery*	Productivity	Susceptibility	Level 2 ERA Risk Category Score	Current and Planned Management/ Assessment	Level 2 ERA Residual Risk Guideline(s) Applied	Justification	Level 2 ERA Residual Risk Score
Marine Bird	Chatham Albatross	<i>Thalassarche eremita</i>	TEP	2.86	3.00	High 4.14		Guideline 3	This species has 3 missing productivity attributes (Average Max Age, Average Age at Maturity and Trophic Level). There are closely related species from the genus <i>Thalassarche</i> including Shy Albatross, White-capped Albatross and Campbell Albatross. The attribute risk scores from these three species were the same for the missing productivity attributes and were therefore borrowed for this species.	Medium 2.95
Marine Bird	South Polar Skua	<i>Catharacta maccormicki</i>	TEP	3.00	1.67	High 3.43		Guideline 1	Literature review of missing productive information for 4 out of 7 attributes. Missing data was added for Average Max Size: 353cm, Fecundity: 2 eggs, Average Max Age: 10.5 years and Average Age of Maturity: 5 years.	Low 2.63
							Species is subject to a TAP	Guideline 7	Species has a TAP in place which seeks to ensure the fishery does not exceed a catch rate of 0.05 birds per 1000 hooks. Mitigation measures such as tori	

Level 2 ERA Residual Risk Score	
Justification	<p>line use, line-weighting, no offal discharge and using thawed bait have reduced seabird catch. These reduce the encounterability of seabirds to hooks. In 2006 and 2008 a number of bird interactions were recorded in a relatively small part of the fishery. In both years fishing in the area of high bird interactions was restricted to night setting and mitigation measures were reviewed. The captures in winter season of 2008 resulted in a bird interaction rate of 0.06 birds per 1000 hooks in the area between 30° - 35° S, in excess of the TAP trigger limit. The fishery has remained closed to daylight setting in this area. In every season the fishery as a whole has remained below the TAP level of 0.05 birds per 1000 hooks. The responses to interactions with seabirds are mandated in the TAP and AFMA and the fishing industry</p>
Level 2 ERA Residual Risk Guideline(s) Applied	
Current and Planned Management/ Assessment	
Level 2 ERA Risk Category Score	
Susceptibility	
Productivity	
Role in Fishery*	
Scientific Name	
Common Name	
Taxonomic Group	

Taxonomic Group	Common Name	Scientific Name	Role in Fishery*	Productivity	Susceptibility	Level 2 ERA Risk Category Score	Current and Planned Management/ Assessment	Level 2 ERA Residual Risk Guideline(s) Applied	Justification	Level 2 ERA Residual Risk Score
									have proven the current TAP is capable of minimising interactions and dealing with the occurrence of any unusual issues.	
Marine Bird	White-capped Albatross	<i>Thalassarche steadi</i>	TEP	2.71	1.67	High 3.19	Species is subject to a TAP	Guideline 7	As above.	Medium 2.98
Marine Bird	Tristan Albatross	<i>Diomedea dabbenena</i>	TEP	2.86	3.00	High 4.14	Species is subject to a TAP	Guideline 7	As above	Medium 3.06
Marine Bird	Gibson's Albatross	<i>Diomedea gibsoni</i>	TEP	2.86	3.00	High 4.14	Species is subject to a TAP	Guideline 7	As above	Medium 3.06
Marine Bird	Campbell Albatross	<i>Thalassarche impavida</i>	TEP	2.71	3.00	High 4.05	Species is subject to a TAP	Guideline 7	As above	Medium 3.06
Marine Bird	Wedge-tailed Shearwater	<i>Diomedea sanfordi</i>	TEP	2.43	3.00	High 3.86	Species is subject to a TAP	Guideline 7	As above.	Medium 3.06
Marine Bird	Indian yellow-nosed Albatross	<i>Thalassarche carteri</i>	TEP	2.57	2.33	High 3.47	Species is subject to a TAP	Guideline 7	As above	Medium 2.95
Marine Bird	Antipodean Albatross	<i>Diomedea antipodensis</i>	TEP	2.86	1.67	High 3.31	Species is subject to a TAP	Guideline 7	As above	Medium 3.11
Marine Bird	Northern Royal Albatross	<i>Diomedea sanfordi</i>	TEP	2.57	3.00	High 3.95	Species is subject to a TAP	Guideline 7	As above	Medium 3.06
Marine Bird	Light-mantled Albatross	<i>Phoebastria palpebrata</i>	TEP	2.43	2.33	High 3.37	Species is subject to a TAP	Guideline 7	As above	Medium 2.83
Marine Bird	Long-tailed jaeger	<i>Stercorius longicaudus</i>	TEP	3.00	3.00	High 4.24		Guideline 1	Literature review of missing productive information for 3 out of 7 attributes. Missing data was added for Average Max Size:	Low 2.63

Taxonomic Group	Common Name	Scientific Name	Role in Fishery*	Productivity	Susceptibility	Level 2 ERA Risk Category Score	Current and Planned Management/ Assessment	Level 2 ERA Residual Risk Guideline(s) Applied	Justification	Level 2 ERA Residual Risk Score
									54cm, Fecundity: 2 eggs and Average Age of Maturity: 3.5 years.	
Marine Bird	Southern Giant Petrel	<i>Macronectes giganteus</i>	TEP	2.33	2.29	High 3.27	Species is subject to a TAP	Guideline 7	Species has a TAP in place which seeks to ensure the fishery does not exceed a catch rate of 0.05 birds per 1000 hooks. Mitigation measures such as tori line use, line-weighting, no offal discharge and using thawed bait have reduced seabird catch. These reduce the encounterability of seabirds to hooks. In 2006 and 2008 a number of bird interactions were recorded in a relatively small part of the fishery. In both years fishing in the area of high bird interactions was restricted to night setting and mitigation measures were reviewed. The captures in winter season of 2008 resulted in a bird interaction rate of 0.06 birds per 1000 hooks in the area between 30° - 35° S, in excess of the TAP trigger limit. The fishery has remained closed to daylight setting in this area. In	Medium 3.06

Taxonomic Group	Common Name	Scientific Name	Role in Fishery*	Productivity	Susceptibility	Level 2 ERA Risk Category Score	Current and Planned Management/ Assessment	Level 2 ERA Residual Risk Guideline(s) Applied	Justification	Level 2 ERA Residual Risk Score
									every season the fishery as a whole has remained below the TAP level of 0.05 birds per 1000 hooks. The responses to interactions with seabirds are mandated in the TAP and AFMA and the fishing industry have proven the current TAP is capable of minimising interactions and dealing with the occurrence of any unusual issues.	
Marine Bird	Northern Giant Petrel	<i>Macronectes halli</i>	TEP	2.33	2.29	High 3.27	Species is subject to a TAP	Guideline 7	As above	Medium 2.70
Marine Mammal	Pygmy Killer Whale	<i>Feresa attenuata</i>	TEP	2.86	1.44	High 3.2		Guideline 5	There is an effective level of observer coverage in the ETBF. CSIRO in 2003 recommended 5.1% as an effective level of coverage in the ETBF but this has since been exceeded with a revised target of 8.5% for the fishery due to increased coverage during SBT season. The TAP also requires 5% coverage in 5° latitude bands in the ETBF. Total observer interaction data for this species was 0 with a negligible level of cryptic mortality.	Low 2.63

Taxonomic Group	Common Name	Scientific Name	Role in Fishery*	Productivity	Susceptibility	Level 2 ERA Risk Category Score	Current and Planned Management/ Assessment	Level 2 ERA Residual Risk Guideline(s) Applied	Justification	Level 2 ERA Residual Risk Score
									Species has a low susceptibility of 1.44 so reduce risk score from High to Low.	
Marine Mammal	Short-finned Pilot Whale	<i>Globicephala macrorhynchus</i>	TEP	2.86	1.44	High 3.2			None	High 3.2
Marine Reptile	Leatherback Turtle	<i>Dermochelys coriacea</i>	TEP	2.57	2.33	High 3.47	Anecdotal evidence of a high uptake of circle hooks by operators which has been shown to have the potential to reduce turtle mortality	None	None	High 3.47
Marine Mammal	Long-beaked Common Dolphin	<i>Delphinus capensis</i>	TEP	2.29	2.33	High 3.27		Guideline 5	There is an effective level of observer coverage in the ETBF. CSIRO in 2003 recommended 5.1% as an effective level of coverage in the ETBF but this has since been exceeded with a revised target of 8.5% for the fishery due to increased coverage during SBT season. The TAP also requires 5% coverage in 5° latitude bands in the ETBF. Total observer interaction data for this species was 0 with a negligible level of cryptic mortality. Species has a high susceptibility of 2.33 so	Low 2.49

Taxonomic Group	Common Name	Scientific Name	Role in Fishery*	Productivity	Susceptibility	Level 2 ERA Risk Category Score	Current and Planned Management/ Assessment	Level 2 ERA Residual Risk Guideline(s) Applied	Justification	Level 2 ERA Residual Risk Score
									reduce susceptibility from 3-1.	
Marine Mammal	Gingko Beaked Whale	<i>Mesoplodon ginkgodens</i>	TEP	2.86	1.44	High 3.2		Guideline 5	There is an effective level of observer coverage in the ETBF. CSIRO in 2003 recommended 5.1% as an effective level of coverage in the ETBF but this has since been exceeded with a revised target of 8.5% for the fishery due to increased coverage during SBT season. The TAP also requires 5% coverage in 5° latitude bands in the ETBF. Total observer interaction data for this species was 0 with a negligible level of cryptic mortality. Species has a low susceptibility of 1.44 so reduce risk score from High to Low.	Low 2.63
Marine Mammal	False Killer Whale	<i>Pseudorca crassidens</i>	TEP	2.86	2.33	High 3.69		Guideline 5	There is an effective level of observer coverage in the ETBF. CSIRO in 2003 recommended 5.1% as an effective level of coverage in the ETBF but this has since been exceeded with a revised target of 8.5% for the fishery due to increased coverage during SBT	High 3.49

Level 2 ERA Residual Risk Score	Justification	Level 2 ERA Residual Risk Guideline(s) Applied	Current and Planned Management/ Assessment	Level 2 ERA Risk Category Score	Susceptibility	Productivity	Role in Fishery*	Scientific Name	Common Name	Taxonomic Group
	<p>season. The TAP also requires 5% coverage in 5° latitude bands in the ETBF. Total observer interaction data for this species was 0 with a negligible level of cryptic mortality but there has been one recorded capture in logbook data. Species has a high susceptibility of 2.33 so reduce susceptibility score from 3 to 2.</p>									

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

Table 4 Summary of Level 2 PSA Residual Risk Results

Component	Changed from high to medium	Changed from high to low	Changed from medium to low	High Residual Risk	Medium Residual Risk	Low Residual Risk
Target	1	0	0	0	1	0
Target Bait	0	0	0	0	0	0
Bycatch (discard)	0	0	0	0	0	0
Byproduct	1	0	0	2	1	0
TEP	22	5	0	3	22	5
Total	24	5	0	5	24	5



4. CONCLUSION

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

Twenty three of the initial 34 high risk species in the Level 2 PSA residual risk were seabird species. The ETBF is compliant with the statutory Threat Abatement Plan (TAP) which reduces the encounterability of birds to hooks through line weighting, tori lines, use of thawed bait and prohibition on offal discharge for all vessels. For this reason Guideline 7 was used to reduce the risk scores for the 23 seabird species.

Of the remaining species at high risk under the Level 2 PSA residual risk seven species' risk scores were reduced under Guideline 5, where there were minimal to zero observed interactions with that species since 2001 in the fishery. Guideline 6 was used once to reduce risk score for Broadbill Swordfish where the implementation of a competitive TAC of 1,400t with attached trigger limits has addressed concerns of localised depletion. Guidelines 1 and 3 were used five times and twice respectively, to complete productivity attributes for species that were missing or had incorrect values. In total the guidelines were employed 42 times across 32 species.

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 priority species as part of the ERM framework.



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	<p>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;</p> <p>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.</p>
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.
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	<i>Environment Protection and Biodiversity Conservation Act (Cth) 1999</i>
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).

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



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