Australia's National
Science Agency

Ecological Risk Assessment for the Effects of Fishing

Draft Report for the Northern Prawn Fishery: Redleg Banana Prawn sub-fishery, 2017 - 2021

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Report for the Australian Fisheries Management Authority

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Important disclaimer

Notes to this document

This fishery ERA Report document contains figures and tables with numbers that correspond to the full methodology document for the ERAEF method:

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

Thus, table and figure numbers within the fishery ERA Report document are not sequential as not all are relevant to the fishery ERA Report results.

Additional details on the rationale and the background to the methods development are contained in the ERAEF Final Report:

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

This document also reflects some changes in methods that are detailed in AFMA's ERA guide (2017):

Australian Fisheries Management Authority (2017). Guide to AFMA's Ecological Risk Management. 130 p. (Commonwealth of Australia, Canberra).

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Executive Summary

The "Ecological Risk Assessment for Effect of Fishing" ERAEF was developed jointly by CSIRO Oceans and Atmosphere (now CSIRO Environment) and the Australian Fisheries Management Authority (Hobday et al., 2007, 2011a). This assessment of the ecological impacts of the Northern Prawn Fishery - Redleg Banana Prawn sub-fishery was undertaken using the ERAEF method version 9.2, with some additional modifications currently in the final stages of development with AFMA. This revised ERAEF provides a hierarchical framework for a comprehensive assessment of the ecological risks arising from fishing, with impacts assessed against five revised ecological components: key commercial and secondary commercial species; byproduct and bycatch species; protected species; habitats; and (ecological) communities (see ERM Guide, AFMA, 2017).

The ERAEF proceeds through four stages of analysis: scoping; an expert judgement-based Level 1 analysis (SICA – Scale Intensity Consequence Analysis); an empirically based Level 2 analysis (including PSA – Productivity Susceptibility Analysis and SAFE – Sustainability Assessment for Fishing Effects); and a model-based Level 3 analysis. This hierarchical approach provides a cost-efficient way of screening hazards, with increasing time and attention paid only to those hazards that are not eliminated at lower levels in the analysis. Risk management responses may be identified at any level in the analysis.

Application of the ERAEF methods to a fishery represents a set of screening or prioritization steps that work towards a full quantitative ecological risk assessment. At the start of the process, all components are assumed to be at risk. Each step, or Level, potentially screens out issues that are of low concern. The Scoping stage screens out activities that do not occur in the specific fishery. Level 1 screens out activities that are judged to have low impact, and potentially screens out components with all low impact scores. Level 2 is a screening or prioritization process for individual species, habitats and communities at risk from direct impacts of fishing, using either PSA or bSAFE. The Level 2 methods do not provide absolute measures of risk. Instead they combine information on productivity and exposure to fishing to assess potential risk – the term used at Level 2 is risk. Because of the precautionary approach to uncertainty, there will be more false positives than false negatives at Level 2, and the list of high risk species or habitats should not be interpreted as all being at high risk from fishing. Level 2 is a screening process to identify species or habitats that require further investigation. Some of these may require only a little further investigation to identify them as a false positive; for some of them managers and industry may decide to implement a management response; others will require further analysis using Level 3 methods, which assess absolute levels of risk.

This NPF Redleg Banana Prawn ERAEF assessment is based on analyses of data from 2017 to 2021 and conducted over 2022-23 period, the first ERA for this sub-fishery. This 2017-21 assessment of the Northern Prawn Fishery - Redleg Banana Prawn sub-fishery fishery consists of the following:

- Scoping
- Level 1 results for all components
- Level 2 PSA and bSAFE results
- Residual risk for high (and two medium) risk PSA species and high/extreme risk bSAFE species where applicable

Fishery Description

Gear Otter board trawl
Area The Joseph Bonaparte Gulf (JBG) Box of the Northern Prawn Fishery
Depth range ~50 to 80 m below the surface, occasionally to 100 m
Fleet size 10-15 vessels p.a.
Effort 75 - 548 fishing days p.a.
Landings 47.3 - 412.4 t p.a.
Discard rate fishery-wide estimate unavailable
Key commercial species Redleg Banana Prawn
Management Quota management system across species/stocks
Observer program (2017-2021) AFMA Observer Program Coverage: 1.1 - 2.0%. Crew Member Observer Program Coverage: 12.7 - 15.8%.

Ecological Components Assessed

A total of 401 species across all ecological components were assessed in this ERAEF (Table 0.1).

Table 0.1: Ecological components assessed in 2025 (data from 2017 to 2021). NA: not assessed.

Ecological components assessed	2025
Key/secondary commercial species	6
Commercial species/Bait	NA
Byproduct species	3
Bycatch species	363
Protected species	29
Benthic habitats	7
Pelagic habitats	2
Demersal communities	1
Pelagic communities	2

Level 1 Results and Summary

Most hazards (fishing activities) were eliminated at Level 1 (risk scores 1 or 2). In particular, the key/secondary commercial species component was eliminated after Level 1 as all risk scores were less than three. None of the remaining four assessed ecological components were eliminated at Level 1 i.e., there was at least one risk score of 3 – moderate – or above for each component.

Those remaining consist of:

- Fishing (direct and indirect impacts on protected species and habitats; moderate risk)
- Fishing (direct impacts on byproduct/bycatch species; moderate risk)
- Fishing through physical disturbance (impact on habitats and communities; moderate risk)

Habitat-forming benthos, particularly bryozoans and gorgonians corresponding to assemblages 15, 11 and 10 of the Timor Region were rated at moderate risk (score 3) from direct and indirect impacts from primary fishing operations and physical disturbance.

Significant external hazards included aquaculture in the region, which presented a moderate risk (risk score 3) to byproduct/bycatch species and communities, and a potential major risk to protected species (e.g., Green Sawfish and Freshwater Sawfish). In addition, external hazards from other fisheries in the region also presented a moderate risk (risk score of 3) to byproduct/bycatch species and a potential major risk to protected species (e.g., Green Sawfish and Freshwater Sawfish). Coastal development presented a moderate risk to both byproduct/bycatch species. Lastly, coastal development, other anthropogenic and non-extractive activities presented a moderate risk to protected species.

A Level 2 analysis for habitats and communities was not possible at this time (Table 0.2).

The NPF Redleg Banana Prawns stock is assessed and managed by a Total Allowable Effort (TAE). It is classified as not overfished (with respect to biomass) and not subject to overfishing (with respect to fishing mortality) (see Table 0.3 and references within).

Table 0.2: Outcomes of assessments for ecological components conducted in 2022-23.

Ecological Component	2022-23
Key/secondary commercial species	Level 1
Byproduct and bycatch species	Level 2
Protected species	Level 2
Habitats	Level 2
Communities	Level 2

Level 2 Results and Summary

A total of 395 unique species were evaluated at Level 2 (114 with PSA and 303 with bSAFE, which includes any unassessable species in a bSAFE, subsequently assessed in a PSA). Under the revised ERAEF framework (AFMA, 2017), key commercial species that undergo tiered assessments are not assessed at Level 2. However, an ERA should be considered for species that are subject to lower tiered assessments (e.g., Tier 4/5, based on catch/effort or catch data only) when the model-based assumptions may not be satisfied.

PSA and Residual Risk

For ecological components in the sub-fishery not explicitly listed here, no species were assessed at Level 2.

Secondary commercial species
The secondary commercial species component was not evaluated in this assessment since it was eliminated at Level 1.

Byproduct species
All three byproduct species were assessed in the PSA. All three species were found to be at low risk. Of these, none were non-robust (i.e., data deficient) species.

Bycatch species
A total of 82 out of 363 bycatch species were assessed in the PSA. Of these, 22 were unassessable in bSAFE. Of all assessed bycatch species, 20 were at high risk, 45 were at medium risk, and 17 were at low risk. Of these, 33 were non-robust (i.e., data deficient) species. Of the 20 high risk species, none have all 11 attributes, two are missing one to three attributes, and 18 are non-robust (i.e., missing more than three attributes). A residual risk analysis was performed on 20 species. Following the residual risk analysis, none of the 20 species remained at high risk, i.e., all species were reduced to medium risk. Therefore, overall, there were no high risk species, 65 medium risk species and 17 low risk species.

Protected species
All 29 protected species were assessed in the PSA. Four of these were additionally assigned to PSA instead of bSAFE as a precautionary approach. Of all assessed protected species, two were at high risk (Narrow Sawfish *Anoxypristis cuspidata*; Dwarf Sawfish *Pristis clavata*), 26 were at medium risk, and one was at low risk. Of these, none were non-robust (i.e., data deficient) species. Of the two high risk species, both have all 11 attributes. A residual risk analysis was performed on four species. Following the residual risk analysis, all of the four species were at high risk (Narrow Sawfish *Anoxypristis cuspidata*; Dwarf Sawfish *Pristis clavata*; Green Sawfish *Pristis zijsron*; Freshwater Sawfish *Pristis pristis*), i.e., two species were increased to high risk (from medium risk) and two remained at high risk. Therefore, overall, there were a total of four high risk species, 24 medium risk species and one low risk species.

Table 0.3: Stock assessments including status detail (where available) of key and secondary commercial species in the NPF Redleg Banana Prawn sub-fishery. NOF: not overfished, NSTOF: not subject to overfishing, UNC: Uncertain, ABARES: Australian Bureau of Agricultural and Resource Economics and Sciences, ^: based on ABARES classification, TAE: Total Allowable Effort, S-R: Stock-Recruitment.

Common Name	Species Name	ERA Classification	Biomass^ / Fishing Mortality^	References	Additional Assessments
Redleg Banana Prawn	*Penaeus indicus*	Key commercial	NOF / NSTOF	Stock assessment: Plagányi et al. (2022), data to 2021. ABARES classification: Butler et al. (2021)	Plagányi et al. (2023): data to 2022; Plagányi et al. (2024): data to 2023
White Banana Prawn	*Penaeus merguiensis*	Secondary commercial	NOF / NSTOF	No formal assessment. High natural recruitment variability based on seasonal rainfall, oceanographic conditions and food availability (Turschwell et al., 2022; van-der-Velde et al., 2021). No reliable S-R relationship established to date. ABARES classification: Butler et al. (2021)	
Brown Tiger Prawn	*Penaeus esculentus*	Secondary commercial	NOF / NSTOF	Stock assessment: Deng et al. (2022), data to 2021. ABARES classification: Butler et al. (2021)	Parker et al. (2024), data to 2023
Grooved Tiger Prawn	*Penaeus semisulcatus*	Secondary commercial	NOF / NSTOF	Stock assessment: Deng et al. (2022), data to 2021. ABARES classification: Butler et al. (2021)	Parker et al. (2024), data to 2023
Blue Endeavour Prawn	*Metapenaeus endeavouri*	Secondary commercial	NOF / NSTOF	Stock assessment: Deng et al. (2022), data to 2021; Zhou et al. (2023). ABARES classification: Butler et al. (2021)	Parker et al. (2024), data to 2023
Red Endeavour Prawn	*Metapenaeus ensis*	Secondary commercial	UNC / UNC	Stock assessment: Deng et al. (2022), data to 2021; Zhou et al. (2023). ABARES classification: Butler et al. (2021)	Parker et al. (2024), data to 2023

bSAFE and Residual Risk

For ecological components in the sub-fishery not explicitly listed here, no species were assessed at Level 2.

Bycatch species

There were 303 out of 363 bycatch species considered in the bSAFE. Twenty-two species were unassessable due to missing biological attributes employed in the bSAFE method. Of the remaining 281 species, all 281 species were below the three reference points (low risk), none were medium risk, and none were high or extreme risk.

Summary

A total of four chondrichthyan species were evaluated at high risk following a residual risk analysis (Table 0.4). These four protected species of sawfishes, i.e., green, narrow, freshwater and dwarf sawfishes were classified at high risk, following a residual risk analysis partly due to life history and vulnerability parameters, and uncertainty in stock status. Most interactions were recorded as Narrow Sawfish *Anoxypristis cuspidata* (170 animals consisting of 93 alive, 77 dead), followed by the family taxonomic classification, i.e., Pristidae – unidentified (129 animals consisting of 58 alive and 71 dead).

Table 0.4: Extreme or high-risk PSA or bSAFE species following a preliminary residual risk (RR) analysis in the Northern Prawn Fishery - Redleg Banana Prawn sub-fishery. No. Missing: Number of missing attributes in PSA. PS: protected.

Level 2 analysis	ERA Classification	Taxa	No. Missing	Scientific Name	Common Name	Final risk score
PSA	PS	NA	0	*Anoxypristis cuspidata*	Narrow Sawfish	High
PSA	PS	NA	0	*Pristis clavata*	Dwarf Sawfish	High
PSA	PS	NA	0	*Pristis zijsron*	Green Sawfish	High
PSA	PS	NA	0	*Pristis pristis*	Freshwater Sawfish	High

1 Overview - Ecological Risk Assessment for the Effects of Fishing (ERAEF) Framework

1.1 The Hierarchical Approach

The Ecological Risk Assessment for the Effects of Fishing (ERAEF) framework involves a hierarchical approach that moves from a comprehensive but largely qualitative analysis of risk at Level 1, through a more focused and semi-quantitative approach at Level 2, to a highly focused and fully quantitative “model-based” approach at Level 3 (Figure 1.1). This approach is efficient because many potential risks are screened out at Level 1, so that the more intensive and quantitative analyses at Level 2 (and ultimately at Level 3) are limited to a subset of the higher risk activities associated with fishing. It also leads to rapid identification of high-risk activities, which in turn can lead to immediate remedial action (risk management response). The ERAEF approach is also precautionary, in the sense that risks will be scored high in the absence of information, evidence or logical argument to the contrary.

1.2 Conceptual Model

The approach makes use of a general conceptual model of how fishing impacts ecological systems, which is used as the basis for the risk assessment evaluations at each level of analysis (Levels 1-3). For the ERAEF approach, five general ecological components are evaluated, corresponding to five areas of focus in evaluating the impacts of fishing for strategic assessment under EPBC legislation. The five revised components are:

- Key commercial species and secondary commercial species
- Byproduct and bycatch species
- protected[5] species (formerly referred to as threatened, endangered and Protected[6] species or TEPs)
- Habitats
- Ecological communities

This conceptual model (Figure 1.2) progresses from fishery characteristics of the fishery or sub-fishery, → fishing activities associated with fishing and external activities, which may impact the five ecological components (target, byproduct and bycatch species, protected species, habitats, and communities); → effects of fishing and external activities which are the direct impacts of fishing and external activities; → natural processes and resources that are affected by the impacts of fishing and external activities; → sub-components which are affected by impacts to natural processes and resources; → components, which are affected by impacts to the sub-components. Impacts to the sub-components and components in turn affect the achievement of management objectives.

The external activities that may impact the fishery objectives are also identified at the Scoping stage and evaluated at Level 1. This provides information on the additional impacts on the ecological components being evaluated, even though management of the external activities is outside the scope of management for that fishery.

The assessment of risk at each level takes into account current management strategies and arrangements. A crucial process in the risk assessment framework is to document the rationale behind assessments and decisions at each step in the analysis. The decision to proceed to subsequent levels depends on

- Estimated risk at the previous level
- Availability of data to proceed to the next level
- Management response (e.g., if the risk is high but immediate changes to management regulations or fishing practices will reduce the risk, then analysis at the next level may be unnecessary).

[5]The term “protected species” refers to species listed under [Part 13] of the EPBC Act (1999) and replaces the term “Threatened, endangered and protected species (TEPs)” commonly used in past Commonwealth (including AFMA) documents.

[6]Note “protected” (with small “p”) refers to all species covered by the EPBC Act (1999) while “Protected” (capital P) refers only to those protected species that are threatened (vulnerable, endangered or critically endangered).

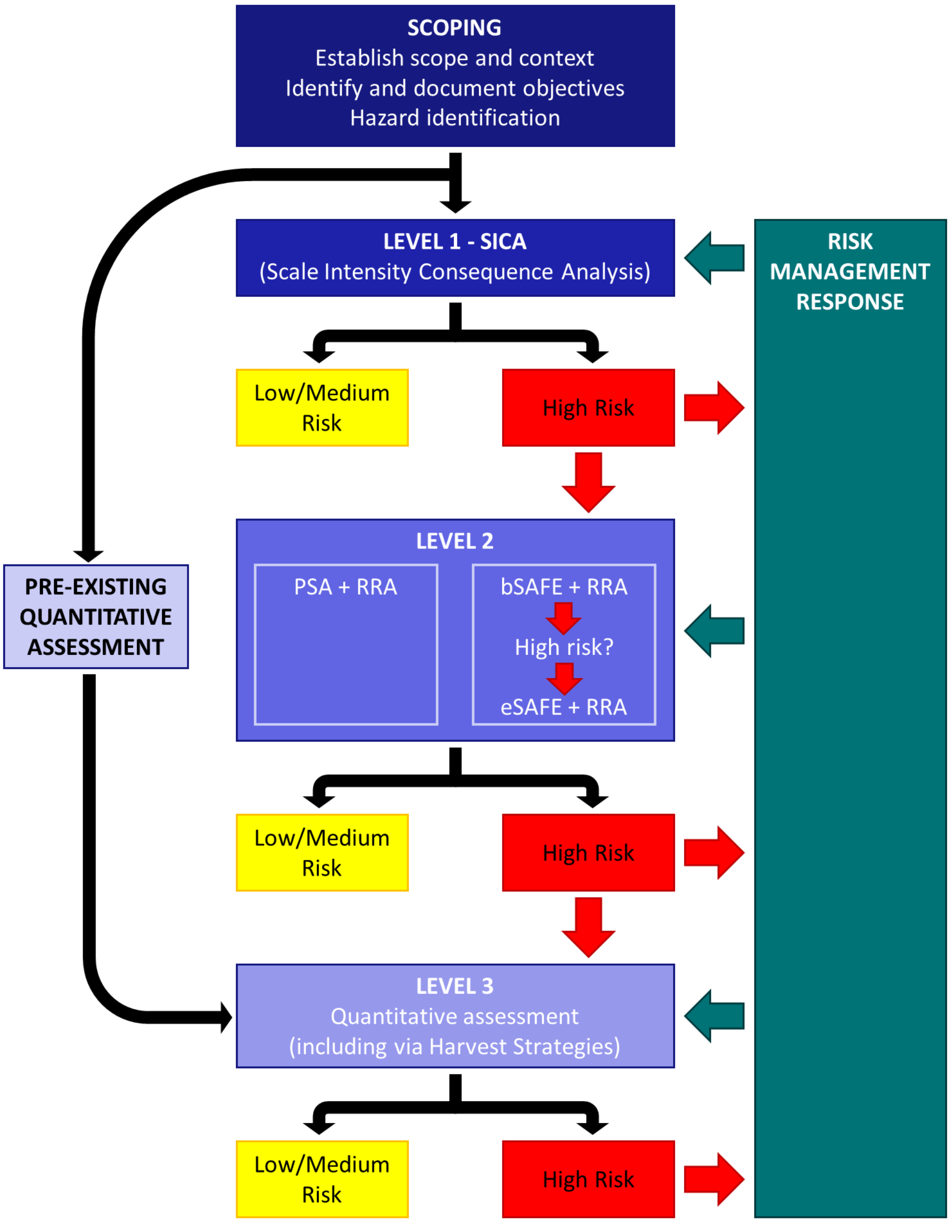


Figure 1.1: Structure of the 3 level hierarchical ERAEF methodology. SICA – Scale Intensity Consequence Analysis; PSA – Productivity Susceptibility Analysis; SAFE – Sustainability Assessment for Fishing Effects; RRA – Residual Risk Analysis. T1 – Tier 1. eSAFE may be used for species classified as high risk by bSAFE.

1.3 ERAEF Stakeholder Engagement Process

A recognized part of conventional risk assessment is the involvement of stakeholders involved in the activities being assessed. Stakeholders can make an important contribution by providing expert judgment, fishery-specific and ecological knowledge, and process and outcome ownership. The ERAEF method also relies on stakeholder involvement at each stage in the process, as outlined below. Stakeholder interactions are recorded.

1.4 Scoping

In the first instance, scoping is based on a review of existing documents and information, with much of it collected and completed to a draft stage prior to full stakeholder involvement. This provides all the stakeholders with information on the relevant background issues. Three key outputs are required from the scoping, each requiring stakeholder input.

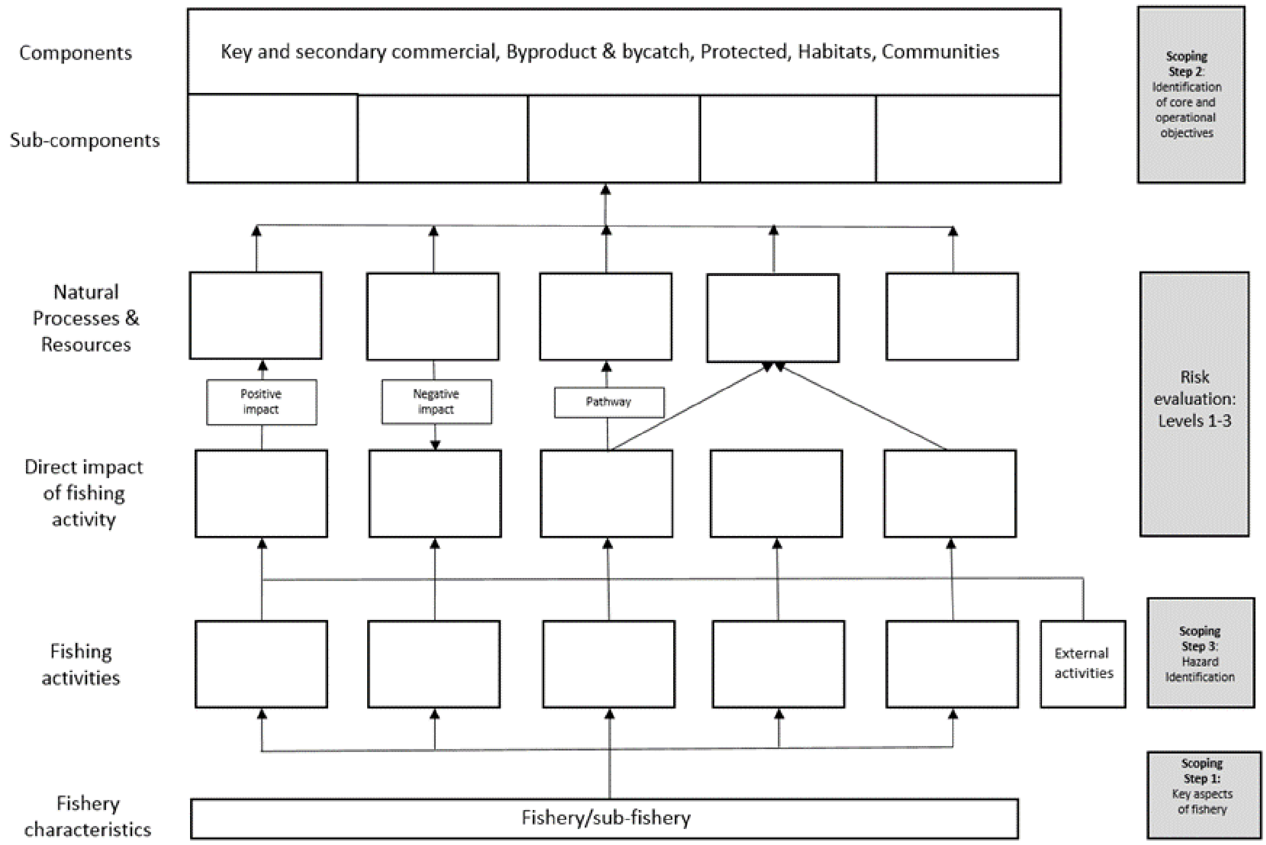


Figure 1.2: Generic conceptual model used in ERAEF.

1. **Identification of units of analysis** (species, habitats and communities) potentially impacted by fishery activities (Section 2.2.2; Scoping Documents S2A, S2B1, S2B2 and S2C1, S2C2).
2. **Selection of objectives** (Section 2.2.4; Scoping Document S3). The primary objective to be pursued for species assessed under ERAF is that of ensuring populations are maintained at biomass levels above which recruitment failure is likely, as stated in Chapter 2 (AFMA, 2017 Ecological Risk Management (ERM) Guide). This is consistent with current legislation and fisheries policies and represents a change from when the ERAEF was first developed and there was less policy or legislation-based guidance on sustainability objectives, with stakeholders able to choose from a range of "sustainability" objectives (e.g., Tables 5A-C in Hobday et al., 2007).
3. **Selection of activities** (hazards) (Section 2.2.5; Scoping Document S4) that occur in the sub-fishery is made using a checklist of potential activities provided. The checklist was developed following extensive review and allows repeatability between fisheries. Additional activities raised by the stakeholders can be included in this checklist (and would feed back into the original checklist). The background information and/or consultation with the stakeholders are used to finalize the set of activities. Many activities will be self-evident (e.g., fishing, which obviously occurs), but for others, expert or anecdotal evidence may be required.

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

The SICA evaluates the risk to ecological components resulting from the stakeholder-agreed set of activities. Evaluation of the temporal and spatial scale, intensity, sub-component, unit of analysis, and credible scenario (consequence for a sub-component) should be prepared by the draft fishery ERAF report author and reviewed at an appropriate stakeholder meeting (e.g., Resource Assessment Group meeting). Due to the number of activities (up to 24) in each of the five components (resulting in up to 120 SICA elements), preparation before involving the full set of stakeholders may allow time and attention to be focused on the uncertain or controversial or high risk elements. Documenting the rationale for each SICA element ahead of time for the straw-man scenarios is crucial to allow the workshop debate to focus on the right portions of the logical progression that resulted in the consequence score.

SICA elements are scored on a scale of 1 to 6 (negligible to extreme) using a "plausible worst case" approach (see ERAEF Methods Document for details, Smith et al., 2007). Level 1 analysis potentially results in the elimination of activities (hazards) and in some cases whole components. Any SICA element that scores 2 or less is documented, but not considered further for analysis or management response.

1.6 Level 2. PSA and SAFE (Semi-quantitative and Quantitative Methods)

When the risk of an activity at Level 1 (SICA) on a species component is moderate or higher and no planned management interventions that would remove this risk are identified, an assessment is required at Level 2 (to determine if the risk is real and provide further information on the risk). The tools used to assess risk at Level 2 allow units (e.g., all individual species) within any of the ecological species components (e.g., key/secondary commercial, byproduct/bycatch, and protected species) to be effectively and comprehensively screened for risk. The analysis units are identified at the scoping stage. To date, Level 2 tools have been designed to measure risk from direct impacts of fishing only (i.e., risk of overfishing, leading to an overfished fishery), which in all assessments to date has been the hazard with the greatest risks identified at Level 1[7].

In the period since the first ERAEF was implemented across Commonwealth fisheries, much of the management focus has been on the assessment results associated with Level 2 and Level 2.5 or 3 risk assessment methods, which comprise semi-quantitative or rapid simple quantitative methods (e.g., PSA and SAFE). This level has been subject to the greatest level of change and improvement which are discussed in the following sections. Additional improvements are being developed for implementation in the near future (see Chapter 4.13 of AFMA ERM Guide, AFMA, 2017).

Level 2 was originally designed to rely on a single risk assessment methodology, the Productivity-Susceptibility Analysis (PSA) (see Chapter 4.9 of AFMA ERM Guide, AFMA, 2017). However, a more quantitative method called the Sustainability Assessment for Fishing Effects (SAFE) (see Chapter 4.10 of AFMA ERM Guide, AFMA, 2017) was developed early in the implementation of the ERAEF and classed as a Level 2.5 or Level 3 tool.

Under the revised ERAEF:

- bSAFE has now been reclassified as the preferred Level 2 method (over PSA) where sufficient spatial and biological data (to support bSAFE) are available. Typically this has been used for teleost and chondrichthyan species.
- Species estimated to be at high risk under bSAFE may then be assessed under eSAFE which may provide reduced estimates of uncertainty pertaining to the actual risk.
- Where either the data or species biological characteristics are insufficient to support bSAFE analyses, it is recommended that PSA be applied instead. This will be the case for many protected species, invertebrate bycatch species and some other species.
- At Level 2, either PSA or SAFE methods should be applied to any given species, not both.
- For high risk species it is a management choice whether to progress to eSAFE, pursue a Level 3 fully quantitative stock assessment, or take more immediate management action to reduce the risk. The types of considerations required in making that choice (i.e., moving up the ERAEF assessment hierarchy or taking direct management action) are outlined in Chapter 5.5 of the AFMA ERM Guide (AFMA, 2017).

It is also recognised that a number of additional tools, including some of the "data poor" assessment tools that are used to inform harvest strategies, could potentially be included within the Level 2 toolkit. They are distinguished from Level 3 quantitative tools (i.e., stock assessment models) that are more data-rich and able to more precisely quantify uncertainty.

1.6.1 PSA (Productivity Susceptibility Analysis)

Details of the PSA method are described in the accompanying ERAEF Methods Document and also summarised in Section 4.8.3 of the AFMA ERM Guide (AFMA, 2017). Stakeholders can provide input and

[7]Future iterations of the methodology will include PSAs modified to measure the risk due to other activities, such as gear loss.

suggestions on appropriate attributes, including novel ones, for evaluating risk in the specific fishery. Attribute values for many of the units (e.g., age at maturity, depth range, mean trophic level) can be obtained from published literature and other resources (e.g., scientific experts) without initial stakeholder involvement. Stakeholder input is required after preliminary attribute values are obtained. In particular, where information is missing, expert opinion can be used to derive the most "reasonable" conservative estimate. For example, if species attribute values for annual fecundity have been categorized as low, medium or high on the set (<5, 5-500, >500), estimates for species with no data can still be made. Also, the estimated fecundity of a broadcast-spawning fish species with unknown fecundity is still likely to be greater than the high fecundity category (>500). Susceptibility attribute estimates, such as "fraction alive when landed", can also be made based on input from experts such as scientific observers. Feedback to stakeholders regarding comments received during the preliminary PSA consultations is considered crucial. The final PSA is completed by scientists and results are presented to the relevant stakeholder group (e.g., RAG and/or MAC) before decisions regarding Level 3 analysis are considered. The stakeholder group may also decide on priorities for analysis at Level 3.

1.6.2 Residual Risk Analysis

There were several limitations due to the semi-quantitative nature of a Level 2 PSA assessment. For example, certain management arrangements which mitigate the risks posed by a fishery, as well as additional information concerning levels of direct mortality, may not be easily taken into account in assessments. To overcome this, Residual risk analyses (RRA) are used to consider additional information, particularly mitigating effects of management arrangements that were not explicitly included in the ERAs or introduced after the ERA process commenced. Priority for this process has typically been focused on those species attributed a high risk rating (those likely to be most at risk from fishing activities). It could in theory be used to also determine if some species have been incorrectly classified as low risk.

Recently revised Residual risk guidelines have been developed (AFMA, 2018) to assist in making accurate judgements of residual risk consistently across all fisheries. At the moment, they are applied to species and not applicable to habitats or communities.

These guidelines are not seen as a definitive guide on the determination of residual risk and it is expected they may not apply in a small number of cases. Care must also be taken when applying them to ensure residual risk results are appropriate in a practical sense. There are a number of conditions that underpin the residual risk guidelines and should be understood before the guidelines are applied:

- All assessments and management measures used within the residual risk analysis must be implemented prior to the assessment with sufficient data to demonstrate the effect. Any planned or proposed measures can be referred to in the assessment but cannot be used to revise the risk score.
- When applied, the guidelines generally result in changes to particular "attribute" scores for a particular species. Only after all of the guidelines have been applied to a particular species, should the overall risk category be re-calculated. This will ensure consistency, as well as facilitate the application of multiple guidelines.
- Unless there is clear and substantiated information to support applying an individual guideline, then the attribute and residual risk score should remain unchanged. All supporting information considered in applying these Guidelines must be clearly documented and referenced where applicable. This is consistent with the precautionary approach applied in ERAs, with residual risk remaining high unless there is evidence to the contrary ensuring a transparent process is applied.

The results (including supporting information and justifications) from residual risk analyses must be documented in "Residual Risk Reports" for each fishery (or can be integrated into the Level 2 risk assessment report). These will be publicly available documents.

1.6.3 SAFE (Sustainability Assessment for Fishing Effects)

The SAFE method developed is split into two categories: base SAFE (bSAFE) and an enhanced SAFE (eSAFE). eSAFE has greater data processing requirements and is recommended to only be used to assess species estimated to be at high risk via the bSAFE. It is also able to more appropriately model spatial availability aspects when sufficient data are available.

bSAFE

Relative to the PSA approach, the bSAFE approach (Zhou et al., 2007, 2011; Zhou & Griffiths, 2008):

- is a more quantitative approach (analogous to stock assessment) that can provide absolute measures of risk by estimating fishing mortality rates relative to fishing mortality rate reference points (based on life history parameters);
- requires fewer productivity data than the PSA;
- can account for cumulative risk and
- potentially outperforms PSA in several areas, including the strength of relationship to Tier 1 assessment classifications (Zhou et al., 2016).

Like PSA, the bSAFE method is a transparent, relatively rapid and cost-effective process for screening large numbers of species for risk, and is far less demanding of data and much simpler to apply than a typical quantitative stock assessment.

As such it is recommended that bSAFE be used as the preferred Level 2 assessment tool for all fish species and some invertebrates and reptiles (e.g., some sea snakes) with sufficient data.

In estimating fishing mortality, bSAFE utilises much of the same information as the PSA, to estimate:

- Spatial overlap between species distribution and fishing effort distribution
- Catchability resulting from the probability of encountering the gear and size-dependent selectivity
- Post-capture mortality

The fishing mortality is essentially the fraction of overlap between fished area and the species distribution area within the jurisdiction, adjusted by catchability and post-capture mortality. Uncertainty around the estimated fishing mortality is estimated by including variances in encounterability, selectivity, survival rate and fishing effort between years.

The three biological reference points are based on a simple surplus production model:

- **F_{MSY}** – instantaneous fishing mortality rate that corresponds to the maximum number of fish in the population that can be killed by fishing in the long term. The latter is the maximum sustainable fishing mortality (MSM) at B_{MSM}, similar to the target species MSY.
- **F_{LIM}** – instantaneous fishing mortality rate that corresponds to the limit biomass B_{LIM} where B_{LIM} is assumed to be half of the biomass that supports a maximum sustainable fishing mortality ($0.5B_{MSM}$)
- **F_{CRASH}** – minimum unsustainable instantaneous fishing mortality rate that, in theory, will lead to population extinction in the long term.

This methodology produces quantified indicators of performance against fishing mortality-based reference points and as such does allow calibration with other stock assessment and risk assessment tools that measure fishing mortality. It allows the risk of overfishing to be determined, via the score relative to the reference line. Uncertainty (error bars) is related to the variation in the estimation of the scores for each axis.

It is recommended that species assessed as being potentially at high risk under bSAFE are then progressed to analysis by eSAFE which may narrow uncertainties around the risk (but is more time and resource intensive than bSAFE).

Assumptions and issues to be aware of:

- Comparisons of PSA and SAFE analyses for the same fisheries and species support the claim that the PSA method generally avoids false negatives but can result in many false positives. Limited testing of SAFE results against full quantitative stock assessments suggests that there is less “bias” in the method, but that both false negatives and false positives can arise.
- SAFE analyses retain some of the key precautionary elements of the PSA method, including assumptions that fisheries are impacting local stocks (within the jurisdictional area of the fishery).

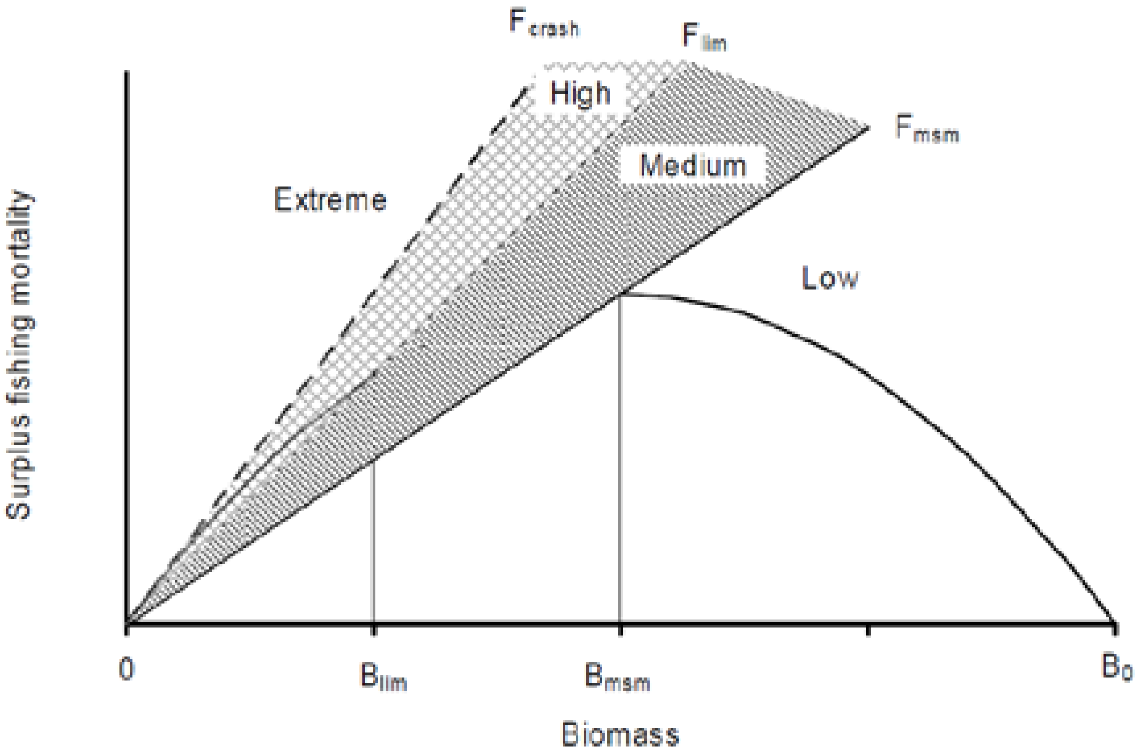


Figure 1.3: Stock productivity, biological reference points and ecological risk assessment for managing bycatch species.

- Although the bSAFE analyses provide direct estimates of uncertainty in both the exploitation rate and associated reference points, they are less explicit about uncertainties arising from key assumptions in the method, including spatial distribution and movement of stocks.
- The method assumes there would be no local depletion effects from repeat trawls at the same location (i.e., populations rapidly mix between fished and unfished areas). The fishing mortality will likely be overestimated if this assumption is not satisfied (ERA TWG 2015). The method also assumes that the mean fish density does not vary between a fished area and non-fished area within their distributional range. Hence, the level of risk would be over-estimated for species found primarily in non-fished habitats, while risk would be under-estimated for species that prefer fished habitats (ERA TWG 2015).
- The SAFE methodology makes greater assumptions than Tier 1 stock assessments in coming to its F estimates (due to a lack of the data relative to that used in a Tier 1 assessment) and it is not capable of measuring risk of a stock being already overfished (so the type of risk it measures relates only to overfishing, which may then lead to future overfished state). The limitations of SAFE with respect to measuring overfished risks are the same essentially as for PSA.

eSAFE

Enhanced SAFE (eSAFE) appears, based on calibration with Level 3 assessments, to provide improved estimates of fishing mortality relative to the base SAFE (bSAFE) method. The eSAFE requires more spatially explicit data and takes more analysis time than bSAFE, and so might only be used to further assess species that were identified as at high risk using bSAFE (and which have not had further direct management action taken). The eSAFE enhances the bSAFE method by estimating varying fish density across their distribution range as well as species- and gear-specific catch efficiency for each species.

1.7 Level 3

This stage of the risk assessment is fully-quantitative and relies on in-depth scientific studies on the units identified as at medium or greater risk in the Level 2 analysis. It will be both time and data-intensive. Individual stakeholders are engaged as required in a more intensive and directed fashion. Results are presented to the stakeholder group and feedback incorporated, but live modification is considered unlikely.

1.8 Conclusion and Final Risk Assessment Report

The conclusion of the stakeholder consultation process will result in a final risk assessment report for the individual fishery according to the ERAEF methods. It is envisaged that the completed assessment will be adopted by the fishery management group and used by AFMA for a range of management purposes, including to address the requirements of the EPBC Act as evaluated by the Department of Climate Change, Energy, the Environment and Water.

1.9 Subsequent Risk Assessment Iterations for a Fishery

The frequency at which each fishery must revise and update the risk assessment is not fully prescribed. As new information arises or management changes occur, the risks can be re-evaluated, and documented as before. The fishery management group or AFMA may take ownership of this process or scientific consultants may be engaged. In any case, the ERAEF should again be based on the input of the full set of stakeholders and reviewed by independent experts familiar with the process.

Fishery re-assessments for byproduct and bycatch species under the ERAEF will be undertaken every five years[8] or sooner if triggered by re-assessment triggers. The five-year timeframe is based on a number of factors including:

- The time it takes to implement risk management measures; for populations to respond to those measures to a degree detectable by monitoring processes; and to collect sufficient data to determine the effectiveness of those measures.
- Alignment with other management and accreditation processes.
- The cost of re-assessments.
- The review period for Fishery Management Strategy (FMS).

For byproduct and bycatch species, in the periods between scheduled five-year ERA reviews[9], AFMA will develop and monitor a set of fishery indicators and triggers, on an annual basis, in order to detect any changes (increase or decrease) in the level of risk posed by the fishery to any species. Where indicators exceed specified trigger levels, AFMA will investigate the causes and provide opportunity for RAG comment/advice during that process. Pending outcomes of that review, and RAG advice, AFMA can if necessary, request a species-specific or full fishery re-assessment (i.e., prior to the scheduled re-assessment dates).

The ERA TWG (September 2015) identified five key indicators upon which such triggers could be based, these being changes in:

- Gear type/use
- Mitigation measures (use or type)
- Area fished
- Catch or interaction rate
- Fishing effort

Where possible, the triggers should look to take into account additional sources of risk from interacting non-Commonwealth fisheries. In addition, if a major management change is planned for a fishery, such as a move from input to output controls, the fishery will need to be reassessed prior to that management change coming into effect. In considering each indicator and trigger level, the RAG should consider the following:

- The data upon which the indicator is based must be sufficiently representative of actual changes in catch, effort, area, gear or mitigation methods. Consideration should be given to the level of uncertainty associated with the data underpinning any prospective indicator.
- The trigger level chosen should not be overly sensitive to the normal inter-annual variance that is typical of the indicator and independent of fishing pressure, assuming such variance is unlikely to relate to a significant change in the risk posed by the fishery to any or all species.

[8] Based on a recommendation by the ERA Technical Working Group, September 2015.

[9] In contrast to key and secondary commercial species managed via catch/effort limits under Harvest Strategies, which depending on species and Harvest Strategy, can be re-assessed any time between 1 and 5 years.

- The trigger level should equate to the minimum level of change that the RAG (by its expert opinion) considers might potentially represent a significant change in the risk posed by the fishery.
- The trigger level could represent an absolute change (number/level) in an indicator or a percentage change in an indicator.
- The RAG should consider whether a "temporal" condition should be placed on the trigger (i.e., the trigger is breached two years in a row) to further reduce the likelihood of natural population variance or data errors triggering a re-assessment unnecessarily.

The final set of indicators and triggers will be developed for each fishery by AFMA in consultation with its fishery RAG (or for fisheries lacking a RAG, the ERA TWG), in association with the next planned re-assessment (see Chapter 6 in AFMA ERM Guide, AFMA, 2017). A RAG may choose a subset of these indicators and triggers, or include an additional indicator/trigger(s), based on consideration of the availability and reliability of data upon which to base any of the above indicators/triggers, however justification of this must be provided.

Research is currently underway to develop specific guidance for RAG to aid in the selection of appropriate triggers, which will in the meantime be determined using RAG expert opinion. In the longer term, it may be possible to refine indicators and triggers using the existing PSA and SAFE methods to test which attributes the end risk scores are most sensitive to (ERA TWG 2015)[10]. The RAG will record both the final set of indicators and triggers chosen, and a justification for those, in the RAG minutes. Once the final set of indicators and triggers is determined for a fishery, they will require implementation within the FMS and a monitoring and review process.

[10] ERA TWG recommendation, September 2015

2 Scoping and Stakeholder Engagement

The focus of analysis is the fishery as identified by the responsible management authority (AFMA). The assessment area is defined by the fishery management jurisdiction within the Australian Fisheries Zone (AFZ). The fishery may also be divided into sub-fisheries based on fishing method and/or spatial coverage. These sub-fisheries should be clearly identified and described during the scoping stage. Portions of the scoping and analysis at Level 1 and beyond are specific to a particular sub-fishery. The fishery is a group of people carrying out certain activities as defined under a management plan. Depending on the jurisdiction, the fishery/sub-fishery may include any combination of commercial, recreational, and/or indigenous fishers.

The results presented below are for the Northern Prawn Fishery - Redleg Banana Prawn sub-fishery. A full description of the ERAEF method is provided in the methodology document (Hobday et al., 2007; Hobday et al., 2011b).

2.1 Stakeholder Engagement

Table 2.1: Summary Document SD1. Summary of stakeholder involvement for Northern Prawn Fishery - Redleg Banana Prawn sub-fishery.

Fishery ERA Report stage	Type of stakeholder interaction	Date of stakeholder interaction	Composition of stakeholder group (names or roles)	Summary of outcome
Scoping	Scoping	Jan. 2022	AFMA contacts	Various information supplied and reports sent to ERA Team. Project discussed, methods for Scoping analysis.
Scoping training	MS Teams meeting	1 Mar. 2022	Miriana Sporcic (CSIRO), Cate Coddington (AFMA), Darci Wallis (AFMA), Elissa Mastroianni (AFMA), Natalie Couchman (AFMA)	Miriana Sporcic (CSIRO) trained AFMA staff on new template for Scoping information towards report automation.
Scoping information	email	17 Mar. 2022	Cate Coddington (AFMA), Darci Wallis (AFMA), Elissa Mastroianni (AFMA)	Initial Scoping document provided to CSIRO
Revised Scoping document	email	19 Apr. 2022	Cate Coddington (AFMA), Darci Wallis (AFMA), Elissa Mastroianni (AFMA)	Revised Scoping document provided to CSIRO
Revised protected species interactions	email	13 May 2022	Miriana Sporcic (CSIRO), Elissa Mastroianni (AFMA), Cate Coddington (AFMA), Darci Wallis (AFMA)	Revised Protected species table for Scoping document provided to CSIRO

Table 2.1: ***(continued)***

Fishery ERA Report stage	Type of stakeholder interaction	Date of stakeholder interaction	Composition of stakeholder group (names or roles)	Summary of outcome
Level 1 (SICA)	Phone calls and emails	May 2022	AFMA contacts, Miriana Sporcic (CSIRO), Tonya van Der Velde (CSIRO), Gary Fry (CSIRO), Anthea Donovan (CSIRO)	Level 1 analysis completed excluding species components due to data unavailability
Draft report	email	Jun. 2022	AFMA; CSIRO, ABARES; Industry members	Draft report (excluding species components) submitted to AFMA
Contract	-	Oct. 2022	AFMA	Contract signed
Species list	emails; phone calls, MS Teams meeting	9 Feb. 2023 - 18 Apr. 2023	Cate Coddington (AFMA); Tamre Sarhan (AFMA); Ben Liddell; Jeremy Smith (AFMA); Gary Fry (CSIRO)	Species queried with AFMA and erroneous species and data confirmed
Species list	-	Apr. 2023	CSIRO	Re-processed data; revised species list completed
Level 1 (SICA) species components, Level , Residual Risk	-	May 2023 - Jun. 2023	CSIRO	Level 1 species components checked subject to new species list; Level 2 and Residual Risk completed
Draft ERA report	email	16 Jun. 2023	Cate Coddington (AFMA), Ryan Murphy (AFMA)	Draft ERA report submitted to AFMA
Draft ERA report	email	30 Apr. 2024	Darci Wallis (AFMA), Miriana Sporcic (AFMA)	Review of draft report provided to CSIRO
Final ERA report	email	3 Apr. 2025	Darci Wallis (AFMA), Ryan Murphy (AFMA), Lachlan Baker (AFMA)	Final ERA report submitted to AFMA

2.2 Scoping

The aim of the Scoping stage is to develop a profile of the fishery being assessed. This provides information needed at stakeholder meetings and to complete Levels 1 and 2. The focus of analysis is the fishery, which may be divided into sub-fisheries based on fishing method and/or spatial coverage. Scoping involves six steps:

- Step 1. Document the general fishery characteristics
- Step 2. Generating “unit of analysis” lists (species, habitat types, communities)
- Step 3. Selection of objectives
- Step 4. Hazard identification
- Step 5. Bibliography
- Step 6. Decision rules to move to Level 1

2.2.1 General Fishery Characteristics (Step 1)

The information used to complete this step came from a range of documents such as the Fishery's Management Plan, Assessment Reports, Bycatch Action Plans, and any other relevant background documents.

The following sections comprise the **Scoping Document S1 General Fishery Characteristics**.

Fishery Assessed: Northern Prawn Fishery

Date of revised ERAEF assessment: April 2025

Assessor: AFMA and authors of this report (CSIRO)

2.2.1.1 General Fishery Characteristics

Fishery Name

Northern Prawn Fishery (NPF)

Sub-fisheries

Three spatially and temporally distinct demersal trawl fisheries exist: White Banana Prawn, Redleg Banana Prawn and Tiger Prawn sub-fisheries. The gear and fishing technique employed by each fishery is similar, with the exception that the height of White Banana Prawn sub-fishery nets is generally higher than Redleg Banana Prawn/Tiger Prawn nets. The split into Banana and Tiger prawn fishery components is based on the composition of the catch in logbook records. If half or more of a vessel's daily catch was Banana Prawns or there was no prawn catch and the vessel was fishing, the vessel was defined as operating in the Banana Prawn fishery on that day; otherwise, it was defined as operating in the Tiger prawn fishery. Banana Prawn fishery catch is the catch of all prawn species (Banana, Tiger, Endeavour, and King Prawns) when a vessel is defined as fishing in the Banana Prawn sub-fishery. Tiger Prawn fishery catch is the catch of all species when a vessel is defined as operating in the Tiger Prawn fishery.

The Banana Prawn sub-fishery is further split into the White Banana Prawn and Redleg Banana Prawn sub-fisheries based on the spatial extent of each species. Redleg Banana Prawns are a relatively small percentage of the total NPF prawn catch and are caught almost exclusively in deep water (>45 metres) in the Joseph Bonaparte Gulf (JBG) and White Banana Prawns elsewhere across northern Australia (Dichmont et al., 2001b).

Sub-fisheries assessed

The NPF Redleg Banana Prawn sub-fishery is being assessed.

Start date/history

Commercially viable stocks of banana prawns were discovered on 25 May 1964 during the Gulf of Carpentaria Prawn Survey (Taylor, 1992). Since that time, prawn stocks over the geographical extent of the NPF have been managed by the various governments of Queensland, Western Australia, Northern Territory and the Commonwealth. In 1988, Offshore Constitutional Settlement Arrangements between the Commonwealth and the other relevant jurisdictions transferred the responsibility of the management of the NPF solely to the Commonwealth.

Fishing effort peaked in 1981 at a level that exceeded the long-term sustainable yield of the resource with 286 vessels in the fishery reporting a total of 43,419 fishing days. Effort has decreased over time to current levels of 52 vessels and 7230 fishing days in 2020. It is generally accepted that fishing effort was severely under-reported from around 1978 to the early 1980s, when completion of logbooks was voluntary. Since the early 1980s, logbook coverage of the fishery has been virtually 100% (Dichmont et al., 2021).

The Redleg Banana Prawn sub-fishery essentially developed in the early 1980s. The fishing grounds are in deeper waters than for White Banana Prawns (*P. merguiensis*) and fishing takes place both day and night. Fishing centres on neap tides, as JBG has large tidal flows (tidal range is up to 7 m).

Substantial changes in fishing effort in the NPF Redleg Banana Prawn sub-fishery saw the number of days fished increase through the 1980s and 1990s, to a peak of about 2471 boat days in 1997, but then falling to lows of just 161 and 149 boat days in 2008 and 2012, respectively. Effort has since increased to 358 boat days, in 2013, to 559 boat days (a 56% increase) in 2014, before decreasing to the lowest level yet of 79 and 76 days in 2015 and 2016 respectively. More recently, effort levels have been variable. Effort was high in 2017 (548 boat days), decreased to 213 boat days in 2018 and then down to a very low level of 75 days in 2019, before increasing again to 195 days in 2020. Changes in effort over the entire period of the fishery reflect not only prawn catch rates but also historical management changes. These included large reductions in the number of vessels able to participate in the fishery and the introduction of seasonal closures over time. Inter-annual changes also reflect the response of operators to fluctuating catch rates, prices and values in other parts of the fishery (Pascoe et al., 2020), and more recently the role of environmental variability has also been explicitly recognised (Plagányi et al., 2021a).

The current management plan, the *Northern Prawn Fishery Management Plan 1995*, was implemented in 1995.

Geographic extent of fishery

The management area of the NPF covers over 771,000 square kilometres off Australia's northern coast, from Cape Londonderry in Western Australia to Cape York in Queensland (Figure 2.1). The area actively fished within this is much smaller (around 220,000 square kilometres) and the fishery is regarded as having two components: a Banana Prawn fishery and a Tiger Prawn fishery.

A Joseph Bonaparte Gulf (JBG) 'box' (129.3567°E, 12°S) is used to delineate the NPF Redleg Banana Prawn sub-fishery from the White Banana Prawn sub-fishery (Figure 2.2). Although both White and Redleg Banana Prawns are caught in the JBG 'box', for practical purposes all Banana prawns caught within this region are considered to be Redleg Banana prawns under the NPF Harvest Strategy. In reality, on average, 16% of the NPF total White Banana Prawn and 65% of the NPF total Redleg Banana Prawn catches are caught in the JBG region (Dichmont et al., 2001a).

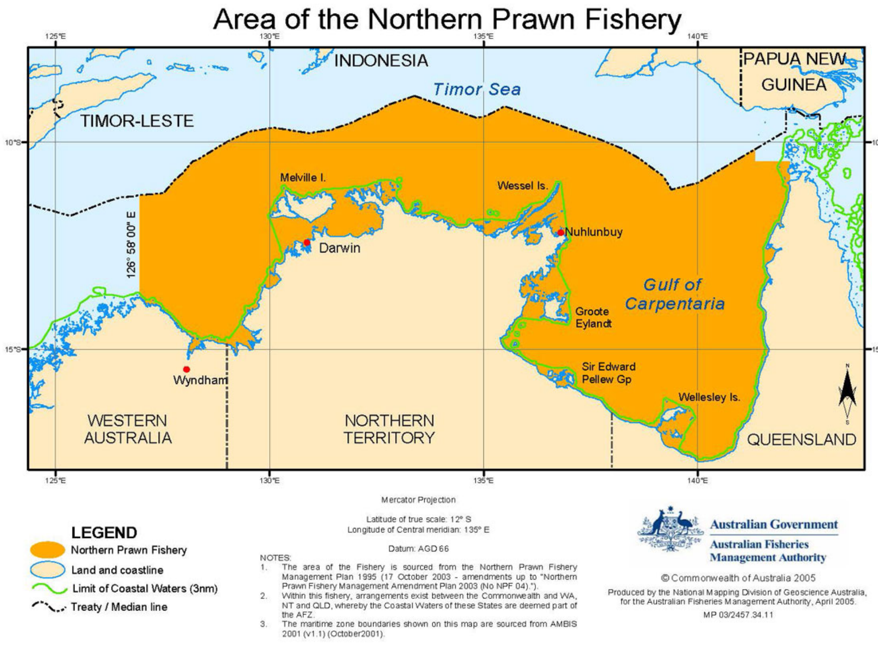


Figure 2.1: Geographic extent of the Northern Prawn Fishery. Source: AFMA.

Regions or Zones within the fishery

The NPF is partitioned into 15 statistical zones (Figure 2.3) for the purpose of reporting catch and effort in the NPF (Laird, 2021).

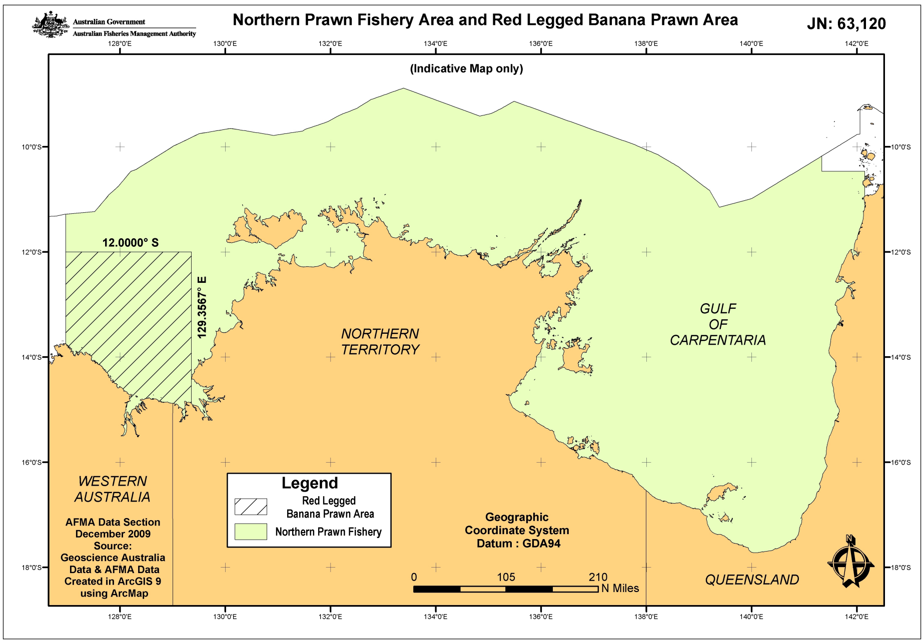


Figure 2.2: Geographic extent of the Redleg Banana Prawn sub-fishery inset in the Northern Prawn Fishery. Source: AFMA.

Fishing season

The NPF has two seasons:

- Season 1 (mainly Banana Prawns caught): 1 April – 15 June (season end date depends on catch rates)
- Season 2 (mainly Tiger Prawns caught): 1 August – 30 November (season end date depends on catch rates).

The NPF Redleg Banana Prawn sub-fishery (when fishing is allowed) opens at the same time as the rest of the NPF and is closed if the catch trigger limits/decisions rules in place for the NPF White Banana Prawn and Tiger Prawn sub-fisheries close the rest of the NPF in any given season.

In 2021, a first-season closure was implemented for the NPF Redleg Banana Prawn sub-fishery. Fishing in the JBG (the NPF Redleg Banana Prawn sub-fishery) is currently only permitted during the second season (1 August – 30 November).

Key/secondary commercial species and stock status

The Northern Prawn Fishery (NPF) uses otter trawl gear to target a range of tropical prawn species. White Banana Prawn and two species of Tiger prawn (brown and grooved) account for around 80% of the landed catch. Redleg Banana Prawns are a relatively small percentage of the total NPF prawn catch (between 2016-19, *P. indicus* were 1-7% of the total banana prawn catch).

Redleg Banana Prawn

The biological status of the Redleg Banana Prawn was classified as not subject to overfishing and not overfished (Butler et al., 2021).

The Redleg Banana Prawn sub-fishery utilises a quarterly age-based biological assessment model that incorporates a limit reference point (LRP) proxy of $0.5B_{MSY}$ (as specified by the Commonwealth Fisheries Harvest Strategy Policy and Guidelines). There are no pre-season surveys for the Redleg Banana Prawn sub-fishery, it relies on a combination of quarterly catch per unit effort (CPUE) and fishing power data.

In 2021, 95% of the fishing effort and 95% of the catch was in the JBG area, with the balance taken from Colville-Melville (CM) and with negligible amount from Fog Bay (FB) (total catch across all areas was 503 t. Effort in JBG 2021 was 415 boat-days (total effort across all areas was 438 boat days). Previously, most of the fishing effort was distributed in the second and third quarters (Apr-Sept), but given the harvest strategy

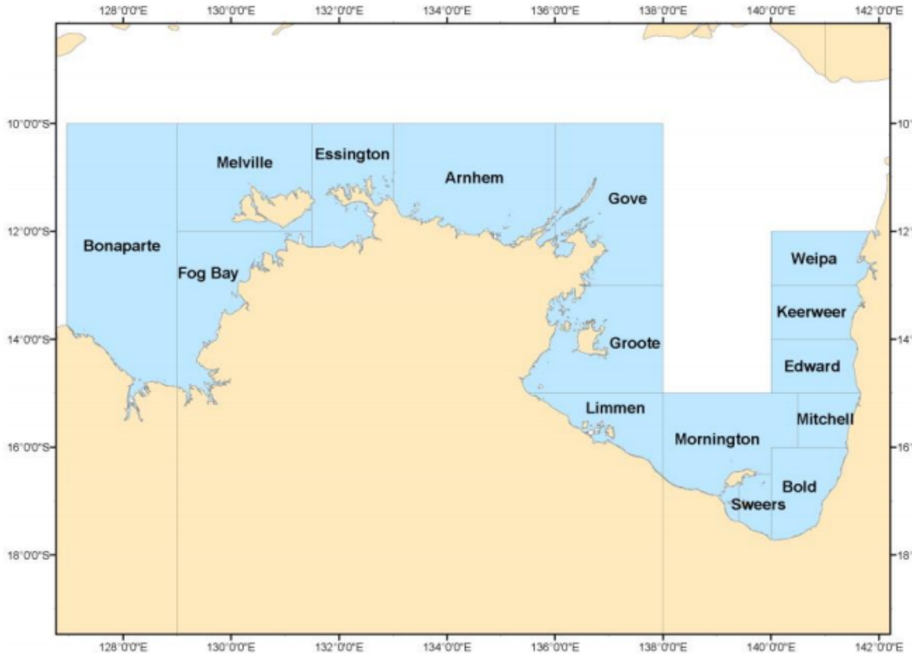


Figure 2.3: Statistical zones of the Northern Prawn Fishery. Source: Laird (2021).

change implemented in 2021 to permanently close the first season to Redleg Banana Prawn fishing, all of the 2021 fishing effort was in the second season.

The 2021 nominal CPUE observation for the third quarter was larger than the average (since the 2000s). The fishing power was estimated to have increased 4% in 2021 relative to 2020. The stock assessment suggests an increase in the stock from 76% B_{MSY} in 2020 to around 93% of the B_{MSY} level in 2021, although the Spawning Biomass (2708 t) is still below (77%) the target B_{MEY} level. Variability about B_{MSY} is to be expected for a variable stock, but the biomass levels are estimated to have been below the target level for a number of recent years, hence it is encouraging that the stock appears to have increased in the recent year. This is consistent with the expected change under the revised Harvest Strategy (HS) as closing the first season is predicted to allow the stock to recover rapidly provided total effort doesn't greatly exceed the Total Allowable Effort (TAE).

** Grooved and Brown Tiger Prawns**

The reference point for the Tiger Prawn Fishery, which includes both Tiger and Endeavour Prawn species, is MEY, which is assumed to be achieved over a seven-year period. The dynamic path to MEY is calculated as the effort level and associated catch in each year over a seven-year projection period that leads to a long run sustainable yield that maximizes profit over time. The annual effort levels (or TAE) in the fishery are adjusted based on the outcomes of the bio-economic model, which includes the biomass estimates of Tiger and Endeavour Prawns and key economic variables, expressed as fishing days.

The 2022 stock assessment base case (including data up until 2021) for Grooved Tiger Prawn is S_{2023}/S_{MSY} = 0.75, and the moving five-year average stock status $S_{2019\text{-}2023}/S_{MSY}$ = 0.95. Across all the scenarios tested, Grooved Tiger Prawn stock status (S_{2023}/S_{MSY}) ranged between 0.66 – 0.82 and the moving five-year average ($S_{2019\text{-}2023}/S_{MSY}$) range was 0.82 – 1.03. Thus, the 2022 stock status for Grooved Tiger Prawn is above the limit reference point (LRP) of $0.5S_{MSY}$. Effort was well below that at E_{MSY}, with E_{2023}/E_{MSY} estimates ranging between 0.41 – 0.66. Grooved Tiger Prawns are therefore considered not overfished, and overfishing is not occurring.

The 2022 stock assessment base case (including data up until 2021) for Brown Tiger Prawn is S_{2023}/S_{MSY} = 0.90, and the moving five-year average stock status $S_{2019\text{-}2023}/S_{MSY}$ = 1.11. The stock status (S_{2023}/S_{MSY}) ranged between 0.66 - 0.90 in all scenarios tested. Furthermore, the moving five-year average ($S_{2019\text{-}2023}/S_{MSY}$) ranged between 0.81 – 1.11, and thus above the limit reference point of $0.5S_{MSY}$. Effort was well below that at E_{MSY}, with E_{2023}/E_{MSY} estimates ranging from 0.32 to 0.64. Therefore, Brown Tiger Prawn are considered not to be overfished nor is overfishing occurring.

Blue and Red Endeavour Prawns

Endeavour prawns are generally caught incidentally during Tiger Prawn targeting, although targeting can occur during periods of higher availability and/or the right economic conditions. Both species of Endeavour Prawns are assessed as part of the Tiger Prawn stock assessment.

The 2022 stock assessment base case (including data up until 2021) for Blue Endeavour Prawn is S_{2023}/S_{MSY} = 0.65, and the moving five-year average $S_{2019\text{-}2023}/S_{MSY}$ = 0.66. In all the sensitivity scenarios tested, the Blue Endeavour Prawn stock status (S_{2023}/S_{MSY}) ranged from 0.61 – 0.82, while the moving five-year average (S_{2023}/S_{MSY}) ranged from 0.62 – 0.83. Blue Endeavour Prawn is, therefore, not considered to be overfished according to the limit reference point of $0.5S_{MSY}$ based on a five-year moving average.

Red Endeavour Prawns are not in the base case, although still assessed in a four species sensitivity test. The 2022 Red Endeavour stock status (including data up until 2021) was S_{2023}/S_{MSY} = 0.87, while the five-year moving average $S_{2019\text{-}2023}/S_{MSY}$ = 0.92. Red Endeavour Prawn is, therefore, not considered to be overfished according to the limit reference point of $0.5S_{MSY}$ based on a five-year moving average or the 2023 biomass estimate.

Bait collection and usage

No bait is used in the Northern Prawn Fishery (NPF).

Current entitlements

Fishers must hold a valid boat fishing right to fish in this fishery. Fishers also need to have gear fishing rights that allow them to use a certain amount of net to catch fish in the fishery. These fishing rights are transferable to others.

In the fishery there are currently 52 boat fishing rights (maximum number of vessels active at one time) and 35,479 gear fishing rights (Table 2.2).

Table 2.2: Entitlement holdings for the NPF Redleg Banana Prawn sub-fishery. Statutory Fishing Rights (SFRs). Source: AFMA

Quota Year	No. Licence holders	No. Boat SFRs	No. Gear SFRs	No. active operators	No. inactive operators
2015	20	52	35 479	10	42
2016	21	52	35 479	7	45
2017	20	52	35 479	15	37
2018	19	52	35 479	11	41
2019	19	52	35 479	10	42
2020	19	52	35 479	13	39
2021	19	52	35 479	18	38

Current and recent TAEs, trends by method

There are no TACs in the NPF. The NPF is managed through a series of input controls, including limited entry to the fishery, individual transferable effort units, gear restrictions (limit on the total length of headrope) (*Northern Prawn Fishery Management (Fishing Capacity) Determination 2021*), byproduct restrictions (catch limits on certain teleost species, Mud Crabs, Rock Lobsters, and Tuna)(*Fisheries Management (Northern Prawn Fishery Limited-take and Prohibited-take Species) Direction 2021*), and a system of seasonal (*Fisheries Management (Northern Prawn Fishery Seasonal Closures) Direction 2021*) and spatial closures (*Fisheries Management (Northern Prawn Fishery Permanent Closures) Direction 2021*).

Current and recent fishery effort trends by method

The annual effort in the Redleg Banana Prawn sub-fishery by calendar year is listed in Table 2.3.

Logbook entries are only required daily, with usually 3-4 shots made on a fishing day. Therefore, the total number of trawls made in 2021 combined for all boats in the Redleg Banana Prawn sub-fishery was about 978 assuming an average effort of three shots per day.

Table 2.3: Annual (calendar year) effort (fishing days) in the Redleg Banana Prawn sub-fishery for 2008-2021 inclusive. Source: AFMA (2021 data from NPFI).

Year	No. of vessels	Redleg Banana Prawn effort (days)
2008	2	161
2009	11	392
2010	10	214
2011	11	461
2012	7	149
2013	20	358
2014	16	559
2015	10	79
2016	7	76
2017	15	548
2018	11	213
2019	10	75
2020	13	195
2021	18	415

Current and recent fishery catch trends by method

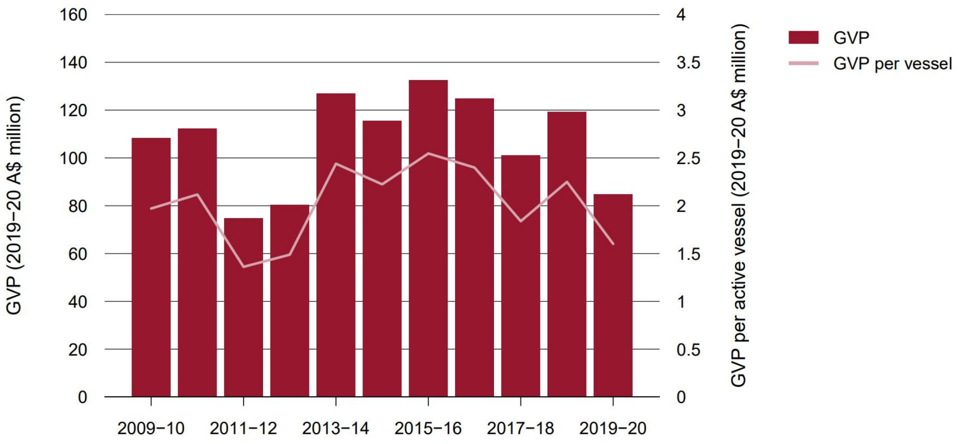
Catch (t) for the years 2008-21 are listed in Table 2.4.

Table 2.4: Annual (calendar year) catch (t) in the Redleg Banana Prawn sub-fishery for 2008-2021 inclusive. Source: AFMA.

Year	Redleg Banana Prawns (t)
2008	162
2009	471
2010	233
2011	435.3
2012	178.9
2013	374.3
2014	819.5
2015	29.5
2016	33.1
2017	364.6
2018	237.6
2019	47.3
2020	133.4
2021	479.3

Current and recent value of fishery ($)

The gross value of production (GVP) for the whole of the NPF has fluctuated over the last decade (Figure 2.4). The GVP declined by 28% in 2019-20 due to a seasonally driven decline in Banana Prawn catch to about $84.8 million from about $120 million in 2018-19. The value of the Redleg Banana Prawn sub-fishery is not reported as it is only a minor component of the overall fishery. For further information see the *ABARES Fishery Status Report 2021* (Butler et al., 2021).



Notes: **GVP** Gross value of production. 2019–20 data are preliminary.

Figure 2.4: Gross Value of Production (GVP) and GVP per active vessel 2009-10 to 2019-20. Source: Butler et al. (2021).

Relationship with other fisheries

The NPF borders or shares common waters with international, Commonwealth, State and recreational fisheries, although direct interaction for common resources is negligible.

Commonwealth fisheries – Torres Strait Prawn Fishery, Eastern Tuna and Billfish Fishery, Western Tuna and Billfish Fishery, Northwest Slope Trawl, Western Deepwater Trawl.

WA fisheries – Kimberley Prawn Fishery, Kimberley Gillnet and Barramundi Fishery, Northern Demersal Scalefish Fishery, Mackerel Fishery.

NT fisheries – Mud Crab Fishery, Coastal Line Fishery, Timor Reef Fishery, Demersal Fishery, Spanish Mackerel Fishery, Barramundi Fishery, Trepang Fishery, Coastal Net Fishery, Bait Net Fishery, Mollusc Fishery, Offshore Net and Line Fishery, Pearl Oyster Fishery.

Qld fisheries – Blue Swimmer Crab Fishery, Coral Fishery, Coral Reef Fin Fish Fishery, Crayfish and Rock lobster Fishery, East Coast Inshore Fin Fish Fishery, East Coast Otter Trawl Fishery, East Coast Pearl Fishery, East Coast Spanish Mackerel Fishery, Gulf of Carpentaria Developmental Fin Fish Trawl Fishery, Gulf of Carpentaria Inshore Fin Fish Fishery, Gulf of Carpentaria Line Fishery, Marine Aquarium Fish Fishery, Mud Crab Fishery, Rocky Reef Fin Fish Fishery, Sea Cucumber Fishery (East Coast), Spanner Crab Fishery, Trochus Fishery.

Recreational fisheries – Recreational fishers use hand-held seine or bait nets of restricted sizes for catching prawns in both Queensland and the Northern Territory in the NPF area. Operators and management regard the interaction of these fisheries as insignificant.

Aquaculture – Licensed aquaculturists in northern Australia contract NPF vessels operating under either specific 'broodstock permits' or the normal NPF concessions to supply gravid prawns for use in the aquaculture industry.

2.2.1.2 Gear

Fishing methods and gear

Prawn otter board trawling is an active fishing method that involves towing a conical-shaped net spread open by two or four steel or timber otter boards over the seabed, commonly called otter trawling (see Figure 2.5).

Ground chains are also used on the nets to stimulate prawns into the trawl mouth. Vessels in the NPF may tow a range of nets in a variety of configurations. These are regulated by the *Northern Prawn Fishery Management Plan 1995* (the Management Plan) and relevant Determinations and Directions. In recent years, many vessels have transitioned from using twin gear to mostly using a quad rig comprising four trawl nets—a configuration that is more efficient. In addition to the main nets, a small 'try-net' is also used to test the potential catches for a given area.

Most of the vessels in the NPF are purpose-built from steel and range in length from 17 m to 30 m. All NPF boats have modern and sophisticated catch handling, packing and freezing capabilities as well as wet (brine) holding facilities. All vessels use electronic aids such as colour echo sounders, Global Positioning Systems (GPS) and plotters. Satellite phones and fax equipment are used by most vessels. Also, on-board computing facilities, electronic logbooks and Wi-Fi were introduced onboard vessels. All vessels are required to have a Vessel Monitoring System (VMS) installed. The most common NPF vessel length in 2020 was between 22.0-22.9 m.

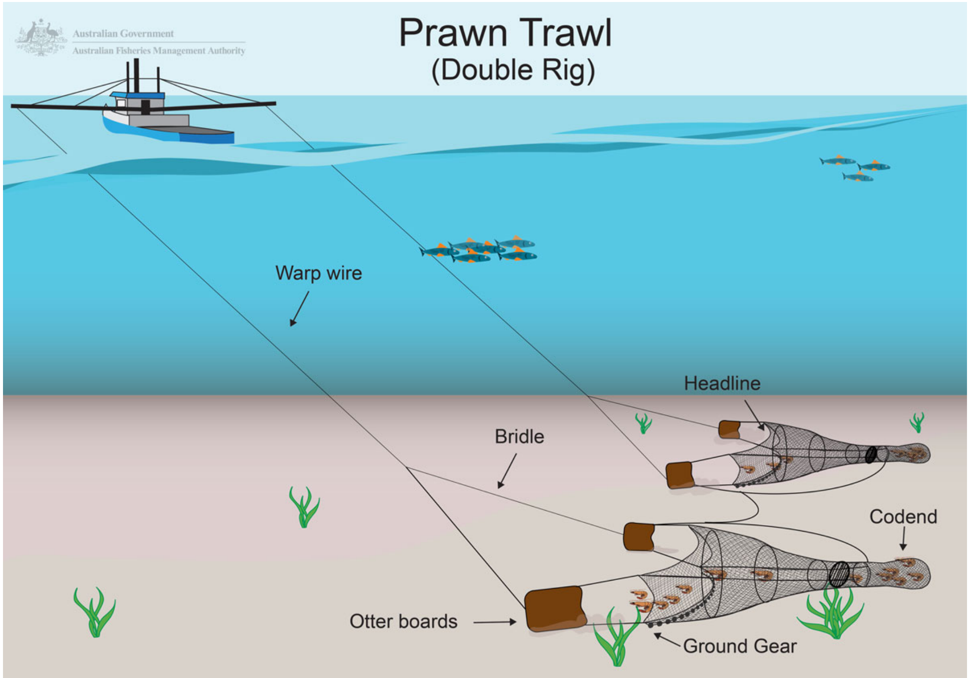


Figure 2.5: Commonly called otter trawl, prawn trawls can be towed in multiples of two, three or four nets, with long arms (or booms) extending out from each side of the boat to allow the nets to fully open. This example is a double rig. Source: AFMA.

Fishing gear restrictions

Fishers must hold a valid boat fishing right to fish in this fishery. Fishers also need to have gear fishing rights that allow them to use a certain amount of net to catch fish in the fishery. These fishing rights are transferable to others (NPF Management Plan: https://www.legislation.gov.au/Details/F2012C00160).

Gear fishing rights entitle the holder to use a net with a certain headrope and footrope length. A gear statutory fishing right (SFR) for operators using:

- twin trawl nets has a headrope value of 9 cm per SFR and
- quad trawl, twin tongue trawl or triple gear has a headrope value of 8.1 cm per SFR.

Since 2000, each net on a vessel is required to have an approved Turtle Excluder Device (TED) and a Bycatch Reduction Device (BRD) installed.

Selectivity of fishing methods

Although the trawl net mesh size is designed to be selective for prawns, trawling is an indiscriminate fishing method, which can capture organisms of various sizes, motile or sessile, which are in the path of the net.

Adult Redleg Banana Prawns form aggregations, but not dense schools like the White Banana Prawns. As such, selectivity for Redleg Banana Prawns is not as high as for the White Banana Prawns.

Spatial gear zone set

About 75% of the NPF fishing effort occurs within the neritic zone in the Gulf of Carpentaria between about 5-50 nm from shore. Along the Arnhem coast and Joseph Bonaparte Gulf, trawling takes place in deeper water and the gear is deployed about 10- 50 nm from the coast.

Depth range gear set

Seasonal and spatial closures prevent the taking of smaller Redleg Banana Prawns inshore. Adults are exploited in offshore deep-water, from 50 to 80 m and occasionally to 100 m.

How gear is set

Redleg Banana Prawn fishing only occurs through the neaps of each tidal cycle, as at the peak of the tidal cycle there are 5-7 m, twice daily, depth changes and the associate current makes effective fishing impossible. Redleg Banana Prawns are generally targeted in two ways in the JBG:

Redleg Banana Prawns are found both dispersed and buried with other prawn species across broad areas, in which case their presence is not distinguishable from other signs of 'life' on echo-sounders. If there are no better prospects for targeted fishing, fishers may trawl the areas of dispersed size classes try to 'scratch up a catch'. In some years this is the only type of fishing that takes place.

Redleg Banana Prawns also form mobile schools like the White Banana Prawn (*P. merguiensis*). At times they aggregate and come out of the sediments to form ball-like schools – mainly in the daytime and then dispersing again at night-time. Fishers target the balls or schools of prawns on the bottom, using their bottom trawls with head-ropes set 3-4 m above the bottom. At times the schools lift off the bottom 50–90 m and move away 20–40 m above the bottom. Fishers try and track the schools with their echo-sounders to target the school again when it settles back on the bottom (Prince & Loneragan, 2012).

Area of gear impact per set or shot

A small increase in relative fishing power is estimated for 2020 (by ~1%) *c.f.* 2019" (Upston et al. (2021) in Plagányi et al. (2021b)). The fishing power series for 1981 to 2020 is shown in Figure 2.6.

Across the fleet fishing in JBG, the average swept area in 2020 was estimated to be 29.6% hectares per hour, a small increase of 5% compared to the 2019 estimate (Judy Upston pers. comm.).

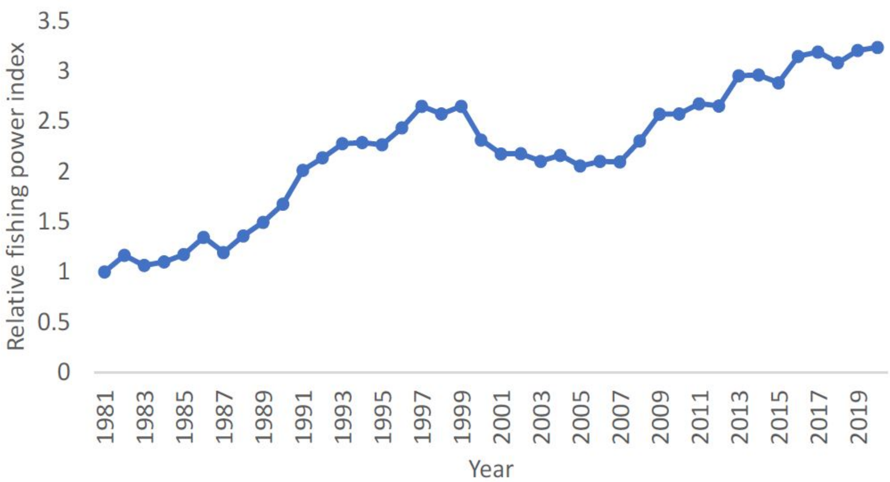


Figure 2.6: Redleg Banana Prawn relative fishing power series (1981-2020) Source: Plagányi et al. (2021b).

Capacity of gear

Net size in all sub-fisheries is restricted by the number of SFR gear units held by the operator, which controls the length of headrope permitted. Most nets have the capacity to retain about 1 t, meaning the total capacity of a single trawl shot using a twin gear configuration is about 2 t and a quad configuration is about 4 t.

Effort per annum all boats

The annual effort in this sub-fishery is listed in Table 2.3.

Lost gear and ghost fishing

Trawl gear loss occurs mainly by the gear becoming bogged in soft sediments or excessively large catch weights. These occurrences are generally rare, less than about five occurrences per year. Lost gear is usually attempted to be retrieved. Small patches of net are sometimes lost, but again this is minimal. If lost, the net probably has minimal impact on marine communities, particularly protected species, since the net generally sinks and remains on the substrata. A recent survey showed that ghost nets washed ashore in the NPF originated from Indonesian and Taiwanese fishers, while 7% could be identified as material used by Australian prawn operators.

2.2.1.3 Issues

Key/secondary commercial species issues and Interactions

No issues have been identified for the key/secondary species in this sub-fishery.

Byproduct and bycatch issues and interactions

Byproduct species are defined as species that do not make a significant contribution to the overall catch but are sometimes landed for sale. Bycatch species are defined as species that are caught as part of fishing activities but are rarely landed. The ERA is the primary assessment tool to assess these species.

The assessed byproduct species are Western King Prawn (*Melicertus latisulcatus*), and Mudbug (*Thenus parindicus*).

Bycatch species in the NPF Redleg sub-fishery include squids (e.g., Mitre Squid *Uroteuthis chinensis*), northern Calamari *Sepioteuthis lessoniana*, bugs, crabs, scallops (e.g., Saucer Scallop *Amusium pleuronrctes*), cuttlefishes, rays and some larger fish species.

Since 1993, a small number of vessels in the NPF have been opportunistically targeting squid. There is a 500 t catch trigger limit for squid. In 2017 the squid catch was 11 t. Currently, there is little understanding of the species composition of the squid catch and their basic biology and distribution. A similar problem exists with bugs where approximately 110 t were taken by the NPF in 2016, exceeding the 100 t limit, and triggering a review of survey and logbook data. The NPF Resource Assessment Group (RAG) reviewed the data and advised that the data indicates that bugs are not being targeted and are an incidental byproduct and there doesn’t appear to be a downward trend in abundance.

Due to the indiscriminate nature of trawling, particularly the Redleg Banana Prawn and Tiger Prawn sub-fisheries, and the small net mesh size used, the NPF interacts with a diversity of organisms including teleosts (411 spp.), invertebrates (234 taxa), elasmobranchs (56 spp.), sea snakes (16 spp.), and turtles (5 spp.). Since 2000, Turtle Excluder Devices (TEDs) have been compulsory in the fishery which has excluded 99% of turtles and large (>1 m) elasmobranchs and sponges. The NPF fishery has achieved significant milestones in the management of bycatch, including more than a 50% reduction of bycatch since its first Bycatch Action Plan was implemented in 1998 by the Northern Prawn Fishery Management Advisory Committee (NORMAC) and through the introduction of TEDs, bycatch reduction devices (BRDs), reduced effort and implementation of spatial and temporal closures.

Protected species issues and interactions

Operators are required to report all interactions with protected species in their logbooks and AFMA reports quarterly to the Department of Environment and Energy (Table 2.5).

This sub-fishery interacted with Protected species: turtles (5 spp.), sea snakes (16 spp.) and sawfishes (4spp.). Since the introduction of turtle excluder devices (TEDs) in 2000, interactions with turtles have been minimal and the NPF does not overlap with key breeding or aggregation areas.

Overall, there were 2106 protected species interactions in the Redleg Banana Prawn sub-fishery over this assessment period (1606 alive; 500 dead). Most of these interactions were with sea snakes (1740: 1403 alive; 337 dead), followed by sawfishes (359: 196 alive; 163 dead). All seven turtle interactions were released alive.

Catch trend analysis for the sea snake species between 2003 to 2016 showed no detectable declines due to trawling (Fry et al., 2018). The breeding locations are largely unknown and there is no evidence of aggregation sites occurring within the NPF (pers. comm. David Milton, CSIRO). A current project is monitoring the impact of the fishery's interactions with protected and at-risk species.

Table 2.5: Recorded wildlife interactions from the AFMA Logbook database for the period 2015-21 inclusive. Source: www.afma.gov.au/sustainability-environment/protected-species-management/protected-species-interaction-reports. Alive (A); Dead (D); Total between 2017-21 (Tot).

Scientific name	Common Name	2015 A	D	2016 A	D	2017 A	D	2018 A	D	2019 A	D	2020 A	D	2021 A	D	Tot
Anoxypristis cuspidata	Narrow Sawfish	0	0	0	0	0	0	0	0	4	1	4	0	85	76	170
Pristis zijsron	Green Sawfish	0	0	0	0	0	1	0	0	0	0	5	0	23	9	38
Pristis clavata	Dwarf Sawfish	0	0	0	0	1	0	0	0	0	0	1	0	0	2	4
Pristis pristis	Freshwater Sawfish	0	0	0	0	0	0	0	0	0	0	1	0	14	3	18
Pristidae	Sawfish (unidentified)	0	2	2	2	17	13	15	27	2	1	6	29	18	1	129
Hydrophiidae	Seasnake (unidentified)	28	20	38	18	362	107	87	51	127	34	226	21	601	124	1740
Cheloniidae	Turtle (unidentified)	0	0	0	0	3	0	0	0	0	0	1	0	0	0	4
Chelonia mydas	Green Turtle	0	0	0	0	0	0	0	0	0	0	0	0	3	0	3
	Total:	28	22	40	20	383	121	102	78	133	36	244	50	744	215	2106

Habitat issues and interactions

There are risks to seabed habitat due to trawling, particularly in the Tiger Prawn sub-fishery and Redleg Banana Prawn sub-fishery when undertaking general trawling, since commercial species occur on or near the seabed. Removal, modification and disturbance of the seabed biota by this method occurs. The extent and effects of these impacts on the ecosystem have been studied extensively on the Great Barrier Reef (Poiner et al., 1998) and more recently in the NPF Pitcher et al. (2016).

Community issues and interactions

There is a risk that food web dynamics may change by removing a species or a size range of the population. This may be due to an increase in prey species or competitive species, and possible declines of predators that rely on the species removed by trawling. There is also the potential that discards provide additional food resources for sharks and birds, which may have an opposite effect on these species groups and probably flow-on effects through communities.

Over the past decade, it has become evident that climate change is changing water temperatures and probably salinities and other water properties. This effect on species could cause changes in distribution and increasingly species are being more regularly sighted beyond previous known distributions. Some species might not be able to disperse or extend their range so readily and populations may decline as a result of their inability to adapt to new environmental conditions. While ecosystem models account to some extent for cumulative pressures, the way in which they interact may be non-linear and is currently the focus of research. As such, whole of ecosystem-based advice is sought and considered by fishery management.

Discarding

In all the sub-fisheries bycatch and juveniles of target species are generally processed and discarded overboard at sea. Discards are generally lower in the White Banana Prawn sub-fishery due to operators targeting prawn aggregations. There tends to be minimal high grading in all sub-fisheries since the freezer capacity on NPF vessels is generally large.

The majority of bycatch in the NPF are teleosts with small body sizes and short life spans (Stobutzki et al., 2001). A previous assessment has shown that fishing intensity at 2010-13 levels had a low impact on fish bycatch and did not affect the long-term sustainability of the bycatch species evaluated (Zhou et al., 2015).

2.2.1.4 Management: planned and those implemented

Management objectives

The objectives of the NPF management plan are to ensure:

a. that the objectives pursued by the Minister in the administration of the Fisheries Management Act, and by AFMA in the performance of its functions, are met in relation to the Northern Prawn Fishery; and

b. that the incidental catch of non-target commercial and other species in that Fishery is reduced to a minimum.

Fishery management plan

A management plan was implemented in the NPF in 1995 and was last revised in 2011. The key features of the plan are (i) introductory provisions, (ii) Statutory Fishing Rights (SFRs), (iii) objectives, (iv) measures by which the objectives are to be attained, and (v) performance criteria.

Input controls

The NPF is managed through a series of input controls, including limited entry to the fishery, gear restrictions, bycatch restrictions and a system of seasonal, spatial and temporal closures.

To fish in the NPF operators must hold SFRs, which control fishing capacity by placing limits on the number of trawlers and the amount of gear permitted in the fishery. There are two types of SFRs:

a. Class B SFR, which permits a boat to fish in the NPF; and

b. gear SFR, which limits the amount of net a fisher can use.

There are currently 35,479 gear SFRs issued for the fishery. The total number of Class B SFRs in the fishery is 52.

A gear SFR currently represents 9 cm of operational headrope for operators towing twin gear and 8.1 cm of headrope for operators towing triple or quad trawl gear or twin tongue nets.

Input controls also exist on fishing effort in the form of temporal and spatial closures (*Fisheries Management (Northern Prawn Fishery Seasonal Closures) Direction 2021* & *Fisheries Management (Northern Prawn Fishery Permanent Closures) Direction 2021*) within the fishery; both to protect spawning stocks and juvenile populations (and their habitats) before they reach a size whereby they contribute substantially to the economic and biological performance of the NPF (Kenyon et al., 2005).

There are also two marine park networks (the North Network and the North-west Network) covering the area of the fishery that protects examples of the region's marine ecosystems and biodiversity. The Networks are located in Commonwealth waters, between three nm (approximately 5.5 km) and 200 nm (approximately 370 km) offshore (Figure 2.7 and Figure 2.8). There are eight marine parks off the coast of the Northern Territory, Queensland and Western Australia that make up the North Network. The marine parks include habitats such as coral reefs, soft sediments, shelves, canyons and limestone pinnacles. They have high species diversity and globally significant populations of internationally threatened species.

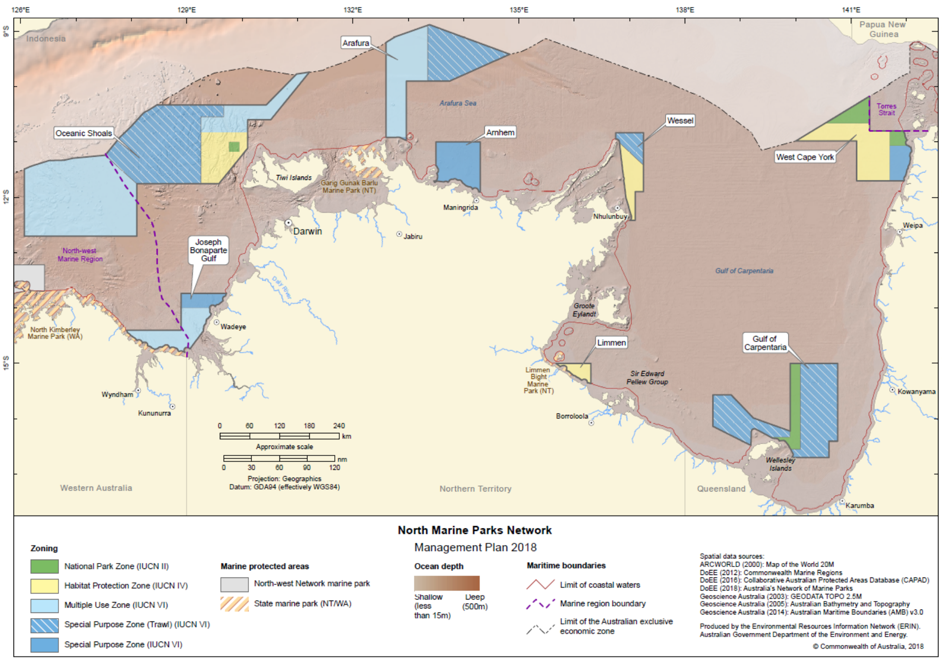


Figure 2.7: Map of North Marine Parks Network.

Output controls

There are currently no output controls in the NPF (i.e. ITQs) for target species due to difficulties in accurately determining total annual catch and individual quotas, particularly for white banana prawns. Under a management regime through output controls, there is the potential for high grading and dumping of lower-value prawns.

There are specific measures (harvest controls) for byproduct species as set in the NPF Harvest Strategy (Table 2.6) (Dichmont et al., 2021). There are also bycatch restrictions (Table 2.7). These measures and trigger limits apply to the NPF overall and not just to the Redleg Banana Prawn sub-fishery.

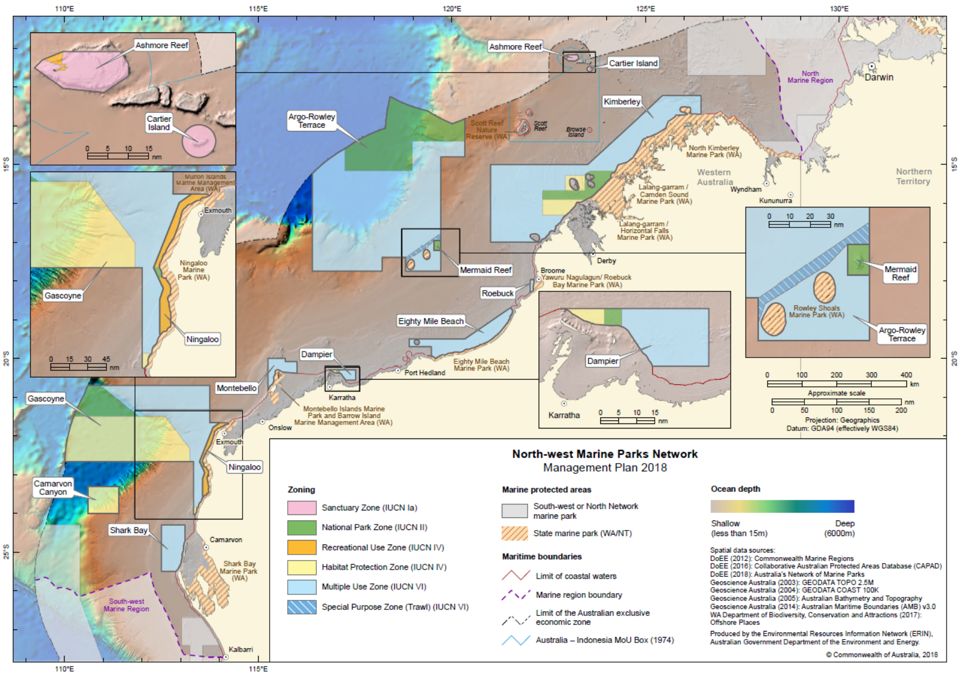


Figure 2.8: Map of North-west Marine Parks Network.

Table 2.6: Byproduct restrictions.

Species	Possession Limit / restrictions
Scampi (all species)	A 30 t limit is imposed for the next year if the catch in the previous year is 30 t.
Bugs (*Thenus indicus, Thenus orientalis*)	60 mm minimum size carapace; no berried female bugs; all bugs retained whole; and, 100 t trigger limit to review survey and logbook data
Squid	500 t catch trigger limit; Review event at 300 t; Appropriate management measures to be developed and implemented if catch trigger is reached.
Saddletail snapper (*Lutjanus malabaricus*), Red snapper (*Lutjanus erythropterus*) and Red emperor (*Lutjanus sebae*)	(a) if the trip ends during the period beginning on 1 March in a year and ending on 30 June the same year, a cumulative total of 550 kg whole weight, or if processed the equivalent to whole weight using the conversion ratio below* (if all catch is processed this equals 211 kg fillet (F) weight / 500 kg gilled & gutted (GG) weight / 393 kg headed & gutted (HG) weight); (b) if the trip ends during any other period (i.e. between 1 July in a year and 28 (29) February in the following year), a cumulative total of 50 kg whole weight, or if processed the equivalent to whole weight using the conversion ratio below* (if all catch is processed this equals 19 kg F weight / 45 kg GG weight / 35 kg HG weight). [*Conversion Ratio's W = GG x 1.1 W = F x 2.6 W = HG x 1.4]
Mud Crab (*Scylla* sp.)	10 per trip

Table 2.6: ***(continued)***

Species	Possession Limit / restrictions
Broad-barred Spanish Mackerel (*Scomberomorus semifasciatus*); Coral trouts, rock cods, sea breams etc. (Serranidae family); Goldband Snapper (*Pristipomoides multidens*); Longtail Tuna (*Thunnus tonggol*); Narrow Barred Spanish Mackerel (*Scomberomorus commerson*); Emperors, sea breams (Lethrinidae family)	No more than a combined catch of 10 individual fish per trip
Rock Lobster (*Panulirus ornatus*), also known as Painted Crayfish	6 lobsters or lobster tails per trip in total

Table 2.7: Species not permitted to be taken in the NPF.

Common name	Scientific name	Additional detail
Shark, Rays & Skates	subclass Elasmobranchii	No part of these species to be retained, including: fins, teeth, skin and saw shark beaks
Tuna or tuna like species (excluding Longtail Tuna).	Genus *Thunnus (excluding Thunnus tonggol), Katsuwonus pelamis*, and Order Istiophoriformes	
Barramundi	*Lates calcarifer*	
Black Jewfish	*Protonibea diacanthus*	
Blue Salmon	*Eleutheronema tetradactylum*	
Coral	Class Anthozoa	
Jewelfish or Yellow Jew or Scaly Jewfish	*Nibea squamosa*	
Pearl shell	*Pinctada* spp.	
Queenfish	*Scomberoides lysan* & *S. commersonnianus*	
Spotted Grunter Bream; Spotted Javelinfish	*Pomadasys kaakan*	
Threadfin Salmon	*Polydactylus macrochir*	
Trepang; Beche-de-mer	Class Holothuroidae	
Trochus	Family Trochidae	

Technical measures

There are no size limits or restrictions on the sex or reproductive state of target prawn species.

There are various types of spatial and temporal closures in the Banana Prawn fishing season including permanent closures (14 areas), VMS start area (1), assembly areas (4), seasonal closures (9), prohibition on daylight trawling (Gulf of Carpentaria) [11] (1) and end of season closure (1).

[11] If MEY decision rule triggered due to low banana prawn catches.

There are no specific regulations on gear or mesh size in the NPF. Permitted gear size is determined by the number of SFRs held by the operator. A try net can be used with otter boards or a beam and has up to 3.66 m and 5.49 m of operational headrope and footrope, respectively.

All nets used in each sub-fishery (except for try nets) must be fitted with an approved TED and a BRD listed under *Fisheries Management (Northern Prawn Fishery Gear Requirements) Direction 2021*.

Regulations

The *Fisheries Management Regulations 1992* prescribes detail on the management arrangements implemented in Commonwealth fisheries. These have since been superseded by the Fisheries Management Regulations 2019, which bridges this assessment period. Specifically, they cover bans on vessels over 130 m, administration of and standard conditions for fishing concessions including VMS operation, carrying observers, processing fish, marine environment impacts, payments and fees, registers and administration and allocation of statutory fishing rights (SFRs), discarding offal at sea (not attributed to this fishery). Additional regulations were introduced regarding navigation in closures. Additional rules are contained in the Management Plan and SFR conditions.

Under the EPBC Act 1999, interactions with a protected species must be reported within seven days of the incident occurring to the Department of Environment and Energy. A Memorandum of Understanding between AFMA and the Department for the Reporting of Fisheries Interactions with Protected Species (Reporting MOU) streamlines those reporting requirements. AFMA reports its protected species interactions to the Department on a quarterly basis.

NPF vessels are required to conform to regulations of MARPOL 73/78 and section 8.7 of the Code of Conduct for Responsible Fisheries administered by FAO, which details responsible practices for managing pollution and discarding at sea.

Under the International Maritime Organisation's International Convention for the Prevention of Pollution from Ships (MARPOL) Annex V the discharge of all garbage, from all ships, into the sea (except as provided otherwise, under specific circumstances) is prohibited (www.imo.org/en/OurWork/Environment/Pages/Garbage-Default.aspx).

Initiatives, strategies and incentives

The *(AFMA, 2022) directions and closures (https://www.afma.gov.au/sites/default/files/final_npf_directions_2022.pdf)* booklet documents all management requirements.

Both the *NPF Bycatch Strategy 2015-2018* (AFMA, 2015) and the strategy that replaced it, the *NPF Bycatch Strategy 2020-24* (AFMA & NPFI, 2020), developed and implemented by NPF Industry Pty Ltd (NPFI), are relevant to the period of this assessment. The NPF Bycatch Strategy is a voluntary industry initiative that aims to better understand and mitigate interactions with priority species and to continue to achieve reductions in bycatch.

A co-management contract in the NPF between AFMA and NPFI details the agreed basis for NPFI to advise AFMA directly on a range of operational and management issues in the NPF including season start and end dates, spatial and temporal closures, gear trial areas and in-season management arrangements.

Other components which NPFI continue to deliver as part of co-management are to (i) undertake NPF pre-season briefings, (ii) develop and implement the *NPF Bycatch Strategy 2020-24* (mentioned above), (iii) manage catch and effort data, (iv) approve the distribution of fishery data and respond to fishery data requests, (v) represent on Indigenous Protected Area management advisory committees, (vi) participate in tender processes for the NPF at-sea monitoring projects, (vii) manage broodstock collection and (viii) recommend research direction and strategies for the NPF.

An Industry Code of Practice for Responsible Fishing was developed in 2004 to define principles and standards of behaviour for responsible fishing practices and continuous improvement in the sustainable management, conservation and utilisation of fishery resources within the NPF.

Enabling processes

The NPF currently has a number of monitoring methods in place including logbooks, scientific observers, crew member observers and independent scientific surveys. Paper logbooks have been in place since 1970 and are designed to provide a continuous record of fishing operations. As of 1 January 2019, all operators fishing 50 days or more in the current or previous fishing season are required to use electronic logbooks (e-logs) to enter and submit daily fishing logs.

Since 2002, the fishery has funded a scientific recruitment survey undertaken annually in January/February and a biennial spawning survey undertaken in June/July prior to the start of each fishing season.

Other initiatives or agreements

The NPF adheres to the Offshore Constitutional Settlement arrangements made in 1988 between the Commonwealth and Queensland, Northern Territory and Western Australia, and associated memorandums of understanding, which primarily relate to byproduct and bycatch species by the NPF.

The NPF was reaccredited by the Department of Agriculture, Water and the Environment under the EPBC Act in January 2019 to allow export of product from the fishery for a period of five years.

In 2012, the NPF received certification from the global environmental Marine Stewardship Council (MSC) standard. The MSC is an international non-profit that independently assesses the fisheries against sustainability and traceability standards.

2.2.1.5 Data

Logbook data

Logbook data is verified in a number of ways:

- by comparing Scientific Observer data with logbook records
- by comparing trawler owner seasonal landing returns for each major species group with the logbook records for the boat
- AFMA at-sea logbook monitoring and enforcement program.

Data summaries of NPF catch and effort by species and regions within the fishery are produced annually by NPFI and available on the AFMA website.

Observer data

Observer programs have been undertaken to monitor target prawn species, byproduct, bycatch, Threatened, Endangered and Protected (TEP) species and potentially at-risk species in the NPF. These include:

- Crew Member Observer (CMO) program (2003 – 2022); long-term bycatch monitoring program in the NPF where trained crew members collect fishery-dependent catch data on TEP species and potentially at-risk species during the banana and tiger prawn seasons.
- A Commonwealth fisheries scientific observer program was implemented in 1979 and has continued to the present day (administered by AFMA since 1992)); fishery-independent data collection by AFMA Scientific Observers on-board NPF commercial vessels during the tiger and banana prawn seasons. Data collected includes operational information and catch data on target, byproduct, bycatch, TEP species and potentially at-risk species.

Information about crew member observer coverage is in Table 2.8 and scientific observer coverage is in Table 2.9.

Table 2.8: Crew Member Observer (CMO) coverage of fishing effort by year. Source: AFMA.

Effort	2015	2016	2017	2018	2019	2020	2021
Total effort days	8233	7880	7418	7988	8093	7230	7042
Total days monitored by CMOs	1058	893	1169	1255	1028	1028	1099

Table 2.8: *(continued)*

Effort	2015	2016	2017	2018	2019	2020	2021
% of fishery effort monitored by CMOs	12.85	11.33	15.76	15.71	12.7	14.22	15.61

Table 2.9: Scientific Observer (SO) coverage of fishing effort by year. Source: AFMA.

Effort	2015	2016	2017	2018	2019	2020	2021
Total effort days	8233	7880	7418	7988	8093	7230	7042
Total days monitored by SOs	159	103	152	148	198	83	213
% of fishery effort monitored by SOs	1.93	1.31	2.05	1.85	2.45	1.1	3

Other data

Additional data on target, byproduct, bycatch and TEP species are also obtained via other surveys:

- NPF prawn population monitoring survey (2002 – 2022); annual (recruitment) and biennial (spawning) fishery-independent monitoring surveys carried out in the NPF by CSIRO to provide prawn recruitment and spawning indices and catch data on TEP species and potentially at-risk species.
- CSIRO scientific research and observer surveys (1975 – 2005); fishery-independent research trawl surveys and CSIRO Scientific Observers on-board NPF commercial vessels collecting catch data on bycatch, TEP and potentially at-risk species.

The Northern Prawn Fishery Strategic Research Plan 2019-2023 (AFMA, 2019) identifies the research priorities for the fishery over five years to assist with the pursuit of the management objectives for the NPF and to enable the effective implementation and appraisal of management arrangements.

Legislative instruments and directions

Environment Protection and Biodiversity Conservation Act 1999. Available at: www.legislation.gov.au/Series/C2004A00485.

Northern Prawn Fishery Management (Fishing Capacity) Determination 2021. Available at: www.legislation.gov.au/Details/F2021L01867

Fisheries Management (Northern Prawn Fishery Limited-take and Prohibited-take Species) Direction 2021. Available at: www.legislation.gov.au/Details/F2021L00253

Fisheries Management (Northern Prawn Fishery Seasonal Closures) Direction 2021. Available at: www.legislation.gov.au/Details/F2021L00250

Fisheries Management (Northern Prawn Fishery Permanent Closures) Direction 2021. Available at: www.legislation.gov.au/Details/F2021L00254

Fisheries Management (Northern Prawn Fishery Gear Requirements) Direction 2021. Available at: www.legislation.gov.au/Details/F2021L00251

Northern Prawn Fishery Management Plan 1995. Available at: www.legislation.gov.au/Details/F2012C00160

An arrangement between the Commonwealth and the Northern Territory in relation to the Northern Prawn Fishery. Commonwealth of Australia Gazette No. GN4, 1 February 1995 pp316-320, Available at: www.legislation.gov.au/content/HistoricGazettes1995. Note: This OCS arrangement replaced an OCS arrangement made on 14 April 1988 GN13 S109 p2, Available at: www.legislation.gov.au/content/HistoricGazettes1988

Arrangement between the Commonwealth and the state of Queensland in relation to the Northern Prawn Fishery (Commonwealth of Australia Gazette14 April 1988 GN13 S109 pp7-8). Available at: www.legislation.gov.au/content/HistoricGazettes1988

Arrangement between the Commonwealth and the state of Western Australia in relation to the Northern Prawn Fishery.Commonwealth of Australia Gazette 14 April 1988 GN13 S109 pp8-9). Available at: www.legislation.gov.au/content/HistoricGazettes1988

FAO Code of Conduct for Responsible Fisheries. Available at: www.fao.org/docrep/005/v9878e/v9878e00.htm.

United Nations Convention Law of the Sea. Available at: www.un.org/depts/los/convention_agreements/texts/unclos/unclos_e.pdf.

Fisheries Management Regulations 2019. Available at: www.legislation.gov.au/Details/F2021C01167.

Memorandum of Understanding between the Australian Fisheries Management Authority and the Department of the Environment and Heritage for the reporting of fisheries interactions with protected species under the Environment and Biodiversity Conservation Act 1999. Available at: www.afma.gov.au/sites/default/files/uploads/2010/06/mou.pdf?acsf_files_redirect.

Declaration of the Harvest Operations of the Northern Prawn Fishery as an approved wildlife trade operation, December 2018. Available at: www.awe.gov.au/environment/marine/fisheries/commonwealth/northern-prawn.

2.2.2 Unit of Analysis Lists (Step 2)

The units of analysis for the sub-fishery are listed by component:

- **Species Components**: (key commercial and secondary commercial; byproduct/discards and protected species components). [Scoping document S2A Species]
- **Habitat Component**: habitat types. [Scoping document S2B1 and S2B2 Habitats]
- **Community Component**: community types. [Scoping document S2C1 and S2C2 Communities]

Ecological Units Assessed

Key commercial and secondary species 1 (C1), 5 (C2), 0 (CB)
Byproduct and bycatch species 3 (BP), 363 (BC)
Protected species 29
Habitats 9 (7 benthic, 2 pelagic)
Communities 3 (1 demersal, 2 pelagic)

Scoping Document S2A. Species

Each species identified during the scoping is added to the ERAEF database used to run the Level 1 and/or Level 2 analyses. A CAAB code (Code for Australian Aquatic Biota) is required to input the information. The CAAB codes for each species may be found at http://www.cmar.csiro.au/caab/

Key/Secondary Commercial Species

- *Key commercial species* – defined in the Harvest Strategy Policy (HSP) Guidelines as a species that is, or has been, specifically targeted and is, or has been, a significant component of a fishery.
- *Secondary commercial species* – commercial species that, while not specifically targeted, are commonly caught and generally retained, and comprise a significant component of a fishery's catch and economic return. These can include quota species in some fisheries.

Table 2.10: Key commercial species (C1) and/or secondary commercial species (C2) and/or commercial bait species (CB) list for the Northern Prawn Fishery - Redleg Banana Prawn sub-fishery. AFMA OBS: refers to AFMA Observer data.

ERA Species ID	Role in Fishery	Taxa	Family Name	CAAB Code	Scientific Name	Common Name	Source(s)
2220	C1	Invertebrate	Penaeidae	28711045	*Penaeus indicus*	Redleg Banana Prawn	AFMA OBS. Also in 28711907 (*Penaeus indicus* & *Penaeus merguiensis*). Also in 28711000 (Penaeidae-undifferentiated).
2745	C2	Invertebrate	Penaeidae	28711026	*Metapenaeus endeavouri*	Blue Endeavour Prawn	AFMA OBS. Also in 28711902 (*Metapenaeus endeavouri* & *Metapenaeus ensis*). Also in 28711000 (Penaeidae-undifferentiated).
2746	C2	Invertebrate	Penaeidae	28711027	*Metapenaeus ensis*	Red Endeavour Prawn	AFMA OBS. Also in 28711902 (*Metapenaeus endeavouri* & *Metapenaeus ensis*). Also in 28711000 (Penaeidae-undifferentiated).
1535	C2	Invertebrate	Penaeidae	28711044	*Penaeus esculentus*	Brown Tiger Prawn	AFMA OBS. Also in 28711906 (*Penaeus esculentus*, *Penaeus semisulcatus* and *Penaeus monodon*). Also in 28711000 (Penaeidae-undifferentiated).
2753 28711907	C2	Invertebrate	Penaeidae	28711050	*Penaeus merguiensis*	White Banana Prawn	AFMA OBS. Also in 28711906 (*Penaeus esculentus*, *Penaeus semisulcatus* & *Penaeus monodon*). Also in (*Penaeus indicus* & *Penaeus merguiensis*). Also in 28711000 (Penaeidae-undifferentiated).
1538	C2	Invertebrate	Penaeidae	28711053	*Penaeus semisulcatus*	Grooved Tiger Prawn	AFMA OBS. Also in 28711000 (Penaeidae-undifferentiated).

Byproduct Species

List the byproduct species of the sub-fishery. Byproduct species refers to any species that are retained for sale but comprise a minor component of the fishery catch and economic return. Byproduct are considered to be commercial species under the CPFB 2000. This list is obtained by reviewing all available fishery literature, including logbooks, observer reports and discussions with stakeholders.

Table 2.11: Byproduct species list for the Northern Prawn Fishery - Redleg Banana Prawn sub-fishery. AFMA OBS: refers to AFMA Observer data. LOG: refers to AFMA Logbook data.

ERA Species ID	Role in Fishery	Taxa	Family Name	CAAB Code	Scientific Name	Common Name	Source(s)
1537	BP	Invertebrate	Penaeidae	28711047	*Melicertus latisulcatus*	Western King Prawn	AFMA OBS. Also in 28711910 (King prawns - *Melicertus latisulcatus, Melicertus plebejus* & *Melicertus longistylus*). Also in 28711000 (Penaeidae-undifferentiated).
2221	BP	Invertebrate	Penaeidae	28711051	*Penaeus monodon*	Black Tiger Prawn - Leader Prawn	LOG, AFMA OBS. Also in 28711906 (*Penaeus esculentus*, *Penaeus semisulcatus* and *Penaeus monodon*). Also in 28711000 (Penaeidae-undifferentiated).
2529	BP	Invertebrate	Scyllaridae	28821007	*Thenus parindicus*	Mudbug	expanded from (28821000, 28821903), AFMA OBS

Bycatch (Discard) Species

Bycatch species are species that are not retained (i.e., are discarded, and includes catch that does not reach the deck of the vessel but which nonetheless is killed (or affected) as a result of the interaction with the fishing gear) and as such make no contribution to the value of the fishery. The term bycatch does not include discards of commercial species. Here, 'bycatch species' refers to general bycatch species only (i.e., species of fish, sharks, invertebrates, etc., that are never retained for sale), it excludes protected species, which are a separate category.

Table 2.12: Bycatch species list for the Northern Prawn Fishery - Redleg Banana Prawn sub-fishery. AFMA OBS: refers to AFMA Observer data. CREW OBS: refers to Crew Member Observer data. LOG: refers to AFMA Logbook data.

ERA Species ID	Role in Fishery	Taxa	Family Name	CAAB Code	Scientific Name	Common Name	Source(s)
379	BC	Chondrichthyan	Hemiscylliidae	37013008	*Chiloscyllium punctatum*	Brownbanded Bambooshark	AFMA OBS
380	BC	Chondrichthyan	Ginglymostomatidae	37013010	*Nebrius ferrugineus*	Tawny Shark	AFMA OBS

Table 2.12: *(continued)*

ERA Species ID	Role in Fishery	Taxa	Family Name	CAAB Code	Scientific Name	Common Name	Source(s)
463	BC	Chondrichthyan	Carcharhinidae	37018005	*Loxodon macrorhinus*	Sliteye Shark	AFMA OBS
866	BC	Chondrichthyan	Carcharhinidae	37018006	*Rhizoprionodon acutus*	Milk Shark	AFMA OBS
619	BC	Chondrichthyan	Carcharhinidae	37018009	*Carcharhinus coatesi*	Whitecheek Shark	AFMA OBS
630	BC	Chondrichthyan	Carcharhinidae	37018013	*Carcharhinus sorrah*	Spot-Tail Shark	AFMA OBS
647	BC	Chondrichthyan	Carcharhinidae	37018014	*Carcharhinus tilstoni*	Australian Blacktip Shark	AFMA OBS
468	BC	Chondrichthyan	Hemigaleidae	37018020	*Hemigaleus australiensis*	Sicklefin Weasel Shark	AFMA OBS
470	BC	Chondrichthyan	Carcharhinidae	37018023	*Carcharhinus brevipinna*	Spinner Shark	AFMA OBS
478	BC	Chondrichthyan	Carcharhinidae	37018034	*Carcharhinus cautus*	Nervous Shark	AFMA OBS
483	BC	Chondrichthyan	Carcharhinidae	37018039	*Carcharhinus limbatus*	Blacktip Shark	AFMA OBS
880	BC	Chondrichthyan	Sphyrnidae	37019001	*Sphyrna lewini*	Scalloped Hammerhead	CREW OBS
486	BC	Chondrichthyan	Sphyrnidae	37019003	*Eusphyra blochii*	Winghead Shark	AFMA OBS, CREW OBS
371	BC	Chondrichthyan	Centrophoridae	37020001	*Centrophorus moluccensis*	Endeavour Dogfish	AFMA OBS
335	BC	Chondrichthyan	Rhinidae	37026005	*Rhynchobatus australiae*	Whitespotted Guitarfish	AFMA OBS
769	BC	Chondrichthyan	Dasyatidae	37035004	*Neotrygon australiae*	Bluespotted Maskray	AFMA OBS
512	BC	Chondrichthyan	Dasyatidae	37035012	*Neotrygon annotata*	Plain Maskray	AFMA OBS
8458	BC	Chondrichthyan	Dasyatidae	37035020	*Maculabatis astra*	Blackspotted Whipray	AFMA OBS
759	BC	Chondrichthyan	Gymnuridae	37037001	*Gymnura australis*	Australian Butterfly Ray	AFMA OBS
528	BC	Chondrichthyan	Myliobatidae	37039002	*Aetomylaeus caeruleofasciatus*	Banded Eagle Ray	AFMA OBS
2217	BC	Invertebrate	Pectinidae	23270003	*Amusium pleuronectes*	Saucer Scallop; Mud Scallop	expanded from 23270000, AFMA OBS

Table 2.12: *(continued)*

ERA Species ID	Role in Fishery	Taxa	Family Name	CAAB Code	Scientific Name	Common Name	Source(s)
1272	BC	Invertebrate	Pectinidae	23270007	*Pecten fumatus*	Commercial Scallop	expanded from 23270000, AFMA OBS
2537	BC	Invertebrate	Sepiidae	23607003	*Sepia elliptica*	Ovalbone Cuttlefish	AFMA OBS
2538	BC	Invertebrate	Sepiidae	23607007	*Sepia papuensis*	Papuan Cuttlefish	expanded from (23607000, 23607901), LOG
2539	BC	Invertebrate	Sepiidae	23607008	*Sepia pharaonis*	Pharaoh Cuttlefish	expanded from (23607000, 23607901), LOG
2541	BC	Invertebrate	Sepiidae	23607011	*Sepia whitleyana*	Whitley's Cuttlefish	expanded from (23607000, 23607901), LOG
2540	BC	Invertebrate	Sepiidae	23607013	*Sepia smithi*	A Cuttlefish	expanded from (23607000, 23607901), LOG
2543	BC	Invertebrate	Sepiidae	23607015	*Metasepia pfefferi*	Flamboyant Cuttlefish	expanded from 23607000, LOG
2542	BC	Invertebrate	Sepiidae	23607019	*Sepia cottoni*	A Cuttlefish	expanded from (23607000, 23607901), LOG
2544	BC	Invertebrate	Sepiolidae	23609004	*Euprymna hoylei*	A Dumpling Squid	expanded from 23615000, AFMA OBS
2531	BC	Invertebrate	Loliginidae	23617006	*Sepioteuthis lessoniana*	Northern Calamari	expanded from 23617000, LOG
2530	BC	Invertebrate	Loliginidae	23617008	*Uroteuthis chinensis*	Loligo Squid	expanded from 23617000, LOG. Also expanded from 23615000, AFMA OBS.
2536	BC	Invertebrate	Loliginidae	23617010	*Uroteuthis noctiluca*	Luminous Bay Squid	expanded from 23617000, LOG. Also expanded from 23615000, AFMA OBS.
920	BC	Invertebrate	Ommastrephidae	23636008	*Ornithoteuthis volatilis*	Long-Tailed Flying Squid	expanded from 23636000, AFMA OBS
7662	BC	Invertebrate	Ommastrephidae	23636013	*Todaropsis eblanae*	Lesser Flying Squid	expanded from 23636000, AFMA OBS
7661	BC	Invertebrate	Ommastrephidae	23636014	*Todarodes pusillus*	A Squid	expanded from 23636000, AFMA OBS
7894	BC	Invertebrate	Comatulidae	25030002	*Capillaster multiradiatus*	A Crinoid	expanded from 25001000, AFMA OBS
7896	BC	Invertebrate	Comatulidae	25030030	*Comatula pectinata*	A Crinoid	expanded from 25001000, AFMA OBS
7897	BC	Invertebrate	Comatulidae	25030031	*Comatula rotalaria*	A Crinoid	expanded from 25001000, AFMA OBS
7898	BC	Invertebrate	Comatulidae	25030032	*Comatula solaris*	A Crinoid	expanded from 25001000, AFMA OBS
7734	BC	Invertebrate	Luidiidae	25105003	*Luidia hardwicki*	Seastar	expanded from 25102000, AFMA OBS
7735	BC	Invertebrate	Luidiidae	25105005	*Luidia maculata*	Seastar	expanded from 25102000, AFMA OBS
7736	BC	Invertebrate	Goniasteridae	25122010	*Iconaster longimanus*	Seastar	expanded from 25102000, AFMA OBS

Table 2.12: *(continued)*

ERA Species ID	Role in Fishery	Taxa	Family Name	CAAB Code	Scientific Name	Common Name	Source(s)
3382	BC	Invertebrate	Goniasteridae	25122026	*Stellaster childreni*	Seastar	expanded from 25102000, AFMA OBS
7902	BC	Invertebrate	Archasteridae	25124002	*Archaster typicus*	A Seastar	expanded from 25102000, AFMA OBS
7739	BC	Invertebrate	Echinasteridae	25143013	*Metrodira subulata*	Seastar	expanded from 25102000, AFMA OBS
2550	BC	Invertebrate	Diadematidae	25211004	*Chaetodiadema granulatum*	A Sea Urchin	expanded from 25200000, AFMA OBS
7713	BC	Invertebrate	Laganidae	25266005	*Peronella lesueuri*	Sand Dollar	expanded from 25200000, AFMA OBS
2669	BC	Invertebrate	Eurysquillidae	28035004	*Manningia notialis*	A Mantis Shrimp	expanded from 28030000, AFMA OBS
2601	BC	Invertebrate	Squillidae	28051019	*Clorida granti*	A Shrimp	expanded from 28051000, AFMA OBS
2720	BC	Invertebrate	Squillidae	28051030	*Dictyosquilla tuberculata*	Warty Mantis Shrimp	AFMA OBS, CREW OBS
2591	BC	Invertebrate	Squillidae	28051035	*Harpiosquilla annandalei*	A Shrimp	expanded from 28051000, AFMA OBS
2557	BC	Invertebrate	Squillidae	28051036	*Harpiosquilla harpax*	A Mantis Shrimp	expanded from 28051000, AFMA OBS
2600	BC	Invertebrate	Squillidae	28051037	*Harpiosquilla melanoura*	A Shrimp	expanded from 28051000, AFMA OBS
2723	BC	Invertebrate	Squillidae	28051039	*Harpiosquilla stephensoni*	Stephenson's Mantis Shrimp	AFMA OBS
2586	BC	Invertebrate	Squillidae	28051041	*Lenisquilla lata*	A Shrimp	expanded from 28051000, AFMA OBS
2734	BC	Invertebrate	Penaeidae	28711003	*Atypopenaeus formosus*	Orange Prawn	expanded from 28711000, AFMA OBS
2739	BC	Invertebrate	Penaeidae	28711016	*Metapenaeopsis novaeguineae*	Northern Velvet Prawn	AFMA OBS. Also in 28711000 (Penaeidae-undifferentiated).
2740	BC	Invertebrate	Penaeidae	28711017	*Metapenaeopsis palmensis*	Southern Velvet Prawn	AFMA OBS. Also in 28711000 (Penaeidae-undifferentiated).
2749	BC	Invertebrate	Penaeidae	28711031	*Kishinouyepenaeopsis cornuta*	Coral Prawn	AFMA OBS. Also in 28711000 (Penaeidae-undifferentiated).

Table 2.12: ***(continued)***

ERA Species ID	Role in Fishery	Taxa	Family Name	CAAB Code	Scientific Name	Common Name	Source(s)
1536	BC	Invertebrate	Penaeidae	28711046	*Penaeus pulchricaudatus*	Tiger Prawn	expanded from 28711000, AFMA OBS
1324	BC	Invertebrate	Penaeidae	28711048	*Melicertus longistylus*	Redspot King Prawn	expanded from 28711000, AFMA OBS. Also in 28711910 (King prawns - *Melicertus latisulcatus*, *Melicertus plebejus* & *Melicertus longistylus)*.
2754	BC	Invertebrate	Penaeidae	28711054	*Trachypenaeus anchoralis*	Northern Rough Prawn	AFMA OBS. Also in 28711000 (Penaeidae-undifferentiated).
2757	BC	Invertebrate	Penaeidae	28711057	*Megokris gonospinifer*	Rough Prawn	AFMA OBS. Also in 28711000 (Penaeidae-undifferentiated).
2759	BC	Invertebrate	Solenoceridae	28714011	*Solenocera australiana*	Coral Prawn	AFMA OBS. Also in 28711000 (Penaeidae-undifferentiated).
1337	BC	Invertebrate	Palinuridae	28820006	*Panulirus ornatus*	Ornate Rocklobster	expanded from 28820000, LOG
2626	BC	Invertebrate	Palinuridae	28820012	*Panulirus polyphagus*	Mud Rock Lobster	AFMA OBS
1338	BC	Invertebrate	Palinuridae	28820013	*Panulirus versicolor*	Painted Rocklobster - Green Cray	AFMA OBS
24	BC	Invertebrate	Scyllaridae	28821008	*Thenus australiensis*	Sandbug	AFMA OBS
3263	BC	Invertebrate	Portunidae	28911002	*Charybdis natator*	Hairyback Crab	expanded from (28911911, 28911000), AFMA OBS
2545	BC	Invertebrate	Portunidae	28911005	*Portunus armatus*	Blue Swimmer Crab	AFMA OBS
2554	BC	Invertebrate	Portunidae	28911006	*Portunus sanguinolentus*	Three-Spotted Crab	AFMA OBS
3264	BC	Invertebrate	Portunidae	28911015	*Charybdis truncata*	A Swimming Crab	AFMA OBS
9241	BC	Invertebrate	Portunidae	28911026	*Monomia rubromarginatus*	A Swimmer Crab	expanded from 28911000, AFMA OBS
9240	BC	Invertebrate	Portunidae	28911027	*Lupocycloporus gracilimanus*	A Swimmer Crab	AFMA OBS
9242	BC	Invertebrate	Portunidae	28911032	*Monomia cf. argentata*	A Swimmer Crab	expanded from 28911000, AFMA OBS
3261	BC	Invertebrate	Portunidae	28911037	*Charybdis callianassa*	A Swimmer Crab	AFMA OBS

Table 2.12: *(continued)*

ERA Species ID	Role in Fishery	Taxa	Family Name	CAAB Code	Scientific Name	Common Name	Source(s)
3365	BC	Invertebrate	Portunidae	28911042	*Xiphonectes tenuipes*	A Swimmer Crab	expanded from 28911000, AFMA OBS
3364	BC	Invertebrate	Portunidae	28911070	*Xiphonectes rugosus*	A Swimmer Crab	expanded from 28911000, AFMA OBS
3265	BC	Invertebrate	Portunidae	28911075	*Charybdis jaubertensis*	A Swimmer Crab	expanded from (28911911, 28911000), AFMA OBS
1192	BC	Teleost	Muraenesocidae	37063002	*Muraenesox cinereus*	Daggertooth Pike Conger	expanded from 37063901, AFMA OBS
801	BC	Teleost	Muraenesocidae	37063003	*Muraenesox bagio*	Common Pike Eel	expanded from 37063901, AFMA OBS
2328	BC	Teleost	Congridae	37067015	*Conger cinereus*	Blacklip Conger	AFMA OBS
2441	BC	Teleost	Clupeidae	37085006	*Amblygaster sirm*	Spotted Sardinella	AFMA OBS
1142	BC	Teleost	Clupeidae	37085007	*Herklotsichthys koningsbergeri*	Largespotted Herring	expanded from 37085905, AFMA OBS
2474	BC	Teleost	Clupeidae	37085008	*Herklotsichthys lippa*	Smallspotted Herring	expanded from 37085905, AFMA OBS
1141	BC	Teleost	Pristigasteridae	37085009	*Pellona ditchela*	Indian Pellona	AFMA OBS
2473	BC	Teleost	Clupeidae	37085014	*Sardinella albella*	White Sardinella	AFMA OBS
2446	BC	Teleost	Clupeidae	37085015	*Anodontostoma chacunda*	Chacunda Gizzard Shad	AFMA OBS
7780	BC	Teleost	Clupeidae	37085016	*Nematalosa come*	Western Pacific Gizzard Shad	AFMA OBS
8333	BC	Teleost	Clupeidae	37085024	*Herklotsichthys gotoi*	Darwin Herring	expanded from 37085905, AFMA OBS
1153	BC	Teleost	Engraulidae	37086004	*Thryssa setirostris*	Longjaw Thryssa	AFMA OBS
2439	BC	Teleost	Engraulidae	37086005	*Thryssa hamiltonii*	Hamilton's Thryssa	AFMA OBS
2370	BC	Teleost	Engraulidae	37086008	*Setipinna tenuifilis*	Common Hairfin Anchovy	AFMA OBS
863	BC	Teleost	Synodontidae	37118001	*Saurida undosquamis*	Brushtooth Lizardfish	AFMA OBS
6420	BC	Teleost	Synodontidae	37118002	*Trachinocephalus trachinus*	Snakefish	AFMA OBS
1363	BC	Teleost	Synodontidae	37118005	*Saurida argentea*	Shortfin Saury	AFMA OBS
5349	BC	Teleost	Synodontidae	37118028	*Saurida tumbil*	Common Saury	AFMA OBS

Table 2.12: *(continued)*

ERA Species ID	Role in Fishery	Taxa	Family Name	CAAB Code	Scientific Name	Common Name	Source(s)
2414	BC	Teleost	Synodontidae	37119001	*Harpadon translucens*	Glassy Bombay Duck	AFMA OBS
2392	BC	Teleost	Myctophidae	37122079	*Benthosema pterotum*	Opaline Lanternfish	AFMA OBS
2289	BC	Teleost	Ariidae	37188001	*Netuma thalassina*	Giant Sea Catfish	AFMA OBS
1218	BC	Teleost	Plotosidae	37192003	*Euristhmus nudiceps*	Nakedhead Catfish	AFMA OBS
2373	BC	Teleost	Plotosidae	37192004	*Euristhmus lepturus*	Longtail Catfish	AFMA OBS
6546	BC	Teleost	Lophiidae	37208001	*Lophiomus setigerus*	Broadhead Goosefish	expanded from 37208000, AFMA OBS
1099	BC	Teleost	Antennariidae	37210003	*Tathicarpus butleri*	Butler's Frogfish	AFMA OBS
1252	BC	Teleost	Tetrabrachiidae	37210010	*Tetrabrachium ocellatum*	Humpback Anglerfish	AFMA OBS
8531	BC	Teleost	Bregmacerotidae	37225001	*Bregmaceros sp. (cf lanceolatus)*	Unicorn-Cod	expanded from 37225901, AFMA OBS
2497	BC	Teleost	Bregmacerotidae	37225002	*Bregmaceros mcclellandi*	Unicorn Codlet	AFMA OBS
7784	BC	Teleost	Bregmacerotidae	37225003	*Bregmaceros atlanticus*	Antenna Codlet	expanded from 37225901, AFMA OBS
2496	BC	Teleost	Bregmacerotidae	37225004	*Bregmaceros japonicus*	Japanese Codlet	expanded from 37225901, AFMA OBS
6567	BC	Teleost	Bregmacerotidae	37225005	*Bregmaceros nectabanus*	Australian Codlet	expanded from 37225901, AFMA OBS
8523	BC	Teleost	Bregmacerotidae	37225007	*Bregmaceros pseudolanceolatus*	A Codlet	expanded from 37225901, AFMA OBS
2302	BC	Teleost	Ophidiidae	37228005	*Sirembo imberbis*	Golden Cusk	AFMA OBS
2374	BC	Teleost	Hemiramphidae	37234016	*Hyporhamphus affinis*	Tropical Garfish	AFMA OBS
8274	BC	Teleost	Atherinidae	37246005	*Atherinomorus endrachtensis*	Endracht Hardyhead	AFMA OBS
1102	BC	Teleost	Apistidae	37287011	*Apistus carinatus*	Longfin Waspfish	AFMA OBS
1101	BC	Teleost	Apistidae	37287033	*Apistops caloundra*	Shortfin Waspfish	AFMA OBS
8564	BC	Teleost	Triglidae	37288009	*Pterygotrigla elicryste*	Dwarf Gurnard	expanded from 37288900, AFMA OBS

Table 2.12: *(continued)*

ERA Species ID	Role in Fishery	Taxa	Family Name	CAAB Code	Scientific Name	Common Name	Source(s)
2403	BC	Teleost	Triglidae	37288010	*Lepidotrigla cf japonica*	Red Spot Gurnard	expanded from (37288900, 37288901), AFMA OBS
112	BC	Teleost	Triglidae	37288014	*Bovitrigla leptacanthus*	Bullhead Gurnard	expanded from 37288900, AFMA OBS
2344	BC	Teleost	Triglidae	37288015	*Lepidotrigla sp. 2 [in Sainsbury et al, 1985]*	Mottled Red Spot Gurnard	expanded from (37288900, 37288901), AFMA OBS
756	BC	Teleost	Triglidae	37288016	*Lepidotrigla russelli*	Smooth Gurnard	AFMA OBS
2402	BC	Teleost	Triglidae	37288017	*Lepidotrigla cf bispinosa [Gomon, pers comm]*	A Searobin	expanded from (37288900, 37288901), AFMA OBS
2343	BC	Teleost	Triglidae	37288020	*Lepidotrigla cf grandis (A) [Gomon, pers comm]*	Supreme Gurnard	expanded from (37288900, 37288901), AFMA OBS
450	BC	Teleost	Triglidae	37288027	*Lepidotrigla punctipectoralis*	Finspot Gurnard	expanded from (37288900, 37288901), AFMA OBS
447	BC	Teleost	Triglidae	37288032	*Lepidotrigla argus*	Eye Gurnard	expanded from (37288900, 37288901), AFMA OBS
449	BC	Teleost	Triglidae	37288033	*Lepidotrigla grandis*	Little Red Gurnard	expanded from (37288900, 37288901), AFMA OBS
1103	BC	Teleost	Aploactinidae	37290004	*Adventor elongatus*	Sandpaper Velvetfish	AFMA OBS
2352	BC	Teleost	Platycephalidae	37296010	*Inegocia harrisii*	Harris' Flathead	AFMA OBS
1212	BC	Teleost	Platycephalidae	37296013	*Elates ransonnettii*	Dwarf Flathead	AFMA OBS
2351	BC	Teleost	Platycephalidae	37296018	*Cociella hutchinsi*	Brownmargin Flathead	AFMA OBS
1215	BC	Teleost	Platycephalidae	37296029	*Inegocia japonica*	Japanese Flathead	AFMA OBS
1526	BC	Teleost	Platycephalidae	37296030	*Rogadius tuberculatus*	Tuberculate Flathead	expanded from 37296915, AFMA OBS
2357	BC	Teleost	Platycephalidae	37296054	*Rogadius pristiger*	Thorny Flathead	expanded from 37296915, AFMA OBS
751	BC	Teleost	Serranidae	37311007	*Epinephelus coioides*	Orange-Spotted Grouper, Goldspotted Rockcod	AFMA OBS
437	BC	Teleost	Serranidae	37311017	*Epinephelus sexfasciatus*	Sixbar Grouper	AFMA OBS

Table 2.12: *(continued)*

ERA Species ID	Role in Fishery	Taxa	Family Name	CAAB Code	Scientific Name	Common Name	Source(s)
8610	BC	Teleost	Synagropidae	37311028	*Parascombrops philippinensis*	Sharptooth Seabass	AFMA OBS
420	BC	Teleost	Serranidae	37311061	*Epinephelus lanceolatus*	Giant Grouper	AFMA OBS
1248	BC	Teleost	Terapontidae	37321001	*Pelates quadrilineatus*	Fourlined Terapon	AFMA OBS
2389	BC	Teleost	Terapontidae	37321002	*Terapon jarbua*	Jarbua Terapon	AFMA OBS
1249	BC	Teleost	Terapontidae	37321003	*Terapon theraps*	Largescaled Terapon	AFMA OBS
1247	BC	Teleost	Terapontidae	37321006	*Terapon puta*	Spinycheek Grunter	AFMA OBS
749	BC	Teleost	Priacanthidae	37326003	*Priacanthus tayenus*	Purple-Spotted Bigeye	AFMA OBS
1110	BC	Teleost	Apogonidae	37327008	*Ostorhinchus fasciatus*	Broadbanded Cardinalfish	AFMA OBS
1376	BC	Teleost	Apogonidae	37327013	*Jaydia truncata*	Flagfin Cardinalfish	AFMA OBS
1112	BC	Teleost	Apogonidae	37327014	*Ozichthys albimaculosus*	Creamspotted Cardinalfish	AFMA OBS
1106	BC	Teleost	Apogonidae	37327016	*Jaydia melanopus*	Monster Cardinalfish	AFMA OBS
1107	BC	Teleost	Apogonidae	37327026	*Jaydia poecilopterus*	Pearlyfin Cardinalfish	AFMA OBS
143	BC	Teleost	Sillaginidae	37330003	*Sillago analis*	Sand Whiting	expanded from 37330904, AFMA OBS
1235	BC	Teleost	Sillaginidae	37330004	*Sillago burrus*	Western Trumpeter Whiting	expanded from 37330904, AFMA OBS
3380	BC	Teleost	Sillaginidae	37330005	*Sillago robusta*	Stout Whiting	expanded from 37330904, AFMA OBS
1234	BC	Teleost	Sillaginidae	37330006	*Sillago sihama*	Northern Whiting	expanded from 37330904, AFMA OBS
144	BC	Teleost	Sillaginidae	37330007	*Sillago lutea*	Mud Whiting	expanded from 37330904, AFMA OBS
2348	BC	Teleost	Sillaginidae	37330009	*Sillago ingenuua*	Bay Whiting	expanded from 37330904, AFMA OBS
3379	BC	Teleost	Sillaginidae	37330015	*Sillago maculata*	Trumpeter Whiting	expanded from 37330904, AFMA OBS
2508	BC	Teleost	Lactariidae	37333001	*Lactarius lactarius*	False Trevally	AFMA OBS
147	BC	Teleost	Rachycentridae	37335001	*Rachycentron canadum*	Cobia	AFMA OBS

Table 2.12: *(continued)*

ERA Species ID	Role in Fishery	Taxa	Family Name	CAAB Code	Scientific Name	Common Name	Source(s)
1088	BC	Teleost	Carangidae	37337002	*Trachurus declivis*	Common Jack Mackerel	expanded from 37337000, AFMA OBS
2416	BC	Teleost	Carangidae	37337005	*Carangoides malabaricus*	Malabar Trevally	AFMA OBS
1128	BC	Teleost	Carangidae	37337008	*Selar boops*	Oxeye Scad	AFMA OBS
2390	BC	Teleost	Carangidae	37337009	*Selar crumenophthalmus*	Bigeye Scad	expanded from 37337000, AFMA OBS
1120	BC	Teleost	Carangidae	37337010	*Alepes apercna*	Smallmouth Scad	expanded from (37337000, 37337914), AFMA OBS
657	BC	Teleost	Carangidae	37337011	*Carangoides chrysophrys*	Longnose Trevally	expanded from 37337000, AFMA OBS
663	BC	Teleost	Carangidae	37337012	*Gnathanodon speciosus*	Golden Trevally	expanded from 37337000, AFMA OBS
1122	BC	Teleost	Carangidae	37337014	*Seriolina nigrofasciata*	Blackbanded Trevally, Blackbanded Amberjack	expanded from 37337000, AFMA OBS
1132	BC	Teleost	Carangidae	37337015	*Selaroides leptolepis*	Yellowstripe Scad	AFMA OBS
1123	BC	Teleost	Carangidae	37337016	*Caranx bucculentus*	Bluespotted Trevally	AFMA OBS
2451	BC	Teleost	Carangidae	37337017	*Decapterus macrosoma*	Shortfin Scad, Slender Scad	expanded from 37337000, AFMA OBS
2299	BC	Teleost	Carangidae	37337018	*Alectis ciliaris*	African Pompano, Pennantfish	expanded from 37337000, AFMA OBS
2420	BC	Teleost	Carangidae	37337020	*Uraspis uraspis*	Whitemouth Jack	AFMA OBS
654	BC	Teleost	Carangidae	37337021	*Carangoides caeruleopinnatus*	Coastal Trevally	expanded from 37337000, AFMA OBS
2405	BC	Teleost	Carangidae	37337022	*Turrum gymnostethus*	Bludger, Bludger Trevally	expanded from 37337000, AFMA OBS
1130	BC	Teleost	Carangidae	37337023	*Decapterus russelli*	Indian Scad	expanded from 37337000, AFMA OBS

Table 2.12: *(continued)*

ERA Species ID	Role in Fishery	Taxa	Family Name	CAAB Code	Scientific Name	Common Name	Source(s)
2415	BC	Teleost	Carangidae	37337024	*Atule mate*	Barred Yellowtail Scad	expanded from 37337000, AFMA OBS
1131	BC	Teleost	Carangidae	37337028	*Megalaspis cordyla*	Torpedo Scad, Finny Scad	AFMA OBS
1125	BC	Teleost	Carangidae	37337031	*Carangoides humerosus*	Duskyshoulder Trevally, Epaulette Trevally	expanded from 37337000, AFMA OBS
2297	BC	Teleost	Carangidae	37337032	*Scomberoides commersonnianus*	Talang Queenfish	expanded from 37337000, AFMA OBS
1129	BC	Teleost	Carangidae	37337036	*Alepes kleinii*	Razorbelly Trevally	expanded from (37337000, 37337914), AFMA OBS
2308	BC	Teleost	Carangidae	37337037	*Carangoides fulvoguttatus*	Yellowspotted Trevally, Turrum	expanded from 37337000, AFMA OBS
1377	BC	Teleost	Carangidae	37337038	*Alectis indica*	Indian Threadfish, Diamond Trevally	expanded from 37337000, AFMA OBS
4938	BC	Teleost	Carangidae	37337040	*Naucrates ductor*	Pilotfish	expanded from 37337000, AFMA OBS
2294	BC	Teleost	Carangidae	37337041	*Ulua aurochs*	Silvermouth Trevally	AFMA OBS
1124	BC	Teleost	Carangidae	37337042	*Carangoides hedlandensis*	Bumpnose Trevally	expanded from 37337000, AFMA OBS
1127	BC	Teleost	Carangidae	37337043	*Carangoides talamparoides*	Whitetongue Trevally; Imposter Trevally	expanded from 37337000, AFMA OBS
2347	BC	Teleost	Carangidae	37337044	*Scomberoides tol*	Needlescaled Queenfish, Needleskin Queenfish	expanded from 37337000, AFMA OBS
2346	BC	Teleost	Carangidae	37337045	*Scomberoides tala*	Barred Queenfish	expanded from 37337000, AFMA OBS
2345	BC	Teleost	Carangidae	37337046	*Scomberoides lysan*	Doublespotted Queenfish	expanded from 37337000, AFMA OBS
1126	BC	Teleost	Carangidae	37337047	*Pantolabus radiatus*	Fringefin Trevally	AFMA OBS
2295	BC	Teleost	Carangidae	37337048	*Ulua mentalis*	Longrakered Trevally	expanded from 37337000, AFMA OBS
7928	BC	Teleost	Carangidae	37337049	*Caranx tille*	Tille Trevally	expanded from 37337000, AFMA OBS

Table 2.12: *(continued)*

ERA Species ID	Role in Fishery	Taxa	Family Name	CAAB Code	Scientific Name	Common Name	Source(s)
2312	BC	Teleost	Carangidae	37337050	*Caranx melampygus*	Bluefin Trevally	expanded from 37337000, AFMA OBS
7929	BC	Teleost	Carangidae	37337056	*Decapterus kurroides*	Redtail Scad	expanded from 37337000, AFMA OBS
2306	BC	Teleost	Carangidae	37337065	*Trachinotus sp. cf mookalee*	A Trevally	expanded from 37337000, AFMA OBS
9236	BC	Teleost	Carangidae	37337068	*Ferdauia ferdau*	Blue Trevally	AFMA OBS
1121	BC	Teleost	Carangidae	37337072	*Parastromateus niger*	Black Pomfret	AFMA OBS
7921	BC	Teleost	Carangidae	37337073	*Trachinotus anak*	Giant Oystercracker	expanded from 37337000, AFMA OBS
1175	BC	Teleost	Menidae	37340001	*Mene maculata*	Moonfish	AFMA OBS
1173	BC	Teleost	Leiognathidae	37341002	*Photopectoralis bindus*	Orangefin Ponyfish	AFMA OBS
8628	BC	Teleost	Leiognathidae	37341003	*Equulites laterofenestra*	Slender Ponyfish	expanded from 37341000, AFMA OBS
8629	BC	Teleost	Leiognathidae	37341004	*Aurigequula longispinis*	Longspine Ponyfish	expanded from 37341000, AFMA OBS
2462	BC	Teleost	Leiognathidae	37341005	*Equulites leuciscus*	Whipfin Ponyfish	AFMA OBS
8659	BC	Teleost	Leiognathidae	37341006	*Deveximentum insidiator*	Pugnose Ponyfish	expanded from 37341000, AFMA OBS
1174	BC	Teleost	Leiognathidae	37341007	*Gazza minuta*	Toothpony	AFMA OBS
2464	BC	Teleost	Leiognathidae	37341009	*Aurigequula fasciata*	Striped Ponyfish	expanded from 37341000, AFMA OBS
1170	BC	Teleost	Leiognathidae	37341010	*Eubleekeria splendens*	Splendid Ponyfish	AFMA OBS
1171	BC	Teleost	Leiognathidae	37341011	*Equulites elongatus*	Elongate Ponyfish	expanded from 37341000, AFMA OBS
8359	BC	Teleost	Leiognathidae	37341012	*Photolateralis moretoniensis*	Zigzag Ponyfish	expanded from 37341000, AFMA OBS
2453	BC	Teleost	Leiognathidae	37341013	*Nuchequula glenysae*	Twoblotch Ponyfish	AFMA OBS
1172	BC	Teleost	Leiognathidae	37341014	*Leiognathus equula*	Common Ponyfish	expanded from 37341000, AFMA OBS
2472	BC	Teleost	Leiognathidae	37341015	*Leiognathus ruconius*	Deep Pugnosed Ponyfish	AFMA OBS
2456	BC	Teleost	Leiognathidae	37341016	*Nuchequula gerreoides*	Ornate Ponyfish	expanded from 37341000, AFMA OBS
2463	BC	Teleost	Leiognathidae	37341018	*Photopectoralis aureus*	Golden Ponyfish	expanded from 37341000, AFMA OBS

Table 2.12: *(continued)*

ERA Species ID	Role in Fishery	Taxa	Family Name	CAAB Code	Scientific Name	Common Name	Source(s)
8645	BC	Teleost	Leiognathidae	37341021	*Secutor interruptus*	Deep Pugnose Ponyfish	expanded from 37341000, AFMA OBS
8632	BC	Teleost	Leiognathidae	37341022	*Deveximentum megalolepis*	Bigscale Ponyfish	expanded from 37341000, AFMA OBS
8633	BC	Teleost	Leiognathidae	37341023	*Gazza dentex*	Ovoid Ponyfish	expanded from 37341000, AFMA OBS
8635	BC	Teleost	Leiognathidae	37341024	*Gazza rhombea*	Rhomboid Ponyfish	expanded from 37341000, AFMA OBS
684	BC	Teleost	Lutjanidae	37346007	*Lutjanus malabaricus*	Saddletail Snapper	AFMA OBS
680	BC	Teleost	Lutjanidae	37346015	*Lutjanus argentimaculatus*	Mangrove Jack	AFMA OBS
679	BC	Teleost	Lutjanidae	37346030	*Lutjanus johnii*	Golden Snapper	AFMA OBS
8665	BC	Teleost	Nemipteridae	37347001	*Nemipterus bathybius*	Yellowbelly Threadfin Bream	expanded from 37347901, AFMA OBS
1196	BC	Teleost	Nemipteridae	37347002	*Nemipterus nematopus*	Yellowtip Threadfin Bream	expanded from 37347901, AFMA OBS
1193	BC	Teleost	Nemipteridae	37347003	*Nemipterus peronii*	Notchedfin Threadfin Bream	expanded from 37347901, AFMA OBS
2364	BC	Teleost	Nemipteridae	37347004	*Nemipterus celebicus*	Celebes Threadfin Bream	expanded from 37347901, AFMA OBS
1195	BC	Teleost	Nemipteridae	37347005	*Nemipterus furcosus*	Rosy Threadfin Bream	expanded from 37347901, AFMA OBS
8654	BC	Teleost	Nemipteridae	37347008	*Scolopsis meridiana*	Redspot Monocle Bream	AFMA OBS
2365	BC	Teleost	Nemipteridae	37347009	*Nemipterus virgatus*	Golden Threadfin Bream	expanded from 37347901, AFMA OBS
8651	BC	Teleost	Nemipteridae	37347013	*Nemipterus zysron*	Slender Threadfin Bream	expanded from 37347901, AFMA OBS
1194	BC	Teleost	Nemipteridae	37347014	*Nemipterus hexodon*	Ornate Threadfin Bream	AFMA OBS
2413	BC	Teleost	Nemipteridae	37347016	*Nemipterus marginatus*	Red-Filament Threadfin Bream	expanded from 37347901, AFMA OBS

Table 2.12: ***(continued)***

ERA Species ID	Role in Fishery	Taxa	Family Name	CAAB Code	Scientific Name	Common Name	Source(s)
8666	BC	Teleost	Nemipteridae	37347019	*Nemipterus isacanthus*	Teardrop Threadfin Bream	expanded from 37347901, AFMA OBS
8676	BC	Teleost	Nemipteridae	37347038	*Nemipterus balinensoides*	Dwarf Threadfin Bream	expanded from 37347901, AFMA OBS
8677	BC	Teleost	Nemipteridae	37347039	*Nemipterus balinensis*	Bali Threadfin Bream	expanded from 37347901, AFMA OBS
1158	BC	Teleost	Gerreidae	37349002	*Pentaprion longimanus*	Longfin Mojarra	AFMA OBS
2459	BC	Teleost	Gerreidae	37349003	*Gerres filamentosus*	Whipfin Silver-Biddy	AFMA OBS
1160	BC	Teleost	Haemulidae	37350002	*Pomadasys maculatus*	Blotched Javelin	AFMA OBS
1162	BC	Teleost	Haemulidae	37350008	*Pomadasys trifasciatus*	Black-Ear Javelin	AFMA OBS
2337	BC	Teleost	Haemulidae	37350011	*Pomadasys kaakan*	Javelin Grunter, Barred Javelin	AFMA OBS
163	BC	Teleost	Sciaenidae	37354003	*Protonibea diacanthus*	Black Jewfish	AFMA OBS
1226	BC	Teleost	Sciaenidae	37354004	*Johnius laevis*	Smooth Jewfish	AFMA OBS
2366	BC	Teleost	Sciaenidae	37354006	*Otolithes ruber*	Silver Teraglin	expanded from 37354000, AFMA OBS
1227	BC	Teleost	Sciaenidae	37354007	*Johnius borneensis*	River Jewfish	AFMA OBS
2524	BC	Teleost	Sciaenidae	37354008	*Austronibea oedogenys*	Yellowtail Jewfish	expanded from 37354000, AFMA OBS
2375	BC	Teleost	Sciaenidae	37354009	*Johnius amblycephalus*	Bearded Jewfish	AFMA OBS
8681	BC	Teleost	Sciaenidae	37354011	*Atrobucca nibe*	Longmouth Jewfish	expanded from 37354000, AFMA OBS
2378	BC	Teleost	Sciaenidae	37354012	*Atrobucca brevis*	Orange Jewfish	AFMA OBS
7937	BC	Teleost	Sciaenidae	37354019	*Nibea soldado*	Soldier Croaker	expanded from 37354000, AFMA OBS
164	BC	Teleost	Sciaenidae	37354020	*Atractoscion atelodus*	Teraglin	expanded from 37354000, AFMA OBS
8682	BC	Teleost	Sciaenidae	37354021	*Johnius macropterus*	A Jewfish	expanded from 37354000, AFMA OBS
2376	BC	Teleost	Sciaenidae	37354022	*Johnius australis*	Little Jewfish	expanded from 37354000, AFMA OBS
8694	BC	Teleost	Sciaenidae	37354023	*Nibea microgenys*	Smallmouth Jewfish	expanded from 37354000, AFMA OBS
7939	BC	Teleost	Sciaenidae	37354024	*Nibea squamosa*	Scale Croaker	expanded from 37354000, AFMA OBS
8685	BC	Teleost	Sciaenidae	37354025	*Johnius novaeguineae*	Paperhead Jewfish	expanded from 37354000, AFMA OBS

Table 2.12: *(continued)*

ERA Species ID	Role in Fishery	Taxa	Family Name	CAAB Code	Scientific Name	Common Name	Source(s)
2305	BC	Teleost	Sciaenidae	37354026	*Larimichthys pamoides*	Southern Yellow Jewfish	AFMA OBS
8678	BC	Teleost	Sciaenidae	37354027	*Nibea leptolepis*	Smallscale Jewfish	expanded from 37354000, AFMA OBS
1186	BC	Teleost	Mullidae	37355003	*Upeneus moluccensis*	Goldband Goatfish	AFMA OBS
1191	BC	Teleost	Mullidae	37355007	*Upeneus sulphureus*	Sulphur Goatfish	AFMA OBS
1184	BC	Teleost	Mullidae	37355013	*Upeneus sundaicus*	Ochrebanded Goatfish	AFMA OBS
1154	BC	Teleost	Ephippidae	37362003	*Zabidius novemaculeatus*	Shortfin Batfish	AFMA OBS
1151	BC	Teleost	Drepaneidae	37362005	*Drepane punctata*	Spotted Sicklefish	AFMA OBS
2523	BC	Teleost	Ephippidae	37364001	*Rhinoprenes pentanemus*	Threadfin Scat	AFMA OBS
2342	BC	Teleost	Mugilidae	37381002	*Mugil cephalus*	Sea Mullet	expanded from 37381000, AFMA OBS
8711	BC	Teleost	Mugilidae	37381006	*Moolgarda cunnesius*	Roundhead Mullet	expanded from 37381000, AFMA OBS
8712	BC	Teleost	Mugilidae	37381007	*Liza subviridis*	Greenback Mullet	expanded from 37381000, AFMA OBS
7074	BC	Teleost	Mugilidae	37381008	*Liza vaigiensis*	Diamondscale Mullet	expanded from 37381000, AFMA OBS
7075	BC	Teleost	Mugilidae	37381009	*Paramugil georgii*	Fantail Mullet	expanded from 37381000, AFMA OBS
8713	BC	Teleost	Mugilidae	37381010	*Moolgarda buchanani*	Bluetail Mullet	expanded from 37381000, AFMA OBS
8728	BC	Teleost	Mugilidae	37381013	*Oedalechilus labiosus*	Hornlip Mullet	expanded from 37381000, AFMA OBS
8786	BC	Teleost	Mugilidae	37381014	*Liza ordensis*	Diamond Mullet	expanded from 37381000, AFMA OBS
8787	BC	Teleost	Mugilidae	37381015	*Paramugil parmatus*	Broadmouth Mullet	expanded from 37381000, AFMA OBS
8729	BC	Teleost	Mugilidae	37381016	*Rhinomugil nasutus*	Popeye Mullet	expanded from 37381000, AFMA OBS
8730	BC	Teleost	Mugilidae	37381017	*Moolgarda seheli*	Bluespot Mullet	expanded from 37381000, AFMA OBS
8731	BC	Teleost	Mugilidae	37381019	*Liza macrolepis*	A Mullet	expanded from 37381000, AFMA OBS
8759	BC	Teleost	Mugilidae	37381020	*Liza melinoptera*	Otomebora Mullet	expanded from 37381000, AFMA OBS
8760	BC	Teleost	Mugilidae	37381022	*Moolgarda engeli*	Kanda Mullet	expanded from 37381000, AFMA OBS
9243	BC	Teleost	Mugilidae	37381023	*Moolgarda perusii*	A Mullet	expanded from 37381000, AFMA OBS

Table 2.12: *(continued)*

ERA Species ID	Role in Fishery	Taxa	Family Name	CAAB Code	Scientific Name	Common Name	Source(s)
8733	BC	Teleost	Mugilidae	37381026	*Liza tade*	Rock Mullet	expanded from 37381000, AFMA OBS
7821	BC	Teleost	Sphyraenidae	37382001	*Sphyraena pinguis*	Striped Barracuda	AFMA OBS
614	BC	Teleost	Sphyraenidae	37382008	*Sphyraena barracuda*	Great Barracuda	AFMA OBS
2311	BC	Teleost	Polynemidae	37383001	*Polydactylus nigripinnis*	Blackfin Threadfin	AFMA OBS
2310	BC	Teleost	Polynemidae	37383002	*Polydactylus multiradiatus*	Australian Threadfin	AFMA OBS
1165	BC	Teleost	Labridae	37384008	*Choerodon monostigma*	Darkspot Tuskfish	AFMA OBS
197	BC	Teleost	Uranoscopidae	37400008	*Uranoscopus cognatus*	Yellowtail Stargazer	expanded from 37400000, AFMA OBS
2528	BC	Teleost	Uranoscopidae	37400009	*Uranoscopus sp. 1 [in Sainsbury et al, 1985]*	White-Spotted Stargazer	expanded from 37400000, AFMA OBS
2527	BC	Teleost	Uranoscopidae	37400010	*Ichthyscopus fasciatus*	Banded Stargazer	expanded from 37400000, AFMA OBS
7826	BC	Teleost	Uranoscopidae	37400012	*Ichthyscopus insperatus*	Doubleband Stargazer	expanded from 37400000, AFMA OBS
8829	BC	Teleost	Uranoscopidae	37400028	*Uranoscopus sp. (scaly nape)*	A Stargazer	expanded from 37400000, AFMA OBS
209	BC	Teleost	Trichiuridae	37440004	*Trichiurus lepturus*	Largehead Hairtail	AFMA OBS
1229	BC	Teleost	Scombridae	37441014	*Scomberomorus queenslandicus*	School Mackerel	AFMA OBS
622	BC	Teleost	Scombridae	37441015	*Scomberomorus munroi*	Spotted Mackerel	AFMA OBS
873	BC	Teleost	Scombridae	37441790	*Scomber scombrus*	Atlantic Mackerel	AFMA OBS
2336	BC	Teleost	Centrolophidae	37445007	*Psenopsis humerosa*	Blackspot Butterfish	AFMA OBS
1223	BC	Teleost	Psettodidae	37457001	*Psettodes erumei*	Australian Halibut	AFMA OBS
221	BC	Teleost	Paralichthyidae	37460002	*Pseudorhombus jenynsii*	Smalltooth Flounder	expanded from 37460919, AFMA OBS

Table 2.12: *(continued)*

ERA Species ID	Role in Fishery	Taxa	Family Name	CAAB Code	Scientific Name	Common Name	Source(s)
1205	BC	Teleost	Paralichthyidae	37460004	*Pseudorhombus dupliciocellatus*	Three Twinspot Flounder	expanded from 37460919, AFMA OBS
1201	BC	Teleost	Paralichthyidae	37460008	*Pseudorhombus elevatus*	Deep Flounder	expanded from 37460919, AFMA OBS
1204	BC	Teleost	Paralichthyidae	37460009	*Pseudorhombus arsius*	Largetooth Flounder	AFMA OBS
1207	BC	Teleost	Paralichthyidae	37460011	*Pseudorhombus spinosus*	Spiny Flounder	expanded from 37460919, AFMA OBS
1203	BC	Teleost	Paralichthyidae	37460015	*Pseudorhombus diplospilus*	Bigtooth Twinspot Flounder	expanded from 37460919, AFMA OBS
8905	BC	Teleost	Paralichthyidae	37460035	*Pseudorhombus megalops*	Bigeye Flounder	expanded from 37460919, AFMA OBS
1206	BC	Teleost	Paralichthyidae	37460038	*Pseudorhombus argus*	Peacock Flounder	expanded from 37460919, AFMA OBS
1115	BC	Teleost	Bothidae	37460045	*Arnoglossus waitei*	Waite's Flounder	AFMA OBS
8904	BC	Teleost	Paralichthyidae	37460065	*Pseudorhombus triocellatus*	Three-Ring Flounder	expanded from 37460919, AFMA OBS
7269	BC	Teleost	Soleidae	37462001	*Aesopia cornuta*	Unicorn Sole	expanded from 37462000, AFMA OBS
1397	BC	Teleost	Soleidae	37462003	*Zebrias craticulus*	Wicker-Work Sole	expanded from 37462000, AFMA OBS
226	BC	Teleost	Soleidae	37462004	*Zebrias quagga*	Zebra Sole	expanded from 37462000, AFMA OBS
2368	BC	Teleost	Soleidae	37462006	*Zebrias cancellatus*	Harrowed Sole	AFMA OBS
1398	BC	Teleost	Soleidae	37462007	*Brachirus muelleri*	Tufted Sole	expanded from 37462000, AFMA OBS
8958	BC	Teleost	Soleidae	37462008	*Brachirus setifer*	Paradice's Sole	expanded from 37462000, AFMA OBS
1236	BC	Teleost	Soleidae	37462009	*Pardachirus pavoninus*	Peacock Sole	expanded from 37462000, AFMA OBS
2371	BC	Teleost	Soleidae	37462011	*Aesopia sp. [in Sainsbury et al, 1985]*	Pale Thick-Rayed Sole	expanded from 37462000, AFMA OBS
8974	BC	Teleost	Soleidae	37462015	*Soleichthys heterorhinos*	Tiger Sole	expanded from 37462000, AFMA OBS

Table 2.12: ***(continued)***

ERA Species ID	Role in Fishery	Taxa	Family Name	CAAB Code	Scientific Name	Common Name	Source(s)
2393	BC	Teleost	Soleidae	37462016	*Aseraggodes melanostictus*	Dappled Sole	expanded from 37462000, AFMA OBS
8930	BC	Teleost	Soleidae	37462021	*Aseraggodes klunzingeri*	Kimberley Sole	expanded from 37462000, AFMA OBS
8931	BC	Teleost	Soleidae	37462024	*Brachirus orientalis*	Oriental Sole	expanded from 37462000, AFMA OBS
8932	BC	Teleost	Soleidae	37462030	*Pardachirus rautheri*	Mottled Sole	expanded from 37462000, AFMA OBS
1399	BC	Teleost	Soleidae	37462031	*Phyllichthys sclerolepis*	Hardscale Sole	expanded from 37462000, AFMA OBS
8909	BC	Teleost	Soleidae	37462032	*Rendahlia jaubertensis*	Jaubert Sole	expanded from 37462000, AFMA OBS
8959	BC	Teleost	Soleidae	37462035	*Brachirus aspilos*	Dusky Sole	expanded from 37462000, AFMA OBS
8929	BC	Teleost	Soleidae	37462039	*Zebrias munroi*	Munro's Sole	expanded from 37462000, AFMA OBS
2394	BC	Teleost	Soleidae	37462040	*Aseraggodes lenisquamis*	Peppered Sole	expanded from 37462000, AFMA OBS
2359	BC	Teleost	Cynoglossidae	37463002	*Paraplagusia longirostris*	Pinocchio Tongue Sole	AFMA OBS
1147	BC	Teleost	Cynoglossidae	37463003	*Cynoglossus maculipinnis*	Spotfin Tongue Sole	expanded from 37463901, AFMA OBS
2341	BC	Teleost	Cynoglossidae	37463006	*Cynoglossus kopsii*	Kops' Tongue Sole	expanded from 37463901, AFMA OBS
2400	BC	Teleost	Cynoglossidae	37463008	*Cynoglossus macrophthalmus*	Longnose Tongue Sole	expanded from 37463901, AFMA OBS
1144	BC	Teleost	Cynoglossidae	37463013	*Cynoglossus bilineatus*	Fourline Tongue Sole	expanded from 37463901, AFMA OBS
2333	BC	Teleost	Cynoglossidae	37463014	*Cynoglossus sp. [Munroe]*	A Tongue Sole	expanded from 37463901, AFMA OBS
1145	BC	Teleost	Cynoglossidae	37463018	*Cynoglossus puncticeps*	Spotted Tongue Sole	expanded from 37463901, AFMA OBS
8907	BC	Teleost	Cynoglossidae	37463024	*Cynoglossus maccullochi*	Mcculloch's Tongue Sole	expanded from 37463901, AFMA OBS
2358	BC	Teleost	Cynoglossidae	37463750	*Cynoglossus arel*	A Tongue Sole	expanded from 37463901, AFMA OBS
1262	BC	Teleost	Triacanthidae	37464001	*Trixiphichthys weberi*	Blacktip Tripodfish	AFMA OBS

Table 2.12: *(continued)*

ERA Species ID	Role in Fishery	Taxa	Family Name	CAAB Code	Scientific Name	Common Name	Source(s)
1178	BC	Teleost	Monacanthidae	37465009	*Monacanthus chinensis*	Fan-Bellied Leatherjacket	expanded from 37465903, AFMA OBS
1177	BC	Teleost	Monacanthidae	37465010	*Anacanthus barbatus*	Bearded Leatherjacket	expanded from 37465903, AFMA OBS
6820	BC	Teleost	Monacanthidae	37465012	*Thamnaconus hypargyreus*	Yellowspotted Leatherjacket	expanded from 37465903, AFMA OBS
1181	BC	Teleost	Monacanthidae	37465013	*Chaetodermis penicilligerus*	Tasselled Leatherjacket	expanded from 37465903, AFMA OBS
2469	BC	Teleost	Monacanthidae	37465017	*Paramonacanthus oblongus*	Japanese Leatherjacket	expanded from 37465903, AFMA OBS
8969	BC	Teleost	Monacanthidae	37465019	*Thamnaconus striatus*	Manyline Leatherjacket	expanded from 37465903, AFMA OBS
1180	BC	Teleost	Monacanthidae	37465020	*Pseudomonacanthus peroni*	Potbelly Leatherjacket	expanded from 37465903, AFMA OBS
1183	BC	Teleost	Monacanthidae	37465022	*Aluterus monoceros*	Grey Leatherjacket	expanded from 37465903, AFMA OBS
1182	BC	Teleost	Monacanthidae	37465024	*Paramonacanthus filicauda*	Threadfin Leatherjacket	AFMA OBS
8911	BC	Teleost	Monacanthidae	37465026	*Thamnaconus tessellatus*	Manyspot Leatherjacket	expanded from 37465903, AFMA OBS
1179	BC	Teleost	Monacanthidae	37465029	*Pseudomonacanthus elongatus*	Fourband Leatherjacket	expanded from 37465903, AFMA OBS
8970	BC	Teleost	Monacanthidae	37465030	*Paramonacanthus pusillus*	Sinhalese Leatherjacket	expanded from 37465903, AFMA OBS
4901	BC	Teleost	Monacanthidae	37465045	*Aluterus scriptus*	Scrawled Leatherjacket	expanded from 37465903, AFMA OBS
6826	BC	Teleost	Monacanthidae	37465050	*Cantherhines dumerilii*	Barred Leatherjacket	expanded from 37465903, AFMA OBS
4410	BC	Teleost	Monacanthidae	37465051	*Cantherhines pardalis*	Honeycomb Leatherjacket	expanded from 37465903, AFMA OBS
4656	BC	Teleost	Monacanthidae	37465062	*Oxymonacanthus longirostris*	Harlequin Filefish	expanded from 37465903, AFMA OBS

Table 2.12: *(continued)*

ERA Species ID	Role in Fishery	Taxa	Family Name	CAAB Code	Scientific Name	Common Name	Source(s)
1176	BC	Teleost	Monacanthidae	37465064	*Paramonacanthus choirocephalus*	Pigface Leatherjacket	AFMA OBS
4676	BC	Teleost	Monacanthidae	37465068	*Pervagor janthinosoma*	Gillblotch Leatherjacket	expanded from 37465903, AFMA OBS
1199	BC	Teleost	Ostraciidae	37466004	*Lactoria cornuta*	Longhorn Cowfish	expanded from 37466000, AFMA OBS
8906	BC	Teleost	Ostraciidae	37466005	*Ostracion nasus*	Shortnose Boxfish	AFMA OBS
1198	BC	Teleost	Ostraciidae	37466006	*Tetrosomus gibbosus*	Humpback Turretfish	expanded from 37466000, AFMA OBS
6831	BC	Teleost	Ostraciidae	37466007	*Lactoria diaphana*	Roundbelly Cowfish	expanded from 37466000, AFMA OBS
6832	BC	Teleost	Ostraciidae	37466008	*Tetrosomus reipublicae*	Smallspine Turretfish	expanded from 37466000, AFMA OBS
8908	BC	Teleost	Ostraciidae	37466009	*Ostracion rhinorhynchos*	Horn-Nose Boxfish	expanded from 37466000, AFMA OBS
4651	BC	Teleost	Ostraciidae	37466013	*Ostracion cubicus*	Yellow Boxfish	expanded from 37466000, AFMA OBS
6833	BC	Teleost	Ostraciidae	37466018	*Lactoria fornasini*	Thornback Cowfish	expanded from 37466000, AFMA OBS
4652	BC	Teleost	Ostraciidae	37466019	*Ostracion meleagris*	Black Boxfish	expanded from 37466000, AFMA OBS
8910	BC	Teleost	Ostraciidae	37466020	*Ostracion solorensis*	Striped Boxfish	expanded from 37466000, AFMA OBS
1256	BC	Teleost	Tetraodontidae	37467007	*Lagocephalus sceleratus*	Silver Toadfish	AFMA OBS
1259	BC	Teleost	Tetraodontidae	37467010	*Feroxodon multistriatus*	Ferocious Puffer	AFMA OBS
1258	BC	Teleost	Tetraodontidae	37467012	*Lagocephalus lunaris*	Rough Golden Toadfish	AFMA OBS
8984	BC	Teleost	Diodontidae	37469003	*Cyclichthys spilostylus*	Spotbase Burrfish	AFMA OBS
1150	BC	Teleost	Diodontidae	37469004	*Tragulichthys jaculiferus*	Longspine Burrfish	AFMA OBS

Protected Species

A protected species[12] refers to all species listed/covered under the EPBC Act 1999, which include Protected[13] species (listed threatened species i.e., vulnerable, endangered or critically endangered), cetaceans, listed migratory species, and listed marine species.

Table 2.13: Protected species list for the Northern Prawn Fishery - Redleg Banana Prawn sub-fishery. AFMA OBS: refers to AFMA Observer data. CREW AFMA OBS: Both AFMA Observer data and Crew Member Observer data. CREW OBS: refers to Crew Member Observer data. LOG: refers to AFMA Logbook data.

ERA Species ID	Role in Fishery	Taxa	Family Name	CAAB Code	Scientific Name	Common Name	Source(s)
326	PS	Chondrichthyan	Pristidae	37025001	*Pristis zijsron*	Green Sawfish	LOG, CREW OBS
327	PS	Chondrichthyan	Pristidae	37025002	*Anoxypristis cuspidata*	Narrow Sawfish	LOG, AFMA OBS, CREW OBS
328	PS	Chondrichthyan	Pristidae	37025003	*Pristis pristis*	Freshwater Sawfish	LOG, CREW OBS
329	PS	Chondrichthyan	Pristidae	37025004	*Pristis clavata*	Dwarf Sawfish	LOG, CREW OBS
324	PS	Marine reptile	Cheloniidae	39020001	*Caretta caretta*	Loggerhead Turtle	expanded from 39020000, CREW AFMA OBS
541	PS	Marine reptile	Cheloniidae	39020002	*Chelonia mydas*	Green Turtle	LOG
822	PS	Marine reptile	Cheloniidae	39020003	*Eretmochelys imbricata*	Hawksbill Turtle	expanded from 39020000, CREW AFMA OBS
844	PS	Marine reptile	Cheloniidae	39020004	*Lepidochelys olivacea*	Olive Ridley Turtle	expanded from 39020000, CREW AFMA OBS
857	PS	Marine reptile	Cheloniidae	39020005	*Natator depressus*	Flatback Turtle	expanded from 39020000, CREW AFMA OBS
613	PS	Marine reptile	Dermochelyidae	39021001	*Dermochelys coriacea*	Leatherback Turtle	expanded from 39001001, LOG
8982	PS	Marine reptile	Elapidae	39125001	*Hydrophis peronii*	Horned Sea Snake	AFMA OBS
1409	PS	Marine reptile	Elapidae	39125002	*Aipysurus apraefrontalis*	Short-Nosed Sea Snake	expanded from 39125000, LOG, CREW AFMA OBS
1410	PS	Marine reptile	Elapidae	39125003	*Aipysurus duboisii*	Reef Shallows Sea Snake	expanded from 39125000, LOG, CREW AFMA OBS
1411	PS	Marine reptile	Elapidae	39125004	*Aipysurus mosaicus*	Stagger-Banded Sea Snake	expanded from 39125000, LOG, CREW AFMA OBS
1414	PS	Marine reptile	Elapidae	39125007	*Aipysurus laevis*	Golden Sea Snake	expanded from 39125000, LOG, CREW AFMA OBS
8961	PS	Marine reptile	Elapidae	39125009	*Hydrophis stokesii*	Stokes' Sea Snake	AFMA OBS, CREW AFMA OBS

[12]The term "protected" species refers to species listed under [Part 13] the EPBC Act 1999 and replaces the term "Threatened, endangered and protected species (PS)" commonly used in past Commonwealth Government (including AFMA) documents.

[13]Note "protected" (with small "p") refers to all species covered by the EPBC Act 1999 while "Protected" (capital P) refers only to those protected species that are threatened (vulnerable, endangered or critically endangered).

Table 2.13: *(continued)*

ERA Species ID	Role in Fishery	Taxa	Family Name	CAAB Code	Scientific Name	Common Name	Source(s)
8962	PS	Marine reptile	Elapidae	39125010	*Hydrophis kingii*	Spectacled Sea Snake	CREW AFMA OBS
8934	PS	Marine reptile	Elapidae	39125011	*Hydrophis major*	Olive-Headed Sea Snake	AFMA OBS, CREW AFMA OBS
1417	PS	Marine reptile	Elapidae	39125012	*Emydocephalus annulatus*	Turtle-Headed Sea Snake	expanded from 39125000, LOG, CREW AFMA OBS
1418	PS	Marine reptile	Elapidae	39125013	*Hydrophis zweifeli*	Beaked Sea Snake	expanded from 39125000, LOG, CREW AFMA OBS
1420	PS	Marine reptile	Elapidae	39125015	*Hydrelaps darwiniensis*	Black-Ringed Mangrove Sea Snake	expanded from 39125000, LOG, CREW AFMA OBS
1681	PS	Marine reptile	Elapidae	39125016	*Hydrophis atriceps*	Black-Headed Sea Snake	expanded from 39125000, LOG, CREW AFMA OBS
1683	PS	Marine reptile	Elapidae	39125018	*Hydrophis caerulescens*	Dwarf Sea Snake	expanded from 39125000, LOG, CREW AFMA OBS
957	PS	Marine reptile	Elapidae	39125021	*Hydrophis elegans*	Elegant Sea Snake	AFMA OBS, CREW AFMA OBS
8971	PS	Marine reptile	Elapidae	39125025	*Hydrophis macdowelli*	Small-Headed Sea Snake	AFMA OBS, CREW AFMA OBS
8983	PS	Marine reptile	Elapidae	39125028	*Hydrophis ocellatus*	A Sea Snake	AFMA OBS, CREW AFMA OBS
1687	PS	Marine reptile	Elapidae	39125029	*Hydrophis pacificus*	Large-Headed Sea Snake	expanded from 39125000, LOG, CREW AFMA OBS
8972	PS	Marine reptile	Elapidae	39125031	*Hydrophis curtus*	Spine-Bellied Sea Snake	AFMA OBS, CREW AFMA OBS
8973	PS	Marine reptile	Elapidae	39125033	*Hydrophis platurus*	Yellow-Bellied Sea Snake	expanded from 39125000, LOG, CREW AFMA OBS

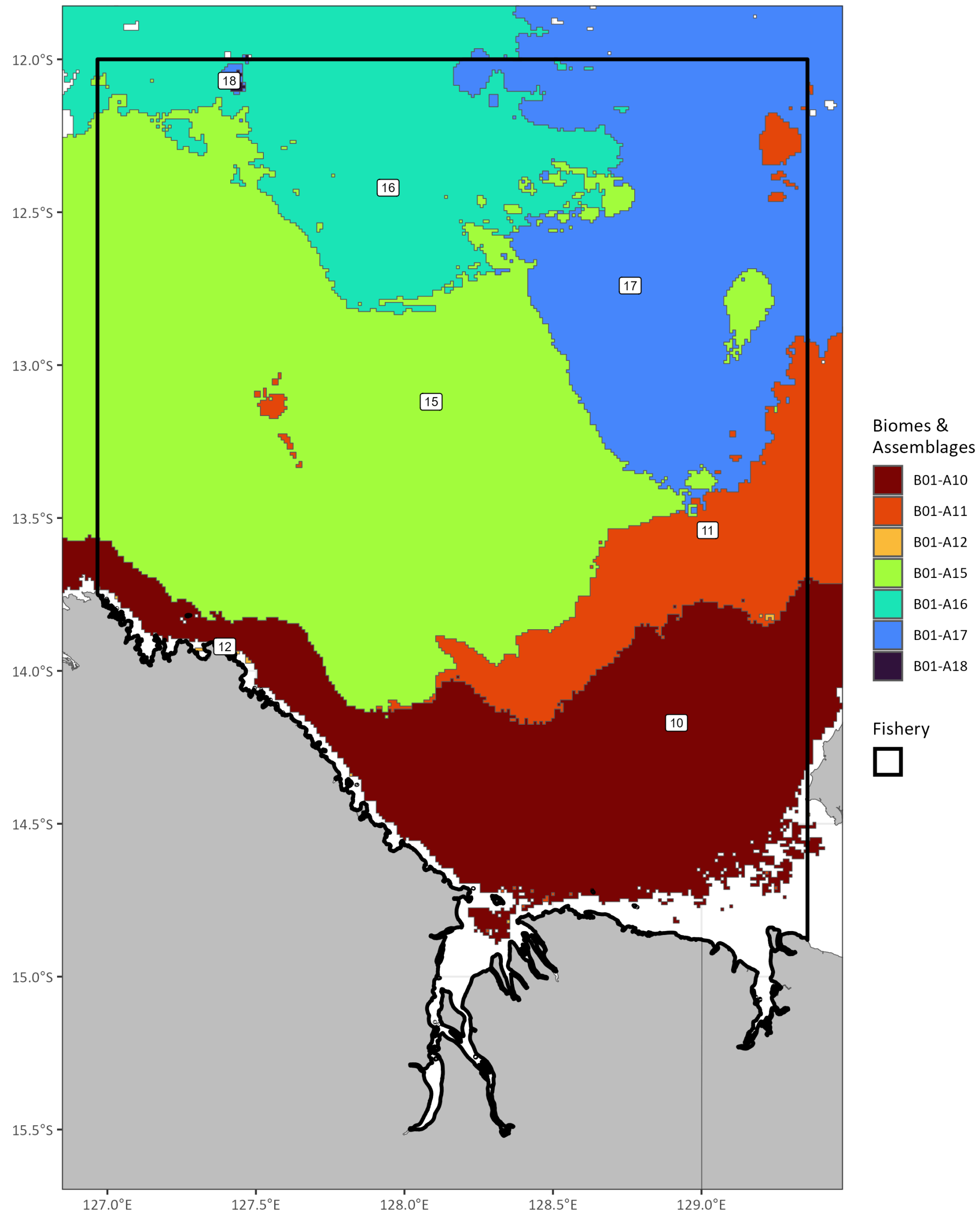


Figure 2.9: Map of the fishery region showing the biomes and assemblages derived by Pitcher et al. (2018). Please note that the map may contain biomes and assemblage numbers that do not overlap the fishery. Biomes: 01 = Arafura Sea / Timor Sea. For detailed descriptions of the biome and assemblage numbers, please refer to Table 2.14.

Since the previous assessments over a decade ago, there has been considerable research and habitat identification and modelling of demersal habitats around Australia (Althaus et al., 2009; Hobday et al., 2011a; Pitcher et al., 2015, 2016; Williams et al., 2009, 2010a; Williams et al., 2010b, 2010c, 2011). This has culminated in Pitcher et al. (2018) in an FRDC–funded project, which redefined much of the Australian seafloor based on mesoscale surrogates collated from data from biological surveys, environmental data, protected area/fishery closure data. Habitat assemblages were predicted, mapped (Figure 2.9) and overlaid with the fishery boundary being assessed.

The new data and new methodology is not directly mappable to the original analyses but these assessments are more comprehensive than the previous assessments, and will therefore be used in preference to the original SICA. The temporal range of the fishery effort data of Pitcher et al. (2018) was from 1985 -~2013.

The habitat assemblages that overlap the fishery jurisdiction were identified as follows:

- assemblages 10, 11, 12, 15, 16, 17 and 18 of the Timor Biome.

The most vulnerable habitat types were bryozoans and gorgonian corals corresponding to assemblages 15, 11 and 10. These habitats were mostly trawled during the 2017-21 assessment period.

Table 2.14: Benthic habitats that occur within the jurisdictional boundary of the Northern Prawn Fishery - Redleg Banana Prawn sub-fishery. Further details of these assemblages were not available. Bold text denotes habitats where fishing effort has occurred (5 habitats).

Biome Number	Biome	ERAEF Assemblage Number	Habitat Type
01	**Arafura Sea / Timor Sea**	**10**	Bryozoans, gorgonians; sessile polychaetes (P. Robinson pers. comm.; A. Raptis & Sons, Pty Ltd)
01	**Arafura Sea / Timor Sea**	**11**	Bryozoans, gorgonians; sessile polychaetes (P. Robinson pers. comm.; A. Raptis & Sons, Pty Ltd)
01	Arafura Sea / Timor Sea	12	
01	**Arafura Sea / Timor Sea**	**15**	Bryozoans, gorgonians, sponges
01	**Arafura Sea / Timor Sea**	**16**	Bryozoans, gorgonians, sponges
01	**Arafura Sea / Timor Sea**	**17**	Bryozoans, gorgonians, sponges
01	Arafura Sea / Timor Sea	18	

Scoping Document S2B2. Pelagic Habitats

Table 2.15: Pelagic habitats for the Northern Prawn Fishery - Redleg Banana Prawn sub-fishery. Shading denotes habitats occurring within the jurisdictional boundary of the fishery. Bold text refers to pelagic habitats where fishing effort has occurred.

ERAEF Pelagic Habitat No.	Pelagic Habitat type	Depth (m)	Comments	Source
P1	Eastern Pelagic Province - Coastal	0 – 200		ERA pelagic habitat database based on pelagic communities definitions
P2	Eastern Pelagic Province - Oceanic	0 – > 600	this is a compilation of the range covered by Oceanic Community (1) and (2)	ERA pelagic habitat database based on pelagic communities definitions
P3	Heard/ McDonald Islands Pelagic Provinces - Oceanic	0 - >1000	this is a compilation of the range covered by Oceanic Community (1) and (2)	ERA pelagic habitat database based on pelagic communities definitions
P4	North Eastern Pelagic Province - Oceanic	0 – > 600	this is a compilation of the range covered by Oceanic Community (1) and (2)	ERA pelagic habitat database based on pelagic communities definitions
P5	**Northern Pelagic Province - Coastal**	**0 – 200**		**ERA pelagic habitat database based on pelagic communities definitions**
P6	North Western Pelagic Province - Oceanic	0 – > 800	this is a compilation of the range covered by Oceanic Community (1) and (2)	ERA pelagic habitat database based on pelagic communities definitions
P7	Southern Pelagic Province - Coastal	0 – 200	this is a compilation of the range covered by Coastal pelagic Tas and GAB	ERA pelagic habitat database based on pelagic communities definitions

Table 2.15: *(continued)*

ERAEF Pelagic Habitat No.	Pelagic Habitat type	Depth (m)	Comments	Source
P8	Southern Pelagic Province - Oceanic	0 – > 600	this is a compilation of the range covered by Oceanic Communities (1, 2 and 3)	ERA pelagic habitat database based on pelagic communities definitions
P9	Southern Pelagic Province - Seamount Oceanic	0 – > 600	this is a compilation of the range covered by Seamount Oceanic Communities (1), (2), and (3)	ERA pelagic habitat database based on pelagic communities definitions
P10	Western Pelagic Province - Coastal	0 – 200		ERA pelagic habitat database based on pelagic communities definitions
P11	Western Pelagic Province - Oceanic	0 – > 400	this is a compilation of the range covered by Oceanic Community (1) and (2)	ERA pelagic habitat database based on pelagic communities definitions
P12	Eastern Pelagic Province - Seamount Oceanic	0 – > 600	this is a compilation of the range covered by Seamount Oceanic Communities (1) and (2)	ERA pelagic habitat database based on pelagic communities definitions
P13	Heard/McDonald Islands Pelagic Provinces - Plateau	0 -1000	this is the same as community Heard Plateau 0-1000m	ERA pelagic habitat database based on pelagic communities definitions
P14	North Eastern Pelagic Province - Coastal	0 – 200		ERA pelagic habitat database based on pelagic communities definitions
P15	North Eastern Pelagic Province - Plateau	0 – > 600	this is a compilation of the range covered by the North Eastern Seamount Oceanic (1) and (2)	ERA pelagic habitat database based on pelagic communities definitions
P16	North Eastern Pelagic Province - Seamount Oceanic	0 – > 600		ERA pelagic habitat database based on pelagic communities definitions
P17	Macquarie Island Pelagic Province - Oceanic	0 – 250		ERA pelagic habitat database based on pelagic communities definitions
P18	Macquarie Island Pelagic Province - Coastal	0 - > 1500	this is a compilation of the range covered by Oceanic Community (1) and (2)	ERA pelagic habitat database based on pelagic communities definitions

Scoping Document S2C1. Demersal Communities

In ERAEF, communities are defined as the set of species assemblages that occupy the large-scale provinces and biomes identified from national bioregionalisation studies. The biota includes mobile fauna, both vertebrate and invertebrate, but excludes sessile organisms such as corals that are largely structural and are used to identify benthic habitats. The same community lists are used for all fisheries, with those selected as relevant for a particular fishery being identified based on the spatial overlap with effort in the fishery. The spatial boundaries for demersal communities are based on IMCRA boundaries for the shelf, and on slope bioregionalisation for the slope (Interim Marine and Coastal Regionalisation for Australia Technical Group, 1998; Last et al., 2005). The spatial boundaries for the pelagic communities are based on pelagic bioregionalisation and oceanography (Condie et al., 2003; Lyne & Hayes, 2004). Fishery and region-specific modifications to these boundaries are described in detail in Hobday et al. (2007) and briefly outlined in the footnotes to the community Tables below.

Table 2.16: Demersal communities in which fishing activity can occur (white shading). Shaded blue cells indicate all communities present within the province. Crosses refer to communities where fishing has occurred in the Northern Prawn Fishery - Redleg Banana Prawn sub-fishery.

Demersal Community	Cape Province	North Eastern Transition	North Eastern Province	Central Eastern Transition	Central Eastern Province	South Eastern Transition	Central Bass	Tasmanian Province	Western Tasmanian Transition	Southern Province	South Western Transition	Central Western Province	Central Western Transition	North Western Province	North Western Transition	Timor Province	Timor Transition	Heard/McDonald Islands	Macquarie Island
Inner Shelf 0 – 110 m[1]																X			
Outer Shelf 110 – 250 m																			
Upper Slope 250 – 565 m																			
Mid–Upper Slope 565 – 820 m																			
Mid Slope 820 – 1100 m																			
Lower Slope/ Abyssal > 1100 m																			
Inner Shelf Arafura 0 – 110 m																			
Inner Shelf Groote 0 – 110 m																			
Inner Shelf Cape York 0 – 110 m																			
Inner Shelf Gulf of Carpentaria 0 – 110 m																			
Cape York Shelf Reef 0 – 110 m																			
Inner Shelf Reef 0 – 110 m[7] [8]																			
Slope Reef 110 – 250 m[8]																			

Table 2.16: ***(continued)***

Demersal Community	Cape Province	North Eastern Transition	North Eastern Province	Central Eastern Transition	Central Eastern Province	South Eastern Transition	Central Bass	Tasmanian Province	Western Tasmanian Transition	Southern Province	South Western Transition	Central Western Province	Central Western Transition	North Western Province	North Western Transition	Timor Province	Timor Transition	Heard/McDonald Islands	Macquarie Island
Seamount 0 – 110 m			■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Seamount 110 – 250 m			■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Seamount 250 – 565 m			■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Seamount 565 – 820 m			■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Seamount 820 – 1100 m			■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Seamount > 1100 m	■	■					■		■	■	■	■	■	■	■	■	■	■	■
Plateau 0 – 110 m	■	■		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Plateau 110 – 250 m	■	■		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Plateau 250 – 565 m	■	■		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Plateau 565 – 820 m	■	■		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Plateau 820 – 1100 m	■	■		■	■	■	■	■	■	■	■	■	■		■	■	■	■	■
Shelf (Territorial Seas) 0 – 100 m	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		■
Shelf 0 – 250 m[2]	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	
Upper-Mid Slope 250 – 1100 m[3]	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	
Inner Heard Plateau 100 – 500 m[4]	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		■
Outer Heard Plateau 100 – 500 m[4]	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		■
Shell Bank 100 – 500 m[4]	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		■
Western Banks 200 – 500 m[4]	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		■
North Eastern Plateau 500 – 1000 m[5]	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		■
North Eastern Trough 500 – 1000 m[5]	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		■
South Eastern Trough 500 – 1000 m[5]	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		■

Table 2.16: ***(continued)***

Demersal Community	Cape Province	North Eastern Transition	North Eastern Province	Central Eastern Transition	Central Eastern Province	South Eastern Transition	Central Bass	Tasmanian Province	Western Tasmanian Transition	Southern Province	South Western Transition	Central Western Province	Central Western Transition	North Western Province	North Western Transition	Timor Province	Timor Transition	Heard/McDonald Islands	Macquarie Island
Western Trough 500 – 1000 m[5]	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		■
Southern Upper Slope 500 – 1000 m[5]	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		■
Shell Bank Deep > 1000 m[6]	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		■
North East Lower Slope/ Abyssal > 1000 m[6]	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		■
Southern Lower Slope/ Abyssal > 1100 m	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	

Note:

[1] Three inner shelf communities occur in the Southern (Eyre, Eucla and South West Coast).

At Macquarie Island: [2] inner & outer shelves (0-250 m), and [3] upper and midslope communities combined (250-1000 m).

At Heard/McDonald Islands: [4] outer and upper slope plateau communities combined to form four communities: Shell Bank, inner and outer Heard Plateau (100-500 m) and Western Banks (200-500 m), [5] mid and upper plateau communities combined into 3 trough, southern slope and North Eastern plateau communities (500-1000 m), and [6] 2 groups at Heard Is: Deep Shell Bank (>1000 m) and North East Lower slope/abyssal,

[7] Great Barrier Reef in the North Eastern Province and Transition and [8] Rowley Shoals in North Western Transition.

Table 2.17: Pelagic communities in which fishing activity occurs in the Northern Prawn Fishery - Redleg Banana Prawn sub-fishery (cross; x). Shaded cells indicate all communities that exist in the province.

Pelagic Community	Northeastern	Eastern	Southern	Western	Northern	Northwestern	Heard and McDonald Is	Macquarie Is
Coastal pelagic 0-200m[1] [2]					X			
Oceanic (1) 0 – 600m								
Oceanic (2) >600m								
Seamount oceanic (1) 0 – 600m								
Seamount oceanic (2) 600–3000m								
Oceanic (1) 0 – 200m								
Oceanic (2) 200-600m								
Oceanic (3) >600m								
Seamount oceanic (1) 0 – 200m								
Seamount oceanic (2) 200 – 600m								
Seamount oceanic (3) 600–3000m								
Oceanic (1) 0-400m								
Oceanic (2) >400m								
Oceanic (1) 0-800m								
Oceanic (2) >800m								
Plateau (1) 0-600m								
Plateau (2) >600m								
Heard Plateau 0-1000m[3]								
Oceanic (1) 0-1000m								
Oceanic (2) >1000m								
Oceanic (1) 0-1600m								
Oceanic (2) >1600m								

Note:
[1] Northern Province has five coastal pelagic zones (NWS, Bonaparte, Arafura, Gulf and East Cape York) and Southern Province has two zones (Tas, GAB).
[2] At Macquarie Island: coastal pelagic zone to 250m.
[3] At Heard and McDonald Is: coastal pelagic zone broadened to cover entire plateau to maximum of 1000 m.

2.2.3 Units Excluded from Analysis

Species lists for Level 2 analysis are derived from recent observer data where possible or, for fisheries with no observer programs, from logbook and scientific data. In some logbook data, there may only be family-level identifications. Where possible these are resolved to species level by cross-checking with alternative data sources and discussion with experts. In cases where this is not possible (mainly invertebrates) the analysis may be based on family average data.

A list of the species/species groups/taxa excluded in this fishery is provided in Table 2.18.

(a)

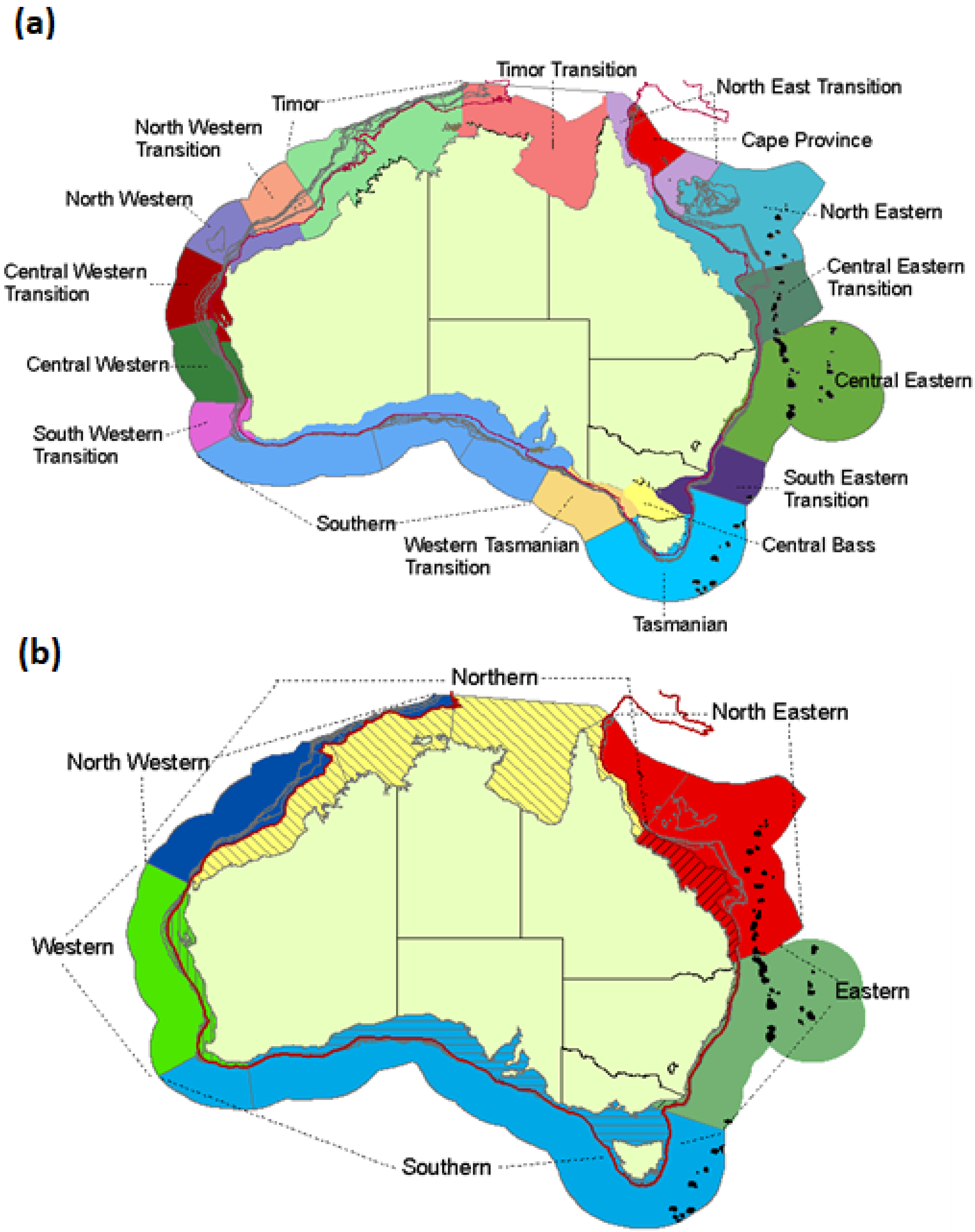


Figure 2.10: (a) Demersal communities around mainland Australia based on bioregionalisation schema. Some inshore (0-110 m) communities comprise more than one community e.g., Timor Transition comprises four distinct communities. (b) Australian pelagic provinces. Hatched areas indicate coastal epipelagic zones overlying the shelf. Offshore (oceanic) provinces comprise two or more overlaying pelagic zones as indicated in Table 2.17. Seamounts (black) and plateaux (light green) are illustrated in their demersal or pelagic provinces.

Table 2.18: Species/species groups/taxa excluded from analysis because they were either not identified at the species level, not interacted in the fishery or outside the fishery's jurisdictional boundary. No obs/ints: No observations or interactions. These entries have been excluded from the protected species list since the last ERA because they have not been observed within the fishery and/or occur outside the depth range of the fishery. AFMA OBS: refers to AFMA Observer data. LOG: refers to AFMA Logbook data. CREW OBS: refers to Crew Member Observer data.

Role in Fishery	Taxa	Family Name	CAAB Code	Scientific Name	Common Name	Rationale
BC	Benthos		20050411		Bryozoan	AFMA OBS, benthos
BC	Chondrychthyan	Carcharhinidae	37018903	*Carcharhinus limbatus* & *Carcharhinus tilstoni*	A whaler shark	AFMA OBS, separate species already exist in list (3701814, 3701839)
BC	Invertebrate	Class Ascidiacea	35000000	Class Ascidiacea - undifferentiated	Ascidians	AFMA OBS, insufficiently taxonomically resolved. Did not expand (< 9 kg).
BC	Invertebrate	Class Asteroidea	25102000	Class Asteroidea - undifferentiated	Starfish	AFMA OBS, insufficiently taxonomically resolved. Added 6 species to list (25105003, 25105005, 25122010, 25122026, 25124002, 25143013).
BC	Invertebrate	Class Echinoidea	25200000	Class Echinoidea - undifferentiated	Sea Urchins	AFMA OBS, Not expanded as 25000000: Phylum Echinodermata - undifferentiated was already used to add species.
BC	Invertebrate	Infraorder Brachyura	28850000	Infraorder Brachyura - undifferentiated	Crabs	AFMA OBS, insufficiently taxonomically resolved
BC	Invertebrate	Loliginidae	23617000	Loliginidae - undifferentiated	loligo squids	LOG, added 3 species to list (23617006, 23617008, 23617010)
BC	Invertebrate	Majidae	28880911	Majidae - undifferentiated	Spider Crabs (Majidae)	AFMA OBS, insufficiently taxonomically resolved. Did not expand (< 4 kg).
BC	Invertebrate	Ommastrephidae	23636000	Ommastrephidae - undifferentiated	Flying squids	AFMA OBS, added 3 species to list (23636008, 23636013, 23636014)
BC	Invertebrate	Ommastrephidae	23636907	Ommastrephes spp.	A flying squid	AFMA OBS, *Ommastrephes volatilis* is synonym of *Ornithoteuthis volatilis* which is already in species list (from Ommastrephidae-undifferentiated).
BC	Invertebrate	Order Octopoda	23650000	Order Octopoda - undifferentiated	Octopoda	AFMA OBS, insufficiently taxonomically resolved
BC	Invertebrate	Order Stomatopoda	28030000	Order Stomatopoda - undifferentiated	Mantis Shrimps	AFMA OBS, insufficiently taxonomically resolved
BC	Invertebrate	Palinuridae	28820000	Palinuridae - undifferentiated	Spiny Lobsters	LOG, 3 existing species in list (28820003, 28820012, 28820013). Added 1 species to list (28820006).

Table 2.18: *(continued)*

Role in Fishery	Taxa	Family Name	CAAB Code	Scientific Name	Common Name	Rationale
BC	Invertebrate	Pectinidae	23270000	Pectinidae - undifferentiated	Scallops	AFMA OBS, added 2 species to list (23270003, 23270007)
BC	Invertebrate	Penaeidae	28711904	*Metapenaeus* spp.	School Prawns (mixed)	AFMA OBS, 2 existing species in list (28711026, 28711027)
BC	Invertebrate	Portunidae	28911000	Portunidae, Polybiidae - undifferentiated	Swimming crabs	AFMA OBS, 5 existing species in list (28911005, 28911006, 28911015, 28911027, 28911037), also added 6 species to list (28911002, 28911026, 28911032, 28911042, 28911070, 28911075). No Polybiidae known to area.
BC	Invertebrate	Portunidae	28911001	*Charybdis feriata*	Crucifix Crab	AFMA OBS, possible mis-identification: outside fishery area
BC	Invertebrate	Portunidae	28911011	*Thalamita creta*	A swimming crab	AFMA OBS, possible mis-identification: outside fishery area
BC	Invertebrate	Portunidae	28911911	*Charybdis* spp.	A swimmer crab	AFMA OBS, already expanded (see 28911000)
BC	Invertebrate	Scyllaridae	28821000	Scyllaridae - undifferentiated	Bugs - Shovel nosed and slipper lobsters	AFMA OBS, 1 existing species in list (28821008). Added 1 species to list, 28821007
BC	Invertebrate	Sepiidae	23607000	Sepiidae - undifferentiated	Cuttlefishes	LOG, 1 existing species in list (23607003). Added 6 species to list (23607007, 23607008, 23607011, 23607013, 23607015, 23607019)
BC	Invertebrate	Sepiidae	23607901	*Sepia* spp.	Cuttlefish (mixed)	AFMA OBS, 1 existing species in list (23607003). Added 5 species to list (23607007, 23607008, 23607011, 23607013, 23607019)
BC	Invertebrate	Squillidae	28051000	Squillidae - undifferentiated	Squilla Mantis Shrimps	AFMA OBS, 3 existing species in list (28051030, 28051039, 28051050). Added 5 species to list (28051019, 28051035, 28051036, 28051037, 28051041)
BC	Invertebrate	Squillidae	28051050	*Oratosquilli gravieri*	A mantis shrimp	AFMA OBS, possible mis-identification: outside fishery area
BC	Invertebrate	Subphylum Crustacea	27000000	Crustacea - undifferentiated	Crustaceans	AFMA OBS, insufficiently taxonomically resolved

Table 2.18: *(continued)*

Role in Fishery	Taxa	Family Name	CAAB Code	Scientific Name	Common Name	Rationale
BC	Scyphozoa	Class Scyphozoa	11120000	Class Scyphozoa - undifferentiated	Jellyfish	AFMA OBS, insufficiently taxonomically resolved
BC	Shells		23999999	Shells	Shells	AFMA OBS, insufficiently taxonomically resolved
BC	Soft Coral	Order Alcyonacea	11173000	Order Alcyocea - undifferentiated	Octocorals & gorgonians	AFMA OBS, insufficiently taxonomically resolved
BC	Sponge	Spongiidae	10114000	Spongiidae - undifferentiated	Spongiid sponges	AFMA OBS, insufficiently taxonomically resolved
BC	Teleost	Apogonidae, Dinolestidae	37327000	Apogonidae, Dinolestidae - undifferentiated	Cardilfishes	AFMA OBS, insufficiently taxonomically resolved. Also, 5 existing species in list (3732713, 3732714, 3732716, 3732726, 37327158). No Dinolestidae spp. known to area.
BC	Teleost	Ariidae	37188901	*Arius* spp.	Forktail catfish (mixed)	AFMA OBS, possible mis-identification: outside fishery area
BC	Teleost	Bregmacerotidae	37225901	*Bregmaceros* spp.	Codlet	AFMA OBS, 1 existing species in list (37225002). Also added 5 species to list (37225001, 37225003, 37225004, 37225005, 37225007)
BC	Teleost	Carangidae	37337000	Carangidae - undifferentiated	Trevallies and Scads	AFMA OBS, 12 existing species in list (37337003, 37337005, 37337008, 37337015, 37337016, 37337020, 37337025, 37337028, 37337041, 37337047, 37337068, 37337072). Added 29 species to list (37337002, 37337009, 37337010, 37337011, 37337012, 37337014, 37337017, 37337018, 37337021, 37337022, 37337023, 37337024, 37337031, 37337032, 37337036, 37337037, 37337038, 37337040, 37337042, 37337043, 37337044, 37337045, 37337046, 37337048, 37337049, 37337050, 37337056, 37337065, 37337073)
BC	Teleost	Carangidae	37337025	*Seriola dumerili*	Amberjack	AFMA OBS, possible mis-identification: outside fishery area
BC	Teleost	Carangidae	37337914	*Alepes* spp.	Scad	AFMA OBS, added 2 species to list (3733710, 3733736)
BC	Teleost	Clupeidae	37085905	*Herklotsichthys* spp.	[a herring]	AFMA OBS, added 3 species to list (37085007, 37085008, 37085024)

Table 2.18: *(continued)*

Role in Fishery	Taxa	Family Name	CAAB Code	Scientific Name	Common Name	Rationale
BC	Teleost	Coryphaenidae	37338002	*Coryphae equiselis*	Pompano Mahi Mahi	AFMA OBS, possible mis-identification: outside fishery area
BC	Teleost	Cynoglossidae	37463901	*Cynoglossus* spp.	Tongue Soles (Mixed)	AFMA OBS, added 8 species to list (37463003, 37463006, 37463008, 37463013, 37463014, 37463018, 37463024, 37463750)
BC	Teleost	Harpadontidae	37119750	*Harpadon nehereus*	Bombay Duck	AFMA OBS, possible mis-identification: outside fishery area
BC	Teleost	Leiognathidae	37341000	Leiogthidae - undifferentiated	Ponyfishes	AFMA OBS, 8 existing species in list (37341002, 37341005, 37341007, 37341010, 37341013, 37341014, 37341015. 37341999). Added 12 species to list (37341003, 37341004, 37341006, 37341009, 37341011, 37341012, 37341016, 37341018, 37341021, 37341022, 37341023, 37341024)
BC	Teleost	Monacanthidae	37465903	Mocanthidae - undifferentiated	Leatherjacket	AFMA OBS, 2 existing species in list (37465024, 37465064). Added 16 species to list (37465009, 37465010, 37465012, 37465013, 37465017, 37465019, 37465020, 37465022, 37465026, 37465029, 37465030, 37465045, 37465050, 37465051, 37465062, 37465068)
BC	Teleost	Mugilidae	37381000	Mugilidae - undifferentiated	Mullets	AFMA OBS, added 16 species to list (37381002, 37381006, 37381007, 37381008, 37381009, 37381010, 37381013, 37381014, 37381015, 37381016, 37381017, 37381019, 37381020, 37381022, 37381023, 37381026)
BC	Teleost	Muraenesocidae	37063901	*Muraenesox* spp.	Pike eels (mixed)	AFMA OBS, added 2 species to list (37063002, 37063003)
BC	Teleost	Muraenolepididae	37223999	*Muraenolepis andriashevi*	Species unknown to that area	AFMA OBS, possible mis-identification: outside fishery area

Table 2.18: *(continued)*

Role in Fishery	Taxa	Family Name	CAAB Code	Scientific Name	Common Name	Rationale
BC	Teleost	Nemipteridae	37347901	*Nemipterus* spp.	Threadfin breams nei	AFMA OBS, 1 existing species in list (37347014). Added 11 species to list (37347001, 37347002, 37347003, 37347004, 37347005, 37347009, 37347013, 37347016, 37347019, 37347038, 37347039)
BC	Teleost	Ostraciidae	37466000	Ostraciidae - undifferentiated	Boxfishes	AFMA OBS, 3 existing species in list (37466005, 37466007, 37466015). Added 8 species to list (37466004, 37466006, 37466008, 37466009, 37466013, 37466018, 37466019, 37466020)
BC	Teleost	Ostraciidae	37466015	*Anoplocapros amygdaloides*	Western smooth boxfish	AFMA OBS, possible mis-identification: outside fishery area
BC	Teleost	Paralichthyidae	37460919	*Pseudorhombus* spp.	Flounder	AFMA OBS, 1 existing species in list (37460009). Added 8 species to list (37460002, 37460004, 37460008, 37460011, 37460015, 37460035, 37460038, 37460065)
BC	Teleost	Platycephalidae	37296915	*Rogadius* spp.	Flathead	AFMA OBS, added 3 species to list (37296008, 37296030, 37296054)
BC	Teleost	Sciaenidae	37354000	Sciaenidae - undifferentiated	Jewfishes	AFMA OBS, 6 existing species in list (37354003, 37354004, 37354007, 37354009, 37354012, 37354026). Added 11 species to list (37354006, 37354008, 37354011, 37354019, 37354020, 37354021, 37354022, 37354023, 37354024, 37354025, 37354027)
BC	Teleost	Siganidae	37438008	*Siganus corallinus*	Blue-spotted spinefoot	AFMA OBS, possible mis-identification: outside fishery area
BC	Teleost	Sillaginidae	37330904	*Sillago* spp.	Whiting	AFMA OBS, added 7 species to list (37330003, 37330004, 37330005, 37330006, 37330007, 37330009, 37330015)

Table 2.18: *(continued)*

Role in Fishery	Taxa	Family Name	CAAB Code	Scientific Name	Common Name	Rationale
BC	Teleost	Soleidae	37462000	Soleidae - undifferentiated	Soles	AFMA OBS, 1 existing species in list (37462006). Added 17 species to list (37462001, 37462003, 37462004, 37462007, 37462008, 37462009, 37462011, 37462015, 37462016, 37462021, 37462024, 37462030, 37462031, 37462032, 37462035, 37462039, 37462040)
BC	Teleost	Triglidae	37288900	Triglidae - undifferentiated	Searobins	AFMA OBS, 1 existing species in list (37288016). Added 9 species to list (37288009, 37288010, 37288014, 37288015, 37288017, 37288020, 37288027, 37288032, 37288033)
BC	Teleost	Triglidae	37288901	*Lepidotrigla* spp.	Butterfly gurrd (mixed)	AFMA OBS, 1 existing species in list (37288016). Added 7 species to list (37288010, 37288015, 37288017, 37288020, 37288027, 37288032, 37288033)
BC	Teleost	Uranoscopidae	37400000	Uranoscopidae - undifferentiated	Stargazers	AFMA OBS, added 5 species to list (37400008, 37400009, 37400010, 37400012, 37400028)
BC			99999999	Unknown - other	Unknown or other	AFMA OBS, insufficiently taxonomically resolved
BP	Invertebrate	Penaeidae	28711902	*Metapenaeus endeavouri* & *Metapenaeus ensis*	Endeavour Prawns	LOG, already exist in species list as separate species (28711026 and 28711027)
BP	Invertebrate	Penaeidae	28711906	*Penaeus esculentus*, *Penaeus semisulcatus* & *Penaeus monodon*	Tiger Prawns (mixed)	LOG, already exist in species list as separate species (28711044, 28711053, and 28711051)
BP	Invertebrate	Penaeidae	28711910	King prawns - *Melicertus latisulcatus*, *Melicertus plebejus* & *Melicertus longistylus*	King Prawns (mixed)	LOG, 1 species already exist in species list as separate species (28711047). Added 1 species (28711048). *Melicertus plebejus* not known to area
BP	Invertebrate	Scyllaridae	28821903	*Thenus* spp.	Moreton Bay Bugs	LOG, AFMA OBS, 1 existing species in list (28821008). Added 1 species to list (28821007)
BP	Teleost		37999999	Mixed reef fish	Fish (mixed)	LOG, insufficiently taxonomically resolved
C1	Invertebrate	Penaeidae	28711907	*Penaeus indicus* & *Penaeus merguiensis*	Banana Prawns (mixed)	LOG, already exist in species list as separate species (28711045, 28711050)

Table 2.18: *(continued)*

Role in Fishery	Taxa	Family Name	CAAB Code	Scientific Name	Common Name	Rationale
C1	Invertebrate	Penaeidae	28711999	Commercial Prawns	Commercial Prawns	LOG, 13 existing species in list (28711016, 28711017, 28711026, 28711027, 28711031, 28711044, 28711045, 28711047, 28711050, 28711051, 28711053, 28711054, 28711057). Added 3 species to list (28711003, 28711046, 28711048)
PS	Chondrychthyan	Pristidae	37025000	Pristidae - undifferentiated	Sawfishes	LOG, 4 existing species in list (37025001, 37025002, 37025003, 37025004)
PS	Marine reptile	Hydrophiidae	39125000	Hydrophiidae - undifferentiated	Seasnakes	LOG, CREW OBS, 8 existing species in list (39125001, 39125009, 39125010, 39125011, 39125021, 39125025, 39125028, 39125031). Added 10 species to list (39125004, 39125005, 39125015, 39125018, 39125019, 39125020, 39125024, 39125027, 39125030, 39125032)
PS	Marine turtle	Cheloniidae	39020000	Cheloniidae - undifferentiated	Sea Turtles	CREW OBS, 1 existing species in list (39020002). Added 4 species to list (39020001, 39020003, 39020004, 39020005)
PS	Marine turtle	Testudines - undifferentiated	39001001	Testudines - undifferentiated	Turtles	LOG, 1 existing species in list (39020002). Added 5 species to list (39020001, 39020003, 39020004, 39020005, 39021001)

2.2.4 Identification of Objectives for Components and Sub-components (Step 3)

Objectives are identified for each sub-fishery for the five ecological components (key/secondary commercial, bycatch/byproduct, protected species, habitats, and communities) and sub-components, and are clearly documented. It is important to identify objectives that managers, the fishing industry, and other stakeholders can agree on, and that scientists can quantify and assess. The criteria for selecting ecological operational objectives for risk assessment are that they:

- are biologically relevant;
- have an unambiguous operational definition;
- are accessible to prediction and measurement; and
- that the quantities they relate to are exposed to the hazards.

For fisheries that have completed Ecological Sustainable Development (ESD) reports, use can be made of the operational objectives stated in those reports.

Each 'operational objective' is matched to example indicators. **Scoping Document S3** provides suggested examples of operational objectives and indicators. Where operational objectives are already agreed for a fishery (Existing Management Objectives) and/or provided by existing fisheries legislation, policies or Guidelines, those should be used (e.g., AFMA ERM Guide objective). The objectives need not be exactly specified, with regard to numbers or fractions of removal/impact, but should indicate that an impact in the sub-component is of concern/interest to the sub-fishery. The rationale for including or discarding an operational objective is a crucial part of the table and must explain why the particular objective has or has not been selected for in the (sub) fishery. Only the operational objectives selected for inclusion in the (sub) fishery are used for Level 1 analysis (**Level 1 SICA Document L1.1**).

Key Commercial and Secondary Commercial Species

Core objectives:

- Avoid recruitment failure of the key/secondary commercial species
- Avoid negative consequences for species or population sub-components

Table 2.19: Scoping Document S3. Identification of operational objectives and rationale for C1-C2 component. Operational objectives that are eliminated are shaded out. EMO: Existing Management Objective; AMO: Existing AFMA Objective

Sub-component	Example Operational Objectives	Example indicators	Rationale
1. Population size	1.1 No trend in biomass	Biomass, numbers, density, CPUE, yield	1.1 Increases in biomass of the key/secondary commercial species would be acceptable.
	1.2 Maintain biomass above a specified level		1.2. To ensure that population at acceptable level by the assessment.
	1.3 Maintain catch at specified level		1.3. TAC levels are specified.
	1.4 Species do not approach extinction or become extinct		1.4. This is a general objective for all AFMA fisheries as per Fisheries Management Act 1991 (objective (b): ensuring that the exploitation of fisheries resources and the carrying on of any related activities are conducted in a manner consistent with the principles of ecologically sustainable development).
2. Geographic range	2.1 Geographic range of the population, in terms of size and continuity does not change outside acceptable bounds	Presence of population across the known distribution range	2.1 Not currently monitored. No specific management objective based on the geographic range of key/secondary commercial species.

Table 2.19: *(continued)*

Sub-component	Example Operational Objectives	Example indicators	Rationale
3. Genetic structure	3.1 Genetic diversity does not change outside acceptable bounds	Frequency of genotypes in the population, effective population size (Ne), number of spawning units	3.1 1 Genetic studies may identify multiple stocks of key commercial species, but not currently monitored.
4. Age/size/sex structure	4.1 Age/size/sex structure does not change outside acceptable bounds (e.g. more than X% from reference structure)	Biomass, numbers or relative proportion in age/size/sex classes Biomass of spawners Mean size, sex ratio	4.1 Covered in general by 1.2 EMO and AMO. Monitoring Survey/recruitment (annual) provides indication of size/sex/species split deviations and spawner survey every second year – but no levels set for unacceptable bounds. Large deviations of the size range of key commercial species have not been observed.
5. Reproductive Capacity	5.1 Fecundity of the population does not change outside acceptable bounds (e.g. more than X% of reference population fecundity)	Recruitment survey (annual) of population	5.1 Covered by 1.2 EMO and AMO. Reproductive capacity in terms of annual recruitment survey may be easier to monitor via changes in age/size/sex structure.
	5.2 Recruitment to the population does not change outside acceptable bounds	Recruitment indices	5.2 Covered by 1.2 EMO and AMO. May be easier to monitor via changes in age/size/sex structure in the fishery. Large deviations of recruitment indices of key commercial species have not been observed.
6. Behaviour /Movement	6.1 Behaviour and movement patterns of the population do not change outside acceptable bounds	Presence of population across space, movement patterns within the population (e.g. attraction to bait, lights)	6.1. Changes to behaviour that are deleterious to the species and populations are to be avoided.

Byproduct and Bycatch

Core objectives:

- Avoid recruitment failure of the byproduct and bycatch species
- Avoid negative consequences for species or population sub-components

Table 2.20: Scoping Document S3. Identification of operational objectives and rationale for BP-BC component. Operational objectives that are eliminated are shaded out. EMO: Existing Management Objective; AMO: Existing AFMA Objective

Sub-component	Example Operational Objectives	Example indicators	Rationale
1. Population size	1.1 No trend in biomass	Biomass, numbers, density, CPUE, yield	1.1 Increases in biomass of the byproduct and bycatch species would be acceptable.

Table 2.20: *(continued)*

Sub-component	Example Operational Objectives	Example indicators	Rationale
	1.2 Maintain biomass above a specified level		1.2. To ensure that population at acceptable level by the assessment. Covered by EMO and AMO that ensures the fishery does not threaten bycatch species.
	1.3 Maintain catch at specified level		1.3. TAE levels are specified. EMO/AMO - annual reviews of all information on bycatch species with the aim of developing species specific bycatch (trigger, trip) limits. These exist for bycatch species.
	1.4 Species do not approach extinction or become extinct		1.4. This is a general objective for all AFMA fisheries as per Fisheries Management Act 1991 (objective (b): and mentions specifically non-target species and the long-term sustainability of the marine environment).
2. Geographic range	2.1 Geographic range of the population, in terms of size and continuity does not change outside acceptable bounds	Presence of population across space	2.1 Not currently monitored. No specific management objective based on the geographic range of byproduct/bycatch species.
3. Genetic structure	3.1 Genetic diversity does not change outside acceptable bounds	Frequency of genotypes in the population, effective population size (Ne), number of spawning units	3.1 Not currently monitored. No reference levels established. No specific management objective based on the genetic structure of bycatch species.
4. Age/size/sex structure	4.1 Age/size/sex structure does not change outside acceptable bounds (e.g. more than X% from reference structure)	Biomass, numbers or relative proportion in age/size/sex classes Biomass of spawners Mean size, sex ratio	4.1 EMO – move on provisions require that if bycatch in any one haul exceeds set limits then the vessel must not use that fishing method within 5 nm of that site for at least 5 days.
5. Reproductive Capacity	5.1 Fecundity of the population does not change outside acceptable bounds (e.g. more than X% of reference population fecundity)	Egg production of population Abundance of recruits, Mean size, sex ratio	5.1 Beyond the generality of the EMO "Fishing is conducted in a manner that does not threaten stocks of byproduct/bycatch species". Reproductive capacity is not currently measured for bycatch/byproduct species (except for bugs) and is largely covered by other objectives.
	5.2 Recruitment to the population does not change outside acceptable bounds	Abundance of recruits	5.2 Beyond the generality of the EMO "Fishing is conducted in a manner that does not threaten stocks of byproduct/bycatch species". Reproductive capacity is not currently measured for bycatch/byproduct species (except for bugs) and is largely covered by other objectives.

Table 2.20: *(continued)*

Sub-component	Example Operational Objectives	Example indicators	Rationale
6. Behaviour /Movement	6.1 Behaviour and movement patterns of the population do not change outside acceptable bounds	Presence of population across space, movement patterns within the population (e.g. attraction to bait, lights)	6.1 Trawling does not appear to attract bycatch species or alter their behaviour and movement patterns, resulting in the attraction of species to fishing grounds.

Protected Species

Core objectives:

- Avoid recruitment failure of protected species
- Avoid negative consequences for protected species or population sub-components
- Avoid negative impacts on the population from fishing

Table 2.21: Scoping Document S3. Identification of operational objectives and rationale for PS component. Operational objectives that are eliminated are shaded out. EMO: Existing Management Objective; AMO: Existing AFMA Objective

Sub-component	Example Operational Objectives	Example indicators	Rationale
1. Population size	1.1 Species do not further approach extinction or become extinct	Biomass, numbers, density	1.1 EMO – This is a general objective for all AFMA fisheries as per Fisheries Management Act 1991 objective (1b): ensuring that the exploitation of fisheries resources and the carrying on of any related activities are conducted in a manner consistent with the principles of ecologically sustainable development); and objective (2): ensuring, through proper conservation and management measures, that the living resources of the AFZ are not endangered by over-exploitation; Therefore the fishery is conducted in a manner that avoids mortality of, or injuries to, endangered, threatened or protected species.
	1.2 No trend in biomass	CPUE, yield	1.2 A positive trend in biomass is desirable for protected species.
	1.3 Maintain biomass above a specified level		1.3 Maintenance of protected species biomass above specified levels not currently a fishery operational objective.
	1.4 Maintain catch at specified level		1.4 The above EMO states 'must avoid mortality/injury to protected species'.
2. Geographic range	2.1 Geographic range of the population, in terms of size and continuity does not change outside acceptable bounds	Presence of population across space, i.e. the Southern Ocean	2.1 Change in geographic range of protected species may have serious consequences e.g. population fragmentation and/or forcing species into sub-optimal areas.

Table 2.21: ***(continued)***

Sub-component	Example Operational Objectives	Example indicators	Rationale
3. Genetic structure	3.1 Genetic diversity does not change outside acceptable bounds	Frequency of genotypes in the population, effective population size (Ne), number of spawning units	3.1 Because population size of protected species is often small, protected species are sensitive to loss of genetic diversity. Genetic monitoring may be an effective approach to measure possible fishery impacts and is currently being studied in the NPF.
4. Age/size/sex structure	4.1 Age/size/sex structure does not change outside acceptable bounds (e.g. more than X% from reference structure)	Biomass, numbers or relative proportion in age/size/sex classes Biomass of spawners Mean size, sex ratio	4.1 Not currently monitored. However, data is being collected on size and/or sex for some TEP species. Monitoring the age/size/sex structure of protected species populations is a useful management tool allowing the identification of possible fishery impacts and that cross-section of the population most at risk.
5. Reproductive Capacity	5.1 Fecundity of the population does not change outside acceptable bounds (e.g. more than X% of reference population fecundity)	Egg production of population	5.1 The reproductive capacity of protected species is of concern because potential fishery induced changes in reproductive ability may have immediate impact on the population size of protected species. This is currently not being done, apart from size data being collected annually.
	5.2 Recruitment to the population does not change outside acceptable bounds	Abundance of recruits	5.2 The reproductive capacity of protected species is of concern because potential fishery induced changes in reproductive ability may have immediate impact on the population size of protected species. This is currently not being done, apart from size data being collected annually.
6. Behaviour /Movement	6.1 Behaviour and movement patterns of the population do not change outside acceptable bounds	Presence of population across space, movement patterns within the population (e.g. attraction to bait, lights)	6.1 Trawling operations may attract protected species and alter behaviour and movement patterns, resulting in the habituation of protected species to fishing vessels. The overall effect may be to prevent juveniles from learning to fend for themselves therefore increasing the animals' reliance on fishing vessels. Subsequently this could substantially increase the risk of injury/mortality by collision, entrapment or entanglement with a vessel or fishing gear.
7. Interactions with fishery	7.1 Survival after interactions is maximised 7.2 Interactions do not affect the viability of the population or its ability to recover	Survival rate of species after interactions Number of interactions, biomass or numbers in population	7.1, 7.2, EMO – The fishery is conducted in a manner that avoids mortality of, or injuries to, endangered, threatened or protected species. Includes the prohibition on discarding offal (bycatch, fish processing waste, unwanted dead fish), gear restrictions and reduced lighting levels to minimise interactions and attraction of the vessel to protected species.

Habitats

Core objectives:

- Avoid negative impacts on quality of environment
- Avoid reduction in the amount and quality of habitat

Table 2.22: Scoping Document S3. Identification of operational objectives and rationale for Habitats component. Operational objectives that are eliminated are shaded out. EMO: Existing Management Objective; AMO: Existing AFMA Objective

Sub-component	Example Operational Objectives	Example indicators	Rationale
1. Water quality	1.1 Water quality does not change outside acceptable bounds	Water chemistry, noise levels, debris levels, turbidity levels, pollutant concentrations, light pollution from artificial light	1.1 EMO control the discharge or discarding of waste (fish offal) and limit lighting on the vessels. MARPOL regulations prohibit discharge of oils, discarding of plastics.
2. Air quality	2.1 Air quality does not change outside acceptable bounds	Air chemistry, noise levels, visual pollution, pollutant concentrations, light pollution from artificial light	2.1 Not currently perceived as an important habitat sub-component, trawling operations not believed to strongly influence air quality.
3. Substrate quality	3.1 Sediment quality does not change outside acceptable bounds	Sediment chemistry, stability, particle size, debris, pollutant concentrations	3.1 EMO – General objective for all AFMA fisheries as per Fisheries Management Act 1991 (objective 1b): ensuring that the exploitation of fisheries resources and the carrying on of any related activities are conducted in a manner consistent with the principles of ecologically sustainable development. The fishery is conducted, in a manner that minimises the impact of fishing operations on benthic habitat.
4. Habitat types	4.1 Relative abundance of habitat types does not vary outside acceptable bounds	Extent and area of habitat types, % cover, spatial pattern, landscape scale	4.1 Trawling activities may result in changes to the local habitat types on fishing grounds.
5. Habitat structure and function	5.1 Size, shape and condition of habitat types does not vary outside acceptable bounds	Size structure, species composition and morphology of biotic habitats	5.1 Trawling activities may result in local disruption to pelagic and benthic processes.

Communities

Core objectives:

- Avoid negative impacts on the composition/function/distribution/structure of the community

Table 2.23: Scoping Document S3. Identification of operational objectives and rationale for Communities component. Operational objectives that are eliminated are shaded out. EMO: Existing Management Objective; AMO: Existing AFMA Objective

Sub-component	Example Operational Objectives	Example indicators	Rationale
1. Species composition	1.1 Species composition of communities does not vary outside acceptable bounds	Species presence/absence, species numbers or biomass (relative or absolute) Richness Diversity indices Evenness indices	1.1 EMO – General objective for all AFMA fisheries as per Fisheries Management Act 1991 (objective 1b): ensuring that the exploitation of fisheries resources and the carrying on of any related activities are conducted in a manner consistent with the principles of ecologically sustainable development) in particular the need to have regard to the impact of fishing activities on non-target species and the long term sustainability of the marine environment.
2. Functional group composition	2.1 Functional group composition does not change outside acceptable bounds	Number of functional groups, species per functional group (e.g. autotrophs, filter feeders, herbivores, omnivores, carnivores)	2.1 The presence/abundance of 'functional group' members may fluctuate widely, however in terms of maintenance of ecosystem processes it is important that the aggregate effect of a functional group is maintained.
3. Distribution of the community	3.1 Community range does not vary outside acceptable bounds	Geographic range of the community, continuity of range, patchiness	3.1 Demersal trawling operations have unknown impacts on the benthos in the fishing grounds. The current MPA and conservation areas reserve large areas of the known habitat types from fishing disturbance.
4. Trophic/size structure	4.1 Community size spectra/trophic structure does not vary outside acceptable bounds	Size spectra of the community Number of octaves, Biomass/number in each size class Mean trophic level Number of trophic levels	4.1 Trawling activities for key/secondary commercial species have the potential to remove a significant component of the predator functional group. Increased abundance of the prey groups may then allow shifts in relative abundance of higher trophic level organisms.
5. Bio- and geo- chemical cycles	5.1 Cycles do not vary outside acceptable bounds	Indicators of cycles, salinity, carbon, nitrogen, phosphorus flux	5.1 Dredging operations not perceived to have a detectable effect on bio and geochecmical cycles, but other activities may e.g., aquaculture.

2.2.5 Hazard Identification (Step 4)

Hazards are the activities undertaken in the process of fishing, and any external activities, which have the potential to lead to harm. The effects of fishery/sub-fishery specific hazards are identified under the following categories:

- capture
- direct impact without capture
- addition/movement of biological material
- addition of non-biological material
- disturbance of physical processes
- external hazards

These fishing and external activities are scored on a presence/absence basis for each fishery/sub-fishery. An activity is scored as a zero if it does not occur and as a one if it does occur. The rationale for the scoring is also documented in detail and must include if/how the activity occurs and how the hazard may impact organisms/habitat.

Scoping Document S4. Hazard Identification Scoring Sheet

This table is completed once for each sub-fishery. Table A.1 provides a set of examples of fishing activities for the effects of fishing to be used as a guide to assist in scoring the hazards.

Fishery name Northern Prawn Fishery - Redleg Banana Prawn sub-fishery

Table 2.24: Hazard identification, score (i.e., presence/absence) and rationale(s) for the Northern Prawn Fishery - Redleg Banana Prawn sub-fishery.

Direct impact of Fishing	Fishing Activity	Presence (1) Absence (0)	Documentation of Rationale
Capture	Bait collection	0	Not required by this fishery method.
	Fishing	1	Capture of organisms due to gear deployment, retrieval and actual fishing.
	Incidental behaviour	0	None occurs
Direct impact without capture	Bait collection	0	Not required for this fishery method.
	Fishing	1	Fishing is most likely to impact benthic habitats and animals as the gear contacts seafloor. Unknown mortality on fish arising from net escapement. Organisms may come into contact with TEDs, BRDs or fishing net.
	Incidental behaviour	0	None occurs
	Gear loss	1	Major gear loss reported rarely and no information on minor components but likely to occur.
	Anchoring/ mooring	1	Vessels might anchor inshore when not fishing. Occurs during daylight hours.
	Navigation/steaming	1	Continuous searching and trawling during the night, some steaming between locations during the day. Steaming/navigation to fishing grounds may result in collisions.
Addition/ movement of biological material	Translocation of species	1	Vessel travel relatively constrained, however, known reports of previous incursion of introduced species: black-striped mussel (Mytilopsis sallei) could be a potential threat.

Table 2.24: *(continued)*

Direct impact of Fishing	Fishing Activity	Presence (1) Absence (0)	Documentation of Rationale
	On board processing	0	No onboard processing occurs
	Discarding catch	1	Discarding is common
	Stock enhancement	0	None occurs
	Provisioning	0	None occurs
	Organic waste disposal	1	Disposal of organic wastes occurs (food scraps and sewage).
Addition of non-biological material	Debris	0	MARPOL regulations via Protection of the Sea (Prevention of Pollution from Ships) Act 1983 prohibits rubbish generated during general fishing vessel operations to be discharged at sea. Rubbish must be collected onboard and disposed of ashore.
	Chemical pollution	0	MARPOL regulations via Protection of the Sea (Prevention of Pollution from Ships) Act 1983 prohibits domestic and operational waste discharge from vessels. Leakage of substances such as fuel, oil, bilge discharges, natural decay of antifouling agents may occur in normal course of operations.
	Exhaust	1	Vessel introduces exhaust into the environment
	Gear loss	1	MARPOL regulations via Protection of the Sea (Prevention of Pollution from Ships) Act 1983 prohibits fishing gear to be discharged at sea. Accidental gear losses of whole nets rare.
	Navigation/ steaming	1	Navigation to and from fishing grounds introduces noise and visual stimuli into the environment. Depth sounders/ acoustic net positioning systems have potential to disturb marine species.
	Activity/ presence on water	1	Vessel introduces noise and visual stimuli into the environment.
Disturb physical processes	Bait collection	0	Bait not required by fishery.
	Fishing	1	Fishing disturbs seabed sediments and structure.
	Boat launching	0	Not applicable. Vessels in fishery come from designated ports.
	Anchoring/ mooring	1	Anchoring/mooring may affect the physical processes in the area where anchors and anchor chains contact the seafloor.
	Navigation/ steaming	1	Vessels may disturb sediments in shallow water.

Table 2.24: *(continued)*

Direct impact of Fishing	Fishing Activity	Presence (1) Absence (0)	Documentation of Rationale
External Hazards	Other capture fishery methods	1	Other fisheries which occur in the same area (e.g. *P. monodon* broodstock; Northern Territory Demersal Fishery; Abalone Managed Fishery (WA); Kimberley Crab Managed fishery (WA); Kimberley Gillnet and Barramundi Fishery (WA); Marine Aquarium Managed fishery (WA); Northern Demersal Managed Fishery (WA); Shark and Demersal Gillnet and Demersal Longline Managed fishery (WA); Specimen Shell Managed fishery (WA)).
	Aquaculture	1	Special permit for *P. monodon* for aquaculture industry
	Coastal development	1	Agricultural runoff could impact shelf fisheries and may affect breeding grounds and nursery areas for some of the species in the fishery.
	Other extractive activities	1	Oil, gas and mining minerals on shore may require the development of port facilities which directly impact the nursery habitat of target species.
	Other non-extractive activities	1	Shipping and sub-marine cables.
	Other anthropogenic activities	1	Recreation boating and fishing leading to coral damage when anchoring possible collisions with turtles and dugongs. Shipping and possible oil spills. Loading and spillage of mine concentrate at sea and in rivers. Catchment issues including alter water flows and hence target species emigration cues; as well as long-term effects on water quality and habitat productivity. Tourist activities and charter fishing occurs in the fishery.

2.2.6 Bibliography (Step 5)

All references used in the scoping assessment are included in the References section. Key documents can be found on the AFMA web page at www.afma.gov.au and include the following:

- *Environment Protection and Biodiversity Conservation Act 1999*. Available at: www.legislation.gov.au/Series/C2004A00485.
- *Northern Prawn Fishery Management (Fishing Capacity) Determination 2021*. Available at: www.legislation.gov.au/Details/F2021L01867
- *Fisheries Management (Northern Prawn Fishery Limited-take and Prohibited-take Species) Direction 2021*. Available at: www.legislation.gov.au/Details/F2021L00253
- *Fisheries Management (Northern Prawn Fishery Seasonal Closures) Direction 2021*. Available at: www.legislation.gov.au/Details/F2021L00250
- *Fisheries Management (Northern Prawn Fishery Permanent Closures) Direction 2021*. Available at: www.legislation.gov.au/Details/F2021L00254
- *Fisheries Management (Northern Prawn Fishery Gear Requirements) Direction 2021*. Available at: www.legislation.gov.au/Details/F2021L00251

- *Northern Prawn Fishery Management Plan 1995*. Available at: www.legislation.gov.au/Details/F2012C00160 *-An arrangement between the Commonwealth and the Northern Territory in relation to the Northern Prawn Fishery*. Commonwealth of Australia Gazette No. GN4, 1 February 1995 pp316-320, Available at: www.legislation.gov.au/content/HistoricGazettes1995. Note: This OCS arrangement replaced an OCS arrangement made on 14 April 1988 GN13 S109 p2, Available at: www.legislation.gov.au/content/HistoricGazettes1988
- *Arrangement between the Commonwealth and the state of Queensland in relation to the Northern Prawn Fishery* (Commonwealth of Australia Gazette14 April 1988 GN13 S109 pp7-8). Available at: www.legislation.gov.au/content/HistoricGazettes1988
- *Arrangement between the Commonwealth and the state of Western Australia in relation to the Northern Prawn Fishery*.Commonwealth of Australia Gazette 14 April 1988 GN13 S109 pp8-9). Available at: www.legislation.gov.au/content/HistoricGazettes1988
- *FAO Code of Conduct for Responsible Fisheries*. Available at: www.fao.org/docrep/005/v9878e/v9878e00.htm.
- *United Nations Convention Law of the Sea*. Available at: www.un.org/depts/los/convention_agreements/texts/unclos/unclos_e.pdf.
- *Fisheries Management Regulations 2019*. Available at: www.legislation.gov.au/Details/F2021C01167.
- *Memorandum of Understanding between the Australian Fisheries Management Authority and the Department of the Environment and Heritage for the reporting of fisheries interactions with protected species under the Environment and Biodiversity Conservation Act 1999*. Available at: www.afma.gov.au/sites/default/files/uploads/2010/06/mou.pdf?acsf_files_redirect.
- *Declaration of the Harvest Operations of the Northern Prawn Fishery as an approved wildlife trade operation*, December 2018. Available at: www.awe.gov.au/environment/marine/fisheries/commonwealth/northern-prawn.

Other publications that provided information include

- ABARES Fishery Status Reports
- Strategic Plans

Further details and data on the fishery and on the processes and methods used for the assessment can also be found in the appendices A to C.

2.2.7 Decision Rules to Move to Level 1 (Step 6)

Any hazards that are identified at Step 4 Hazard Identification as occurring in the fishery are carried forward for analysis at Level 1.

In this case, 15 out of 26 possible internal activities were identified as occurring in this fishery. All six external activities were identified. Thus, a total of 21 activity-component scenarios will be considered at Level 1 for Habitats and Communities.

3 Level 1: Scale, Intensity and Consequence Analysis (SICA)

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

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

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

3.1 Record the Hazard Identification Score (Absence (0) Presence (1) Scores) Identified at Step 3 in the Scoping Level onto the SICA Document (Step 1)

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

3.2 Score Spatial Scale of Activity (Step 2)

The greatest spatial extent must be used for determining the spatial scale score for each identified hazard (Table 3.1). For example, if fishing (e.g., capture by longline) takes place within an area of 200 nm by 300 nm, then the spatial scale is scored as 4. The score is then recorded onto the SICA Document and the rationale documented.

Table 3.1: Spatial scale score of activity.

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

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

3.3 Score Temporal Scale of Activity (Step 3)

The highest frequency must be used for determining the temporal scale score for each identified hazard (Table 3.2). If the fishing activity occurs daily, the temporal scale is scored as 6. If oil spillage occurs about once per year, then the temporal scale of that hazard scores a 3. The score is then recorded onto the SICA Document and the rationale documented.

Table 3.2: Temporal scale score of activity.

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

It may be more logical for some activities to consider the aggregate number of days that an activity occurs. For example, if the activity “fishing” was undertaken by 10 boats during the same 150 days of the year, the score is 4. If the same 10 boats each spend 30 non-overlapping days fishing, the temporal scale of the activity is a sum of 300 days, indicating that a score of 6 is appropriate. In the case where the activity occurs over many days, but only every 10 years, the number of days by the number of years in the cycle is used to determine the score. For example, 100 days of an activity every 10 years averages to 10 days every year, so a score of 3 is appropriate.

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

3.4 Choose the Sub-component Most Likely to be Affected by Activity (Step 4)

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

3.5 Choose the Unit of Analysis Most Likely to be Affected by Activity and to Have Highest Consequence Score (Step 5)

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

3.6 Select the Most Appropriate Operational Objective (Step 6)

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

3.7 Score the Intensity of the Activity for the Component (Step 7)

The score for the intensity of an activity considers the direct impacts in line with the categories shown in the conceptual model (Figure 1.2: capture, direct impact without capture, addition/movement of biological material, addition of non-biological material, disturbance to physical processes, external hazards). The intensity of the activity is judged based on the scale of the activity, its nature and extent. Activities are scored as per intensity scores in Table 3.3.

Table 3.3: Intensity score of activity (Modified from Fletcher et al., 2002).

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

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

3.8 Score the Consequence of Intensity for that Component (Step 8)

The consequence of the activity is a measure of the likelihood of not achieving the operational objective for the selected sub-component and unit of analysis. It considers the flow-on effects of the direct impacts from Step 7 for the relevant indicator (e.g., decline in biomass below the selected threshold due to direct capture). Activities are scored as per consequence scores defined in Table 3.4. A more detailed description of the consequences at each level for each component (key/secondary commercial, bycatch and byproduct, protected species, habitats, and communities) is provided as a guide for scoring the consequences of the activities in the description of consequences table (see Tables B.1 to B.5 in Appendix B).

The score should be based on existing information and/or the expertise of the risk assessment group. The rationale for assigning each consequence score must be documented. The conceptual model may be used to link impact to consequence by showing the pathway that was considered. In the absence of agreement or information, the highest score (worst-case scenario) considered plausible is applied to the activity.

Table 3.4: Consequence score for ERAEF activities (Modified from Fletcher et al., 2002).

Level	Score	Description
Negligible	1	Impact unlikely to be detectable at the scale of the stock/habitat/community
Minor	2	Minimal impact on stock/habitat/community structure or dynamics
Moderate	3	Maximum impact that still meets an objective (e.g., sustainable level of impact such as full exploitation rate for a target species).
Major	4	Wider and longer term impacts (e.g., long-term decline in CPUE)
Severe	5	Very serious impacts now occurring, with relatively long time period likely to be needed to restore to an acceptable level (e.g., serious decline in spawning biomass limiting population increase).
Intolerable	6	Widespread and permanent/irreversible damage or loss will occur-unlikely to ever be fixed (e.g., extinction)

3.9 Record Confidence/Uncertainty for the Consequence Scores (Step 9)

The information used at this level is qualitative and each step is based on expert (fishers, managers, conservationists, scientists) judgment. The confidence rating for the consequence score is rated as 1 (low confidence) or 2 (high confidence) for the activity/component (Table 3.5). The score is recorded on the SICA Document and the rationale documented. The confidence will reflect the levels of uncertainty for each score at steps 2, 3, 7 and 8.

Table 3.5: Description of Confidence scores for Consequences. The confidence score appropriate to the rationale is used, and documented on the SICA Document.

Confidence	Score	Rationale for the confidence score
Low	1	Data exists, but is considered poor or conflicting No data exists Disagreement between experts
High	2	Data exists and is considered sound Consensus between experts Consequence is constrained by logical consideration

3.10 Document Rationale for Each of the Above Steps (Step 10)

The rationale forms a logical pathway to the consequence score. It is provided for each choice at each step of the SICA.

SICA steps 1-10. Tables of descriptions of consequences for each component and each sub-component provide a guide for scoring the level of consequence (see Tables above).

3.10.1 Key/Secondary Commercial Species Component

Table 3.6: Level 1 (SICA) Document L1.1
Key commercial/secondary commercial species. Commercial bait species are also included here.

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
Capture	Bait collection	0									
	Fishing	1	4	4	Population size	Redleg Banana Prawn (*Penaeus indicus*)	1.2	3			There are no key or secondary commercial species that are not assessed. No further action required for this activity.
	Incidental behaviour	0									
Direct impact without capture	Bait collection	0									
	Fishing	1	4	4	Population size	Redleg Banana Prawn (*Penaeus indicus*)	1.2	3	1	1	Approximately 1.15% of the total Joseph Bonaparte Gulf (JBG) area was fished across the 2017-21 assessment period (AFMA logbook data). Population size likely to be affected before major changes in other sub-components due to damaging/ injuring the prawns leading to death. The Redleg Banana Prawn is the most likely species to be affected by this activity. Intensity: moderate, approximately 4 hours, highly localised interannually. Consequence: negligible, as fishing does not impact an additional component of the population that is not caught. Confidence: low, as data unavailable for direct impacts without capture.
	Incidental behaviour	0									

Table 3.6: *(continued)*

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
	Gear loss	1	1	1	Population size	Redleg Banana Prawn (*Penaeus indicus*)	1.2	2	1	2	Approximately 1.15% of the total Joseph Bonaparte Gulf (JBG) area was fished across the 2017-21 assessment period (AFMA logbook data). Gear loss approximately less than 5 times per year. Population size likely to be affected before major changes in other sub-components due to entrapment of individuals. The Redleg Banana Prawn is the most likely species to be affected. Intensity: minor, as gear loss without capture is rare and interaction of Redleg Banana Prawn with gear remote. Consequence: negligible, as impact unlikely to be measurable. Confidence: high, as it is known that very little gear is lost, and interaction with Redleg Banana Prawn is considered unlikely.
	Anchoring/ mooring	1	3	1	Population size	Redleg Banana Prawn (*Penaeus indicus*)	1.2	1	1	2	Anchoring occurs sometime in the NPF Redleg Banana Prawn sub-fishery. Anchoring may occur over coral reefs, where Redleg Banana Prawns are not abundant. Population size likely to be affected before major changes in other sub-components due to impact with the anchor. The Redleg Banana Prawn is the most likely species to be affected. Intensity: negligible, as the likelihood of detection is negligible and anchoring has a very small footprint. Consequence: negligible, as impact unlikely to be measurable. Confidence: high, as it's very unlikely for Redleg Banana Prawns to be negatively affected by anchoring/ mooring.

Table 3.6: *(continued)*

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
	Navigation/ steaming	1	4	4	Population size	Redleg Banana Prawn (*Penaeus indicus*)	1.2	1	1	2	Navigation/ steaming occurs in the JBG and has the potential to cause collision with animals. Population size likely to be affected before major changes in other sub-components due to injury/ death from collision. The Redleg Banana Prawn is the most likely species to be affected. Intensity: negligible, as Redleg Banana Prawns are demersal and will not collide with a vessel and this activity is thus likely to be undetectable. Consequence: negligible, as impact likely to be undetectable on the population size. Confidence: high, as it is known that prawns and vessels do not collide.

Table 3.6: ***(continued)***

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
Addition/ movement of biological material	Translocation of species	1	5	4	Population size	Redleg Banana Prawn (*Penaeus indicus*)	1.2	2	1	1	Translocation of species may occur in the JBG, as larvae through ballast water or as adults via hull fouling, gear or anchor entanglement, and has the potential to establish as the majority of fishing areas and ports used are of similar depths. Three species of introduced marine organisms have the potential to in the NPF - mussel (*Perna viridis*), limpet (*Crepidula fornicata*) and black-striped mussel (*Mytilopsis sallei*), and establish precedence for translocation to occur in the NPF area. A massive infestation of the latter species, black-striped mussel was discovered in Cullen Bay Marina (Darwin) in March 1999 and rapidly eradicated (Summerson et al., 2013). Population size likely to be affected before major changes in other sub-components, by introducing a foreign competitor or through transmission of disease, but also directly or indirectly through changing trophic linkages. No mitigating measures are currently in place. The Redleg Banana Prawn is the most likely species to be affected. Intensity: considered minor at present. Consequence: minor, as while there is the potential to alter population size and potentially trophic structure of the community (based on its incursion in 1999 of black-striped mussel), it was quickly eradicated. Confidence: low, as there is no data to show the spread of the species and the likely impact on population size of this community. Also, there is no data exists to refute the NPF risk.
	On board processing	0									

Table 3.6: *(continued)*

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
	Discarding catch	1	4	4	Population size	Redleg Banana Prawn (*Penaeus indicus*)	1.2	3	2	1	Discarding occurs during fishing operations in the JBG. Population size likely to be affected before major changes in other sub-components if scavengers and predators (e.g., sharks and trevallies) are attracted to prawn habitat due to the addition of discards, and in turn prey upon prawns. The Redleg Banana Prawn is the most likely species to be affected by this activity. Intensity: moderate, as high volumes of bycatch occur and are discarded in localised areas. Consequence: minor, but could change when fishery discard estimates become available. The fishery discards diverse bycatch but localised and may cause more permanent changes in population size of scavenger species. Confidence: low, as discard estimates were unavailable at the time of this assessment.
	Stock enhancement	0									
	Provisioning	0									
	Organic waste disposal	1	4	4	Behaviour/ movement	Redleg Banana Prawn (*Penaeus indicus*)	6.1	1	1	2	Approximately 1.15% of the total Joseph Bonaparte Gulf (JBG) area was fished across the 2017-21 assessment period (AFMA logbook data). Organic waste disposal is possible over this scale. Behaviour/ movement likely to be affected before major changes in other sub-components as a result of the attraction (e.g., food scraps) or repulsion (e.g., raw sewage) of the organic waste. The Redleg Banana Prawn is the most likely species to be affected by this activity. Intensity: negligible, as each disposal event wouldn't have a detectable change on behaviour/ movement. Consequence: negligible, as impact is unlikely to be detectable. Confidence: high, because expert consensus is that general fishing waste disposal is unlikely to impact the behaviour/ movement of demersal prawns.

Table 3.6: *(continued)*

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
Addition of non-biological material	Debris	0									
	Chemical pollution	0									
	Exhaust	1	4	4	Behaviour/ movement	Redleg Banana Prawn (*Penaeus indicus*)	6.1	1	1	2	Approximately 1.15% of the total Joseph Bonaparte Gulf (JBG) area was fished across the 2017-21 assessment period (AFMA logbook data). Exhaust emissions are possible over this scale. Behaviour/ movement likely to be affected before major changes in other sub-components due to the introduction of the exhaust emissions. The Redleg Banana Prawn is the most likely species to be affected by this activity. Intensity: negligible, because although the hazard could occur over a large range/ scale, exhaust wouldn't have a detectable change on behaviour/ movement. Consequence: negligible, as the impact of exhaust emissions is unlikely to be detectable. Confidence: high, because expert consensus is that exhaust is unlikely to impact the behaviour/ movement of demersal prawns.
	Gear loss	1	1	1	Population size	Redleg Banana Prawn (*Penaeus indicus*)	1.2	2	1	2	Approximately 1.15% of the total Joseph Bonaparte Gulf (JBG) area was fished across the 2017-21 assessment period (AFMA logbook data). Gear loss is rare. Retrieval is usually attempted and possible in shallow depths. Population size likely to be affected before major changes in other sub-components due to entrapment of individuals. The Redleg Banana Prawn is the most likely species to be affected by this activity. Intensity: minor, as lost gear would rarely interact with prawns. Consequence: negligible, as the impact is unlikely to be detectable. Confidence: high, because it is known that very little gear is lost, and interaction with prawns is considered unlikely.

Table 3.6: *(continued)*

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
	Navigation/ steaming	1	4	4	Behaviour and Movement	Redleg Banana Prawn (*Penaeus indicus*)	6.1	1	1	2	Navigation to and from fishing grounds and steaming between trawls occurs during each season in the JBG and introduces noise and visual stimuli into the environment. Behaviour and movement likely to be affected before major changes in other sub-components due to the repellent nature of the noise and visual stimuli. The Redleg Banana Prawn is the most likely species to be affected by this activity. Intensity: negligible, as Redleg Banana Prawns are a demersal species and unlikely to be affected by the shipping which is localised. Consequence: negligible, as any impact is unlikely to be detectable. Confidence: high, as no research has shown prawns are affected by noise and visual stimuli introduced into the environment by vessels.
	Activity/ presence on water	1	4	4	Behavior and Movement	Redleg Banana Prawn (*Penaeus indicus*)	6.1	1	1	2	Activity/ presence on water occurs in the JBG during fishing for about four months annually. Fishing occurs during the day and night. Behaviour and movement likely to be affected before major changes in other sub-components due to the repellent nature of the noise and visual stimuli. The Redleg Banana Prawn is the most likely species to be affected by this activity. Intensity: negligible, as Redleg Banana Prawns are a demersal species and unlikely to be affected. Consequence: negligible, as any impact is unlikely to be detectable. Confidence: high, as no research has shown prawns are affected by noise and visual stimuli introduced into the environment by vessels.
Disturb physical processes	Bait collection	0									

Table 3.6: *(continued)*

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
	Fishing	1	4	4	Population size	Redleg Banana Prawn (*Penaeus indicus*)	1.2	3	2	1	Disturbance of physical processes may occur in the JBG for about four months annually, with the action of direct disturbance to the seafloor. Population size likely to be affected before major changes in other sub-components due to trawl gear disturbing the seafloor habitat of benthic organisms. The Redleg Banana Prawn is the most likely species to be affected by this activity. Intensity: moderate, as although fishing has a severe impact, it is localized due to suitable habitat for trawling. Consequence: minor, as disturbance of sediment will have a minimal impact on stocks. Confidence: low, as no data available.
	Boat launching	0									
	Anchoring/ mooring	1	3	1	Population size	Redleg Banana Prawn (*Penaeus indicus*)	1.2	1	1	2	Anchoring occurs sometimes in the NPF Redleg Banana Prawn sub-fishery. Anchoring may occur over reefs, where Redleg Banana Prawns are not abundant. Population size likely to be affected before major changes in other sub-components due to the anchor disturbing the seafloor. The Redleg Banana Prawn is the most likely species to be affected by this activity. Intensity: negligible, as vessels don't often anchor and anchoring has a very small footprint. Consequence: negligible, as impact unlikely to be measurable. Confidence: high, because expert consensus is that interaction with Redleg Banana Prawn is considered unlikely.

Table 3.6: *(continued)*

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
	Navigation/ steaming	1	4	4	Behaviour/ movement	Redleg Banana Prawn (*Penaeus indicus*)	6.1	1	1	2	Navigation/ steaming occurs in the JBG for about four months annually and creates turbulent action from the propellers. Behaviour and movement likely to be affected before major changes in other sub-components due to the repellent nature of this turbulence. The Redleg Banana Prawn is the most likely species to be affected by this activity. Intensity: negligible, as Redleg Banana Prawns are demersal and unlikely to be affected by the shipping which is localised. Consequence: negligible, as impact unlikely to be measurable. Confidence: high, because expert consensus is that interaction with prawns is considered unlikely.

Table 3.6: *(continued)*

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
External Impacts	Other fisheries: Northern Territory Demersal Fishery; Abalone Managed Fishery (WA); Kimberley Crab Managed fishery (WA); Kimberley Gillnet and Barramundi Fishery (WA); Marine Aquarium Managed fishery (WA); Northern Demersal Managed Fishery (WA); Shark and Demersal Gillnet and Demersal Longline Managed fishery (WA); Specimen Shell Managed fishery (WA).	1	3	3	Population size	Redleg Banana Prawn (*Penaeus indicus*)	1.2	2	2	2	Fishing occurs by other fisheries including the *P. monodon* broodstock special permit in the NPF managed region including the JBG. Population size likely to be affected before major changes in other sub-components due to the removal of individuals. The Redleg Banana Prawn is the most likely species to be affected by this activity. Intensity: minor, as prawns are rarely caught in other fisheries targeting other species in different habitats within the JBG. Also, *P. monodon* broodstock collection is likely to capture many commercial prawns due to the gear type used. Consequence: minor, as minimal impact on stock. Confidence: high, as catch data from other fisheries are recorded.

Table 3.6: ***(continued)***

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
	Aquaculture	1	1	1	Population size	Redleg Banana Prawn (*Penaeus indicus*)	1.2	2	2	2	Boat licenses exist for capturing *P. monodon* broodstock for aquaculture. Broodstock are currently captured around Tiwi Islands, Darwin and in the JBG. Population size likely to be affected before major changes in other sub-components due to the removal of individuals. The Redleg Banana Prawn is the most likely species to be affected by this activity. Intensity: minor, as fishing for this broodstock only occurs at a few restricted locations. Consequence: minor, as minimal impact on Redleg Banana Prawn stock. Confidence: high, as catch data exists from *P. monodon* broodstock collection.
	Coastal development	1	1	1	Behaviour/ movement	Redleg Banana Prawn (*Penaeus indicus*)	6.1	2	2	1	Coastal development occurs in small pockets surrounding Cambridge Gulf and town Wyndham. Behaviour and movement likely to be affected before major changes in other sub-components due to altered water/ habitat quality. The Redleg Banana Prawn (which are coastal and occur in estuaries during its early life stages; (Kenyon et al., 2004) is the most likely species to be affected by this activity. Intensity: minor, as localised at few locations of which impact is likely undetectable. Consequence: minor, as minimal impact of run-off from farming activities on behaviour/ movement. Confidence: low, as there is little data available to demonstrate the effects of coastal development on prawn behaviour/ movement.

Table 3.6: *(continued)*

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
	Other extractive activities	1	3	6	Behaviour/ movement	Redleg Banana Prawn (*Penaeus indicus*)	6.1	3	2	1	Exploration for oil, gas, diamonds and gold is underway or proposed throughout JBG. Behaviour and movement likely to be affected before major changes in other sub-components due to movement away from the exploratory activity e.g., drilling. The Redleg Banana Prawn is the most likely species to be affected by this activity. Intensity: moderate, as exploration activity probably occurs at a greater scale than the current areas mostly fished. Consequence: minor, as effect localised and changes to behaviour/ movement likely to be undetectable. Confidence: low, as effects are unknown.
	Other non extractive activities	1	5	6	Behaviour/ movement	Redleg Banana Prawn (*Penaeus indicus*)	6.1	2	1	2	Shipping occurs in the JBG. Behaviour and movement likely to be affected before major changes in other sub-components due an avoidance reaction. The Redleg Banana Prawns are the most likely target species to be affected by this activity. Intensity: minor, as shipping occurs in the JBG and shipping routes cross the fishery area yet are concentrated near ports, e.g., Darwin, which is outside the JBG. Consequence: negligible, as impact unlikely to be measurable. Confidence: high, because expert consensus is that interaction with Redleg Banana Prawns is considered unlikely.

Other anthropogenic activities	1	3	6	Behaviour/ movement	Redleg Banana Prawn (*Penaeus indicus*)	6.1	2	2	1	Recreational boating/ fishing and tourism occurs throughout the year in the JBG, but particularly inshore and near major towns, however, southern part of JPG is very remote. Behaviour and movement likely to be affected before major changes in other sub-components due an avoidance reaction. The Redleg Banana Prawn is the most likely species to be affected by this activity. Intensity: minor, as these activities occur in restricted locations. Consequence: minor, as impact of recreational fishing probably minimal on target species population. Confidence: low, as data unavailable for effects of recreational fishing on Redleg Banana Prawns.

3.10.2 Byproduct/Bycatch Species Component

Table 3.7: Level 1 (SICA) Document L1.2 - Byproduct and Bycatch Component.

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
Capture	Bait collection	0									
	Fishing	1	4	4	Population size	Plain Maskray (*Neotrygon annotata*)	1.2	3	3	2	Approximately 1.15% of the total Joseph Bonaparte Gulf (JBG) area was fished across the 2017-21 assessment period (AFMA logbook data). Population size likely to be affected before major changes in other sub-components due to damaging/ injuring the species. The Plain Maskray is considered as the most vulnerable species to be affected by this activity as it comprises the most of the chondrichthyan species caught in the JBG in numbers and second largest discarded species recorded by weight; is an endemic species; although discarded, they are unlikely to survive encounters with trawling gear; they have a limited distribution of which approximately one-fourth overlaps with JBG; suitable habitat overlaps with suitable trawling habitat; low reproductive rate; and they have near threatened IUCN status. Intensity: moderate, as fishing has a severe impact, it is localized due to suitable habitat for trawling yet which overlaps with species habitat. Consequence: moderate, as this may impact on the stock. Confidence: high, as data shows these species are caught in high numbers compared to other chondrichthyan species in the JBG.
	Incidental behaviour	0									
Direct impact without capture	Bait collection	0									

Table 3.7: *(continued)*

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
	Fishing	1	4	4	Population size	Black Jewfish (*Protonibea diacanthus*)	1.2	3	2	1	Approximately 1.15% of the total Joseph Bonaparte Gulf (JBG) area was fished across the 2017-21 assessment period (AFMA logbook data). Population size likely to be affected before major changes in other sub-components due to removal of individuals. The Black Jewfish is the most likely species to be affected as they are large enough to escape via the TED but is likely to have a high mortality rate and there is already concern about their population status. Intensity: moderate, approximately four hours, highly localised interannually. Consequence: minor, as this has a minimal impact on the stock. Confidence: low, as it is unknown what their survivability is after escapement from the TED.
	Incidental behaviour	0									
	Gear loss	1	1	1	Population size	Plain Maskray (*Neotrygon annotata*)	1.2	2	1	2	Approximately 1.15% of the total Joseph Bonaparte Gulf (JBG) area was fished across the 2017-21 assessment period (AFMA logbook data). Gear loss is rare. Retrieval is usually attempted and possible in shallow depths. Population size likely to be affected before major changes in other sub-components due to entrapment of individuals. The Plain Maskray is considered to be the most vulnerable species as it makes up most of chondrichthyan species caught in the JBG in numbers and would be expected to be in the net if gear loss occurred. Intensity: minor, as gear loss is rare. Consequence: negligible, as impact unlikely to be measurable. Confidence: high, as it is known that very little gear is lost.

Table 3.7: *(continued)*

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
	Anchoring/ mooring	1	3	1	Population size	Mudbug (*Thenus parindicus*)	1.2	1	2	1	Anchoring occurs sometimes in the NPF Redleg Banana Prawn sub-fishery. Anchoring may occur over reefs. Population size likely to be affected before major changes in other sub-components due to impact with the anchor. The Mudbug (which are a byproduct of the Redleg Banana Prawn sub-fishery) is the most likely species to be affected due to injury/ death from impact with the anchor. Intensity: negligible, as vessels don't often anchor and anchoring has a very small footprint. Consequence: minor, as this would have a minimal impact on the stock. Confidence: low, as it is unknown how often anchors come in contact with bugs.
	Navigation/ steaming	1	4	4	Population size	Whitecheek shark (*Carcharhinus coatesi*)	1.2	1	1	2	Navigation/ steaming occurs in the JBG and has the potential to cause collision with animals. Population size likely to be affected before major changes in other sub-components due to injury/ death from collision. The Whitecheek Shark is the most likely species to be affected as they can swim at the water surface. Intensity: negligible, as sharks are generally highly mobile and able to move out of a vessel's path. Consequence: negligible, as any impact is unlikely to be detectable. Confidence: high, as it is unlikely that the sharks and vessels collide.

Table 3.7: ***(continued)***

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
Addition/ movement of biological material	Translocation of species	1	5	4	Population size	Saucer Scallop; Mud Scallop (*Amusium pleu-ronectes*)	1.2	2	2	1	Translocation of species may occur in the JBG, as larvae through ballast water or as adults via hull fouling, gear or anchor entanglement, and has the potential to establish as the majority of fishing areas and ports used are of similar depths. Three species of introduced marine organisms have the potential to in the NPF - *Perna viridis* (mussel), limpet (*Crepidula fornicata*) and black-striped mussel (*Mytilopsis sallei*), and establish precedence for translocation to occur in the JBG area. A massive infestation of the latter species, black-striped mussel was discovered in Cullen Bay Marina (Darwin) in March 1999 and rapidly eradicated (Summerson et al., 2013). Population size likely to be affected before major changes in other sub-components, by introducing a foreign competitor or through transmission of disease, but also directly or indirectly through changing trophic linkages. No mitigating measures are currently in place. The Saucer Scallop is the most likely bycatch/ byproduct species to be at risk as they could easily be out-competed by other introduced bivalves for food and habitat. Intensity: considered, minor at present. Consequence: minor, as although there is the potential for impacts to significantly alter population size, the previously introduced pest was quickly eradicated. Confidence: low, as it not known to what extent trawling in the JBG contributes to the spread of the species. No data exists to refute this risk.
	On board processing	0									

Table 3.7: *(continued)*

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
	Discarding catch	1	4	4	Behaviour/ movement	Whitecheek Shark (*Carcharhinus coatesi*)	6.1	3	2	2	Discarding (of bycatch) occurs during fishing operations in the JBG. Behaviour and movement likely to be affected before major changes in other sub-components if scavengers and predators (e.g., sharks and trevallies) are attracted due to the addition of discards. Discarding catch is considered most likely to affect the behaviour/ movement of the Whitecheek Shark as they are in the area (regularly caught in trawl nets) through the attraction of discards. Intensity: moderate, as high volumes of bycatch occur and are discarded in localised areas. Consequence: minor, as these changes are likely to be short-lived. Confidence: high, as the effects of discarding of bycatch is well documented in the NPF.
	Stock enhancement	0									
	Provisioning	0									
	Organic waste disposal	1	4	4	Behaviour/ movement	Whitecheek Shark (*Carcharhinus coatesi*)	6.1	1	1	2	Approximately 1.15% of the total Joseph Bonaparte Gulf (JBG) area was fished across the 2017-21 assessment period (AFMA logbook data). Organic waste disposal is possible over this scale. Behaviour/ movement likely to be affected before major changes in other sub-components as a result of the attraction (e.g., food scraps) or repulsion (e.g., raw sewage) of the organic waste. The Whitecheek Shark is the most likely species to be at risk as they would be attracted or repelled from the above organic waste. Intensity: negligible, as a disposal event wouldn't have a detectable change on behaviour/ movement. Consequence: negligible, as impact is unlikely to be detectable. Confidence: high, because expert consensus is that general fishing waste disposal is unlikely to impact the behaviour/ movement of sharks.

Table 3.7: *(continued)*

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
Addition of non-biological material	Debris	0									
	Chemical pollution	0									
	Exhaust	1	4	4	Behaviour/ movement	Whitecheek Shark (*Carcharhinus coatesi*)	6.1	1	1	2	Approximately 1.15% of the total Joseph Bonaparte Gulf (JBG) area was fished across the 2017-21 assessment period (AFMA logbook data). Exhaust emissions possible over this scale. Behaviour/ movement likely to be affected before major changes in other sub-components due to the deterrent nature of the exhaust emissions. The Whitecheek Shark is the most likely bycatch/ byproduct species to be affected as they are closest to the water surface where pollutants will first affect. Intensity: negligible, because although the hazard could occur over a large range/ scale, exhaust wouldn't have a detectable change on behaviour/ movement. Consequence: negligible, as the impact of exhaust emissions is unlikely to be detectable. Confidence: high, because expert consensus is that exhaust was considered unlikely to impact the behaviour/ movement of highly mobile species.

Table 3.7: *(continued)*

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
	Gear loss	1	1	1	Population size	A Swimmer Crab (*Charybdis cal-lianassa*)	1.2	2	1	2	Approximately 1.15% of the total Joseph Bonaparte Gulf (JBG) area was fished across the 2017-21 assessment period (AFMA logbook data). Gear loss is rare. Retrieval is usually attempted and possible in shallow depths. Population size likely to be affected before major changes in other sub-components due to entrapment of individuals. This Swimmer Crab species (most commonly caught portunid crab) is the most likely bycatch/ byproduct species to be at risk as their body structure causes them to become easily trapped in ghost nets. Intensity: minor, as lost gear would rarely interact with crabs. Consequence: negligible, as the impact is unlikely to be detectable. Confidence: high, because it is known that very little gear is lost, so interaction with crabs is considered unlikely.
	Navigation/ steaming	1	4	4	Behaviour/ movement	Whitecheek shark (*Car-charhinus coatesi*)	6.1	1	1	1	Navigation to and from fishing grounds and steaming between trawls occurs during each season in the JBG and introduces noise and visual stimuli into the environment. Behaviour and movement likely to be affected before major changes in other sub-components due to the repellent nature of the noise and visual stimuli. The Whitecheek Shark is the most likely species to be affected as they can swim at the water surface. Intensity: negligible, as sharks are highly mobile and easily move away from vessels. Consequence: negligible, as any impact is unlikely to be detectable. Confidence: low, as it not known to what impact navigation/ steaming in the JBG has on sharks.

Table 3.7: ***(continued)***

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
	Activity/ presence on water	1	4	4	Behaviour/ movement	Whitecheek Shark (*Carcharhinus coatesi*)	6.1	1	1	1	Activity/ presence on water occurs in the JBG during fishing for about four months annually. Fishing occurs during the day and night. Behaviour and movement likely to be affected before major changes in other sub-components due to the repellent nature of the noise and visual stimuli. The Whitecheek Shark are the most likely species to be affected as they can swim at the water surface. Intensity: negligible, as sharks are highly mobile and easily move away from vessels. Consequence: negligible, as any impact is unlikely to be detectable. Confidence: low, as it not known to what extent noise and visual stimuli from fishing has on sharks.
Disturb physical processes	Bait collection	0									
	Fishing	1	4	4	Population size	Stephenson's Mantis Shrimp (*Harpiosquilla stephensoni*)	1.2	3	2	1	Disturbance of physical processes may occur in the JBG for across the fishing season, with the action of direct disturbance to the seafloor. Population size likely to be affected before major changes in other sub-components due to trawl gear disturbing the seafloor habitat of benthic organisms. The Stephenson's Mantis Shrimp (larger shrimp usually found near banana schools) is the most likely bycatch/ byproduct species to be affected as the ground-chain would disturb their burrows and remove their food (small fish/ crustaceans) from the benthos. Intensity: moderate, as although fishing has a severe impact, it is localized due to suitable habitat for trawling. Consequence: minor, as disturbance of sediment will have a minimal impact on stocks. Confidence: low, as no data is available.
	Boat launching	0									

Table 3.7: *(continued)*

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
	Anchoring/ mooring	1	3	1	Population size	Stephenson's Mantis Shrimp (*Harpiosquilla stephensoni*)	1.2	1	1	2	Anchoring occurs sometimes in the NPF Redleg Banana Prawn sub-fishery. Anchoring may occur over reefs. Population size likely to be affected before major changes in other sub-components due to the anchor disturbing the seafloor. The Stephenson's Mantis Shrimp (larger shrimp usually found near banana schools) is the most likely bycatch/ byproduct species to be affected as the anchor would disturb their burrows. Intensity: negligible, as vessels don't often anchor and anchoring has a very small footprint. Consequence: negligible, as impact unlikely to be measurable. Confidence: high, because expert consensus is that interaction with Stephenson's mantis shrimp is considered unlikely.
	Navigation/ steaming	1	4	4	Behaviour/ movement	Whitecheek Shark (*Carcharhinus coatesi*)	6.1	1	1	1	Navigation/ steaming occurs in the JBG for about four months annually and creates turbulent action from the propellers. Behaviour and movement likely to be affected before major changes in other sub-components due to the repellent nature of this turbulence. The Whitecheek Shark is the most likely bycatch/ byproduct species to be affected as they swim at the water surface. Intensity: negligible, as sharks are highly mobile and unlikely to be affected by the shipping which is localised. Consequence: negligible, as any impact is unlikely to be detectable. Confidence: low, as it not known to what extent navigation/ steaming in the JBG has on sharks.

Table 3.7: *(continued)*

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
External Impacts	Other fisheries: Northern Territory Demersal Fishery; Abalone Managed Fishery (WA); Kimberley Crab Managed fishery (WA); Kimberley Gillnet and Barramundi Fishery (WA); Marine Aquarium Managed fishery (WA); Northern Demersal Managed Fishery (WA); Shark and Demersal Gillnet and Demersal Longline Managed fishery (WA); Specimen Shell Managed fishery (WA).	1	3	3	Population size	Plain Maskray (*Neotrygon annotata*)	1.2	3	3	2	Several other fisheries border or overlap the area fished for Redleg Banana Prawns in the JBG. Population size likely to be affected before major changes in other sub-components due to the removal of individuals. The Plain Maskray (most commonly caught chondrichthyans species in the JBG) is the most likely species to be affected as they would also be captured in other trawl nets. Intensity: moderate, as although fishing has a severe impact, it is localized to fishing hotspots. Consequence: moderate, as this has a measurable impact on the stock. Confidence: high, as data exists on bycatch of these species in the different fisheries.

Table 3.7: *(continued)*

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
	Aquaculture	1	1	1	Population size	Plain Maskray (*Neotrygon annotata*)	1.2	2	3	2	Boat licenses exist for capturing *P. monodon* broodstock for aquaculture. Broodstock are currently captured around Tiwi Islands, Darwin and in the JBG. Population size likely to be affected before major changes in other sub-components due to the removal of individuals. The Plain Maskray (most commonly caught chondrichthyan species in the JBG) is the most likely species to be affected as they would also be captured in these trawl nets. Intensity: minor, as fishing for this broodstock only occurs at a few restricted locations. Consequence: moderate, as this may impact on the stock. Confidence: high, as bycatch from *P. monodon* broodstock collection would be similar to that from the Redleg Banana Prawn sub-fishery.
	Coastal development	1	1	1	Behaviour/ movement	Smooth Jewfish (*Johnius laevis*)	6.1	2	3	1	Coastal development occurs in small pockets surrounding Cambridge Gulf and town Wyndham. Behaviour and movement likely to be affected before major changes in other sub-components due to altered water/ habitat quality. The Smooth Jewfish is the most likely species to be affected as they spend time in estuaries during their juvenile stage, e.g., for food and protection (https:// www.environment.nsw.gov.au/ topics/ water/ estuaries/ biodiversity-in-estuaries/ fish-in-estuaries) that would be affected by high sedimentation/ smothering in the water. Meanwhile, they are the most caught bycatch fish species recorded in the sub-fishery. Intensity: minor, as this would be in restricted locations (most coastal development is limited to large estuaries). Consequence: moderate, as coastal development may have a detectable impact on these jewfish during their early lifecycle phase inshore. Confidence: low, as there is little data available to demonstrate the effects of coastal development on Smooth Jewfish behaviour/ movement.

Table 3.7: *(continued)*

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
	Other extractive activities	1	3	6	Behavior and Movement	Indian Pellona (*Pellona ditchela*)	6.1	3	2	1	Exploration for oil, gas, diamonds and gold is underway or proposed throughout JBG. Behaviour and movement likely to be affected before major changes in other sub-components due to the addition of structures (rigs) in the sea. The Indian Pellona is the most likely species to be affected as they would tend to school around the large structure feeding on components of the community that grows on these hard structures. Intensity: moderate, as exploration activity probably occurs at a greater scale than the current areas mostly fished. Consequence: minor, as this would have a minimal effect on the stock. Confidence: low, as data unavailable for effects of extractive activities on these fish.
	Other non extractive activities	1	5	6	Behavior and Movement	Whitecheek Shark (*Car-charhinus coatesi*)	6.1	2	1	1	Shipping occurs throughout the year throughout the JBG. Behaviour and movement likely to be affected before major changes in other sub-components due an avoidance reaction. The Whitecheek Shark is the most likely species to be affected as they swim at the surface. Intensity: minor, as shipping occurs throughout the JBG and shipping routes cross the fishery area yet are concentrated near ports, e.g., Darwin, which is outside the JBG. Consequence: negligible, as any impact is unlikely to be detectable. Confidence: low, as it not known to what extent non-JBG fishery shipping has on sharks.

Table 3.7: ***(continued)***

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
	Other anthropogenic activities	1	3	6	Population size	Black Jewfish (*Protonibea diacanthus*)	1.2	2	2	1	Recreational fishing and tourism occurs throughout the year in the JBG, but particularly inshore and near major towns, however, southern part of JPG is very remote. Population size likely to be affected before major changes in other sub-components due to catch of recreational fishing. The Black Jewfish is the most likely species to be affected as they are a popular target fish of recreational fishers (https:// marinewaters.fish.wa.gov.au/ resource/ fact-sheet-cambridge-gulf/). Intensity: minor, as recreational activities occurs primarily in inshore areas and near major towns/ cities. Consequence: minor, as recreational fishing probably has a minimal impact on the stock. Confidence: low, as data unavailable for numbers of fish caught from recreational activities.

3.10.3 Protected Species Component

Table 3.8: Level 1 (SICA) Document L1.3 - Protected Species Component.

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
Capture	Bait collection	0									
	Fishing	1	4	4	Population size	Green Sawfish (*Pristis zijsron*); Freshwater Sawfish (*Pristis pristis*)	1.2	3	3	1	Approximately 1.15% of the total Joseph Bonaparte Gulf (JBG) area was fished across the 2017-21 assessment period (AFMA logbook data). Population size likely to be affected before major changes in other sub-components due to removal of individuals. The Green - and Freshwater Sawfish are likely the most vulnerable species as their rostra are likely to interact with fishing trawl operations and escapement rates of sawfish from trawl nets through TED openings are currently unknown. Also, (i) population status of each species is unknown, (ii) there is either no or little information on any trends based on abundances indices (e.g., catch-per-unit-effort) within this assessment period, and (iii) the breeding grounds of Green Sawfish are likely overlapping the southern boundary of the JBG (Galaiduk et al., 2018). This fisheries activity could in turn affect the population of these species. Intensity: moderate, as although fishing has a severe impact, it is localized due to suitable habitat for trawling. Consequence: moderate, as population of Green - and Freshwater Sawfish are already relatively low and taking only few could have an impact on stocks. Confidence: low, as stock status of these species are uncertain.
	Incidental behaviour	0									
Direct impact without capture	Bait collection	0									

Table 3.8: ***(continued)***

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
	Fishing	1	4	4	Population size	Olive Ridley Turtle (*Lepi-dochelys olivacea*)	1.2	3	3	1	Approximately 1.15% of the total Joseph Bonaparte Gulf (JBG) area was fished across the 2017-21 assessment period (AFMA logbook data). Population size likely to be affected before major changes in other sub-components due to removal of individuals. The Olive Ridley Turtle is likely the most vulnerable species to be affected as they have the greatest risk of extinction for marine turtle stocks in the JBG (C. Limpus pers. comm.). The closest important nesting area for Olive Ridley Turtles is on the Tiwi Islands, off the coast of Darwin counting a few hundred nests annually (Chatto & Baker, 2008). They are approaching zero recruitment of new adults annually into the breeding population (C. Limpus pers. comm.). Intensity: moderate, as Olive Ridley Turtles are encountered on a larger spatial scale. Consequence: moderate, as the loss of only tens of adult females annually would represent a serious impact. Confidence: low, as there is no data available to show the number or condition of turtles that escape the TED.
	Incidental behaviour	0									

Table 3.8: *(continued)*

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
	Gear loss	1	1	1	Population size	Green Sawfish (*Pristis zijsron*); Freshwater Sawfish (*Pristis pristis*)	1.2	2	2	2	Approximately 1.15% of the total Joseph Bonaparte Gulf (JBG) area was fished across the 2017-21 assessment period (AFMA logbook data). Gear loss occurs approximately less than 5 times per year. Population size likely to be affected before major changes in other sub-components due to entrapment of individuals. The Green - and Freshwater Sawfish are likley the most vulnerable protected species to be affected from lost gear as they are benthic and their rostra easily entangle in net mesh. Intensity: minor, as gear loss is rare and interaction of sawfish with gear remote. Consequence: minor, as gear loss unlikely to contribute to further population decline. Confidence: high, as it is known that very little gear is lost, and interaction with sawfish is considered unlikely.
	Anchoring/ mooring	1	3	1	Population size	Olive Ridley Turtle (*Lepi-dochelys olivacea*)	1.2	1	2	2	Anchoring occurs sometimes in the NPF Redleg Banana Prawn sub-fishery. Anchoring may occur over reefs. Population size likely to be affected before major changes in other sub-components due to impact with the anchor. The Olive Ridley Turtle is likely the most vulnerable species to be affected of interacting with the anchor or chain. Intensity: negligible, as vessels don't often anchor and anchoring has a very small footprint. Consequence: minor, as anchoring is unlikely to have a detectable effect on the populations. Confidence: high, as expert consensus is that it is very unlikely that turtles would interact with the anchor chain/ rope.

Table 3.8: ***(continued)***

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
	Navigation/ steaming	1	4	4	Population size	Olive Ridley Turtle (*Lepi-dochelys olivacea*)	1.2	1	2	1	Navigation/ steaming occurs in the JBG and has the potential to cause collision with animals. Population size likely to be affected before major changes in other sub-components due to injury/ death from collision. The Olive Ridley Turtle is likely the most vulnerable species to be affected as they are slow moving, spend time at the surface (like other species), yet their stocks are already severely depleted and require population recovery. Intensity: negligible, as the likelihood of detection is negligible. Consequence: minor, as there is minimal impact on stock structure. Confidence: low, as it is unknown the effect shipping has on this species - data is too deficient to assess.

Table 3.8: *(continued)*

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
Addition/ movement of biological material	Translocation of species	1	5	4	Population size	Olive Ridley Turtle (*Lepidochelys olivacea*)	1.2	2	2	1	Translocation of species may occur in the JBG, as larvae through ballast water or as adults via hull fouling, gear or anchor entanglement, and has the potential to establish as the majority of fishing areas and ports used are of similar depths. Three species of introduced marine organisms have the potential to in the NPF - mussel (*Perna viridis*), limpet (*Crepidula fornicata*) and black-striped mussel (*Mytilopsis sallei*), and establish precedence for translocation to occur in the JBG area. A massive infestation of the latter species, black-striped mussel was discovered in Cullen Bay Marina (Darwin) in March 1999 and rapidly eradicated (Summerson et al., 2013). Population size likely to be affected before major changes in other sub-components, by introducing a foreign competitor or through transmission of disease, but also directly or indirectly through changing trophic linkages. No mitigating measures are currently in place. The Olive Ridley Turtle is likley the most vulnerable species to be affected as the introduction of marine pests that may affect the feeding grounds of this species. Translocated species most likely to affect compromised habitats in terms of structure and function, by altering pelagic and sediment processes, and displacing species. Intensity: minor at present. Consequence: minor, as although there is the potential for impacts to significantly alter population size, the previously introduced pest was quickly eradicated. Confidence: low, as it not known to what extent trawling in the JBG contributes to the spread of the species. No data exists to refute this risk.
	On board processing	0									

Table 3.8: ***(continued)***

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
	Discarding catch	1	4	4	Population size	Olive Ridley Turtle (*Lepi-dochelys olivacea*)	1.2	3	2	2	Discarding occurs during fishing operations in the JBG. Population size likely to be affected before major changes in other sub-components if scavengers and predators (e.g., sharks) are attracted due to the addition of discards and in turn prey upon other species in the area. The Olive Ridley Turtle is likely the most vulnerable species to be affected by this activity. Intensity: moderate, as high volumes of bycatch occur and are discarded in localised areas. Consequence: minor, as the impact of this on the population size is likely to be minimal. Confidence: high, as the effects of discarding of bycatch is well documented in the NPF.
	Stock enhancement	0									
	Provisioning	0									
	Organic waste disposal	1	4	4	Behaviour / Movement	Olive Ridley Turtle (*Lepi-dochelys olivacea*)	6.1	1	1	1	Approximately 1.15% of the total Joseph Bonaparte Gulf (JBG) area was fished across the 2017-21 assessment period (AFMA logbook data). Organic waste disposal is possible over this scale. Behaviour/ movement likely to be affected before major changes in other sub-components as a result of the attraction (e.g., food scraps) or repulsion (e.g., raw sewage) of the organic waste. The Olive Ridley Turtle is likely the most vulnerable species to be at risk as they would be attracted or repelled from the above organic waste. Intensity: negligible, as a disposal event wouldn't have a detectable change on behaviour/ movement. Consequence: negligible, as impact is unlikely to be detectable. Confidence: low, as it is unknown how the behaviour/ movement of sea turtles is affected by general fishing waste disposal.

Table 3.8: *(continued)*

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
Addition of non-biological material	Debris	0									
	Chemical pollution	0									
	Exhaust	1	4	4	Behaviour / Movement	Olive Ridley Turtle (*Lepidochelys olivacea*)	6.1	1	1	1	Approximately 1.15% of the total Joseph Bonaparte Gulf (JBG) area was fished across the 2017-21 assessment period (AFMA logbook data). Exhaust emissions possible over this scale. Behaviour/ movement likely to be affected before major changes in other sub-components due to the deterrent nature of the exhaust emissions. The Olive Ridley Turtle is likely the most vulnerable protected species to be affected as they breathe at the water surface where pollutants will first affect and it has been shown that sea turtles can respond to airborne odorants (Pfaller et al., 2020). Intensity: negligible, because although the hazard could occur over a large range/ scale, exhaust wouldn't have a detectable change on behaviour/ movement. Consequence: negligible, as the impact of exhaust emissions is unlikely to be detectable. Confidence: low, because it is unknown how exhaust impacts the behaviour/ movement of sea turtles.

Table 3.8: ***(continued)***

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
	Gear loss	1	1	1	Population size	Green Sawfish (*Pristis zijsron*); Freshwater Sawfish (*Pristis pristis*)	1.2	2	2	2	Approximately 1.15% of the total Joseph Bonaparte Gulf (JBG) area was fished across the 2017-21 assessment period (AFMA logbook data). Gear loss is rare. Retrieval is usually attempted and possible in shallow depths. Population size likely to be affected before major changes in other sub-components due to entrapment of individuals. The Green - and Freshwater Sawfish are likely the most vulnerable species to be affected as they are benthic and their rostra easily entangle in net mesh. Also, nets may wash up near shore where nursery grounds are. Intensity: minor, as gear loss is rare and interaction of sawfish with gear remote. Consequence: minor, as gear loss unlikely to contribute to further population decline. Confidence: high, as it is known that very little gear is lost, and interaction with sawfish is considered unlikely.
	Navigation/ steaming	1	4	4	Behaviour / Movement	Olive Ridley Turtle (*Lepi-dochelys olivacea*)	6.1	1	1	1	Navigation to and from fishing grounds and steaming between trawls occurs during each season in the JBG and introduces noise and visual stimuli into the environment. Behaviour and movement likely to be affected before major changes in other sub-components due to the repellent nature of the noise and visual stimuli. The Olive Ridley Turtle is likely the most vulnerable species to be affected as they occur at the surface to breathe between dives and are slow-moving. Intensity: negligible, as sea turtles spend the majority of their time underwater and the shipping is localised. Consequence: negligible, as any impact is unlikely to be detectable. Confidence: low, as it not known to what impact navigation/ steaming in the JBG has on turtles.

Table 3.8: *(continued)*

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
	Activity/ presence on water	1	4	4	Behaviour / Movement	Olive Ridley Turtle (*Lepidochelys olivacea*)	6.1	1	1	1	Activity/ presence on water occurs in the JBG for about four months annually. Fishing occurs during the day and night. Behaviour and movement likely to be affected before major changes in other sub-components due to the repellent nature of the noise and visual stimuli. The Olive Ridley Turtle is the most likely vulnerable species to be affected as they come to the surface to breathe. Intensity: negligible, as sea turtles spend the majority of their time underwater and the shipping is localised. Consequence: negligible, as any impact is unlikely to be detectable. Confidence: low, as it not known to what extent noise and visual stimuli from fishing has on turtles.
Disturb physical processes	Bait collection	0									
	Fishing	1	4	4	Behaviour / Movement	Green Sawfish (*Pristis zijsron*); Freshwater Sawfish (*Pristis pristis*)	6.1	3	2	1	Disturbance of physical processes may occur throughout the JBG across the fishing seasons each year, with the action of direct disturbance to the seafloor. Behaviour and movement likely to be affected before major changes in other sub-components due to trawl gear disturbing the seafloor habitat of benthic organisms. The Green - and Freshwater Sawfish are the most likely vulnerable species to be affected as trawling may disturb sediments and prevent sawfish from feeding. Intensity: moderate, as sediment disturbance occurs regularly. Consequence: minor, as disturbance of sediment causes minimal impact on sawfish behaviour/ movement. Confidence: low, since no data are available.
	Boat launching	0									

Table 3.8: *(continued)*

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
	Anchoring/ mooring	1	3	1	Behaviour / Movement	Green Sawfish (*Pristis zijsron*); Freshwater Sawfish (*Pristis pristis*)	6.1	1	2	1	Anchoring occurs sometimes in the NPF Redleg Banana Prawn sub-fishery. Anchoring may occur over reefs. Behaviour and movement likely to be affected before major changes in other sub-components due to the anchor disturbing the seafloor. The Green - and Freshwater Sawfish are the most likely vulnerable species to be affected as anchoring may disturb sediments and prevent sawfish from feeding. Intensity: negligible, as vessels don't often anchor and anchoring has a very small footprint. Consequence: minor,as disturbance of sediment causes minimal impact on sawfish behaviour/ movement. Confidence: low, since no data are available.
	Navigation/ steaming	1	4	4	Behaviour / Movement	Spine-bellied Sea Snake (*Hydrophis curtus*)	6.1	1	1	1	Navigation/ steaming occurs in the JBG for about four months annually and creates turbulent action from the propellers. Behaviour and movement likely to be affected before major changes in other sub-components due to the repellent nature of this turbulence. The Spine-Bellied Sea Snake is the most likely vulnerable species to be affected as turbulence from the boat will move/ displace these relatively light/ small sea snakes that swim at the surface as they travel and they are more regularly caught (in comparison to the Spectacled Seasnake). Intensity: negligible, as it is unlikely that turbulence would have a detectable change on behaviour/ movement as shipping is very local. Consequence: negligible, as any impact is unlikely to be detectable. Confidence: low, as it not known to what extent turbulence affects sea snakes.

Table 3.8: *(continued)*

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
External Impacts	Other fisheries: Northern Territory Demersal Fishery; Abalone Managed Fishery (WA); Kimberley Crab Managed fishery (WA); Kimberley Gillnet and Barramundi Fishery (WA); Marine Aquarium Managed fishery (WA); Northern Demersal Managed Fishery (WA); Shark and Demersal Gillnet and Demersal Longline Managed fishery (WA); Specimen Shell Managed fishery (WA).	1	3	3	Population size	Green Sawfish (*Pristis zijsron*); Freshwater Sawfish (*Pristis pristis*)	1.2	3	4	2	Several other fisheries border or overlap the area fished for Redleg Banana Prawns in the JBG. Population size likely to be affected before major changes in other sub-components due to the removal of individuals. The Green - and Freshwater Sawfish are the most likely vulnerable species to be affected as their rostra get entangled in gillnets. Intensity: moderate, as although fishing has a severe impact, it is localized to fishing hotspots. Consequence: major, as sawfish populations declining and continual catches may deplete the population in the JBG region. Confidence: high, as catch data from other fisheries show high catch of sawfishes.

Table 3.8: *(continued)*

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
	Aquaculture	1	1	1	Population size	Green Sawfish (*Pristis zijsron*); Freshwater Sawfish (*Pristis pristis*)	1.2	2	4	2	Boat licenses exist for capturing *P. monodon* broodstock for aquaculture. Broodstock are currently captured around Tiwi Islands, Darwin and in the JBG. Population size likely to be affected before major changes in other sub-components due to the removal of individuals. The Green - and Freshwater Sawfish are the most likely vulnerable species to be affected as they would also be captured in trawl net. Intensity: minor, as fishing for this broodstock only occurs at a few restricted locations. Consequence: major, as likely high impact on stocks due to the number of sawfish being caught when trawling for broodstock. Confidence: high, as sawfish catch data exists from *P. monodon* broodstock collection.
	Coastal development	1	1	1	Behaviour / Movement	Green Sawfish (*Pristis zijsron*); Freshwater Sawfish (*Pristis pristis*)	6.1	2	3	1	Coastal development occurs in small pockets surrounding Cambridge Gulf and town Wyndham. Behaviour and movement likely to be affected before major changes in other sub-components due to altered water/ habitat quality. The Green - and Freshwater Sawfish are the most likely vulnerable species to be affected as their habitats are in shallower waters and they may move in response to altered turbidity/ habitat quality. Intensity: minor, as this would be in restricted locations yet most coastal development is limited to large estuaries which have high numbers of sawfish. Consequence: moderate, as coastal development may change sedimentation regimes which may directly affect sawfish. Confidence: low, as there is little data available to demonstrate the effects of coastal development on sawfish.

Table 3.8: *(continued)*

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
	Other extractive activities	1	3	6	Behaviour / Movement	Olive Ridley Turtle (*Lepi-dochelys olivacea*)	6.1	3	1	1	Exploration for oil, gas, diamonds and gold is underway or proposed throughout JBG. Behaviour and movement likely to be affected before major changes in other sub-components. The Olive Ridley Turtle is the most likely vulnerable species to be affected as they may change their behaviour/ movement as an avoidance strategy to noise related to exploration activities and it is known that sea turtles rely on low-frequency hearing for foraging and communication of which frequencies overlap with those of anthropogenic sounds of these activities (Charrier et al., 2022). Also, it may be that their prey moves out of the area according to which they will adjust their behaviour/ movement. Intensity: moderate, as exploration activity probably occurs at a greater scale than the current areas mostly fished. Consequence: negligible, as effect on behaviour expected to be undetectable at this scale. Confidence: low, as effects of noise on both turtles and their prey are poorly understood.

Table 3.8: *(continued)*

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
	Other non extractive activities	1	5	6	Population size	Olive Ridley Turtle (*Lepidochelys olivacea*)	1.2	2	3	2	Shipping occurs throughout the year throughout the JBG. Population size likely to be affected before major changes in other sub-components. This is mainly due to collision with ships as turtles are slow moving. The Olive Ridley Turtle is likely the most vulnerable species to be affected as they have the greatest risk of extinction for marine turtle stocks in the JBG (C. Limpus pers. comm.). The closest important nesting area for Olive Ridley Turtles is on the Tiwi Islands, off the coast of Darwin counting a few hundred nests annually (Chatto & Baker, 2008). They are approaching zero recruitment of new adults annually into the breeding population (C. Limpus pers. comm.). Intensity: minor, as shipping occurs throughout the JBG and shipping routes cross the fishery area yet are concentrated near ports, e.g., Darwin, which is outside the JBG. Consequence: moderate, as the loss of only tens of adult females annually could represent an impact. Confidence: high, as turtle experts agree this species is extremely vulnerable.

Table 3.8: *(continued)*

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
	Other anthropogenic activities	1	3	6	Population size	Olive Ridley Turtle (*Lepidochelys olivacea*)	1.2	2	3	2	Recreational fishing and tourism occurs throughout the year in the JBG, but particularly inshore and near major towns, however, southern part of JPG is very remote. Population size likely to be affected before major changes in other sub-components due to boat strikes. The Olive Ridley Turtle is likely the most vulnerable species to be affected as they have the greatest risk of extinction for marine turtle stocks in the JBG (C. Limpus pers. comm.). The closest important nesting area for Olive Ridley Turtles is on the Tiwi Islands, off the coast of Darwin counting a few hundred nests annually (Chatto & Baker, 2008). They are approaching zero recruitment of new adults annually into the breeding population (C. Limpus pers. comm.). Intensity: minor, as recreational activities occurs primarily in inshore areas and near major towns/ cities. Consequence: moderate, as the loss of only tens of adult females annually could represent an impact. Confidence: high, as turtle experts agree this species is extremely vulnerable.

3.10.4 Habitats Component

Table 3.9: Level 1 (SICA) Document L1.4 - Habitats Component.

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
Capture	Bait collection	0									
	Fishing	1	4	4	Habitat structure and function	Habitat forming benthos: particularly bryozoans, and gorgonians (region 1: assem-blage 15,11,10)	5.1	3	3	1	Approximately 1.15% of the total Joseph Bonaparte Gulf (JBG) area was fished across the 2017-21 assessment period (AFMA logbook data). Trawling occurs in waters generally about 50 m deep. Shot length is approximately four hours and relative gear selectivity creates bycatch issues in this fishery. Gear footprint is large, due to relatively large, heavy nets with high mobility. Intensity: moderate, highly localised fishing over suitable prawn habitat (generally muddy sediments) may result in severe localised structural modification of susceptible epifaunal and infaunal habitats. Consequence: major, for some habitats in these depths, as encounter with heavier demersal trawl gears will result in removal and damage of erect, rugose and inflexible octocorals associated with soft muddy substrata. Regeneration times of fauna will vary between species, however in inner shelf depths (25-100 m), may be reasonably rapid as fauna are likely to be well adapted to frequent and considerable disturbance regimes (e.g., strong currents, runoff, cyclones). More structurally complex forms/ communities may take more than one year to recover. Confidence: low, as data on resilience and recovery times of mud based habitats is required.
	Incidental behaviour	0									
Direct impact without capture	Bait collection	0									

Table 3.9: *(continued)*

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
	Fishing	1	4	4	Habitat structure and function	Habitat forming benthos: particularly bryozoans, and gorgonians (region 1: assem-blage 15,11,10)	5.1	3	3	1	Octocorals and hexacorals which survive passing of a prawn trawl shot, due to their apparent flexibility or strong subsurface attachment, are likely to sustain some degree of damage to contacted polyps. Sponges, bryozoans and ascidians may be detached from the seafloor completely. Intensity: moderate, approximately four hours, highly localised interannually. Consequence: moderate. Post encounter fate of fauna unknown, regeneration times of damaged tissues will vary between species, however in inner shelf depths (25-100 m), can be expected to be reasonably rapid as fauna are likely to be well adapted to frequent and considerable disturbance regimes (e.g., strong currents, runoff, cyclones). More structurally complex forms/ communities may take more than one year to recover. Confidence: low, as data on resilience and recovery times of mud based habitats is required.
	Incidental behaviour	0									
	Gear loss	1	1	1	Habitat structure and function	Habitat forming benthos: particularly bryozoans, and gorgonians (region 1: assem-blage 15,11,10)	5.1	2	1	2	Approximately 1.15% of the total Joseph Bonaparte Gulf (JBG) area was fished across the 2017-21 assessment period (AFMA logbook data). Gear loss approximately less than five times per year and is retrieved where possible. Trawling often over low relief muddy sediments likely to be interspersed with patches of biogenic encrusted/ coral outcrops but snagging unlikely if terrain known and hard patches avoided. Intensity: minor, as gear loss is rare across the spatial scale of the fishery, therefore alteration of habitat structure from lost gear minimal. Consequence: negligible. Gear likely to be retrievable in these depths. Lost gear may change habitat structure by virtue of creating new structure, which remains to eventually become habitat, impact unlikely to be measurable. Confidence: high, as it is known that very little gear is lost.

Table 3.9: *(continued)*

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
	Anchoring/ mooring	1	3	1	Habitat structure and function	Habitat forming benthos: particularly bryozoans, and gorgonians (region 1: assem-blage 15,11,10)	5.1	1	2	1	Anchoring occurs occasionally, mainly in about 50 m. Anchoring may occur over sandy substratum or coral reefs. Attached/ sessile fauna may be damaged by physical contact with anchor, during anchoring and retrieval. Intensity: negligible, across scale of fishery. Consequence: minor, over scale of fishery, considered to affect only a very small percentage of the area of the habitat overall, and in very localised locations. Confidence: low, as unknown effect on NPF habitat caused by anchoring/ mooring.
	Navigation/ steaming	1	4	4	Water quality	Northern coastal pelagic 0-200 m	1.1	1	1	2	Navigation/ steaming associated with fishing activity occurs in approximately 1.15% of the total Joseph Bonaparte Gulf (JBG) area that was fished across the 2017-21 assessment period (AFMA logbook data). Navigation/ steaming considered to influence water quality by disrupting the water column. Intensity: negligible, considered unlikely that there would be detectable impacts on pelagic habitat water quality. Consequence: negligible. Confidence: high, because negative interactions between navigation/ steaming and pelagic habitat were considered unlikely to be detectable.

Table 3.9: *(continued)*

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
Addition/ movement of biological material	Translocation of species	1	5	4	Habitat structure and function	Biogenic, low outcrop, seagrass, coastal margin (region 1: assem-blage 15,11,10)	5.1	2	1	1	Translocation of species may occur in the JBG, through ballast water or hull fouling, and more likely to establish in shallower waters. Three species of introduced marine organisms are known to NPF: barnacle (*Megabalanus tintinnabulum*), nudibranch (*Aeolidiella indica*), and algae (*Caulerpa taxifolia*). The bivalve, black-striped mussel, currently eradicated from Darwin harbour, this species remains a potentially serious threat. Translocated species most likely to affect compromised habitats in terms of structure and function, by altering pelagic and sediment processes, and displacing species. Intensity: considered minor at present. Consequence: minor, as although there is the potential for impacts to significantly alter habitat structure and function, the previously introduced pest was quickly eradicated. Confidence: low, as it not known to what extent trawling in the NPF contributes to the spread of the species.
	On board processing	0									

Table 3.9: *(continued)*

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
	Discarding catch	1	4	4	Substrate quality	Habitat forming benthos: particularly bryozoans, and gorgonians (region 1: assem-blage 15,11,10)	3.1	3	2	2	Discarding occurs during fishing operations in the JBG. Hard bodied organisms discarded in considerable volumes in a single dump, may well sink to the benthos and accumulate in shallow depths, less than 20% noted to be consumed by scavengers. If accumulate over fine sediments, altering substrate quality via changed biogeochemical processes and sediment ecology. Habitat ecology will be modified by the attraction of scavengers and predators. Intensity: moderate, as high volumes of bycatch occur localised areas. Consequence: minor, as fishery discards high volumes of diverse bycatch in localised accumulations which may take long periods to breakdown. Confidence: high. Australian based references on fate of discards include: Wassenberg and Hill (1990), Harris and Poiner (1990), Hill and Wassenberg (1990).
	Stock enhancement	0									
	Provisioning	0									
	Organic waste disposal	1	4	4	Water quality	Northern coastal pelagic 0-200 m	1.1	1	1	2	Discharge of organic waste (e.g., uncontaminated food waste) likely to occur daily although relatively small amounts. Intensity: negligible over area. Consequence: negligible, volume likely to be small and quickly dispersed through the water column. Confidence: high, localised short term increases in nutrient not expected to adversely affect water column.
Addition of non-biological material	Debris	0									
	Chemical pollution	0									

Table 3.9: *(continued)*

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
	Exhaust	1	4	4	Air quality	Northern coastal pelagic 0-200 m	2.1	1	1	2	Approximately 1.15% of the total Joseph Bonaparte Gulf (JBG) area was fished across the 2017-21 assessment period (AFMA logbook data). Chemical pollution from exhaust emissions is possible over this scale. Chemical pollution poses greatest potential threat to the water quality of the northern pelagic coastal province habitats. Intensity: negligible, because although the hazard could occur over a large range/ scale, pollution considered to only impact a small area. Consequence: negligible, as the effects of chemical pollution are likely to be rapidly undetectable if volume small and affect surface conditions briefly until winds, wave action dissipates chemical pollution. Confidence: low, as effects of the exhaust is unknown.
	Gear loss	1	1	1	Habitat structure and function	Habitat forming benthos: particularly bryozoans, and gorgonians (region 1: assem-blage 15,11,10)	5.1	2	1	2	Gear loss rare. Retrieval is usually attempted and possible in shallow depths. Lost gear may change habitat structure by virtue of creating new structure, which remains to eventually become habitat. Intensity: minor, as gear loss is rare across the spatial scale of the fishery, therefore alteration of habitat structure from lost gear minimal. Consequence: negligible, impact unlikely to be measurable. Confidence: high, as it is known that very little gear is lost.

Table 3.9: ***(continued)***

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
	Navigation/ steaming	1	4	4	Water quality	Northern coastal pelagic 0-200 m	1.1	1	1	2	Navigation to and from fishing grounds and steaming between trawls occurs in the JBG and introduces noise and visual stimuli into the environment, affecting water quality. Intensity: negligible, as there is a minimal amount and it occurs in restricted locations where fishing occurs. Consequence: negligible, as any impact is unlikely to be detectable. Confidence: low, as effect on pelagic habitats of noise and visual stimuli not known.
	Activity/ presence on water	1	4	4	Water quality	Northern coastal pelagic 0-200 m	1.1	1	1	2	Navigation/ steaming occurs in the JBG across the fishing seasons. Fishing occurs during the day and night. At night, noise and light associated with fishing operations likely to alter the pelagic habitat for the duration of the shot. Intensity: negligible, because it occurs over a large range but detection of impact unlikely. Consequence: negligible, impacts unlikely to be measurable for pelagic species interactions. Confidence: high, logical consideration.
Disturb physical processes	Bait collection	0									

Table 3.9: *(continued)*

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
	Fishing	1	4	4	Substrate quality	Habitat forming benthos: particularly bryozoans, and gorgonians (region 1: assem-blage 15,11,10)	3.1	3	3	1	Trawl nets are deployed over sandy/ muddy sediments which may support large/ tall erect sponges and other suspension feeding sessile invertebrates in patches. Trawling may cause suspension of fine sediment layers which settle out on filter feeding organisms smothering ability to function normally, in a way that is greater than expected from wave/ current action alone. Intensity: moderate. Consequence: moderate, as impact on seafloor is high but localised. Confidence: high, however, the area fished is a highly dynamic zone, much of its fauna is adapted to mobile sediments from natural disturbance, but fishing may occur at greater frequency than these natural events.
	Boat launching	0									
	Anchoring/ mooring	1	3	1	Water quality	Pelagic waters of the southern Joseph Bonaparte Gulf	1.1	1	1	1	Anchoring sometimes occurs in the NPF Redleg Banana Prawn sub-fishery. Physical contact with anchor may disturb substratum in the process and damage hard, benthic organisms in a more persistent way, particularly in frequently used sites. Risk of sediment suspension low as likely to anchor on 'hard' structures or coarse sands. Intensity: negligible, as anchoring doesn't regularly occur. Consequence: negligible, as disturbance of sediment unlikely. Confidence: low, since no data are available.

Table 3.9: ***(continued)***

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
	Navigation/ steaming	1	4	4	Water quality	Northern coastal pelagic 0-200 m	1.1	1	1	2	Fishing activity hence navigation/ steaming occurs in the JBG. Disturbance of physical processes will occur during the normal course of steaming throughout the fishing zone. Turbulence and disturbance of pelagic water quality is unlikely to affect normal water column processes for long. Any disruption to these processes can therefore be expected to alter habitat function only briefly. Intensity: negligible, undetectable. Consequence: negligible, remote likelihood of detection of impact against natural variation. Confidence: high, logical.

Table 3.9: *(continued)*

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
External Impacts	Other fisheries: Northern Territory Demersal Fishery; Abalone Managed Fishery (WA); Kimberley Crab Managed fishery (WA); Kimberley Gillnet and Barramundi Fishery (WA); Marine Aquarium Managed fishery (WA); Northern Demersal Managed Fishery (WA); Shark and Demersal Gillnet and Demersal Longline Managed fishery (WA); Specimen Shell Managed fishery (WA).	1	3	3	Habitat type, structure and function	Habitat forming benthos: particularly bryozoans, and gorgonians (region 1: assem-blage 15,11,10)	4.1, 5.1	3	2	1	Other fisheries overlap the area fished for Redleg Banana Prawns. Intensity: moderate, for benthic habitat structure and function across the spatial scale of the JBG. Consequence: minor, as occurs in localised areas. Confidence: low, requires data on cumulative effects in JBG.

Table 3.9: *(continued)*

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
	Aquaculture	1	1	1	Water quality, substrate quality	Habitat forming benthos: particularly bryozoans, and gorgonians (region 1: assem-blage 15,11,10)	1.1, 3.1	2	2	1	Boat licenses exist for capturing *P. monodon* broodstock for aquaculture in the fishery area. Water and substrate quality likely to be affected before major changes in other sub-components. Intensity: minor, as fishing for this broodstock only occurs at a few restricted locations. Consequence: minor, as minimal impact on the habitat as relatively little fishing occurs. Confidence: low, since no data available.
	Coastal development	1	1	1	Water quality, substrate quality	Habitat forming benthos: particularly bryozoans, and gorgonians (region 1: assem-blage 15,11,10)	1.1, 3.1	2	2	2	Coastal development occurs in small pockets surrounding Cambridge Gulf and town Wyndham. This activity is most likely to affect coastal margin habitats. Habitat structure and function most at risk of modification through indirect effects of coastal development, altered runoff from farming activities and coastal sedimentation regimes, fragmentation of habitat, modified biogeochemical processes due to high nutrient loads, introduced species associated with traditional activities (Hill et al., 2002). Intensity: minor, as minimal impact on the habitat given that run-off is likey to be small. Consequence: minor, as minimal impact of run-off from farming activities which may fragment crucial habitats. Confidence: high, as data exists that demonstrates the effects of coastal development on shallow tropical coastal zones.

Table 3.9: *(continued)*

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
	Other extractive activities	1	3	6	Substrate quality	Habitat forming benthos: particularly bryozoans, and gorgonians (region 1: assem-blage 15,11,10)	3.1	3	2	1	Exploration for oil, gas, diamonds and gold is underway or proposed throughout JBG. Most likely to affect substrate quality by exploratory activity e.g., drilling; port development for mineral shipment affecting coastal nursery habitats. Intensity: moderate, as exploration activity probably occurs at a greater scale than the current areas mostly fished. Consequence: minor, as effect localised and changes to the distribution of the communities likely to be undetectable. Confidence: low, as effects are unknown.
	Other non extractive activities	1	5	6	Water quality	Northern coastal pelagic 0-200 m	1.1	2	2	1	Shipping occurs during the year in the JBG. Greatest threat to pelagic habitat function is water quality due to introduction of turbulence from vessels. Intensity: minor, as shipping occurs in the JBG and shipping routes cross the fishery area yet are concentrated near ports, e.g., Darwin, which is outside the JBG. Consequence: minor, as effects on water quality are expected to be minimal. Confidence: low, as data unavailable for effect of shipping on water quality in NPF.

Table 3.9: *(continued)*

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
	Other anthropogenic activities	1	3	6	Water, air and substrate quality, habitat types, structure and function	Habitat forming benthos: particularly bryozoans, and gorgonians (region 1: assem-blage 15,11,10), Northern coastal pelagic 0-200 m	1.1, 2.1 3.1, 4.1, 5.1	2	2	1	Recreational boating/ fishing and tourism occurs during the year in the JBG, but particularly inshore and near major towns, however, southern part of JPG is very very remote. Greatest threats to water quality, substrate quality, habitat types, structure and function as it includes boat launching, recreational fishing, diving, etc., that has effect from the water surface to the seafloor. Intensity: minor, as these activities occur in restricted locations. Consequence: minor, as effects on habitat expected to be minimal. Confidence: low, as data unavailable for effects of these activities on habitats.

3.10.5 Communities Component

Table 3.10: Level 1 (SICA) Document L1.5 - Communities Component.

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
Capture	Bait collection	0									
	Fishing	1	4	4	Species composition	Timor inner shelf	1.1	3	2	2	Approximately 1.15% of the total Joseph Bonaparte Gulf (JBG) area was fished across the 2017-21 assessment period (AFMA logbook data). Species composition likely to be affected before major changes in other sub-components. Redleg Banana Prawns are the primary key commercial species and diverse taxonomically, therefore species composition might be affected overall. Intensity: moderate, as fishing often localized due to suitable habitat. Consequence: minor, at current effort level (see Scoping section). Localised targetting spatially and temporally, non-targetting of bycatch occurs. Confidence: high, as biomass estimates from stock assessment models are available, but estimate of sustainable byproduct/ bycatch levels are required.
	Incidental behaviour	0									
Direct impact without capture	Bait collection	0									
	Fishing	1	4	4	Species composition	Timor inner shelf	1.1	3	2	1	Approximately 1.15% of the total Joseph Bonaparte Gulf (JBG) area was fished across the 2017-21 assessment period (AFMA logbook data). Species composition likely to be affected before major changes in other sub-components. Intensity: moderate. Consequence: minor, as the scale of this activity. Confidence: low, as data unavailable for direct impacts without capture.
	Incidental behaviour	0									

Table 3.10: ***(continued)***

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
	Gear loss	1	1	1	Species composition	Timor inner shelf	1.1	2	2	2	Approximately 1.15% of the total Joseph Bonaparte Gulf (JBG) area was fished across the 2017-21 assessment period (AFMA logbook data). Gear loss is rare and retrieved where possible. Species composition likely to be affected before major changes in other sub-components. Benthic species most likely to be affected due to entanglement, smothering or habitat alteration. Intensity: minor, as gear loss is rare (estimated approximately less than five occurrences per year). Consequence: minor, as impact would affect very small area and any effect on community due to gear loss is immeasurable. Confidence high, as it is known that very little gear is lost.
	Anchoring/ mooring	1	3	1	Distribution of the community	Timor inner shelf	3.1	1	1	2	Anchoring occurs occasionally in the NPF Redleg Banana Prawn sub-fishery. Some sedentary fish may be disturbed by presence of vessel in very shallow waters and distributions may be disrupted briefly. Anchoring occurs on reefs, where Redleg Banana Prawns are not abundant. Intensity: negligible, as as the likelihood of detection is negligible. Consequence: negligible. Confidence: high, as it's very unlikely for community to be negatively affected by anchoring/ mooring.
	Navigation/ steaming	1	4	4	Distribution of the community	Timor inner shelf; Northern coastal Bonaparte (pelagic)	3.1	1	1	2	Navigation/ steaming occurs in the JBG. Intensity: negligible, as this activity is likely to be undetectable. Consequence: negligible, as impact likely to be undetectable on the distribution of the community. Confidence: high, as it is unlikely for a strong interaction to occur between navigation/ steaming and the community.

Table 3.10: *(continued)*

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
Addition/ movement of biological material	Translocation of species	1	5	4	Species composi- tion; trophic/ size structure	Timor inner shelf	1.1, 4.1	2	2	1	Translocation of species may occur in the JBG, as larvae through ballast water or as adults via hull fouling, gear or anchor entanglement, and has the potential to establish as the majority of fishing areas and ports used are of similar depths. Three species of introduced marine organisms have the potential to translocate to the NPF- mussel (*Perna viridis*), limpet (*Crepidula fornicata*) and black-striped mussel (*Mytilopsis sallei*), and establish precedence for translocation to occur in the JBG area. A massive infestation of the latter species, black-striped mussel was discovered in Cullen Bay Marina (Darwin) in March 1999 and rapidly eradicated (Summerson et al., 2013). Translocation most likely to change the species composition and trophic structure of the community, possibly by introducing a foreign competitor or through transmission of disease, but also directly or indirectly through changing trophic linkages. No mitigating measures are currently in place. Intensity: considered minor at present. Consequence: minor, as while there is the potential to alter the species composition and potentially trophic structure of the community (based on its incursion in 1999 of black-striped mussel), it was quickly eradicated. Confidence: low, as there is no data to show the spread of the species and the likely impact on species composition of this community. Also, there is no data exists to refute the NPF risk.
	On board processing	0									

Table 3.10: *(continued)*

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
	Discarding catch	1	4	4	Distribution of the community	Timor inner shelf	3.1	3	2	2	Discarding occurs during fishing operations in the JBG. Most likely to affect distribution of community if scavengers and predators (e.g. sharks and trevallies) are attracted to discard site. Intensity: moderate, as discarding occurs. Consequence: minor, as these changes are likely to be short lived. The fishery discards diverse bycatch but localised and may cause more permanent changes in population size of scavenger species. Confidence: high, as discard estimates were available.
	Stock enhancement	0									
	Provisioning	0									
	Organic waste disposal	1	4	4	Distribution of the community	Northern coastal Bonaparte pelagic 0 - 200 m	3.1	1	1	2	Approximately 1.15% of the total Joseph Bonaparte Gulf (JBG) area was fished across the 2017-21 assessment period (AFMA logbook data). Organic waste disposal is possible over this scale. Disposal of organic waste poses greatest potential risk for distribution of Northern Coastal Bonaparte pelagic community resulting in either attraction (e.g., food scraps) or repulsion (e.g., raw sewage). Intensity: negligible, as each disposal event probably only affects a small (less than one nm) area. Consequence: negligible, as it's unlikely to be detectable nor persistent. Confidence: high, because consensus among experts is that general fishing waste disposal was unlikely to impact the distribution of the community.
Addition of non-biological material	Debris	0									
	Chemical pollution	0									

Table 3.10: *(continued)*

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
	Exhaust	1	4	4	Distribution of the community	Northern coastal Bonaparte pelagic 0 - 200 m	3.1	1	1	2	Approximately 1.15% of the total Joseph Bonaparte Gulf (JBG) area was fished across the 2017-21 assessment period (AFMA logbook data). Exhaust emissions possible over this scale. Exhaust emissions poses greatest potential risk for the distribution of this community by affecting the distribution of birds in the vicinity of vessels. Intensity: negligible, because although the hazard could occur over a large range/ scale, exhaust considered to only impact a small area. Consequence: negligible, as the effects of exhaust emissions is unlikely to be detectable. Confidence: high, because consensus among experts is that exhaust is unlikely to impact the distribution of community.
	Gear loss	1	1	1	Distribution of the community	Timor inner shelf	3.1	2	1	2	Gear loss rare. Retrieval is usually attempted and possible in shallow depths. Lost gear may change habitat structure by virtue of creating new structure, which remains to eventually become habitat. Intensity: minor, as gear loss is rare across the spatial scale of the fishery, therefore alteration of habitat structure from lost gear minimal. Consequence: negligible, impact unlikely to be measurable. Confidence: high, as it is known that very little gear is lost.

Table 3.10: *(continued)*

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
	Navigation/ steaming	1	4	4	Distribution of the community	Northern coastal Bonaparte pelagic 0 - 200 m	3.1	1	1	2	Navigation to and from fishing grounds and steaming between trawls occurs in the JBG and introduces noise from vessel engines and echo-sounding during trawling. Navigation/ steaming is expected to pose greatest potential risk to the distribution of the community which may alter the distribution of the community members which are most likely impacted (e.g., over areas of biological importance for turtles, dugongs). Intensity: negligible, as there is a minimal amount and it occurs in restricted locations where fishing occurs. Consequence: negligible, as any impact is unlikely to be detectable. Confidence: high, because concensus among experts is that the addition of non-biological material due to navigation/ steaming is unlikely to impact upon the behaviour/ movement of commercial prawns and thus the distribution of the community.
	Activity/ presence on water	1	4	4	Distribution of the community	Northern coastal Bonaparte pelagic 0 - 200 m	3.1	1	1	1	Activity/ presence on water occurs in the JBG during each fishing season. Activity/ presence considered most likely to affect function group composition by changing the behaviour and distribution of marine reptiles (e.g., turtles), teleosts (e.g., sea snakes) due to avoidance reaction. Intensity: negligible, impact unlikely to be detectable. Consequence: negligible, since any change the community distribution would be undetectable against background variation except during fishing operations. Confidence: low, because the effects of activity/ presence on water is unknown.
Disturb physical processes	Bait collection	0									

Table 3.10: *(continued)*

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
	Fishing	1	4	4	Distribution of the community	Timor inner shelf	3.1	3	3	1	Disturbance of physical processes may occur in the JBG during each fishing season, which is most likely to affect distribution of the community. Benthic species most likely to be affected since trawling may disturb sediments. Intensity: moderate, as sediment disturbance may occur regularly. Consequence: moderate, as disturbance of sediment could affect distribution. Confidence: low, as no data available.
	Boat launching	0									
	Anchoring/ mooring	1	3	1	Distribution of the community	Timor inner shelf	3.1	1	2	1	Fishing occurs across the fishing seasons annually. Anchoring occurs sometimes in this sub-fishery. Distribution of the community most likely to be affected as anchoring occurs on reefs where damage to habitat may result in alteration of species distributions. Also, some sedentary fish may be disturbed by anchor disturbance of sediments smothering some community components. Intensity: negligible, occurs in a few restricted locations and vessels only anchor during the day or night when they are not fishing and anchoring has a very small footprint. Consequence: minor, as minimal impact on distribution of community. Confidence low, as data is unavailable.
	Navigation/ steaming	1	4	4	Bio- and geo-chemical cycles	Northern coastal Bonaparte pelagic 0 - 200 m	5.1	1	1	1	Navigation/ steaming occurs in the JBG across the fishing seasons each year. Possible impact on bio- and geo-chemical cycles of pelagic waters by disturbing mixed layer via surface turbulence. Pelagic species most likely to be affected. Intensity: negligible, as unlikely to be detectable. Consequence: negligible, as impact unlikely to be detectable. Confidence: low, as effects unknown.

Table 3.10: ***(continued)***

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
External Impacts	Other fisheries: Northern Territory Demersal Fishery; Abalone Managed Fishery (WA); Kimberley Crab Managed fishery (WA); Kimberley Gillnet and Barramundi Fishery (WA); Marine Aquarium Managed fishery (WA); Northern Demersal Managed Fishery (WA); Shark and Demersal Gillnet and Demersal Longline Managed fishery (WA); Specimen Shell Managed fishery (WA).	1	3	3	Species composition	Timor inner shelf	1.1	3	2	2	The NT demersal and other fisheries overlaps the area fished for Redleg Banana Prawns (i.e., in the JBG). Other fisheries which catch a diverse range of species most likely to affect species composition of different communities. Intensity: moderate, as other trawl and non-trawl fisheries target other species in other habitats e.g., fish trawling over reefs or catch prawns in low numbers (e.g., recreational fisheries). Consequence: minor, as diverse range of species captured. Confidence: high, catch data from other fisheries are recorded.

Table 3.10: *(continued)*

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
	Aquaculture	1	1	1	Trophic/ size structure	Timor inner shelf	4.1	2	3	1	Boat licenses exist for capturing *P. monodon* broodstock for aquaculture. Broodstock are currently captured around Tiwi Islands, Darwin and in the JBG. Removal of spawners could affect the size structure of this community as large spawners are removed from these locations. Intensity: moderate, as perceived to be localized but severe. Consequence: moderate, as currently impact on the size structure of this community is possible. Confidence: low, as no data available on the removal of large spawners of this species on the size structure of this community.
	Coastal development	1	1	1	Species composition	Northern coastal Bonaparte pelagic 0 - 200 m	1.1	2	2	1	Coastal development occurs in small pockets surrounding Cambridge Gulf and town Wyndham. Species composition most at risk of modification through indirect effects of coastal development, altered runoff from farming activities and coastal sedimentation regimes, fragmentation of habitat, modified biogeochemical processes due to high nutrient loads, introduced species associated with traditional activities (Hill et al., 2002). Intensity: minor, as minimal impact on the Northern coastal Bonaparte community given that run-off is likey to be small. Consequence: minor, as minimal impact of run-off from farming activities which may alter species composition. Confidence: low, as there is little data data available that demonstrates the effects of coastal development on species composition.

Table 3.10: *(continued)*

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
	Other extractive activities	1	3	6	Distribution of the community	Timor inner shelf; Northern coastal Bonaparte (pelagic)	3.1	3	2	1	Exploration for oil, gas, diamonds and gold is underway or proposed throughout JBG. Most likely to affect substrate quality by exploratory activity e.g., drilling; port development for mineral shipment affecting coastal nursery habitats. Intensity: moderate, as exploration activity probably occurs at a greater scale than the current areas mostly fished. Consequence: minor, as effect localised and changes to the distribution of the communities likely to be undetectable. Confidence: low, as effects are unknown.
	Other non extractive activities	1	5	6	Distribution of the community	Northern coastal Bonaparte pelagic 0 - 200 m	3.1	2	2	1	Commercial shipping occurs throughout the year in the JBG. Greatest threat to distribution of community as a result of avoidance reaction. Intensity: minor, as shipping occurs throughout the JBG and is concentrated near ports e.g., Darwin, which is outside the JBG. Consequence: minor, as effects on distribution of community are expected to be minimal, but there is the possibility that aggregations of Redleg Banana Prawns may be affected. Confidence: low, as data on the impact of shipping on distribution of species is unknown.

Other anthropogenic activities	1	3	6	Distribution of the community	Northern coastal Bonaparte pelagic 0 - 200 m	3.1	2	2	1	Recreational boating/ fishing (including boat launching) and tourism (e.g., diving) occurs throughout the year in the JBG, but particularly inshore and near major towns, however, southern part of JPG is very very remote. Greatest potential risk for the distribution of the community resulting from aviodance reaction. Intensity: minor, as these activities occur in restricted locations and therefore unlikely to detect direct and/ or indirect impacts on pelagic community at the scale of activities, concentrated along the ports (e.g., Darwin). Consequence: minor, as long term effects on distribution of community is minimal, but there is a possibility that pelagic aggregations of Redleg Banana Prawns may be affected. Confidence: low, as data on the effect of these activities on distribution of species is unknown.

3.11 Summary of SICA Results

A summary table (**Level 1 (SICA) Document L1.6**) of consequence scores for all activity/component combinations and a table showing those that scored 3 or above for consequence (shaded) and differentiating those that did so with high confidence (in bold) is outlined in Table 3.11.

Table 3.11: Level 1 (SICA) Document L1.6.
Summary table of consequence scores for all activity/component combinations. Internal activities that scored 3 or more are coloured light blue and bold if high confidence. * existing stock assessment for all species within component. Therefore, assessment not required. Note: external hazards are not considered at Level 2.

Impact	Activity	Key/ secondary commercial species	Bycatch/ byproduct species	Protected species	Habitats	Communities
Capture	Bait collection	0	0	0	0	0
	Fishing	*	**3**	3	3	**2**
	Incidental behaviour	0	0	0	0	0
Direct impact without capture	Bait collection	0	0	0	0	0
	Fishing	1	2	3	3	2
	Incidental behaviour	0	0	0	0	0
	Gear loss	**1**	**1**	**2**	**1**	**2**
	Anchoring/ mooring	**1**	2	**2**	2	**1**
	Navigation/ steaming	**1**	**1**	2	**1**	**1**
Addition/ movement of biological material	Translocation of species	1	2	2	1	2
	On board processing	0	0	0	0	0
	Discarding catch	2	**2**	**2**	**2**	**2**
	Stock enhancement	0	0	0	0	0
	Provisioning	0	0	0	0	0
	Organic waste disposal	**1**	**1**	1	**1**	**1**
Addition of non-biological material	Debris	0	0	0	0	0
	Chemical pollution	0	0	0	0	0
	Exhaust	**1**	**1**	1	**1**	**1**
	Gear loss	**1**	**1**	**2**	**1**	**1**
	Navigation/ steaming	**1**	1	1	**1**	**1**
	Activity/ presence on water	**1**	1	1	**1**	1
Disturb physical processes	Bait collection	0	0	0	0	0
	Fishing	2	2	2	3	3
	Boat launching	0	0	0	0	0
	Anchoring/ mooring	**1**	**1**	2	1	2
	Navigation/ steaming	**1**	1	1	**1**	1

Table 3.11: *(continued)*

Impact	Activity	Key/ secondary commercial species	Bycatch/ byproduct species	Protected species	Habitats	Communities
	Other fisheries: Northern Territory Demersal Fishery; Abalone Managed Fishery (WA); Kimberley Crab Managed fishery (WA); Kimberley Gillnet and Barramundi Fishery (WA); Marine Aquarium Managed fishery (WA); Northern Demersal Managed Fishery (WA); Shark and Demersal Gillnet and Demersal Longline Managed fishery (WA); Specimen Shell Managed fishery (WA).	**2**	**3**	**4**	2	**2**
	Aquaculture	**2**	**3**	**4**	2	3
External Impacts	Coastal development	2	3	3	**2**	2
	Other extractive activities	2	2	1	2	2
	Other non extractive activities	**1**	1	**3**	2	2
	Other anthropogenic activities	2	2	**3**	2	2

Figure 3.1 to Figure 3.5 show the frequency distribution of consequence scores for all components that were assessed.

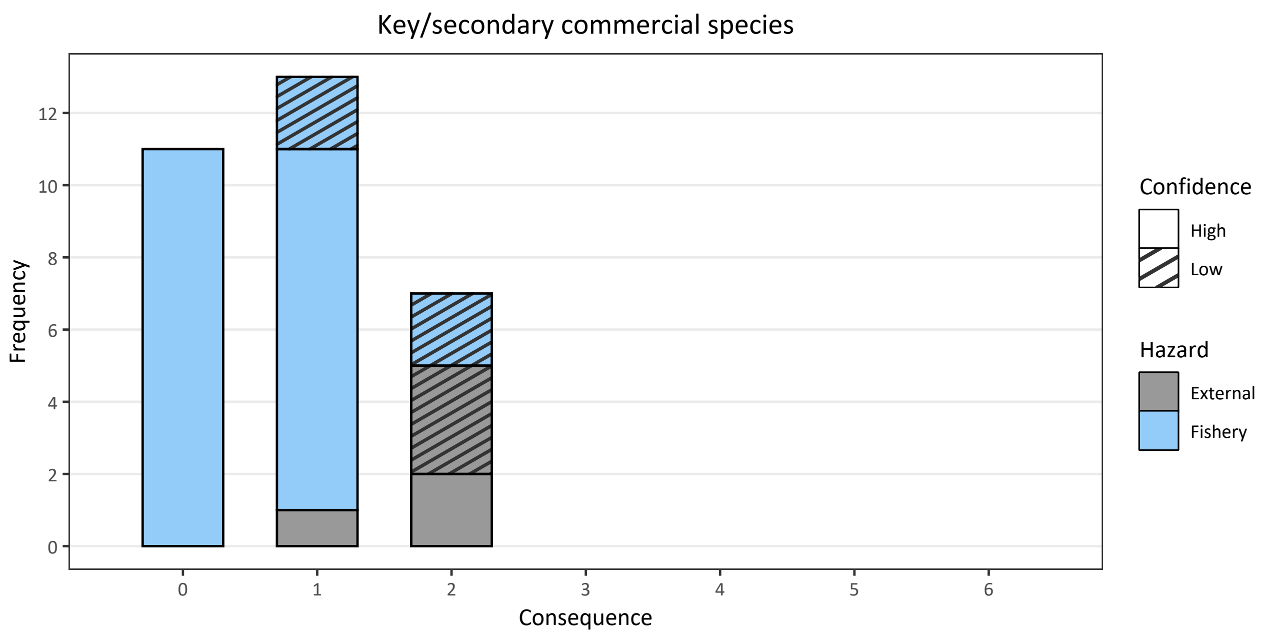


Figure 3.1: Key/secondary commercial species component: Frequency of consequence score by high and low confidence.

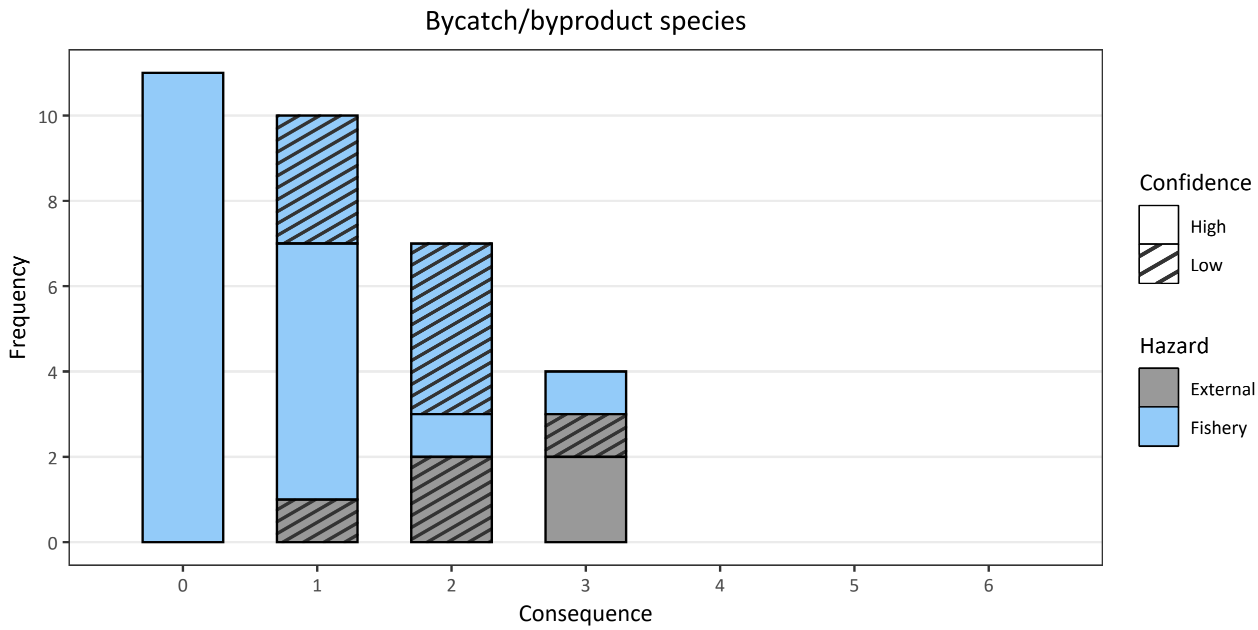


Figure 3.2: Bycatch/byproduct species component: Frequency of consequence score by high and low confidence.

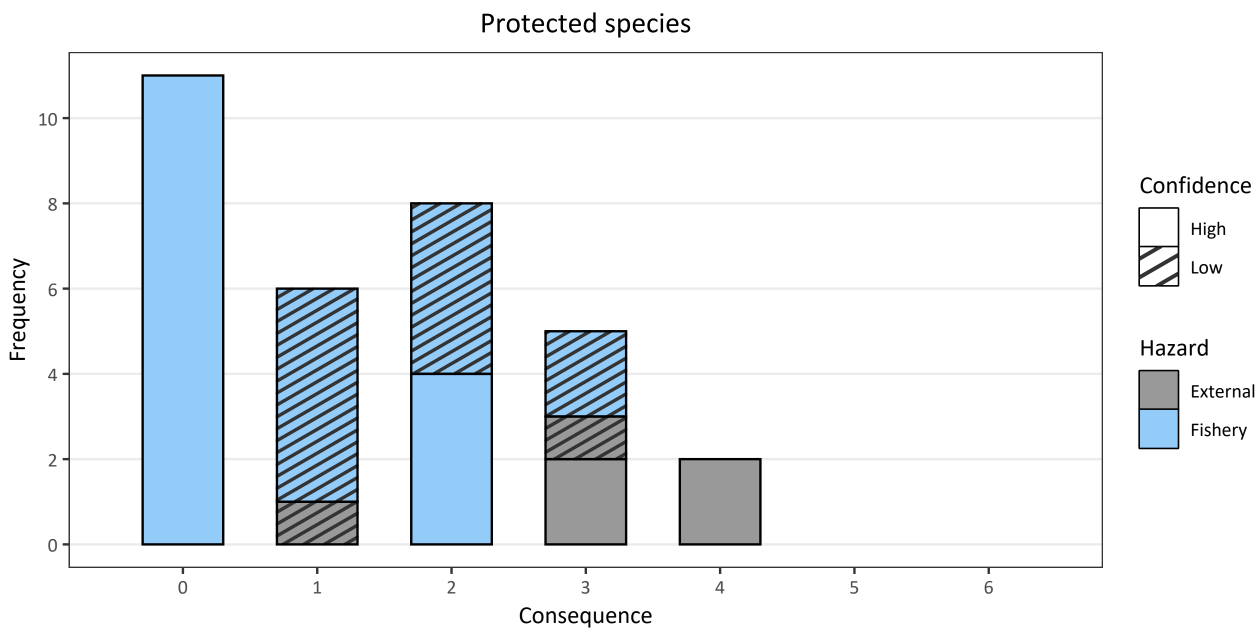


Figure 3.3: Protected species component: Frequency of consequence score by high and low confidence.

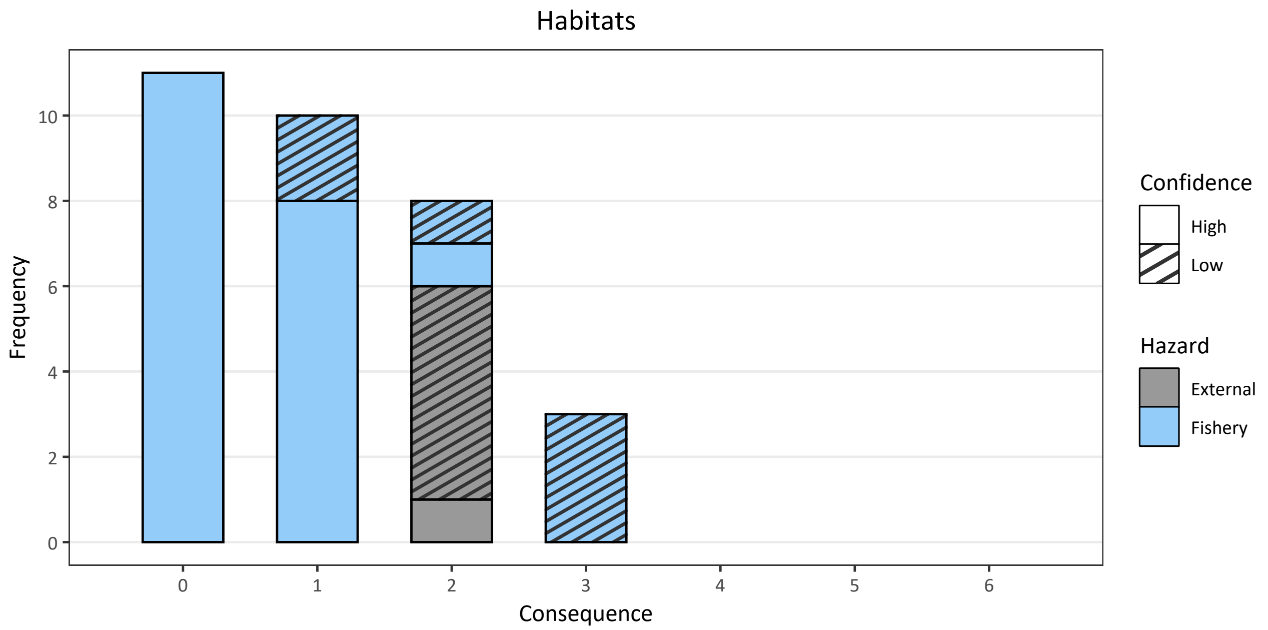


Figure 3.4: Habitats component: Frequency of consequence score by high and low confidence.

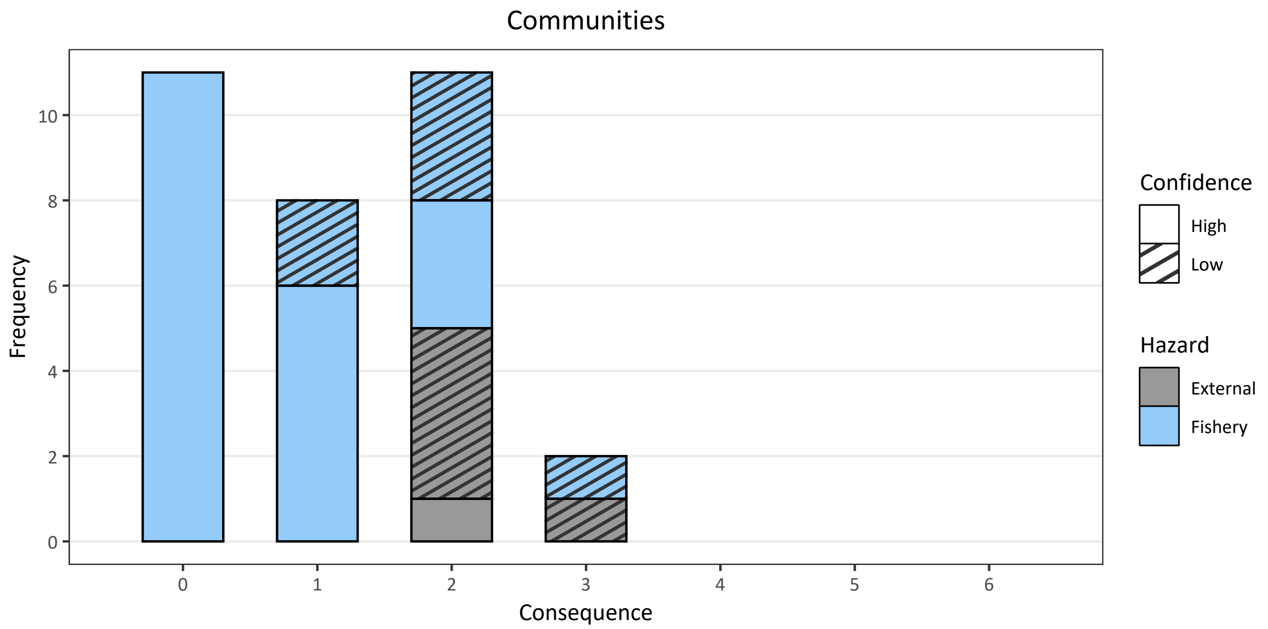


Figure 3.5: Communities component: Frequency of consequence score by high and low confidence.

3.12 Evaluation/Discussion of Level 1

Most hazards (fishing activities) were eliminated at Level 1 (risk scores 1 or 2; Table 3.11); Figure 3.4-Figure 3.5).

The key/secondary commercial species component was eliminated after Level 1 as all risk scores were less than three.

None of the remaining four assessed ecological components were eliminated at Level 1 i.e., there was at least one risk score of 3 – moderate – or above for each component.

Those remaining consist of:

- Fishing (direct and indirect impacts on protected species and habitats; moderate risk)
- Fishing (direct impacts on byproduct/bycatch species; moderate risk)
- Fishing through physical disturbance (impact on habitats and communities; moderate risk)

Habitat-forming benthos, particularly bryozoans and gorgonians corresponding to assemblages 15, 11 and 10 of the Timor Region were rated at moderate risk (score 3) from direct and indirect impacts from primary fishing operations and physical disturbance.

Significant external hazards included aquaculture in the region, which presented a moderate risk (risk score 3) to byproduct/bycatch species and communities, and a potential major risk to protected species (e.g., Green Sawfish and Freshwater Sawfish). In addition, external hazards from other fisheries in the region also presented a moderate risk (risk score of 3) to byproduct/bycatch species and a potential major risk to protected species (e.g., Green Sawfish and Freshwater Sawfish). Coastal development presented a moderate risk to both byproduct/bycatch species. Lastly, coastal development, other anthropogenic and non-extractive activities presented a moderate risk to protected species.

3.13 Components to be Examined at Level 2

As a result of the preliminary SICA, the assessed components that are to be examined at Level 2 are those with any consequence scores of 3 or above. These components are:

- Byproduct/bycatch species
- Protected species
- Habitats
- Communities

It was not possible to conduct a Level 2 ERA for habitats and communities components, as it is outside the project scope.

It was not possible to conduct a Level 2 ERA for the communities component, as it is outside the project scope.

4 Level 2

When the risk of an activity at Level 1 (SICA) on a component is moderate or higher and no planned management interventions that would remove this risk are identified, an assessment is required at Level 2.

A residual risk (RR) analysis was undertaken for species at high risk in PSA and for any species at high risk in bSAFE (Table 4.1). There may be instances where a RR analysis may be required for medium risk species resulting from a PSA and/or bSAFE.

Table 4.1: Residual risk guidelines drawn from document "Revision of residual risk guidelines to reflect updated Ecological Risk Assessment Methodology – version Oct 12, 2016.

1	Risk rating due to missing, incorrect or out of date information
2	At risk due to external factors (cumulative risks)
3	At risk in regards to level of interaction/capture with a zero or negligible level of susceptibility
4	Effort and catch management arrangements for target and byproduct species
5	Management arrangements to mitigate against the level of bycatch
6	Management arrangements relating to seasonal, spatial and depth closures

4.1 Level 2 Productivity and Susceptibility Analysis (PSA)

The PSA approach is a method of assessment which allows all units within any of the ecological components to be effectively and comprehensively screened for risk. The units of analysis are the complete set of species habitats or communities identified at the scoping stage. The PSA results in Sections 4.1.1 and 4.1.2 of this report measure risk of direct impacts of fishing only. Future iterations of the methodology will include PSAs modified to measure the risk due to other activities, such as gear loss.

The PSA approach is based on the assumption that the risk to an ecological component will depend on two characteristics of the component units: (1) the extent of the impact due to the fishing activity, which will be determined by the susceptibility of the unit to the fishing activities (Susceptibility) and (2) the productivity of the unit (Productivity), which will determine the rate at which the unit can recover after potential depletion or damage by the fishing. It is important to note that the PSA essentially measures potential for risk, hereafter denoted as "risk". A measure of absolute risk requires some direct measure of abundance or mortality rate for the unit in question, and this information is generally lacking at Level 2.

The PSA approach examines attributes of each unit that contribute to or reflect its productivity or susceptibility to provide a relative measure of risk to the unit. The following section describes how this approach is applied to the different components in the analysis. Full details of the methods are described in Hobday et al., (2007).

Species

Table 4.2 outlines the seven attributes that are averaged to measure productivity, and the four aspects that are multiplied to measure susceptibility for all the species components.

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

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

Encounterability is the likelihood that a species will encounter fishing gear deployed within its range.

Table 4.2: Attributes that measure productivity and susceptibility.

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

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

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

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

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

Habitats

Similar to species, PSA methods for habitats are based around a set of attributes that measure productivity and susceptibility. Productivity attributes include speed of regeneration of fauna, and likelihood of natural disturbance. The susceptibility attributes for habitats are described in Table 4.3.

Communities

There are seven steps for the PSA undertaken for each component brought forward from Level 1 analysis (see Hobday et al., 2007 for full details).

- Step 1. Identify the units excluded from analysis and document the reason for exclusion (see Table 2.18)
- Step 2. Score units for productivity
- Step 3. Score units for susceptibility
- Step 4. Plot individual units of analysis onto a PSA Plot
- Step 5. Ranking of overall risk of each unit
- Step 6. Evaluation of the PSA results
- Step 7. Decision rules to move from Level 2 to Level 3

Table 4.3: Description of susceptibility attributes for habitats.

Aspect	Attribute	Concept	Rationale
Susceptibility			
Availability	General depth range (Biome)	Spatial overlap of subfishery with habitat defined at biomic scale	Habitat occurs within the management area
Encounterability	Depth zone and feature type	Habitat encountered at the depth and location at which fishing activity occurs	Fishing takes place where habitat occurs
	Ruggedness (fractal dimension of substratum and seabed slope)	Relief, rugosity, hardness and seabed slope influence accessibility to different sub-fisheries	Rugged substratum is less accessible to mobile gears. Steeply sloping seabed is less accessible to mobile gears
	Level of disturbance	Gear footprint and intensity of encounters	Degree of impact is determined by the frequency and intensity of encounters (inc. size, weight and mobility of individual gears)
Selectivity	Removability/ mortality of fauna/ flora	Removal/ mortality of structure forming epifauna/ flora (inc. bioturbating infauna)	Erect, large, rugose, inflexible, delicate epifauna and flora, and large or delicate and shallow burrowing infauna (at depths impacted by mobile gears) are preferentially removed or damaged.
	Areal extent	How much of each habitat is present	Effective degree of impact greater in rarer habitats: rarer habitats may maintain rarer species.
	Removability of substratum	Certain size classes can be removed	Intermediate sized clasts (~6 cm to 3 m) that form attachment sites for sessile fauna can be permanently removed
	Substratum hardness	Composition of substrata	Harder substratum is intrinsically more resistant
	Seabed slope	Mobility of substrata once dislodged; generally higher levels of structural fauna	Gravity or latent energy transfer assists movement of habitat structures, e.g., turbidity flows, larger clasts. Greater density of filter feeding animals found where currents move up and down slopes.
Productivity			
	Regeneration of fauna	Accumulation/ recovery of fauna	Fauna have different intrinsic growth and reproductive rates which are also variable in different conditions of temperature, nutrients, productivity.
	Natural disturbance	Level of natural disturbance affects intrinsic ability to recover	Frequently disturbed communities adapted to recover from disturbance

4.1.1 Level 2 PSA (Steps 2 and 3)

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

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

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

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

The PSA Tables also report on “missing information” (the number of attributes with missing data that therefore score at the highest risk level by default). There are seven attributes used to score productivity and four aspects (availability, encounterability, selectivity and post capture mortality) used to score susceptibility (though encounterability is the average of two attributes). An attribute or aspect is scored as missing if there are no data available to score it, and it has defaulted to high risk for this reason. For some species, attributes may be scored on information from related species or other supplementary information, and even though this information is indirect and less reliable than if species specific information was available, this is not scored as a missing attribute.

Observer data and observer expert knowledge are important sources of information in the PSA analyses, particularly for the bycatch and protected species components. The level of observer data for this fishery is regarded as low. An AFMA observer program was implemented in 1979, and coverage varies depending on the fishery and fishing location. Information on key commercial and byproduct species is well collected, and bycatch attempts are made, but may be compromised by taxonomic difficulties. Interactions with protected species are recorded, although again, taxonomic resolution may be weak for some taxa (e.g. whales and seabirds).

Summary of Habitats PSA results

The habitats component was not assessed at Level 2 as it was outside the project scope.

Summary of Communities PSA results

The communities component was not assessed at Level 2 as it was outside the project scope.

4.1.2 PSA Results for Individual Units of Analysis (Step 4-6)

The average productivity and susceptibility scores for each unit of analysis (e.g., for each species) are then used to place the individual units of analysis on 2D plots (as below). The relative position of the units on the plot will determine relative risk at the unit level as per PSA plot below. The overall risk value for a unit is the Euclidean distance from the origin of the graph. Units that fall in the upper third of the PSA plots are deemed to be at high risk. Units with a PSA score in the middle are at medium risk, while units in the lower third are at low risk with regard to the productivity and susceptibility attributes. The divisions between these risk categories are based on dividing the area of the PSA plots into equal thirds. If all productivity and susceptibility scores (scale 1-3) are assumed to be equally likely, then 1/3rd of the Euclidean overall risk values will be greater than 3.18 (high risk), 1/3rd will be between 3.18 and 2.64 (medium risk), and 1/3rd will be lower than 2.64 (low risk).

The PSA output allows identification and prioritization (via ranking the overall risk scores) of the units (e.g., species, habitat types, communities) at greatest risk to fishing activities. This prioritization means units with the lowest inherent productivity or highest susceptibility, which can only sustain the lowest level of impact, can be examined in detail. The overall risk of an individual unit will depend on the level of impact as well its productivity and susceptibility.

The overall risk value for each unit is the Euclidean distance from the origin to the location of the species on the PSA plot. The units are then divided into three risk categories, high, medium and low, according to the risk values described above.

4.1.3 Uncertainty Analysis Ranking of Overall Risk (Step 5)

The final PSA result for a species is obtained by ranking overall risk value resulting from scoring the productivity and susceptibility attributes. Uncertainty in the PSA results can arise when there is imprecise, incorrect or missing data, where an average for a higher taxonomic unit was used (e.g., average genera value for species units), or because an inappropriate attribute was included. The number of missing attributes, and hence conservative scores, is tallied for each unit of analysis. Units with missing scores will have a more conservative overall risk value than those species with fewer missing attributes, as the highest score for the attribute is used in the absence of data. Gathering the information to allow the attribute to be scored may reduce the overall risk value. Identification of high-risk units with missing attribute information should translate into prioritisation of additional research (an alternative strategy).

A second measure of uncertainty is due to the selection of the attributes. The influence of particular attributes on the final result for a unit of analysis (e.g., a habitat unit) can be quantified with an uncertainty analysis, using a Monte Carlo resampling technique. A set of productivity and susceptibility scores for each unit is calculated by removing one of the productivity or susceptibility attributes at a time, until all attribute combinations have been used. The variation (standard deviation) in the productivity and susceptibility scores is a measure of the uncertainty in the overall PSA score. If the uncertainty analysis shows that the unit would be treated differently with regard to risk, it should be the subject of more study.

The validity of the ranking can also be examined by comparing the results with those from other data sources or modelling approaches that have already been undertaken in specific fisheries. For example, the PSA results of the individual species (target, byproduct and bycatch and protected) can be compared against catch rates for any species or against completed stock assessments. These comparisons will show whether the PSA ranking agrees with these other sources of information or more rigorous approaches.

4.1.4 PSA Results and Discussion

Productivity Attributes

Available productivity attributes for each species used in a PSA and corresponding risk scores are listed in Table 4.4.

Table 4.4: Productivity attribute names and cutoff scores for the ERAF L2 PSA method. These cutoff scores have been determined from analysis of the distribution of attribute values for species in the ERAF database, and are intended to divide the attribute values into low, medium and high productivity categories.

Attribute number	Attribute name	Low productivity (risk score: 3)	Medium productivity (risk score: 2)	High productivity (risk score: 1)
P1	Average age at maturity	> 15 years	5 – 15 years	< 5 years
P2	Average max age	> 25 years	10-25 years	< 10 years
P3	Fecundity	< 100 eggs per year	100-20,000 eggs per year	> 20,000 eggs per year
P4	Average max size	> 300 cm	100-300 cm	< 100 cm
P5	Average size at Maturity	> 200 cm	40-200 cm	< 40 cm
P6	Reproductive strategy	Taxa is *Marine Bird* OR *Marine Mammal*	(Family is *Syngnathidae* OR *Solenostomidae*) OR (Reproductive Strategy is *Demersal Spawner* OR *Brooder*)	Reproductive Strategy is *Broadcast Spawner*
P7	Trophic level	> 3.25	2.75-3.25	< 2.75

Table 4.5: Susceptibility attribute names and cutoff scores for the ERAF L2 PSA method. These cutoffs have been determined from analysis of the distribution of attribute values for species in the ERAF database, and are intended to divide the attribute values into low, medium and high susceptibility categories.

Attribute number	Attribute name	Low susceptibility (risk score: 1)	Medium susceptibility (risk score: 2)	High susceptibility (risk score: 3)
S1	Availability	< 10% overlap	Continuous [1,3]	> 30% overlap
S2	Encounterability (habitat and bathymetry based)	Fishery Specific	Fishery Specific	Fishery Specific
S3	Selectivity (size based)	Fishery Specific	Fishery Specific	Fishery Specific
S4	Post-Capture Mortality (role in fishery based, protected Species based)	Some Protected (Live)	Byproduct or bycatch; Some protected (generally alive)	Key or secondary commercial; Some protected (likely to be dead)

Susceptibility Attributes

Available susceptibility attributes for each species used in a PSA and corresponding risk scores are listed in Table 4.5.

Post Capture Mortality

The following rules were used to assign a risk score to Post Capture Mortality (PCM), based on each species ERAEF classification (see also Table 4.6):

- Commercial, secondary commercial, commercial bait or byproduct species: score is 3.
- Bycatch species: score is 2
- Protected species (which are discarded), PCM is based on taxa, i.e.,
  - marine birds and marine reptiles: score is 3
  - marine mammals and chondrichthyans: score is 2
  - syngnathids: score is 1

Table 4.6: Post capture mortality attribute risk score for the Northern Prawn Fishery - Redleg Banana Prawn sub-fishery for the ERAEF L2 PSA and bSAFE methods. High: H; medium: M; Low: L. Risk scores that are not assigned by taxa (not specific) for each ERAEF classification are in italics.

Role in fishery	Taxa	Rationale	Risk category	Risk score
Key commercial	*Not specific*	Retained, therefore dead	H	3
Secondary commercial	*Not specific*	Retained, therefore dead	H	3
Commercial bait	*Not specific*	Retained, therefore dead	H	3
Byproduct	*Not specific*	Retained, therefore dead	H	3
Bycatch	*Not specific*	Discarded alive or dead	M	2
Protected Species	Marine birds	long duration set, if caught, highly likely to drown	H	3
	Marine reptiles	long duration set, if caught, highly likely to drown	H	3
	Marine mammals	large enough/strong swimming to have a chance of survival	M	2
	Chondrichthyans	large enough/strong swimming to have a chance of survival	M	2
	All others (e.g., syngnathids, invertebrates (if any))	Do not get hooked	L	1

Key Commercial Species

Under the revised ERAEF (AFMA, 2017), key commercial species were not assessed at Level 2.

Secondary Commercial Species

The secondary commercial species component was not evaluated in this assessment since it was eliminated at Level 1.

Commercial Bait Species

There are no commercial bait species to be assessed at Level 2 in this fishery.

Byproduct Species

All three byproduct species were assessed in the PSA. All three species were found to be at low risk (Figure 4.1 and Table 4.7). Of these, none were non-robust (i.e., data deficient) species (Figure 4.1).

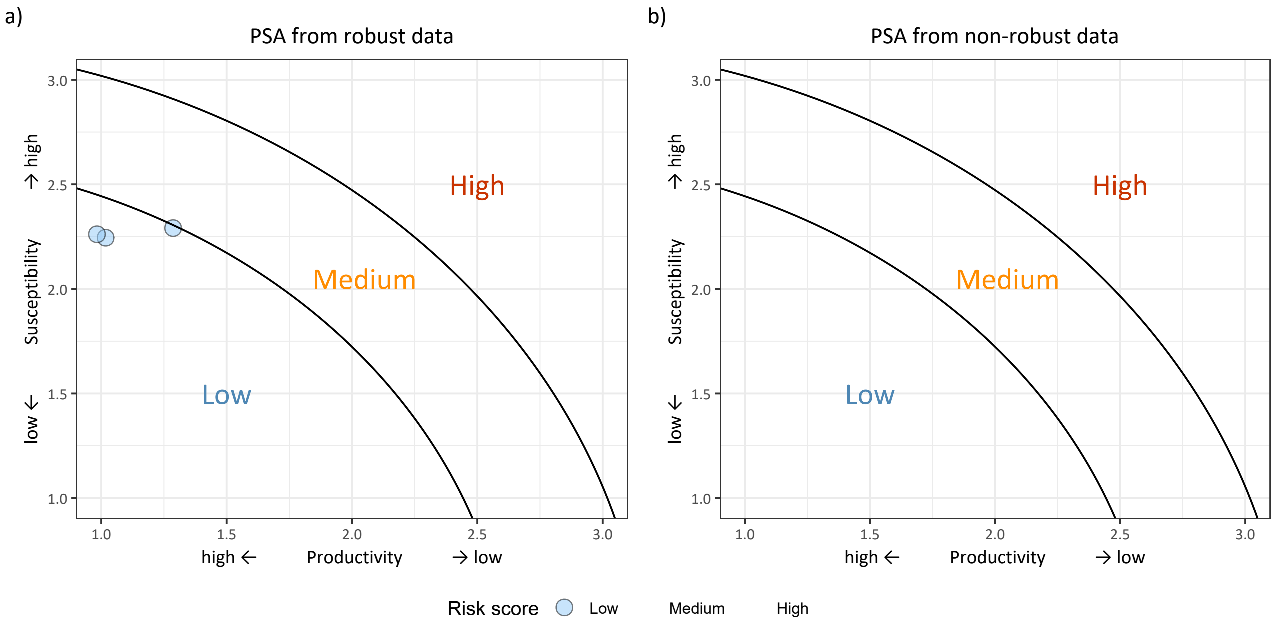


Figure 4.1: PSA plot for byproduct species in the Northern Prawn Fishery - Redleg Banana Prawn sub-fishery for (a) robust [left, less than three missing attributes] and (b) data deficient species [right, three or more missing attributes].

Table 4.7: Summary of the regular PSA scores on the set of productivity and susceptibility attributes for byproduct species and residual risk (RR) for high risk species. Productivity attributes (P1-P7) are listed in Table 4.4. Susceptibility attributes (S1-S4) are listed in Table 4.5. Missing attributes are highlighted (red). Productivity score (Prod. score); Susceptibility score (Susc. score).

CAAB code	Scientific name	Common name	P1	P2	P3	P4	P5	P6	P7	S1	S2	S3	S4	Prod. score	Susc. score	Missing attributes	PSA 2D	Risk category
28711047	Melicertus latisulcatus	Western King Prawn	1	1	1	1	1	1	1	1	2.9	3	3	1	2.26	0	2.47	Low
28711051	Penaeus monodon	Black Tiger Prawn - Leader Prawn	1	1	1	1	1	1	1	1	3	3	3	1	2.28	0	2.49	Low
28821007	Thenus parindicus	Mudbug	1	1	2	1	1	2	1	1	3	3	3	1.29	2.28	0	2.62	Low

Bycatch Species

A total of 82 out of 363 bycatch species were assessed in the PSA. Of these, 22 were unassessable in bSAFE. Of all assessed bycatch species, 20 were at high risk, 45 were at medium risk, and 17 were at low risk (Figure 4.2 and Table 4.8 and 4.9). Of these, 33 were non-robust (i.e., data deficient) species (Figure 4.2). Of the 20 high risk species, none have all 11 attributes, two are missing one to three attributes, and 18 are non-robust (i.e., missing more than three attributes). A residual risk analysis was performed on 20 species (Table 4.8 and 4.9; see also Section 4.6). Following the residual risk analysis, none of the 20 species remained at high risk, i.e., all species were reduced to medium risk. Therefore, overall, there were no high risk species, 65 medium risk species and 17 low risk species.

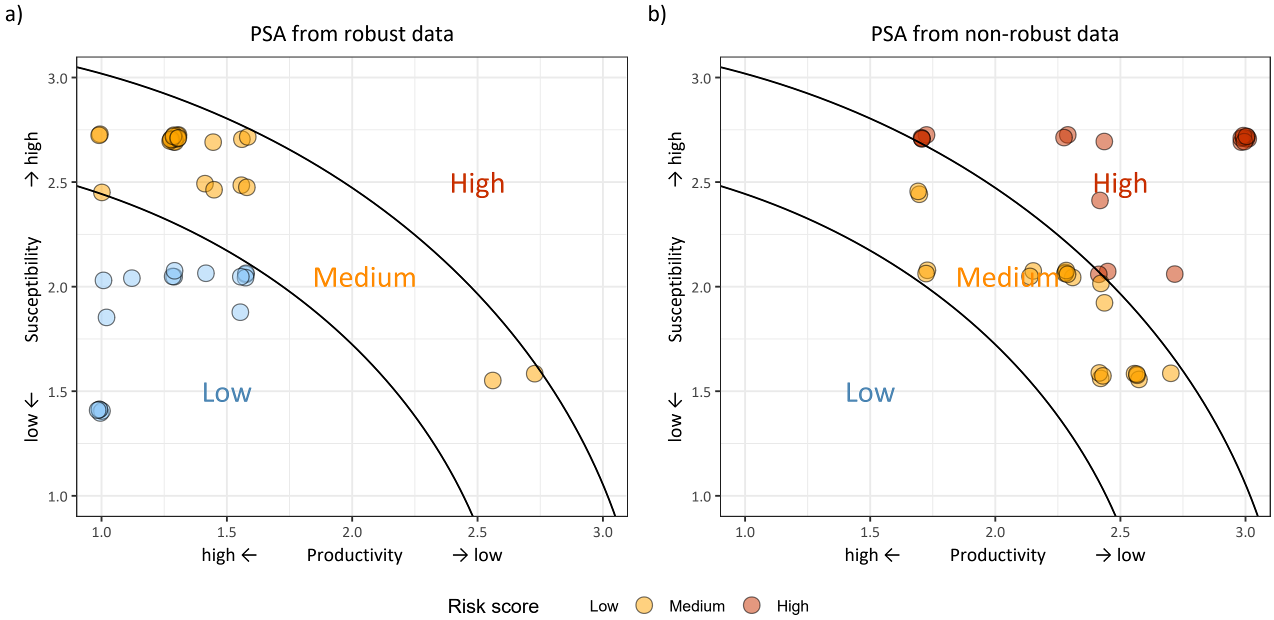


Figure 4.2: PSA plot for bycatch species in the Northern Prawn Fishery - Redleg Banana Prawn sub-fishery for (a) robust [left, less than three missing attributes] and (b) data deficient species [right, three or more missing attributes].

Table 4.8: Summary of the regular PSA scores on the set of productivity and susceptibility attributes for bycatch species and residual risk (RR) for high risk species. Productivity attributes (P1-P7) are listed in Table 4.4. Susceptibility attributes (S1-S4) are listed in Table 4.5. Missing attributes are highlighted (red). Productivity score (Prod. score); Susceptibility score (Susc. score). No. interactions (No. Int. 2017-2021) reported for high risk scores only (source: Commonwealth logbook (LOG) and Observer (AFMA OBS) databases). Residual risk guidelines drawn from document "Revision of residual risk guidelines to reflect updated Ecological Risk Assessment Methodology" - version Oct 12, 2016. See numbers in Table 4.1. NE: not entered. Ret: retained; dis: discarded. A: alive. D: dead. kg: kilograms. EPBC Act: Environment Protection and Biodiversity Act. IUCN: International Union of Conservation of Nature.

CAAB code	Scientific name	Common name	P1	P2	P3	P4	P5	P6	P7	S1	S2	S3	S4	Prod. score	Susc. score	Missing attributes	PSA 2D	Risk category	Interaction Numbers	Risk score following Residual Risk	Final risk score
23609004	*Euprymna hoylei*	A Dumpling Squid	3	3	3	3	3	3	3	3	3	3	2	3	2.71	9	4.04	High	Expanded from 23615000 (Order Teuthoidea), AFMA OBS: 346.97 kg dis.; 4080 animals dis.	Current population size and trend unknown. 3 – low/interaction capture. Risk reduced to Medium.	Medium
25030002	*Capillaster multiradiatus*	A Crinoid	3	3	3	3	3	3	3	3	3	3	2	3	2.71	10	4.04	High	Expanded from 25001000 (Class Crinoidea), AFMA OBS: 18.49 kg dis.; 537 animals dis.	Current population size and trend unknown. 3 – low/interaction capture. Risk reduced to Medium.	Medium
25030030	*Comatula pectinata*	A Crinoid (*continued*)	3	3	3	3	3	3	3	3	3	3	2	3	2.71	10	4.04	High	Expanded from 25001000 (Class Crinoidea), AFMA OBS: 18.49 kg dis.; 537 animals dis.	Current population size and trend unknown. 3 – low/interaction capture. Risk reduced to Medium.	Medium
25030031	*Comatula rotalaria*	A Crinoid (*continued*)	3	3	3	3	3	3	3	3	3	3	2	3	2.71	10	4.04	High	Expanded from 25001000 (Class Crinoidea), AFMA OBS: 18.49 kg dis.; 537 animals dis.	Current population size and trend unknown. 3 – low/interaction capture. Risk reduced to Medium.	Medium

Table 4.8: *(continued)*

CAAB code	Scientific name	Common name	P1	P2	P3	P4	P5	P6	P7	S1	S2	S3	S4	Prod. score	Susc. score	Missing attributes	PSA 2D	Risk category	Interaction Numbers	Risk score following Residual Risk	Final risk score
25030032	*Comatula solaris*	A Crinoid (*continued*)	3	3	3	3	3	3	3	3	3	3	2	3	2.71	10	4.04	High	Expanded from 25001000 (Class Crinoidea), AFMA OBS: 18.49 kg dis.; 537 animals dis.	Current population size and trend unknown. 3 – low/interaction capture. Risk reduced to Medium.	Medium
25105003	*Luidia hardwicki*	Seastar	3	3	3	1	1	3	2	3	3	3	2	2.29	2.71	4	3.55	High	Expanded from 25102000 (Class Asteroidea), AFMA OBS: 23.21 kg dis.; 336 animals dis.	Current population size and trend unknown. 3 – low/interaction capture. Risk reduced to Medium.	Medium
25105005	*Luidia maculata*	Seastar (*continued*)	3	3	3	1	1	3	2	3	3	3	2	2.29	2.71	4	3.55	High	Expanded from 25102000 (Class Asteroidea), AFMA OBS: 23.21 kg dis.; 336 animals dis.	Current population size and trend unknown. 3 – low/interaction capture. Risk reduced to Medium.	Medium
25122010	*Iconaster longimanus*	Seastar (*continued*)	3	3	3	3	3	3	3	3	3	3	2	3	2.71	10	4.04	High	Expanded from 25102000 (Class Asteroidea), AFMA OBS: 23.21 kg dis.; 336 animals dis.	Current population size and trend unknown. 3 – low/interaction capture. Risk reduced to Medium.	Medium
25122026	*Stellaster childreni*	Seastar (*continued*)	3	3	3	3	3	3	3	3	3	3	2	3	2.71	10	4.04	High	Expanded from 25102000 (Class Asteroidea), AFMA OBS: 23.21 kg dis.; 336 animals dis.	Current population size and trend unknown. 3 – low/interaction capture. Risk reduced to Medium.	Medium

Table 4.8: *(continued)*

CAAB code	Scientific name	Common name	P1	P2	P3	P4	P5	P6	P7	S1	S2	S3	S4	Prod. score	Susc. score	Missing attributes	PSA 2D	Risk category	Interaction Numbers	Risk score following Residual Risk	Final risk score
25124002	*Archaster typicus*	A Seastar	3	3	3	3	3	3	3	3	3	3	2	3	2.71	10	4.04	High	Expanded from 25102000 (Class Asteroidea), AFMA OBS. AFMA OBS: 23.21 kg dis.; 336 animals dis.	Current population size and trend unknown. 3 – low/interaction capture. Risk reduced to Medium.	Medium
25143013	*Metrodira subulata*	Seastar	3	3	3	1	1	3	3	3	3	3	2	2.43	2.71	6	3.64	High	Expanded from 25102000 (Class Asteroidea), AFMA OBS. AFMA OBS: 23.21 kg dis; 336 animals dis.	Current population size and trend unknown. 3 – low/interaction capture. Risk reduced to Medium.	Medium
25211004	*Chaetodiadema granulatum*	A Sea Urchin	3	3	3	3	3	3	3	3	3	3	2	3	2.71	9	4.04	High	Expanded from 25200000 (Class Echinoidea), AFMA OBS. AFMA OBS: 5.5 kg dis.; 344 animals dis.	Current population size and trend unknown. 3 – low/interaction capture. Risk reduced to Medium.	Medium
25266005	*Peronella lesueuri*	Sand Dollar	3	3	3	1	1	3	3	3	1.8	3	2	2.43	2.4	6	3.42	High	Expanded from 25200000 (Class Echinoidea), AFMA OBS. AFMA OBS: 5.5 kg dis; 344 animals dis.	Current population size and trend unknown. 3 – low/interaction capture. Risk reduced to Medium.	Medium

Table 4.8: *(continued)*

CAAB code	Scientific name	Common name	P1	P2	P3	P4	P5	P6	P7	S1	S2	S3	S4	Prod. score	Susc. score	Missing at-tributes	PSA 2D	Risk cate-gory	Interaction Numbers	Risk score following Residual Risk	Final risk score
28051030	*Dictyosquilla tuberculata*	Warty Mantis Shrimp	1	1	3	1	1	2	3	3	3	3	2	1.71	2.71	4	3.2	High	AFMA OBS: 0.39 kg dis., 13 animals dis. CREW OBS: 1.23 kg dis., 46 animals dis., comprising 21 alive; 9 dead; 16 unknown.	Current population size and trend unknown. 3 – low/interaction capture. Risk reduced to Medium.	Medium
28051035	*Harpiosquilla annandalei*	A Shrimp	1	1	3	1	1	2	3	3	3	3	2	1.71	2.71	3	3.2	High	Expanded from 2851000 (Squilidae), AFMA OBS: 167.0 kg dis., 7393 animals dis.	Current population size and trend unknown. 3 – low/interaction capture. Risk reduced to Medium.	Medium
28051036	*Harpiosquilla harpax*	A Mantis Shrimp	1	1	3	1	1	2	3	3	3	3	2	1.71	2.71	3	3.2	High	Expanded from 2851000 (Squilidae), AFMA OBS: 167.0 kg dis., 7393 animals dis.	Current population size and trend unknown. 3 – low/interaction capture. Risk reduced to Medium.	Medium
28051039	*Harpiosquilla stephensoni*	Stephenson's Mantis Shrimp	1	1	3	1	1	2	3	3	3	3	2	1.71	2.71	4	3.2	High	AFMA OBS: 0.22 kg dis., 2 animals dis.	Current population size and trend unknown. 3 – low/interaction capture. Risk reduced to Medium.	Medium
23270003	*Amusium pleuronectes*	Saucer Scallop; Mud Scallop	1	1	1	1	1	1	1	3	3	2	2	1	2.45	1	2.65	Medium	NE	No RR required	Medium

Table 4.8: *(continued)*

CAAB code	Scientific name	Common name	P1	P2	P3	P4	P5	P6	P7	S1	S2	S3	S4	Prod. score	Susc. score	Missing at-tributes	PSA 2D	Risk cate-gory	Interaction Numbers	Risk score following Residual Risk	Final risk score
23270007	*Pecten fumatus*	Commercial Scallop	1	1	1	1	1	1	1	3	3	3	2	1	2.71	1	2.89	Medium	NE	No RR required	Medium
23607015	*Metasepia pfefferi*	Flamboyant Cuttlefish	1	1	2	1	1	2	3	3	2.1	3	2	1.57	2.49	1	2.94	Medium	NE	No RR required	Medium
23607019	*Sepia cottoni*	A Cuttlefish	1	1	2	1	1	2	3	3	2.1	3	2	1.57	2.49	1	2.94	Medium	NE	No RR required	Medium
23617008	*Uroteuthis chinensis*	Loligo Squid	1	1	2	1	1	2	3	3	3	3	2	1.57	2.71	1	3.13	Medium	NE	No RR required	Medium
23617010	*Uroteuthis noctiluca*	Luminous Bay Squid	1	1	2	1	1	2	3	3	3	3	2	1.57	2.71	1	3.13	Medium	NE	No RR required	Medium
23636008	*Ornithoteuthis volatilis*	Long-Tailed Flying Squid	1	1	1	1	1	2	3	3	2.1	3	2	1.43	2.48	1	2.86	Medium	NE	No RR required	Medium
23636013	*Todaropsis eblanae*	Lesser Flying Squid	1	1	1	1	1	2	3	3	2.1	3	2	1.43	2.48	1	2.86	Medium	NE	No RR required	Medium
23636014	*Todarodes pusillus*	A Squid	1	1	1	1	1	2	3	3	3	3	2	1.43	2.71	1	3.06	Medium	NE	No RR required	Medium
28035004	*Manningia notialis*	A Mantis Shrimp	1	1	3	1	1	2	3	3	3	1	2	1.71	2.06	3	2.68	Medium	NE	No RR required	Medium
28051019	*Clorida granti*	A Shrimp	1	1	3	1	1	2	3	3	3	1	2	1.71	2.06	3	2.68	Medium	NE	No RR required	Medium
28051037	*Harpiosquilla melanoura*	A Shrimp (*continued*)	1	1	3	1	1	2	3	3	3	2	2	1.71	2.45	3	2.99	Medium	NE	No RR required	Medium
28051041	*Lenisquilla lata*	A Shrimp (*continued*)	1	1	3	1	1	2	3	3	3	2	2	1.71	2.45	3	2.99	Medium	NE	No RR required	Medium
28711046	*Penaeus pulchricaudatus*	Tiger Prawn	1	1	1	1	1	1	1	3	3	3	2	1	2.71	1	2.89	Medium	NE	No RR required	Medium
28821008	*Thenus australiensis*	Sandbug	1	1	2	1	1	2	1	3	3	3	2	1.29	2.71	1	3	Medium	NE	No RR required	Medium
28911002	*Charybdis natator*	Hairyback Crab	1	1	1	1	1	2	2	3	3	3	2	1.29	2.71	1	3	Medium	NE	No RR required	Medium
28911005	*Portunus armatus*	Blue Swimmer Crab	1	1	1	1	1	2	2	3	3	3	2	1.29	2.71	1	3	Medium	NE	No RR required	Medium
28911006	*Portunus sanguinolentus*	Three-Spotted Crab	1	1	1	1	1	2	2	3	3	3	2	1.29	2.71	1	3	Medium	NE	No RR required	Medium
28911015	*Charybdis truncata*	A Swimming Crab	1	1	1	1	1	2	2	3	3	3	2	1.29	2.71	1	3	Medium	NE	No RR required	Medium

Table 4.8: *(continued)*

CAAB code	Scientific name	Common name	P1	P2	P3	P4	P5	P6	P7	S1	S2	S3	S4	Prod. score	Susc. score	Missing attributes	PSA 2D	Risk category	Interaction Numbers	Risk score following Residual Risk	Final risk score
28911026	*Monomia rubromarginatus*	A Swimmer Crab	1	1	1	1	1	2	2	3	3	3	2	1.29	2.71	1	3	Medium	NE	No RR required	Medium
28911027	*Lupocycloporus gracilimanus*	A Swimmer Crab (*continued*)	1	1	1	1	1	2	2	3	3	3	2	1.29	2.71	1	3	Medium	NE	No RR required	Medium
28911032	*Monomia cf. argentata*	A Swimmer Crab (*continued*)	1	1	1	1	1	2	2	3	3	3	2	1.29	2.71	1	3	Medium	NE	No RR required	Medium
28911037	*Charybdis callianassa*	A Swimmer Crab (*continued*)	1	1	1	1	1	2	2	3	3	3	2	1.29	2.71	1	3	Medium	NE	No RR required	Medium
28911042	*Xiphonectes tenuipes*	A Swimmer Crab (*continued*)	1	1	1	1	1	2	2	3	3	3	2	1.29	2.71	1	3	Medium	NE	No RR required	Medium
28911070	*Xiphonectes rugosus*	A Swimmer Crab (*continued*)	1	1	1	1	1	2	2	3	3	3	2	1.29	2.71	1	3	Medium	NE	No RR required	Medium
28911075	*Charybdis jaubertensis*	A Swimmer Crab (*continued*)	1	1	1	1	1	2	2	3	3	3	2	1.29	2.71	1	3	Medium	NE	No RR required	Medium
23607003	*Sepia elliptica*	Ovalbone Cuttlefish	1	1	2	1	1	2	3	1	3	3	2	1.57	2.06	0	2.59	Low	NE	No RR required	Low
23607007	*Sepia papuensis*	Papuan Cuttlefish	1	1	2	1	1	2	3	1	3	2	2	1.57	1.86	0	2.43	Low	NE	No RR required	Low
23607008	*Sepia pharaonis*	Pharaoh Cuttlefish	1	1	2	1	1	2	3	1	3	3	2	1.57	2.06	0	2.59	Low	NE	No RR required	Low
23607011	*Sepia whitleyana*	Whitley's Cuttlefish	1	1	2	1	1	2	3	1	3	3	2	1.57	2.06	0	2.59	Low	NE	No RR required	Low
23607013	*Sepia smithi*	A Cuttlefish	1	1	2	1	1	2	3	1	3	3	2	1.57	2.06	0	2.59	Low	NE	No RR required	Low
23617006	*Sepioteuthis lessoniana*	Northern Calamari	1	1	2	1	1	2	2	1	3	3	2	1.43	2.06	0	2.51	Low	NE	No RR required	Low
28711003	*Atypopenaeus formosus*	Orange Prawn	1	1	1	1	1	1	1	1	3	2	2	1	1.86	0	2.11	Low	NE	No RR required	Low
28711016	*Metapenaeopsis novaeguineae*	Northern Velvet Prawn	1	1	1	1	1	1	1	1	1	2	2	1	1.41	0	1.73	Low	NE	No RR required	Low

Table 4.8: *(continued)*

CAAB code	Scientific name	Common name	P1	P2	P3	P4	P5	P6	P7	S1	S2	S3	S4	Prod. score	Susc. score	Missing at-tributes	PSA 2D	Risk cate-gory	Interaction Numbers	Risk score following Residual Risk	Final risk score
28711017	*Metapenaeopsis palmensis*	Southern Velvet Prawn	1	1	1	1	1	1	1	1	1	2	2	1	1.41	0	1.73	Low	NE	No RR required	Low
28711031	*Kishinouyepenaeopsis cornuta*	Coral Prawn	1	1	1	1	1	1	1	1	1	2	2	1	1.41	0	1.73	Low	NE	No RR required	Low
28711048	*Melicertus longistylus*	Redspot King Prawn	1	1	1	1	1	1	1	1	2.9	3	2	1	2.05	0	2.28	Low	NE	No RR required	Low
28711054	*Trachypenaeus anchoralis*	Northern Rough Prawn	1	1	1	1	1	1	1	1	1	2	2	1	1.41	0	1.73	Low	NE	No RR required	Low
28711057	*Megokris gonospinifer*	Rough Prawn	1	1	1	1	1	1	1	1	1	2	2	1	1.41	0	1.73	Low	NE	No RR required	Low
28714011	*Solenocera australiana*	Coral Prawn	1	1	1	1	1	1	2	3	1	3	2	1.14	2.06	1	2.35	Low	NE	No RR required	Low
28820006	*Panulirus ornatus*	Ornate Rocklobster	1	2	1	1	1	2	1	3	1	3	2	1.29	2.06	1	2.43	Low	NE	No RR required	Low
28820012	*Panulirus polyphagus*	Mud Rock Lobster	1	2	1	1	1	2	1	3	1	3	2	1.29	2.06	1	2.43	Low	NE	No RR required	Low
28820013	*Panulirus versicolor*	Painted Rocklobster - Green Cray	1	2	1	1	1	2	1	3	1	3	2	1.29	2.06	1	2.43	Low	NE	No RR required	Low

Table 4.9: Summary of the 'unassessable species in bSAFE' PSA scores on the set of productivity and susceptibility attributes for bycatch species and residual risk (RR) for high risk species. 22 BC species (listed at the top of the table) were found to be unassessable in bSAFE and were assessed in PSA instead. Productivity attributes (P1-P7) are listed in Table 4.4. Susceptibility attributes (S1-S4) are listed in Table 4.5. Missing attributes are highlighted (red). Productivity score (Prod. score); Susceptibility score (Susc. score). No. interactions (No. Int. 2017-2021) reported for high risk scores only (source: Commonwealth logbook (LOG) and Observer (AFMA OBS) databases). Residual risk guidelines drawn from document "Revision of residual risk guidelines to reflect updated Ecological Risk Assessment Methodology" - version Oct 12, 2016. See numbers in Table 4.1. NE: not entered. Ret: retained; dis: discarded. A: alive. D: dead. kg: kilograms. EPBC Act: Environment Protection and Biodiversity Act. IUCN: International Union of Conservation of Nature.

CAAB code	Scientific name	Common name	P1	P2	P3	P4	P5	P6	P7	S1	S2	S3	S4	Prod. score	Susc. score	Missing at-tributes	PSA 2D	Risk cate-gory	Interaction Numbers	Risk score following Residual Risk	Final risk score
37210010	*Tetrabrachium ocellatum*	Humpback Anglerfish	3	3	3	3	1	3	3	1	3	3	2	2.71	2.06	6	3.4	High	AFMA OBS: 1.45 kg dis., 73 animals dis.	Current population size and trend unknown. 3 – low/interaction capture. Risk reduced to Medium.	Medium
37466004	*Lactoria cornuta*	Longhorn Cowfish	3	3	3	1	1	3	3	1	3	3	2	2.43	2.06	4	3.19	High	Expanded from 37466000 (Ostraciidae), AFMA OBS. AFMA OBS: 1.82 kg dis., 35 animals dis.	Current population size and trend unknown. 3 – low/interaction capture. Risk reduced to Medium.	Medium
37466006	*Tetrosomus gibbosus*	Humpback Turretfish	3	3	3	1	1	3	3	1	3	3	2	2.43	2.06	4	3.19	High	Expanded from 37466000 (Ostraciidae), AFMA OBS. AFMA OBS: 1.82 kg dis., 35 animals dis.	Current population size and trend unknown. 3 – low/interaction capture. Risk reduced to Medium.	Medium
37013008	*Chiloscyllium punctatum*	Brownbanded Bambooshark	3	3	3	2	2	2	3	1	3	1	2	2.57	1.57	3	3.01	Medium	NE	No RR required	Medium
37018020	*Hemigaleus australiensis*	Sicklefin Weasel Shark	3	3	3	2	2	3	3	1	3	1	2	2.71	1.57	2	3.13	Medium	NE	No RR required	Medium

Table 4.9: *(continued)*

CAAB code	Scientific name	Common name	P1	P2	P3	P4	P5	P6	P7	S1	S2	S3	S4	Prod. score	Susc. score	Missing at-tributes	PSA 2D	Risk cate-gory	Interaction Numbers	Risk score following Residual Risk	Final risk score
37037001	*Gymnura australis*	Australian Butterfly Ray	3	3	3	1	2	3	3	1	3	1	2	2.57	1.57	2	3.01	Medium	NE	No RR required	Medium
37210003	*Tathicarpus butleri*	Butler's Frogfish	3	3	3	1	1	1	3	1	3	3	2	2.14	2.06	3	2.97	Medium	NE	No RR required	Medium
37225001	*Bregmaceros sp. (cf lanceolatus)*	Unicorn-Cod	3	3	3	3	1	3	2	1	1	3	2	2.57	1.57	6	3.01	Medium	NE	No RR required	Medium
37225002	*Bregmaceros mcclellandi*	Unicorn Codlet	3	3	3	3	1	3	3	1	1	3	2	2.71	1.57	6	3.13	Medium	NE	No RR required	Medium
37225003	*Bregmaceros atlanticus*	Antenna Codlet	3	3	3	3	1	3	2	1	1	3	2	2.57	1.57	6	3.01	Medium	NE	No RR required	Medium
37225005	*Bregmaceros nectabanus*	Australian Codlet	3	3	3	3	1	3	2	1	1	3	2	2.57	1.57	6	3.01	Medium	NE	No RR required	Medium
37287011	*Apistus carinatus*	Longfin Waspfish	3	3	3	1	1	3	3	1	1	3	2	2.43	1.57	4	2.89	Medium	NE	No RR required	Medium
37287033	*Apistops caloundra*	Shortfin Waspfish	3	3	3	1	1	3	3	1	1	3	2	2.43	1.57	4	2.89	Medium	NE	No RR required	Medium
37290004	*Adventor elongatus*	Sandpaper Velvetfish	3	3	3	1	1	3	3	1	1	3	2	2.43	1.57	4	2.89	Medium	NE	No RR required	Medium
37466005	*Ostracion nasus*	Shortnose Boxfish	3	3	3	1	1	3	2	1	3	3	2	2.29	2.06	4	3.08	Medium	NE	No RR required	Medium
37466007	*Lactoria diaphana*	Roundbelly Cowfish	3	3	3	1	1	3	2	1	3	3	2	2.29	2.06	4	3.08	Medium	NE	No RR required	Medium
37466008	*Tetrosomus reipublicae*	Smallspine Turretfish	3	3	3	1	1	3	3	1	2.7	3	2	2.43	2	4	3.15	Medium	NE	No RR required	Medium
37466009	*Ostracion rhinorhynchos*	Horn-Nose Boxfish	3	3	3	1	1	3	2	1	3	3	2	2.29	2.06	4	3.08	Medium	NE	No RR required	Medium
37466013	*Ostracion cubicus*	Yellow Boxfish	3	3	3	1	1	3	3	1	2.3	3	2	2.43	1.93	4	3.1	Medium	NE	No RR required	Medium
37466018	*Lactoria fornasini*	Thornback Cowfish	3	3	3	1	1	3	2	1	3	3	2	2.29	2.06	4	3.08	Medium	NE	No RR required	Medium
37466019	*Ostracion meleagris*	Black Boxfish	3	3	3	1	1	3	1	1	3	3	2	2.14	2.06	4	2.97	Medium	NE	No RR required	Medium
37466020	*Ostracion solorensis*	Striped Boxfish	3	3	3	1	1	3	2	1	3	3	2	2.29	2.06	4	3.08	Medium	NE	No RR required	Medium

Protected Species

All 29 protected species were assessed in the PSA. Four of these were additionally assigned to PSA instead of bSAFE as a precautionary approach. Of all assessed protected species, two were at high risk (Narrow Sawfish *Anoxypristis cuspidata*; Dwarf Sawfish *Pristis clavata*), 26 were at medium risk, and one was at low risk (Figure 4.3 and Table 4.10 and 4.11). Of these, none were non-robust (i.e., data deficient) species (Figure 4.3). Of the two high risk species, both have all 11 attributes. A residual risk analysis was performed on four species (Table 4.10 and 4.11; see also Section 4.6). Following the residual risk analysis, all of the four species were at high risk (Narrow Sawfish *Anoxypristis cuspidata*; Dwarf Sawfish *Pristis clavata*; Green Sawfish *Pristis zijsron*; Freshwater Sawfish *Pristis pristis*), i.e., two species were increased to high risk (from medium risk) and two remained at high risk. Therefore, overall, there were a total of four high risk species, 24 medium risk species and one low risk species.

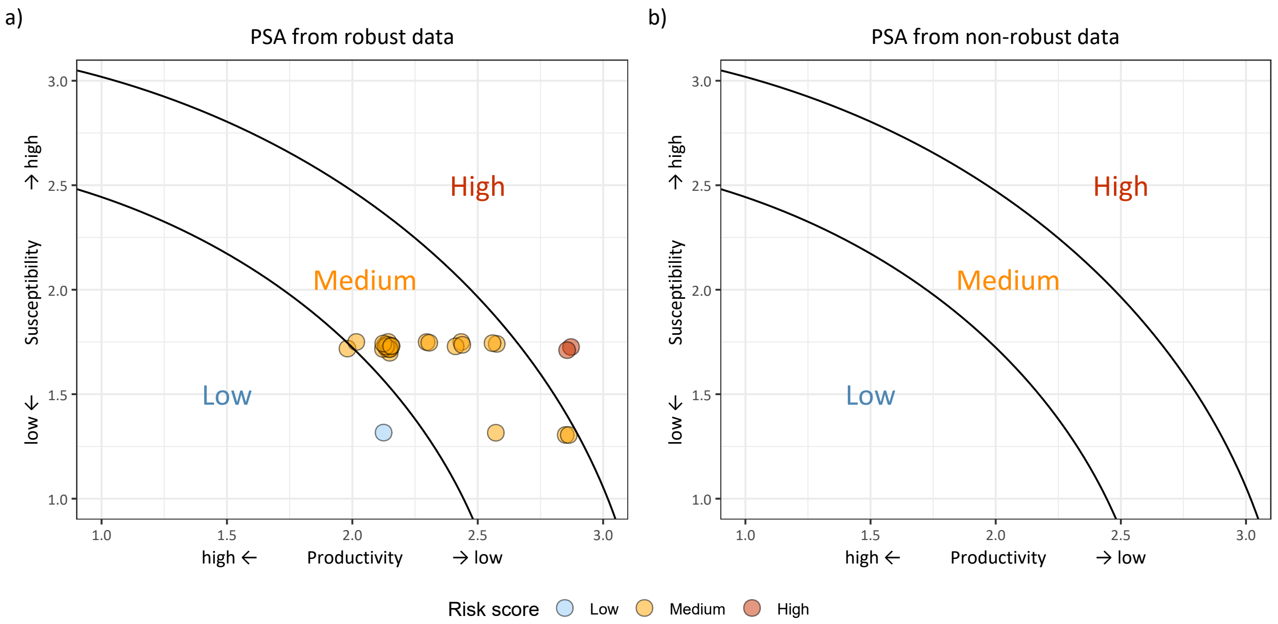


Figure 4.3: PSA plot for protected species in the Northern Prawn Fishery - Redleg Banana Prawn sub-fishery for (a) robust [left, less than three missing attributes] and (b) data deficient species [right, three or more missing attributes].

Table 4.10: Summary of the regular PSA scores on the set of productivity and susceptibility attributes for protected species and residual risk (RR) for high risk species. Productivity attributes (P1-P7) are listed in Table 4.4. Susceptibility attributes (S1-S4) are listed in Table 4.5. Missing attributes are highlighted (red). Productivity score (Prod. score); Susceptibility score (Susc. score).

CAAB code	Scientific name	Common name	P1	P2	P3	P4	P5	P6	P7	S1	S2	S3	S4	Prod. score	Susc. score	Missing attributes	PSA 2D	Risk category
39020001	Caretta caretta	Loggerhead Turtle	2	3	2	2	2	3	3	1	3	1	3	2.43	1.73	0	2.98	Medium
39020002	Chelonia mydas	Green Turtle	3	3	2	2	2	3	2	1	3	1	3	2.43	1.73	0	2.98	Medium
39020003	Eretmochelys imbricata	Hawksbill Turtle	3	3	2	2	2	3	2	1	3	1	3	2.43	1.73	0	2.98	Medium
39020004	Lepidochelys olivacea	Olive Ridley Turtle	3	3	3	1	2	3	3	1	3	1	3	2.57	1.73	0	3.1	Medium
39020005	Natator depressus	Flatback Turtle	2	3	3	2	2	3	3	1	3	1	3	2.57	1.73	1	3.1	Medium
39021001	Dermochelys coriacea	Leatherback Turtle	3	3	2	2	2	3	3	1	1	1	3	2.57	1.32	0	2.89	Medium
39125001	Hydrophis peronii	Horned Sea Snake	1	1	3	2	2	3	3	1	3	1	3	2.14	1.73	0	2.75	Medium
39125002	Aipysurus apraefrontalis	Short-Nosed Sea Snake	1	2	3	1	2	3	3	3	1	1	3	2.14	1.73	1	2.75	Medium
39125003	Aipysurus duboisii	Reef Shallows Sea Snake	1	2	3	2	2	3	3	1	3	1	3	2.29	1.73	0	2.87	Medium
39125004	Aipysurus mosaicus	Stagger-Banded Sea Snake	1	2	3	1	2	3	3	1	3	1	3	2.14	1.73	0	2.75	Medium
39125007	Aipysurus laevis	Golden Sea Snake	1	2	3	2	2	3	3	1	3	1	3	2.29	1.73	0	2.87	Medium
39125009	Hydrophis stokesii	Stokes' Sea Snake	1	1	3	2	2	3	3	1	3	1	3	2.14	1.73	0	2.75	Medium
39125010	Hydrophis kingii	Spectacled Sea Snake	1	1	3	2	2	3	3	1	3	1	3	2.14	1.73	0	2.75	Medium
39125011	Hydrophis major	Olive-Headed Sea Snake	1	1	3	2	2	3	3	1	3	1	3	2.14	1.73	0	2.75	Medium
39125012	Emydocephalus annulatus	Turtle-Headed Sea Snake	1	1	3	2	2	3	3	1	2.7	1	3	2.14	1.68	0	2.72	Medium
39125013	Hydrophis zweifeli	Beaked Sea Snake	1	1	3	2	2	3	3	1	3	1	3	2.14	1.73	0	2.75	Medium
39125016	Hydrophis atriceps	Black-Headed Sea Snake	1	1	3	2	2	3	3	1	3	1	3	2.14	1.73	0	2.75	Medium
39125018	Hydrophis caerulescens	Dwarf Sea Snake	1	1	3	1	2	3	3	1	3	1	3	2	1.73	0	2.64	Medium
39125021	Hydrophis elegans	Elegant Sea Snake	1	1	3	2	2	3	3	1	3	1	3	2.14	1.73	0	2.75	Medium
39125025	Hydrophis macdowelli	Small-Headed Sea Snake	1	1	3	1	2	3	3	1	3	1	3	2	1.73	0	2.64	Medium
39125028	Hydrophis ocellatus	A Sea Snake	1	1	3	2	2	3	3	1	3	1	3	2.14	1.73	0	2.75	Medium
39125029	Hydrophis pacificus	Large-Headed Sea Snake	1	1	3	2	2	3	3	1	3	1	3	2.14	1.73	0	2.75	Medium
39125031	Hydrophis curtus	Spine-Bellied Sea Snake	1	1	3	2	2	3	3	1	3	1	3	2.14	1.73	0	2.75	Medium
39125033	Hydrophis platurus	Yellow-Bellied Sea Snake	1	1	3	2	2	3	3	1	3	1	3	2.14	1.73	0	2.75	Medium

Table 4.10: *(continued)*

CAAB code	Scientific name	Common name	P1	P2	P3	P4	P5	P6	P7	S1	S2	S3	S4	Prod. score	Susc. score	Missing at-tributes	PSA 2D	Risk cate-gory
39125015	Hydrelaps darwiniensis	Black-Ringed Mangrove Sea Snake	1	1	3	2	2	3	3	1	1	1	3	2.14	1.32	0	2.51	Low

Table 4.11: Summary of the additional PSA scores on the set of productivity and susceptibility attributes for protected species and residual risk (RR) for high risk species. Productivity attributes (P1-P7) are listed in Table 4.4. Susceptibility attributes (S1-S4) are listed in Table 4.5. Missing attributes are highlighted (red). Productivity score (Prod. score); Susceptibility score (Susc. score). No. interactions (No. Int. 2017-2021) reported for high risk scores only (source: Commonwealth logbook (LOG) and Observer (AFMA OBS) databases). Residual risk guidelines drawn from document "Revision of residual risk guidelines to reflect updated Ecological Risk Assessment Methodology" - version Oct 12, 2016. See numbers in Table 4.1. NE: not entered. Ret: retained; dis: discarded. A: alive. D: dead. kg: kilograms. EPBC Act: Environment Protection and Biodiversity Act. IUCN: International Union of Conservation of Nature.

CAAB code	Scientific name	Common name	P1	P2	P3	P4	P5	P6	P7	S1	S2	S3	S4	Prod. score	Susc. score	Missing attributes	PSA 2D	Risk category	Interaction Numbers	Risk score following Residual Risk	Final risk score
37025002	*Anoxypristis cuspidata*	Narrow Sawfish	2	3	3	3	3	3	3	1	3	1	3	2.86	1.73	0	3.34	High	170 [93 A; 77 D]. Also, an unknown proportion of Pristidae, sawfishes – unidentified: 129 [58 A; 71 D]	Sawfish appear to have a high entanglement rate in trawl nets and escapement rates of sawfish from trawl nets through TED openings are low (observed underwater trawl video footage; FRDC Sawfish Mitigation Project). Post-release survival rates of sawfish are currently unknown. However, post capture mortality is high (88%) in nearby areas (east coast inshore Finfish fishery; Tobin et al. (2010)). The catch per unit effort (CPUE) trend between 2010-19 (and notably three overlapping years of this assessment period) for Narrow Sawfish in Region 6 (Gulf of Carpentaria), is flat based on survey data (Fry et al., 2021). There are currently no estimated catch rate trends corresponding to the JBG Box.	High
		Narrow Sawfish (*continued*)																High		In Australia, this species is listed as migratory (EPBC Act) and endangered elsewhere (IUCN Redlist). The presence of distinct sub-populations suggests that if local depletion occurs, it would not be replenished by adjacent locations (i.e. between eastern and western part of range; D'Anastasi (2010)). The risk score remains High.	High

Table 4.11: *(continued)*

CAAB code	Scientific name	Common name	P1	P2	P3	P4	P5	P6	P7	S1	S2	S3	S4	Prod. score	Susc. score	Missing at-tributes	PSA 2D	Risk cate-gory	Interaction Numbers	Risk score following Residual Risk	Final risk score
37025004	*Pristis clavata*	Dwarf Sawfish	2	3	3	3	3	3	3	1	3	1	3	2.86	1.73	0	3.34	High	4 [2 A; 2 D]. Also, an unknown proportion of Pristidae, sawfishes – unidentified: 129 [58 A; 71 D]	Sawfish appear to have a high entanglement rate in trawl nets and escapement rates of sawfish from trawl nets through TED openings are low (observed underwater trawl video footage; FRDC Sawfish Mitigation Project). Post-release survival rates of sawfish are currently unknown. This species has low biological productivity, matures at 8 years and is long lived (34 years; Peverell (2009)). In Australia, this species is listed as vulnerable (EPBC Act) and critically endangered elsewhere (IUCN Redlist). No population estimates are available, and this species occurs now only in Australia, as there have been no records elsewhere in the world for more than a century (https://www.iucnssg.org/regional-fast-facts-australia.html).	High
		Dwarf Sawfish (*continued*)																High		Also, trends in catch-per-unit-effort (CPUE) are based on too few data points and only one within the assessment period (2013; Fry et al., (2018)) and no recent indices from population monitoring (Fry et al., 2021). This species has the smallest distribution of any sawfish species in Australia. There may be local refuges where commercial fishing does not occur, but given there are no verified population estimates, and unknown PCS rates, the risk remains High.	High

Table 4.11: *(continued)*

CAAB code	Scientific name	Common name	P1	P2	P3	P4	P5	P6	P7	S1	S2	S3	S4	Prod. score	Susc. score	Missing at-tributes	PSA 2D	Risk cate-gory	Interaction Numbers	Risk score following Residual Risk	Final risk score
37025001	*Pristis zijsron*	Green Sawfish	2	3	3	3	3	3	3	1	1	1	3	2.86	1.32	0	3.15	Medium	38 [28 A; 10 D]. Also, an unknown proportion of Pristidae, sawfishes – unidentified: 129 [58 A; 71 D]	Sawfish appear to have a high entanglement rate in trawl nets and escapement rates of sawfish from trawl nets through TED openings are low (observed underwater trawl video footage; FRDC Sawfish Mitigation Project). Post-release survival rates of sawfish are currently unknown. However, post capture mortality is high (100%) in nearby areas (east coast inshore Finfish fishery; Tobin et al 2010). No population estimates are available. Also, trends in catch-per-unit-effort (CPUE) from population monitoring surveys are based on too few data points and only one within the assessment period (2013, 15, 18; Fry et al. (2021)). This species is long lived (>50 years), grows slowly, matures late (9 years) and has low fecundity (Peverell, 2009).	High
		Green Sawfish (*continued*)																Medium		In Australia, this species is listed as vulnerable (EPBC Act) and critically endangered elsewhere (IUCN Redlist). This species is listed as vulnerable, it has low biological productivity, no available population estimates in northern Australia or trends in CPUE are available, vulnerable to capture by trawl nets and have 100% PCM estimates. Therefore, the risk has been changed to a (precautionary) High.	High

Table 4.11: *(continued)*

CAAB code	Scientific name	Common name	P1	P2	P3	P4	P5	P6	P7	S1	S2	S3	S4	Prod. score	Susc. score	Missing at-tributes	PSA 2D	Risk cate-gory	Interaction Numbers	Risk score following Residual Risk	Final risk score
37025003	*Pristis pristis*	Freshwater Sawfish	2	3	3	3	3	3	3	1	1	1	3	2.86	1.32	0	3.15	Medium	18 [15 A; 3 D]. Also, an unknown proportion of Pristidae, sawfishes – unidentified: 129 [58 A; 71 D]	Sawfish appear to have a high entanglement rate in trawl nets and escapement rates of sawfish from trawl nets through TED openings are low (observed underwater trawl video footage; FRDC Sawfish Mitigation Project). Post-release survival rates of sawfish are currently unknown. This species is long lived (44 years), grows slowly, matures late (8-10 years); and has low fecundity (Peverell, 2009). In Australia, this species is listed as vulnerable (EPBC Act) and critically endangered elsewhere (IUCN Redlist).	High
		Freshwater Sawfish (*continued*)																Medium		This has low biological productivity, no population abundance estimates in northern Australia or trends in CPUE from population monitoring surveys are based on too few data points and only one within the assessment period (Fry et al., 2018, 2021). This species is also highly vulnerable to capture by trawl nets. Therefore, the risk has been changed to (precautionary) High. trends in catch-per-unit-effort (CPUE)	High

4.2 bSAFE Results and Discussion

Each of the reference points (MSM, LIM, and CRASH) were evaluated. If the biological reference point mean was higher than the estimated F attributed to this sub-fishery, then the species was categorised as *Below*. When the biological reference point mean was lower than the estimated F attributed to the sub-fishery, then the species was categorised as *Above* for that species and reference point measure. The overall risk is a summary of the three reference point measures (Table 4.12). If all reference points are categorised as *Below*, then the overall risk is low.

Table 4.12: Overall risk summary against each of the three reference point measures.

MSM	LIM	CRASH	Overall risk
Below	Below	Below	Low
Above	Below	Below	Medium
Above	Above	Below	High
Above	Above	Above	Extreme

4.2.1 bSAFE – Key Commercial Species

Under the revised ERAEF (AFMA, 2017), key commercial species were not assessed at Level 2.

4.2.2 bSAFE - Secondary Commercial Species

The secondary commercial species component was not evaluated in this assessment since it was eliminated at Level 1.

TODO: FILL OUT ManualInput/Level2/bSAFE_C2_after.Rmd

EXAMPLE:

Some additional text on bSAFE analysis

4.2.3 bSAFE - Commercial Bait Species

There are no commercial bait species to be assessed at Level 2 in this fishery.

4.2.4 bSAFE - Byproduct Species

There were no byproduct species assessed in the bSAFE.

4.2.5 bSAFE - Bycatch Species

There were 303 out of 363 bycatch species considered in the bSAFE (Figure 4.4 and Table 4.13). Twenty-two species were unassessable due to missing biological attributes employed in the bSAFE method (classified as NA - not assessable in Table 4.13). Of the remaining 281 species, all 281 species were below the three reference points (low risk), none were medium risk (i.e., above the bSAFE-MSM reference point), and none were high or extreme risk (i.e., above the bSAFE-MSM and bSAFE-LIM reference points, Table 4.13).

Table 4.13: bSAFE risk categories for bycatch species ecological component for F_{MSM}, F_{Lim}, and F_{Crash}. 22 BC species (listed at the top of the table) were found to be unassessable in bSAFE and were assessed in PSA instead.

CAAB code	Scientific name	Common name	Susceptibility	F MSM	F MSM risk	F Lim	F Lim risk	F Crash	F Crash risk	F overall risk
37013008	*Chiloscyllium punctatum*	Brownbanded Bambooshark	0.001	-	NA	-	NA	-	NA	Assessed in PSA (Table 4.8)

Table 4.13: *(continued)*

CAAB code	Scientific name	Common name	Susceptibility	F MSM	F MSM risk	F Lim	F Lim risk	F Crash	F Crash risk	F overall risk
37018020	*Hemigaleus australiensis*	Sicklefin Weasel Shark	0.001	-	NA	-	NA	-	NA	Assessed in PSA (Table 4.8)
37037001	*Gymnura australis*	Australian Butterfly Ray	<0.001	-	NA	-	NA	-	NA	Assessed in PSA (Table 4.8)
37210003	*Tathicarpus butleri*	Butler's Frogfish	0.001	-	NA	-	NA	-	NA	Assessed in PSA (Table 4.8)
37210010	*Tetrabrachium ocellatum*	Humpback Anglerfish	0.003	-	NA	-	NA	-	NA	Assessed in PSA (Table 4.8)
37225001	*Bregmaceros sp. (cf lanceolatus)*	Unicorn-Cod	0.001	-	NA	-	NA	-	NA	Assessed in PSA (Table 4.8)
37225002	*Bregmaceros mcclellandi*	Unicorn Codlet	0.001	-	NA	-	NA	-	NA	Assessed in PSA (Table 4.8)
37225003	*Bregmaceros atlanticus*	Antenna Codlet	0.001	-	NA	-	NA	-	NA	Assessed in PSA (Table 4.8)
37225005	*Bregmaceros nectabanus*	Australian Codlet	0.001	-	NA	-	NA	-	NA	Assessed in PSA (Table 4.8)
37287011	*Apistus carinatus*	Longfin Waspfish	0.001	-	NA	-	NA	-	NA	Assessed in PSA (Table 4.8)
37287033	*Apistops caloundra*	Shortfin Waspfish	<0.001	-	NA	-	NA	-	NA	Assessed in PSA (Table 4.8)
37290004	*Adventor elongatus*	Sandpaper Velvetfish	0.001	-	NA	-	NA	-	NA	Assessed in PSA (Table 4.8)

Table 4.13: *(continued)*

CAAB code	Scientific name	Common name	Susceptibility	F MSM	F MSM risk	F Lim	F Lim risk	F Crash	F Crash risk	F overall risk
37466004	*Lactoria cornuta*	Longhorn Cowfish	0.001	-	NA	-	NA	-	NA	Assessed in PSA (Table 4.8)
37466005	*Ostracion nasus*	Shortnose Boxfish	0.002	-	NA	-	NA	-	NA	Assessed in PSA (Table 4.8)
37466006	*Tetrosomus gibbosus*	Humpback Turretfish	0.003	-	NA	-	NA	-	NA	Assessed in PSA (Table 4.8)
37466007	*Lactoria diaphana*	Roundbelly Cowfish	0.002	-	NA	-	NA	-	NA	Assessed in PSA (Table 4.8)
37466008	*Tetrosomus reipublicae*	Smallspine Turretfish	0.002	-	NA	-	NA	-	NA	Assessed in PSA (Table 4.8)
37466009	*Ostracion rhinorhynchos*	Horn-Nose Boxfish	0.001	-	NA	-	NA	-	NA	Assessed in PSA (Table 4.8)
37466013	*Ostracion cubicus*	Yellow Boxfish	0.001	-	NA	-	NA	-	NA	Assessed in PSA (Table 4.8)
37466018	*Lactoria fornasini*	Thornback Cowfish	0.003	-	NA	-	NA	-	NA	Assessed in PSA (Table 4.8)
37466019	*Ostracion meleagris*	Black Boxfish	0.001	-	NA	-	NA	-	NA	Assessed in PSA (Table 4.8)
37466020	*Ostracion solorensis*	Striped Boxfish	0.001	-	NA	-	NA	-	NA	Assessed in PSA (Table 4.8)
37013010	*Nebrius ferrugineus*	Tawny Shark	<0.001	0.0425	Below	0.0637	Below	0.0849	Below	Low
37018005	*Loxodon macrorhinus*	Sliteye Shark	0.001	0.1138	Below	0.1706	Below	0.2275	Below	Low
37018006	*Rhizoprionodon acutus*	Milk Shark	<0.001	0.2177	Below	0.3265	Below	0.4353	Below	Low

Table 4.13: *(continued)*

CAAB code	Scientific name	Common name	Susceptibility	F MSM	F MSM risk	F Lim	F Lim risk	F Crash	F Crash risk	F overall risk
37018009	*Carcharhinus coatesi*	Whitecheek Shark	<0.001	0.0847	Below	0.1271	Below	0.1694	Below	Low
37018013	*Carcharhinus sorrah*	Spot-Tail Shark	<0.001	0.1403	Below	0.2105	Below	0.2807	Below	Low
37018014	*Carcharhinus tilstoni*	Australian Blacktip Shark	<0.001	0.0989	Below	0.1483	Below	0.1978	Below	Low
37018023	*Carcharhinus brevipinna*	Spinner Shark	<0.001	0.0754	Below	0.1131	Below	0.1508	Below	Low
37018034	*Carcharhinus cautus*	Nervous Shark	<0.001	0.0667	Below	0.1001	Below	0.1335	Below	Low
37018039	*Carcharhinus limbatus*	Blacktip Shark	<0.001	0.0969	Below	0.1453	Below	0.1937	Below	Low
37019001	*Sphyrna lewini*	Scalloped Hammerhead	<0.001	0.068	Below	0.1021	Below	0.1361	Below	Low
37019003	*Eusphyra blochii*	Winghead Shark	<0.001	0.094	Below	0.141	Below	0.188	Below	Low
37020001	*Centrophorus moluccensis*	Endeavour Dogfish	<0.001	0.0493	Below	0.074	Below	0.0987	Below	Low
37026005	*Rhynchobatus australiae*	Whitespotted Guitarfish	0.001	0.1073	Below	0.1609	Below	0.2145	Below	Low
37035004	*Neotrygon australiae*	Bluespotted Maskray	0.003	0.1089	Below	0.1634	Below	0.2178	Below	Low
37035012	*Neotrygon annotata*	Plain Maskray	0.001	0.1057	Below	0.1585	Below	0.2114	Below	Low
37035020	*Maculabatis astra*	Blackspotted Whipray	0.001	0.1016	Below	0.1524	Below	0.2032	Below	Low
37039002	*Aetomylaeus caeruleofascia-tus*	Banded Eagle Ray	<0.001	0.0704	Below	0.1056	Below	0.1409	Below	Low
37063002	*Muraenesox cinereus*	Daggertooth Pike Conger	<0.001	0.2333	Below	0.3499	Below	0.4666	Below	Low
37063003	*Muraenesox bagio*	Common Pike Eel	0.001	0.2333	Below	0.3499	Below	0.4666	Below	Low
37067015	*Conger cinereus*	Blacklip Conger	<0.001	0.2272	Below	0.3408	Below	0.4544	Below	Low
37085006	*Amblygaster sirm*	Spotted Sardinella	<0.001	1.1912	Below	1.7868	Below	2.3824	Below	Low
37085007	*Herklotsichthys koningsbergeri*	Largespotted Herring	<0.001	0.94	Below	1.4099	Below	1.8799	Below	Low
37085008	*Herklotsichthys lippa*	Smallspotted Herring	<0.001	0.94	Below	1.4099	Below	1.8799	Below	Low
37085009	*Pellona ditchela*	Indian Pellona	<0.001	0.9035	Below	1.3552	Below	1.807	Below	Low
37085014	*Sardinella albella*	White Sardinella	<0.001	0.7867	Below	1.1801	Below	1.5734	Below	Low

Table 4.13: *(continued)*

CAAB code	Scientific name	Common name	Susceptibility	F MSM	F MSM risk	F Lim	F Lim risk	F Crash	F Crash risk	F overall risk
37085015	*Anodontostoma chacunda*	Chacunda Gizzard Shad	<0.001	0.7073	Below	1.061	Below	1.4146	Below	Low
37085016	*Nematalosa come*	Western Pacific Gizzard Shad	<0.001	0.7304	Below	1.0955	Below	1.4607	Below	Low
37085024	*Herklotsichthys gotoi*	Darwin Herring	<0.001	0.94	Below	1.4099	Below	1.8799	Below	Low
37086004	*Thryssa setirostris*	Longjaw Thryssa	<0.001	1.4619	Below	2.1929	Below	2.9238	Below	Low
37086005	*Thryssa hamiltonii*	Hamilton's Thryssa	<0.001	1.4109	Below	2.1163	Below	2.8218	Below	Low
37086008	*Setipinna tenuifilis*	Common Hairfin Anchovy	<0.001	1.5073	Below	2.261	Below	3.0147	Below	Low
37118001	*Saurida undosquamis*	Brushtooth Lizardfish	0.001	0.5534	Below	0.8301	Below	1.1068	Below	Low
37118002	*Trachinocephalus trachinus*	Snakefish	0.001	0.5289	Below	0.7934	Below	1.0579	Below	Low
37118005	*Saurida argentea*	Shortfin Saury	0.003	0.5169	Below	0.7753	Below	1.0337	Below	Low
37118028	*Saurida tumbil*	Common Saury	0.001	0.4854	Below	0.7281	Below	0.9708	Below	Low
37119001	*Harpadon translucens*	Glassy Bombay Duck	0.003	0.7434	Below	1.1151	Below	1.4868	Below	Low
37122079	*Benthosema pterotum*	Opaline Lanternfish	<0.001	1.106	Below	1.6591	Below	2.2121	Below	Low
37188001	*Netuma thalassina*	Giant Sea Catfish	0.002	0.2784	Below	0.4176	Below	0.5568	Below	Low
37192003	*Euristhmus nudiceps*	Nakedhead Catfish	0.002	0.43	Below	0.6451	Below	0.8601	Below	Low
37192004	*Euristhmus lepturus*	Longtail Catfish	<0.001	0.43	Below	0.6451	Below	0.8601	Below	Low
37208001	*Lophiomus setigerus*	Broadhead Goosefish	<0.001	0.2544	Below	0.3815	Below	0.5087	Below	Low
37225004	*Bregmaceros japonicus*	Japanese Codlet	<0.001	-	Below	-	Below	-	Below	Low
37225007	*Bregmaceros pseudolanceo-latus*	A Codlet	<0.001	-	Below	-	Below	-	Below	Low
37228005	*Sirembo imberbis*	Golden Cusk	<0.001	0.1974	Below	0.2961	Below	0.3948	Below	Low
37234016	*Hyporhamphus affinis*	Tropical Garfish	<0.001	0.5901	Below	0.8851	Below	1.1802	Below	Low
37246005	*Atherinomorus endrachtensis*	Endracht Hardyhead	<0.001	0.7178	Below	1.0766	Below	1.4355	Below	Low
37288009	*Pterygotrigla elicryste*	Dwarf Gurnard	<0.001	0.4778	Below	0.7167	Below	0.9556	Below	Low

Table 4.13: *(continued)*

CAAB code	Scientific name	Common name	Susceptibility	F MSM	F MSM risk	F Lim	F Lim risk	F Crash	F Crash risk	F overall risk
37288010	*Lepidotrigla cf japonica*	Red Spot Gurnard	0.002	0.6195	Below	0.9293	Below	1.239	Below	Low
37288014	*Bovitrigla leptacanthus*	Bullhead Gurnard	<0.001	0.495	Below	0.7424	Below	0.9899	Below	Low
37288015	*Lepidotrigla sp. 2 [in Sainsbury et al, 1985]*	Mottled Red Spot Gurnard	0.001	0.617	Below	0.9255	Below	1.234	Below	Low
37288016	*Lepidotrigla russelli*	Smooth Gurnard	<0.001	0.6195	Below	0.9293	Below	1.239	Below	Low
37288017	*Lepidotrigla cf bispinosa [Gomon, pers comm]*	A Searobin	<0.001	0.6159	Below	0.9239	Below	1.2319	Below	Low
37288020	*Lepidotrigla cf grandis (A) [Gomon, pers comm]*	Supreme Gurnard	<0.001	0.6159	Below	0.9239	Below	1.2319	Below	Low
37288027	*Lepidotrigla punctipec-toralis*	Finspot Gurnard	0.000	0.6195	Below	0.9293	Below	1.239	Below	Low
37288032	*Lepidotrigla argus*	Eye Gurnard	<0.001	0.6195	Below	0.9293	Below	1.239	Below	Low
37288033	*Lepidotrigla grandis*	Little Red Gurnard	<0.001	0.6195	Below	0.9293	Below	1.239	Below	Low
37296010	*Inegocia harrisii*	Harris' Flathead	0.004	0.3899	Below	0.5849	Below	0.7798	Below	Low
37296013	*Elates ransonnettii*	Dwarf Flathead	0.002	0.3899	Below	0.5849	Below	0.7798	Below	Low
37296018	*Cociella hutchinsi*	Brownmargin Flathead	0.002	0.3899	Below	0.5849	Below	0.7798	Below	Low
37296029	*Inegocia japonica*	Japanese Flathead	0.003	0.3899	Below	0.5849	Below	0.7798	Below	Low
37296030	*Rogadius tuberculatus*	Tuberculate Flathead	0.003	0.3899	Below	0.5849	Below	0.7798	Below	Low
37296054	*Rogadius pristiger*	Thorny Flathead	0.003	0.3899	Below	0.5849	Below	0.7798	Below	Low
37311007	*Epinephelus coioides*	Orange-Spotted Grouper, Goldspotted Rockcod	0.001	0.2755	Below	0.4132	Below	0.5509	Below	Low
37311017	*Epinephelus sexfasciatus*	Sixbar Grouper	0.003	0.333	Below	0.4995	Below	0.666	Below	Low
37311028	*Parascombrops philippinensis*	Sharptooth Seabass	<0.001	0.4276	Below	0.6413	Below	0.8551	Below	Low

Table 4.13: *(continued)*

CAAB code	Scientific name	Common name	Susceptibility	F MSM	F MSM risk	F Lim	F Lim risk	F Crash	F Crash risk	F overall risk
37311061	*Epinephelus lanceolatus*	Giant Grouper	0.001	0.2004	Below	0.3005	Below	0.4007	Below	Low
37321001	*Pelates quadrilineatus*	Fourlined Terapon	<0.001	0.8491	Below	1.2737	Below	1.6982	Below	Low
37321002	*Terapon jarbua*	Jarbua Terapon	<0.001	0.7661	Below	1.1492	Below	1.5323	Below	Low
37321003	*Terapon theraps*	Largescaled Terapon	<0.001	0.8908	Below	1.3362	Below	1.7816	Below	Low
37321006	*Terapon puta*	Spinycheek Grunter	<0.001	0.85	Below	1.2751	Below	1.7001	Below	Low
37326003	*Priacanthus tayenus*	Purple-Spotted Bigeye	0.001	0.748	Below	1.122	Below	1.496	Below	Low
37327008	*Ostorhinchus fasciatus*	Broadbanded Cardinalfish	<0.001	1.6353	Below	2.4529	Below	3.2705	Below	Low
37327013	*Jaydia truncata*	Flagfin Cardinalfish	0.001	1.1878	Below	1.7817	Below	2.3756	Below	Low
37327014	*Ozichthys albimaculosus*	Creamspotted Cardinalfish	0.002	1.1878	Below	1.7817	Below	2.3756	Below	Low
37327016	*Jaydia melanopus*	Monster Cardinalfish	0.001	1.1878	Below	1.7817	Below	2.3756	Below	Low
37327026	*Jaydia poecilopterus*	Pearlyfin Cardinalfish	0.002	1.1878	Below	1.7817	Below	2.3756	Below	Low
37330003	*Sillago analis*	Sand Whiting	<0.001	0.6691	Below	1.0037	Below	1.3382	Below	Low
37330004	*Sillago burrus*	Western Trumpeter Whiting	0.001	0.9672	Below	1.4507	Below	1.9343	Below	Low
37330005	*Sillago robusta*	Stout Whiting	0.004	0.722	Below	1.0831	Below	1.4441	Below	Low
37330006	*Sillago sihama*	Northern Whiting	<0.001	0.7561	Below	1.1342	Below	1.5122	Below	Low
37330007	*Sillago lutea*	Mud Whiting	0.003	0.7574	Below	1.1361	Below	1.5147	Below	Low
37330009	*Sillago ingenuua*	Bay Whiting	0.004	0.7047	Below	1.0571	Below	1.4094	Below	Low
37330015	*Sillago maculata*	Trumpeter Whiting	0.001	0.7047	Below	1.0571	Below	1.4094	Below	Low
37333001	*Lactarius lactarius*	False Trevally	0.000	0.7608	Below	1.1411	Below	1.5215	Below	Low
37335001	*Rachycentron canadum*	Cobia	<0.001	0.3377	Below	0.5065	Below	0.6753	Below	Low
37337002	*Trachurus declivis*	Common Jack Mackerel	<0.001	0.4724	Below	0.7087	Below	0.9449	Below	Low
37337005	*Carangoides malabaricus*	Malabar Trevally	<0.001	0.6778	Below	1.0168	Below	1.3557	Below	Low
37337008	*Selar boops*	Oxeye Scad	<0.001	0.7934	Below	1.19	Below	1.5867	Below	Low

Table 4.13: *(continued)*

CAAB code	Scientific name	Common name	Susceptibility	F MSM	F MSM risk	F Lim	F Lim risk	F Crash	F Crash risk	F overall risk
37337009	*Selar crumenoph-thalmus*	Bigeye Scad	<0.001	0.7119	Below	1.0678	Below	1.4237	Below	Low
37337010	*Alepes apercna*	Smallmouth Scad	<0.001	0.6786	Below	1.0179	Below	1.3572	Below	Low
37337011	*Carangoides chrysophrys*	Longnose Trevally	<0.001	0.5656	Below	0.8484	Below	1.1312	Below	Low
37337012	*Gnathanodon speciosus*	Golden Trevally	<0.001	0.5114	Below	0.7671	Below	1.0228	Below	Low
37337014	*Seriolina nigrofasciata*	Blackbanded Trevally, Blackbanded Amberjack	<0.001	0.5768	Below	0.8652	Below	1.1536	Below	Low
37337015	*Selaroides leptolepis*	Yellowstripe Scad	<0.001	0.9667	Below	1.45	Below	1.9334	Below	Low
37337016	*Caranx bucculentus*	Bluespotted Trevally	<0.001	0.4653	Below	0.698	Below	0.9307	Below	Low
37337017	*Decapterus macrosoma*	Shortfin Scad, Slender Scad	<0.001	0.7747	Below	1.1621	Below	1.5494	Below	Low
37337018	*Alectis ciliaris*	African Pompano, Pennantfish	<0.001	0.4773	Below	0.716	Below	0.9547	Below	Low
37337020	*Uraspis uraspis*	Whitemouth Jack	<0.001	0.6473	Below	0.9709	Below	1.2945	Below	Low
37337021	*Carangoides caeruleopinna-tus*	Coastal Trevally	<0.001	0.5798	Below	0.8697	Below	1.1596	Below	Low
37337022	*Turrum gymnostethus*	Bludger, Bludger Trevally	<0.001	0.6232	Below	0.9348	Below	1.2465	Below	Low
37337023	*Decapterus russelli*	Indian Scad	<0.001	0.6238	Below	0.9356	Below	1.2475	Below	Low
37337024	*Atule mate*	Barred Yellowtail Scad	<0.001	0.6226	Below	0.9339	Below	1.2452	Below	Low
37337028	*Megalaspis cordyla*	Torpedo Scad, Finny Scad	<0.001	0.5766	Below	0.865	Below	1.1533	Below	Low
37337031	*Carangoides humerosus*	Duskyshoulder Trevally, Epaulette Trevally	<0.001	0.6232	Below	0.9348	Below	1.2465	Below	Low
37337032	*Scomberoides commersonni-anus*	Talang Queenfish	<0.001	0.4587	Below	0.688	Below	0.9173	Below	Low
37337036	*Alepes kleinii*	Razorbelly Trevally	<0.001	0.6009	Below	0.9014	Below	1.2018	Below	Low

Table 4.13: *(continued)*

CAAB code	Scientific name	Common name	Susceptibility	F MSM	F MSM risk	F Lim	F Lim risk	F Crash	F Crash risk	F overall risk
37337037	*Carangoides fulvoguttatus*	Yellowspotted Trevally, Turrum	<0.001	0.6232	Below	0.9348	Below	1.2465	Below	Low
37337038	*Alectis indica*	Indian Threadfish, Diamond Trevally	<0.001	0.4773	Below	0.716	Below	0.9547	Below	Low
37337040	*Naucrates ductor*	Pilotfish	<0.001	0.8537	Below	1.2806	Below	1.7075	Below	Low
37337041	*Ulua aurochs*	Silvermouth Trevally	<0.001	0.5768	Below	0.8652	Below	1.1536	Below	Low
37337042	*Carangoides hedlandensis*	Bumpnose Trevally	<0.001	0.6232	Below	0.9348	Below	1.2465	Below	Low
37337043	*Carangoides talamparoides*	Whitetongue Trevally; Imposter Trevally	<0.001	0.6232	Below	0.9348	Below	1.2465	Below	Low
37337044	*Scomberoides tol*	Needlescaled Queenfish, Needleskin Queenfish	<0.001	0.589	Below	0.8834	Below	1.1779	Below	Low
37337045	*Scomberoides tala*	Barred Queenfish	<0.001	0.4977	Below	0.7465	Below	0.9954	Below	Low
37337046	*Scomberoides lysan*	Doublespotted Queenfish	<0.001	0.5023	Below	0.7535	Below	1.0047	Below	Low
37337047	*Pantolabus radiatus*	Fringefin Trevally	<0.001	0.5768	Below	0.8652	Below	1.1536	Below	Low
37337048	*Ulua mentalis*	Longrakered Trevally	<0.001	0.5768	Below	0.8652	Below	1.1536	Below	Low
37337049	*Caranx tille*	Tille Trevally	<0.001	0.4435	Below	0.6652	Below	0.887	Below	Low
37337050	*Caranx melampygus*	Bluefin Trevally	<0.001	0.4088	Below	0.6132	Below	0.8176	Below	Low
37337056	*Decapterus kurroides*	Redtail Scad	<0.001	0.705	Below	1.0576	Below	1.4101	Below	Low
37337065	*Trachinotus sp. cf mookalee*	A Trevally	0.067	0.4331	Below	0.6496	Below	0.8661	Below	Low
37337068	*Ferdauia ferdau*	Blue Trevally	<0.001	0.5423	Below	0.8135	Below	1.0846	Below	Low
37337072	*Parastromateus niger*	Black Pomfret	<0.001	0.5541	Below	0.8312	Below	1.1082	Below	Low
37337073	*Trachinotus anak*	Giant Oystercracker	<0.001	0.5768	Below	0.8652	Below	1.1536	Below	Low
37340001	*Mene maculata*	Moonfish	<0.001	0.9921	Below	1.4882	Below	1.9842	Below	Low

Table 4.13: ***(continued)***

CAAB code	Scientific name	Common name	Susceptibility	F MSM	F MSM risk	F Lim	F Lim risk	F Crash	F Crash risk	F overall risk
37341002	*Photopectoralis bindus*	Orangefin Ponyfish	0.002	1.5272	Below	2.2908	Below	3.0544	Below	Low
37341003	*Equulites laterofenestra*	Slender Ponyfish	0.002	1.4462	Below	2.1693	Below	2.8924	Below	Low
37341004	*Aurigequula longispinis*	Longspine Ponyfish	0.003	1.5919	Below	2.3878	Below	3.1837	Below	Low
37341005	*Equulites leuciscus*	Whipfin Ponyfish	0.001	1.4066	Below	2.1099	Below	2.8132	Below	Low
37341006	*Deveximentum insidiator*	Pugnose Ponyfish	0.002	1.4077	Below	2.1115	Below	2.8153	Below	Low
37341007	*Gazza minuta*	Toothpony	0.004	1.3377	Below	2.0066	Below	2.6754	Below	Low
37341009	*Aurigequula fasciata*	Striped Ponyfish	0.002	1.6513	Below	2.4769	Below	3.3026	Below	Low
37341010	*Eubleekeria splendens*	Splendid Ponyfish	0.004	1.3085	Below	1.9627	Below	2.617	Below	Low
37341011	*Equulites elongatus*	Elongate Ponyfish	0.002	1.3702	Below	2.0553	Below	2.7404	Below	Low
37341012	*Photolateralis moretoniensis*	Zigzag Ponyfish	0.002	1.3964	Below	2.0946	Below	2.7928	Below	Low
37341013	*Nuchequula glenysae*	Twoblotch Ponyfish	0.003	1.9918	Below	2.9876	Below	3.9835	Below	Low
37341014	*Leiognathus equula*	Common Ponyfish	0.004	1.5116	Below	2.2673	Below	3.0231	Below	Low
37341015	*Leiognathus ruconius*	Deep Pugnosed Ponyfish	0.002	1.7412	Below	2.6118	Below	3.4824	Below	Low
37341016	*Nuchequula gerreoides*	Ornate Ponyfish	0.001	1.9766	Below	2.965	Below	3.9533	Below	Low
37341018	*Photopectoralis aureus*	Golden Ponyfish	<0.001	1.5272	Below	2.2908	Below	3.0544	Below	Low
37341021	*Secutor interruptus*	Deep Pugnose Ponyfish	0.003	1.5123	Below	2.2684	Below	3.0246	Below	Low
37341022	*Deveximentum megalolepis*	Bigscale Ponyfish	0.001	1.4077	Below	2.1115	Below	2.8153	Below	Low
37341023	*Gazza dentex*	Ovoid Ponyfish	0.001	1.3377	Below	2.0066	Below	2.6754	Below	Low
37341024	*Gazza rhombea*	Rhomboid Ponyfish	0.005	1.3377	Below	2.0066	Below	2.6754	Below	Low
37346007	*Lutjanus malabaricus*	Saddletail Snapper	0.001	0.2941	Below	0.4412	Below	0.5883	Below	Low
37346015	*Lutjanus argentimaculatus*	Mangrove Jack	0.001	0.2379	Below	0.3569	Below	0.4758	Below	Low
37346030	*Lutjanus johnii*	Golden Snapper	0.001	0.2926	Below	0.4389	Below	0.5853	Below	Low
37347001	*Nemipterus bathybius*	Yellowbelly Threadfin Bream	0.003	1.0181	Below	1.5271	Below	2.0362	Below	Low

Table 4.13: *(continued)*

CAAB code	Scientific name	Common name	Susceptibility	F MSM	F MSM risk	F Lim	F Lim risk	F Crash	F Crash risk	F overall risk
37347002	*Nemipterus nematopus*	Yellowtip Threadfin Bream	0.002	1.0239	Below	1.5358	Below	2.0478	Below	Low
37347003	*Nemipterus peronii*	Notchedfin Threadfin Bream	0.003	0.9014	Below	1.3521	Below	1.8028	Below	Low
37347004	*Nemipterus celebicus*	Celebes Threadfin Bream	0.003	1.0239	Below	1.5358	Below	2.0478	Below	Low
37347005	*Nemipterus furcosus*	Rosy Threadfin Bream	0.002	0.9961	Below	1.4941	Below	1.9922	Below	Low
37347008	*Scolopsis meridiana*	Redspot Monocle Bream	0.001	1.0778	Below	1.6167	Below	2.1556	Below	Low
37347009	*Nemipterus virgatus*	Golden Threadfin Bream	0.002	0.9561	Below	1.4341	Below	1.9122	Below	Low
37347013	*Nemipterus zysron*	Slender Threadfin Bream	0.002	1.0147	Below	1.5221	Below	2.0295	Below	Low
37347014	*Nemipterus hexodon*	Ornate Threadfin Bream	0.002	1.0359	Below	1.5538	Below	2.0717	Below	Low
37347016	*Nemipterus marginatus*	Red-Filament Threadfin Bream	<0.001	0.9827	Below	1.474	Below	1.9653	Below	Low
37347019	*Nemipterus isacanthus*	Teardrop Threadfin Bream	0.003	1.0239	Below	1.5358	Below	2.0478	Below	Low
37347038	*Nemipterus balinensoides*	Dwarf Threadfin Bream	0.004	1.0299	Below	1.5449	Below	2.0598	Below	Low
37347039	*Nemipterus balinensis*	Bali Threadfin Bream	<0.001	1.0239	Below	1.5358	Below	2.0478	Below	Low
37349002	*Pentaprion longimanus*	Longfin Mojarra	0.002	1.2439	Below	1.8658	Below	2.4877	Below	Low
37349003	*Gerres filamentosus*	Whipfin Silver-Biddy	0.003	1.132	Below	1.698	Below	2.2641	Below	Low
37350002	*Pomadasys maculatus*	Blotched Javelin	0.002	0.5956	Below	0.8934	Below	1.1912	Below	Low
37350008	*Pomadasys trifasciatus*	Black-Ear Javelin	0.001	0.6369	Below	0.9554	Below	1.2738	Below	Low
37350011	*Pomadasys kaakan*	Javelin Grunter, Barred Javelin	0.001	0.5934	Below	0.8901	Below	1.1868	Below	Low
37354003	*Protonibea diacanthus*	Black Jewfish	<0.001	0.4144	Below	0.6216	Below	0.8288	Below	Low

Table 4.13: *(continued)*

CAAB code	Scientific name	Common name	Susceptibility	F MSM	F MSM risk	F Lim	F Lim risk	F Crash	F Crash risk	F overall risk
37354004	*Johnius laevis*	Smooth Jewfish	0.003	0.6678	Below	1.0017	Below	1.3356	Below	Low
37354006	*Otolithes ruber*	Silver Teraglin	0.001	0.5501	Below	0.8251	Below	1.1002	Below	Low
37354007	*Johnius borneensis*	River Jewfish	0.000	0.4955	Below	0.7433	Below	0.991	Below	Low
37354008	*Austronibea oedogenys*	Yellowtail Jewfish	<0.001	0.4483	Below	0.6724	Below	0.8966	Below	Low
37354009	*Johnius amblycephalus*	Bearded Jewfish	0.002	0.6678	Below	1.0017	Below	1.3356	Below	Low
37354011	*Atrobucca nibe*	Longmouth Jewfish	0.002	0.4311	Below	0.6467	Below	0.8623	Below	Low
37354012	*Atrobucca brevis*	Orange Jewfish	0.002	0.4311	Below	0.6467	Below	0.8623	Below	Low
37354019	*Nibea soldado*	Soldier Croaker	0.001	0.4456	Below	0.6683	Below	0.8911	Below	Low
37354020	*Atractoscion atelodus*	Teraglin	<0.001	0.3167	Below	0.4751	Below	0.6335	Below	Low
37354021	*Johnius macropterus*	A Jewfish	0.000	0.6678	Below	1.0017	Below	1.3356	Below	Low
37354022	*Johnius australis*	Little Jewfish	0.000	0.6678	Below	1.0017	Below	1.3356	Below	Low
37354023	*Nibea microgenys*	Smallmouth Jewfish	<0.001	0.4456	Below	0.6683	Below	0.8911	Below	Low
37354024	*Nibea squamosa*	Scale Croaker	<0.001	0.4456	Below	0.6683	Below	0.8911	Below	Low
37354025	*Johnius novaeguineae*	Paperhead Jewfish	<0.001	0.6678	Below	1.0017	Below	1.3356	Below	Low
37354026	*Larimichthys pamoides*	Southern Yellow Jewfish	0.001	0.4784	Below	0.7176	Below	0.9568	Below	Low
37354027	*Nibea leptolepis*	Smallscale Jewfish	0.001	0.4456	Below	0.6683	Below	0.8911	Below	Low
37355003	*Upeneus moluccensis*	Goldband Goatfish	0.006	0.7071	Below	1.0606	Below	1.4141	Below	Low
37355007	*Upeneus sulphureus*	Sulphur Goatfish	0.004	1.0234	Below	1.5351	Below	2.0468	Below	Low
37355013	*Upeneus sundaicus*	Ochrebanded Goatfish	0.001	0.8662	Below	1.2994	Below	1.7325	Below	Low
37362003	*Zabidius novemaculeatus*	Shortfin Batfish	<0.001	0.3729	Below	0.5593	Below	0.7458	Below	Low
37362005	*Drepane punctata*	Spotted Sicklefish	0.002	0.3729	Below	0.5593	Below	0.7458	Below	Low
37364001	*Rhinoprenes pentanemus*	Threadfin Scat	0.003	0.3729	Below	0.5593	Below	0.7458	Below	Low
37381002	*Mugil cephalus*	Sea Mullet	<0.001	0.3771	Below	0.5657	Below	0.7542	Below	Low

Table 4.13: *(continued)*

CAAB code	Scientific name	Common name	Susceptibility	F MSM	F MSM risk	F Lim	F Lim risk	F Crash	F Crash risk	F overall risk
37381006	*Moolgarda cunnesius*	Roundhead Mullet	<0.001	0.3996	Below	0.5994	Below	0.7992	Below	Low
37381007	*Liza subviridis*	Greenback Mullet	0.001	0.3996	Below	0.5994	Below	0.7992	Below	Low
37381008	*Liza vaigiensis*	Diamondscale Mullet	0.001	0.3996	Below	0.5994	Below	0.7992	Below	Low
37381009	*Paramugil georgii*	Fantail Mullet	0.001	0.348	Below	0.522	Below	0.6959	Below	Low
37381010	*Moolgarda buchanani*	Bluetail Mullet	<0.001	0.3996	Below	0.5994	Below	0.7992	Below	Low
37381013	*Oedalechilus labiosus*	Hornlip Mullet	0.001	0.3996	Below	0.5994	Below	0.7992	Below	Low
37381014	*Liza ordensis*	Diamond Mullet	0.001	0.3996	Below	0.5994	Below	0.7992	Below	Low
37381015	*Paramugil parmatus*	Broadmouth Mullet	0.001	0.348	Below	0.522	Below	0.6959	Below	Low
37381016	*Rhinomugil nasutus*	Popeye Mullet	0.001	0.3996	Below	0.5994	Below	0.7992	Below	Low
37381017	*Moolgarda seheli*	Bluespot Mullet	0.001	0.3996	Below	0.5994	Below	0.7992	Below	Low
37381019	*Liza macrolepis*	A Mullet	0.002	0.3996	Below	0.5994	Below	0.7992	Below	Low
37381020	*Liza melinoptera*	Otomebora Mullet	0.001	0.3996	Below	0.5994	Below	0.7992	Below	Low
37381022	*Moolgarda engeli*	Kanda Mullet	<0.001	0.3996	Below	0.5994	Below	0.7992	Below	Low
37381023	*Moolgarda perusii*	A Mullet	0.200	0.3996	Below	0.5994	Below	0.7992	Below	Low
37381026	*Liza tade*	Rock Mullet	0.001	0.3996	Below	0.5994	Below	0.7992	Below	Low
37382001	*Sphyraena pinguis*	Striped Barracuda	<0.001	0.4887	Below	0.7331	Below	0.9774	Below	Low
37382008	*Sphyraena barracuda*	Great Barracuda	<0.001	0.4287	Below	0.643	Below	0.8574	Below	Low
37383001	*Polydactylus nigripinnis*	Blackfin Threadfin	0.004	0.8228	Below	1.2342	Below	1.6456	Below	Low
37383002	*Polydactylus multiradiatus*	Australian Threadfin	0.002	0.8228	Below	1.2342	Below	1.6456	Below	Low
37384008	*Choerodon monostigma*	Darkspot Tuskfish	0.001	0.3467	Below	0.52	Below	0.6933	Below	Low
37400008	*Uranoscopus cognatus*	Yellowtail Stargazer	0.001	0.3286	Below	0.4929	Below	0.6572	Below	Low
37400009	*Uranoscopus sp. 1 [in Sainsbury et al, 1985]*	White-Spotted Stargazer	0.001	0.3286	Below	0.4929	Below	0.6572	Below	Low

Table 4.13: *(continued)*

CAAB code	Scientific name	Common name	Susceptibility	F MSM	F MSM risk	F Lim	F Lim risk	F Crash	F Crash risk	F overall risk
37400010	*Ichthyscopus fasciatus*	Banded Stargazer	0.001	0.3286	Below	0.4929	Below	0.6572	Below	Low
37400012	*Ichthyscopus insperatus*	Doubleband Stargazer	<0.001	0.3286	Below	0.4929	Below	0.6572	Below	Low
37400028	*Uranoscopus sp. (scaly nape)*	A Stargazer	<0.001	0.3286	Below	0.4929	Below	0.6572	Below	Low
37440004	*Trichiurus lepturus*	Largehead Hairtail	<0.001	0.448	Below	0.672	Below	0.896	Below	Low
37441014	*Scomberomorus queenslandicus*	School Mackerel	<0.001	0.5433	Below	0.815	Below	1.0867	Below	Low
37441015	*Scomberomorus munroi*	Spotted Mackerel	<0.001	0.6637	Below	0.9955	Below	1.3273	Below	Low
37441790	*Scomber scombrus*	Atlantic Mackerel	0.022	0.3678	Below	0.5517	Below	0.7355	Below	Low
37445007	*Psenopsis humerosa*	Blackspot Butterfish	<0.001	0.3742	Below	0.5614	Below	0.7485	Below	Low
37457001	*Psettodes erumei*	Australian Halibut	0.001	0.4876	Below	0.7314	Below	0.9752	Below	Low
37460002	*Pseudorhombus jenynsii*	Smalltooth Flounder	0.001	0.491	Below	0.7366	Below	0.9821	Below	Low
37460004	*Pseudorhombus dupliciocellatus*	Three Twinspot Flounder	0.002	0.491	Below	0.7366	Below	0.9821	Below	Low
37460008	*Pseudorhombus elevatus*	Deep Flounder	0.002	0.5431	Below	0.8146	Below	1.0861	Below	Low
37460009	*Pseudorhombus arsius*	Largetooth Flounder	0.004	0.4234	Below	0.6351	Below	0.8469	Below	Low
37460011	*Pseudorhombus spinosus*	Spiny Flounder	0.004	0.491	Below	0.7366	Below	0.9821	Below	Low
37460015	*Pseudorhombus diplospilus*	Bigtooth Twinspot Flounder	0.003	0.491	Below	0.7366	Below	0.9821	Below	Low
37460035	*Pseudorhombus megalops*	Bigeye Flounder	<0.001	0.491	Below	0.7366	Below	0.9821	Below	Low
37460038	*Pseudorhombus argus*	Peacock Flounder	0.004	0.491	Below	0.7366	Below	0.9821	Below	Low
37460045	*Arnoglossus waitei*	Waite's Flounder	0.002	0.5732	Below	0.8598	Below	1.1464	Below	Low
37460065	*Pseudorhombus triocellatus*	Three-Ring Flounder	0.001	0.491	Below	0.7366	Below	0.9821	Below	Low
37462001	*Aesopia cornuta*	Unicorn Sole	0.001	0.3761	Below	0.5642	Below	0.7523	Below	Low
37462003	*Zebrias craticulus*	Wicker-Work Sole	0.002	0.3761	Below	0.5642	Below	0.7523	Below	Low
37462004	*Zebrias quagga*	Zebra Sole	0.000	0.3761	Below	0.5642	Below	0.7523	Below	Low

Table 4.13: *(continued)*

CAAB code	Scientific name	Common name	Susceptibility	F MSM	F MSM risk	F Lim	F Lim risk	F Crash	F Crash risk	F overall risk
37462006	*Zebrias cancellatus*	Harrowed Sole	<0.001	0.3761	Below	0.5642	Below	0.7523	Below	Low
37462007	*Brachirus muelleri*	Tufted Sole	0.003	0.3767	Below	0.5651	Below	0.7534	Below	Low
37462008	*Brachirus setifer*	Paradice's Sole	<0.001	0.3552	Below	0.5328	Below	0.7104	Below	Low
37462009	*Pardachirus pavoninus*	Peacock Sole	0.002	0.3761	Below	0.5642	Below	0.7523	Below	Low
37462011	*Aesopia sp. [in Sainsbury et al, 1985]*	Pale Thick-Rayed Sole	<0.001	0.3767	Below	0.5651	Below	0.7534	Below	Low
37462015	*Soleichthys heterorhinos*	Tiger Sole	<0.001	0.3761	Below	0.5642	Below	0.7523	Below	Low
37462016	*Aseraggodes melanostictus*	Dappled Sole	0.002	0.3761	Below	0.5642	Below	0.7523	Below	Low
37462021	*Aseraggodes klunzingeri*	Kimberley Sole	<0.001	0.3761	Below	0.5642	Below	0.7523	Below	Low
37462024	*Brachirus orientalis*	Oriental Sole	<0.001	0.35	Below	0.525	Below	0.6999	Below	Low
37462030	*Pardachirus rautheri*	Mottled Sole	<0.001	0.3761	Below	0.5642	Below	0.7523	Below	Low
37462031	*Phyllichthys sclerolepis*	Hardscale Sole	<0.001	0.3761	Below	0.5642	Below	0.7523	Below	Low
37462032	*Rendahlia jaubertensis*	Jaubert Sole	0.002	0.3761	Below	0.5642	Below	0.7523	Below	Low
37462035	*Brachirus aspilos*	Dusky Sole	<0.001	0.35	Below	0.525	Below	0.6999	Below	Low
37462039	*Zebrias munroi*	Munro's Sole	0.002	0.3761	Below	0.5642	Below	0.7523	Below	Low
37462040	*Aseraggodes lenisquamis*	Peppered Sole	<0.001	0.3761	Below	0.5642	Below	0.7523	Below	Low
37463002	*Paraplagusia longirostris*	Pinocchio Tongue Sole	0.001	0.5072	Below	0.7608	Below	1.0144	Below	Low
37463003	*Cynoglossus maculipinnis*	Spotfin Tongue Sole	0.004	0.5072	Below	0.7608	Below	1.0144	Below	Low
37463006	*Cynoglossus kopsii*	Kops' Tongue Sole	0.002	0.5072	Below	0.7608	Below	1.0144	Below	Low
37463008	*Cynoglossus macrophthal-mus*	Longnose Tongue Sole	<0.001	0.5072	Below	0.7608	Below	1.0144	Below	Low
37463013	*Cynoglossus bilineatus*	Fourline Tongue Sole	0.001	0.5072	Below	0.7608	Below	1.0144	Below	Low
37463014	*Cynoglossus sp. [Munroe]*	A Tongue Sole	0.192	0.5131	Below	0.7697	Below	1.0262	Below	Low
37463018	*Cynoglossus puncticeps*	Spotted Tongue Sole	<0.001	0.5912	Below	0.8868	Below	1.1824	Below	Low

Table 4.13: ***(continued)***

CAAB code	Scientific name	Common name	Susceptibility	F MSM	F MSM risk	F Lim	F Lim risk	F Crash	F Crash risk	F overall risk
37463024	*Cynoglossus maccullochi*	Mcculloch's Tongue Sole	0.003	0.5072	Below	0.7608	Below	1.0144	Below	Low
37463750	*Cynoglossus arel*	A Tongue Sole	0.200	0.4971	Below	0.7457	Below	0.9942	Below	Low
37464001	*Trixiphichthys weberi*	Blacktip Tripodfish	0.003	0.3213	Below	0.4819	Below	0.6426	Below	Low
37465009	*Monacanthus chinensis*	Fan-Bellied Leatherjacket	0.001	0.4314	Below	0.6471	Below	0.8628	Below	Low
37465010	*Anacanthus barbatus*	Bearded Leatherjacket	<0.001	0.4314	Below	0.6471	Below	0.8628	Below	Low
37465012	*Thamnaconus hypargyreus*	Yellowspotted Leatherjacket	<0.001	0.504	Below	0.7561	Below	1.0081	Below	Low
37465013	*Chaetodermis penicilligerus*	Tasselled Leatherjacket	0.003	0.4314	Below	0.6471	Below	0.8628	Below	Low
37465017	*Paramonacanthu oblongus*	Japanese Leatherjacket	0.001	0.4314	Below	0.6471	Below	0.8628	Below	Low
37465019	*Thamnaconus striatus*	Manyline Leatherjacket	<0.001	0.504	Below	0.7561	Below	1.0081	Below	Low
37465020	*Pseudomonacant peroni*	Potbelly Leatherjacket	0.001	0.4314	Below	0.6471	Below	0.8628	Below	Low
37465022	*Aluterus monoceros*	Grey Leatherjacket	0.003	0.3821	Below	0.5731	Below	0.7641	Below	Low
37465024	*Paramonacanthu filicauda*	Threadfin Leatherjacket	0.002	0.4314	Below	0.6471	Below	0.8628	Below	Low
37465026	*Thamnaconus tessellatus*	Manyspot Leatherjacket	<0.001	0.504	Below	0.7561	Below	1.0081	Below	Low
37465029	*Pseudomonacant elongatus*	Fourband Leatherjacket	0.001	0.4314	Below	0.6471	Below	0.8628	Below	Low
37465030	*Paramonacanthus pusillus*	Sinhalese Leatherjacket	<0.001	0.4314	Below	0.6471	Below	0.8628	Below	Low
37465045	*Aluterus scriptus*	Scrawled Leatherjacket	0.003	0.3821	Below	0.5731	Below	0.7641	Below	Low
37465050	*Cantherhines dumerilii*	Barred Leatherjacket	0.001	0.4314	Below	0.6471	Below	0.8628	Below	Low
37465051	*Cantherhines pardalis*	Honeycomb Leatherjacket	<0.001	0.4314	Below	0.6471	Below	0.8628	Below	Low
37465062	*Oxymonacanthus longirostris*	Harlequin Filefish	0.001	0.4314	Below	0.6471	Below	0.8628	Below	Low
37465064	*Paramonacanthu choirocephalus*	Pigface Leatherjacket	0.001	0.4314	Below	0.6471	Below	0.8628	Below	Low
37465068	*Pervagor janthinosoma*	Gillblotch Leatherjacket	0.001	0.4314	Below	0.6471	Below	0.8628	Below	Low
37467007	*Lagocephalus sceleratus*	Silver Toadfish	<0.001	0.3952	Below	0.5928	Below	0.7904	Below	Low

Table 4.13: *(continued)*

CAAB code	Scientific name	Common name	Susceptibility	F MSM	F MSM risk	F Lim	F Lim risk	F Crash	F Crash risk	F overall risk
37467010	*Feroxodon multistriatus*	Ferocious Puffer	0.001	0.422	Below	0.633	Below	0.844	Below	Low
37467012	*Lagocephalus lunaris*	Rough Golden Toadfish	<0.001	0.4031	Below	0.6046	Below	0.8061	Below	Low
37469003	*Cyclichthys spilostylus*	Spotbase Burrfish	0.002	0.4511	Below	0.6766	Below	0.9022	Below	Low
37469004	*Tragulichthys jaculiferus*	Longspine Burrfish	0.003	0.4511	Below	0.6766	Below	0.9022	Below	Low

4.2.6 bSAFE - Protected Species

There were no protected species assessed in the bSAFE.

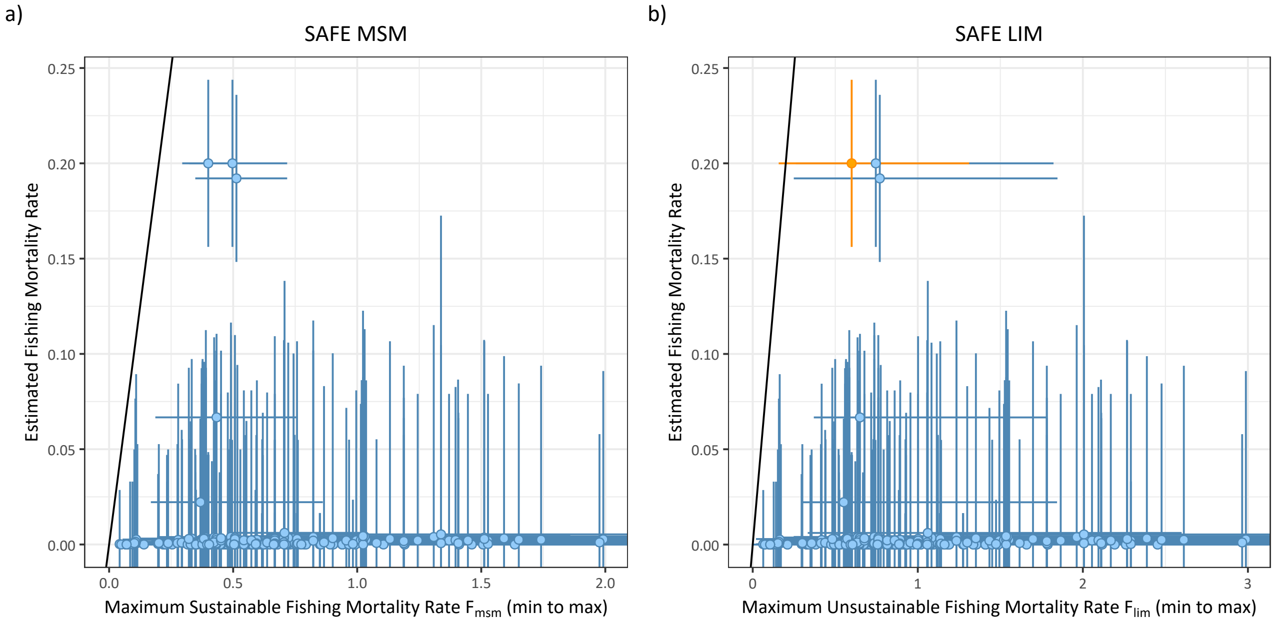


Figure 4.4: SAFE plot for bycatch species in the Northern Prawn Fishery - Redleg Banana Prawn sub-fishery for (a) bSAFE-MSM reference point [left] and (b) bSAFE limit (LIM) [right] reference point. 24 species (out of a total of 303 species) have missing data and may not be shown in the figure. 22 of these are unassessable in bSAFE and have been assessed in PSA instead; two of these lack some biological data but have a susceptibility of 0 and therefore a low risk. Red: Best estimate of mortality rate is above reference point; orange: best estimate of mortality rate is below reference point, but the top of the uncertainty range is above the reference point; blue: mortality rate is below reference point for the given uncertainty.

4.3 Habitats Component

The habitats component was not assessed at Level 2 as it was outside the project scope.

4.4 Communities Component

The communities component was not assessed at Level 2 as it was outside the project scope.

4.5 Decision Rules to Move from Level 2 to Level 3 (Step 7)

For the PSA overall risk values, units that fall in the upper third (risk value > 3.18) and middle third (2.64 < risk value < 3.18) of the PSA plots are deemed to be at high and medium risk respectively. For the SAFE method, species that fall above the SAFE-MSM or limit reference point (SAFE-LIM) are considered to be at risk of overfishing (Table 4.12). Species identified from either method need to be the focus of further work, either through implementing a management response to address the risk to the vulnerable species or by further examination for risk within the particular ecological component at Level 3. PSA-units at low risk, (i.e., in the lower third), or at SAFE where units were below the overfishing limit point (i.e., SAFE-LIM) will be deemed not at risk from the sub-fishery and the assessment is concluded for these units.

The output from the Level 2 analysis will result in four options:

- The risk of a unit of analysis within a component (e.g., single species or habitat type) is not high, the rationale is documented, and the impact of the fishing activity on this unit need not be assessed at a higher level unless management or the fishery changes.
- The risk of a unit is high but management strategies are introduced rapidly that will reduce this risk, this unit need not be assessed further unless the management or the fishery changes.
- The risk of a unit is high but there is additional information that can be used to determine if Level 3, or even a new management action is required. This information should be sought before action is taken
- The risk of a unit is high and there are no planned management interventions that would remove this risk, therefore the reasons are documented and the assessment moves to Level 3. At the conclusion of the

Level 2 analysis, a fishery can decide to further investigate the risk of fishing to the species via a Level 3 assessment or implement a management response to mitigate the risk. To ensure all fisheries follow a consistent process in responding to the results of the risk assessment, AFMA has developed an ecological risk management framework. The framework makes use of the existing AFMA management structures to enable the ERAs to become a part of normal fisheries management, including the involvement of fisheries consultative committees (Figure 4.5). A separate document, the ERM report, will be developed that outlines the reasons why species are at high risk and what actions the fishery will implement to respond to the risks.

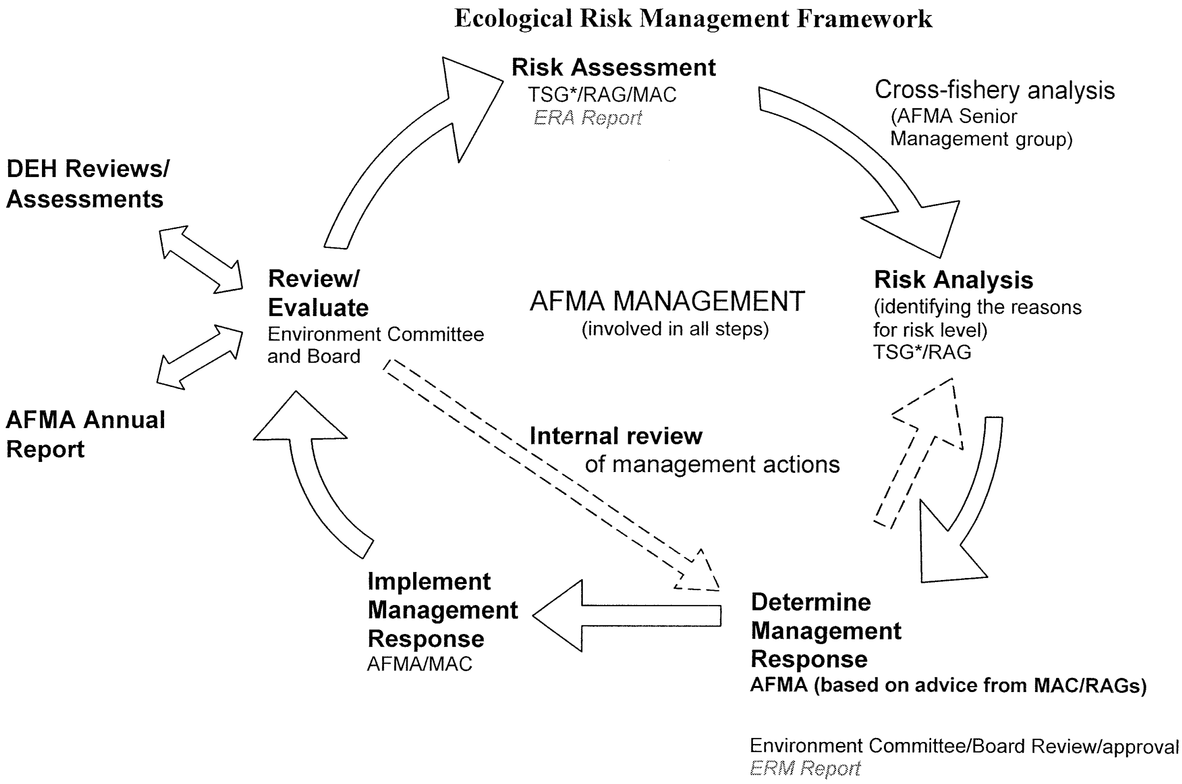


Figure 4.5: Schematic of the Ecological risk management cycle. TSG – Technical Support Group.

4.6 High and Medium Risk Categorisation (Step 8) Update with Residual Risk Information

4.6.1 PSA

Byproduct species

All three byproduct species were low risk following a PSA, so no residual risk analysis was conducted (Table 4.7).

Bycatch species

A residual risk analysis was performed on the 20 high risk species, resulting in all 20 species reduced to medium risk due to the few interactions/capture within the assessment period (Table 4.8 and 4.9).

Protected species

Of the 29 protected species assessed in this PSA, two were high risk (two chondrichthyans), 26 medium risk and one was low risk (marine reptile). A residual risk analysis was performed on the two high risk species and the two medium risk sawfishes. Both high risk species (Narrow Sawfish *Anoxypristis cuspidata* and Dwarf

Sawfish *Pristis clavata*) remained at high risk following a residual risk analysis. In addition, the two medium risk sawfish species increased their risk score to a precautionary high following a residual risk analysis: Green Sawfish (*Pristis zijsron*) and Freshwater Sawfish (*Pristis pristis*) (Table 4.11).

4.6.2 bSAFE

Byproduct species

No residual risk analysis was required, as there were no byproduct species assessed in the bSAFE analysis.

Bycatch species

All 281 bycatch species were low risk following a bSAFE analysis, so no residual risk analysis was conducted (Table 4.13).

Protected species

No residual risk analysis was required, as there were no protected species assessed in the bSAFE analysis.

5 General Discussion and Research Implications

5.1 Level 1

The key/secondary commercial species component was eliminated after Level 1 as all risk scores were less than three.

None of the remaining four assessed ecological components were eliminated at Level 1 i.e., there was at least one risk score of 3 – moderate – or above for each component.

Those remaining consist of:

- Fishing (direct and indirect impacts on protected species and habitats; moderate risk)
- Fishing (direct impacts on byproduct/bycatch species; moderate risk)
- Fishing through physical disturbance (impact on habitats and communities; moderate risk)

Habitat-forming benthos, particularly bryozoans and gorgonians corresponding to assemblages 15, 11 and 10 of the Timor Region were rated at moderate risk (score 3) from direct and indirect impacts from primary fishing operations and physical disturbance.

Significant external hazards included aquaculture in the region, which presented a moderate risk (risk score 3) to byproduct/bycatch species and communities, and a potential major risk to protected species (e.g., Green Sawfish and Freshwater Sawfish). In addition, external hazards from other fisheries in the region also presented a moderate risk (risk score of 3) to byproduct/bycatch species and a potential major risk to protected species (e.g., Green Sawfish and Freshwater Sawfish). Coastal development presented a moderate risk to both byproduct/bycatch species. Lastly, coastal development, other anthropogenic and non-extractive activities presented a moderate risk to protected species.

5.2 Level 2

5.2.1 Species at Risk

Residual Risk

As discussed elsewhere in this report (Section 1), the ERAEF methods are both hierarchically structured and precautionary. The Level 1 (SICA) analyses are used to identify potential hazards associated with fishing and which broad components of the ecological system they apply to. The Level 2 (PSA) analyses consider the direct impacts of fishing on individual species and habitats (rather than whole components), but the large numbers of species that need to be assessed and the nature of the information available for most species in the PSA analyses limits these analyses in several important respects. These include that some existing management measures are not directly accounted for, and that no direct account is taken of the level of mortality associated with fishing. Both these factors are considered in the ERAEF framework at Level 3, but the analyses reported here stop at Level 2. This means that the risk levels for species must be regarded as identifying potential rather than actual risk, and due to the precautionary assumptions made in the PSA analyses, there will be a tendency to overestimate absolute levels of risk from fishing. In moving from ERA to ERM, AFMA will focus scarce resources on the highest priority species and habitats (those likely to be most at risk from fishing). To that end, and because Level 3 analyses are not yet available for most species, AFMA (with input from CSIRO and other stakeholders) has developed guidelines to assess "residual risk" for those species identified as being at high potential risk based on the PSA analyses. The residual risk guidelines will be applied on a species-by-species basis and include consideration of existing management measures not currently accounted for in the PSA analyses, as well as additional information about the levels of direct mortality. These guidelines will also provide a transparent process for including more precise or missing information into the PSA analysis as it becomes available. CSIRO and AFMA will continue to work together to include the broad set of management arrangements in Level 2 analyses, and these methods will be incorporated in future developments of the ERAEF framework. CSIRO has also undertaken some preliminary Level 3 analyses for bycatch species for several fisheries, and these or similar methods will also form part of the overall ERAEF framework into the future.

5.2.2 Habitats at Risk

It was not possible to conduct a Level 2 ERA for habitats, as it is outside the project scope.

5.2.3 Community Assemblages at Risk

It was not possible to conduct a Level 2 ERA for communities, as it is outside the project scope.

5.3 Key Uncertainties/Recommendations for Research and Monitoring

It is recommended that the scores of the four high risk sawfishes be re-assessed as outcomes of new research become available.

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Glossary of Terms

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

- F_{MSM}: Maximum sustainable fishing mortality.
- F_{Lim}: Limit fishing mortality which is half of the maximum sustainable fishing mortality.
- F_{Crash}: minimum unsustainable fishing mortality rate that may lead to population extinction in the longer term.

Habitat The place where fauna or flora complete all or a portion of their life cycle.
Hazard identification The identification of activities (hazards) that may impact the components of interest.
Indicator Used to monitor the effect of an activity on a sub-component. An indicator is something that can be measured, such as biomass or abundance.
Likelihood The chance that a sub-component will be affected by an activity.
Operational objective A measurable objective for a component or sub-component (typically expressed as "the level of X does not fall outside acceptable bounds").
Precautionary approach The approach whereby, if there is uncertainty about the outcome of an action, the benefit of the doubt should be given to the biological entity (such as species, habitat or community).
PSA Productivity-Susceptibility Analysis. Used at Level 2 in the ERAEF methodology.
Scoping A general step in an ERA or the first step in the ERAEF involving the identification of the fishery history, management, methods, scope and activities.
SICA Scale, Impact, Consequence Analysis. Used at Level 1 in the ERAEF methodology.
Sub-component A more detailed aspect of a component. For example, within the target species component, the sub-components include the population size, geographic range, and the age/size/sex structure.
Sub-fishery A subdivision of the fishery on the basis of the gear or areal extent of the fishery. Ecological risk is assessed separately for each sub-fishery within a fishery.
Sustainability Ability to be maintained indefinitely.
Target species A species or group of species whose capture is the goal of a fishery, sub-fishery, or fishing operation.
Trophic position Location of an individual organism or species within a foodweb.
Unit of analysis The entities for which attributes are scored in the Level 2 analysis. For example, the units of

analysis for the Key Commercial Species component are individual “species”, while for Habitats, they are “biotypes”, and for Communities the units are “assemblages”.

A APPENDIX Examples of Fishing Activities

Table A.1: Examples of fishing activities (Modified from Fletcher et al., 2002).

Direct impact of Fishing	Fishing Activity	Examples of activities include
Capture		Activities that result in the capture or removal of organisms. This includes cryptic mortality due to organisms being caught but dropping out prior to the gear's retrieval (i.e., they are caught but not landed).
	Bait collection	Capture of organisms due to bait gear deployment, retrieval and bait fishing. This includes organisms caught but not landed.
	Fishing	Capture of organisms due to gear deployment, retrieval and actual fishing. This includes organisms caught but not landed.
	Incidental behaviour	Capture of organisms due to crew behaviour incidental to primary fishing activities, possible in the crew's down time; e.g., crew may line or spear fish while anchored, or perform other harvesting activities, including any land-based harvesting that occurs when crew are camping in their down time.
Direct impact without capture		This includes any activities that may result in direct impacts (damage or mortality) to organisms without actual capture.
	Bait collection	Direct impacts (damage or mortality) to organisms due to interactions (excluding capture) with bait gear during deployment, retrieval and bait fishing. This includes: damage/mortality to organisms through contact with the gear that doesn't result in capture, e.g., damage/mortality to benthic species by gear moving over them, organisms that hit nets but aren't caught.
	Fishing	Direct impacts (damage or mortality) to organisms due to interactions (excluding capture) with fishing gear during deployment, retrieval and fishing. This includes: damage/mortality to organisms through contact with the gear that doesn't result in capture, e.g., damage/mortality to benthic species by gear moving over them, organisms that hit nets but are not caught.
	Incidental behaviour	Direct impacts (damage or mortality) without capture, to organisms due to behaviour incidental to primary fishing activities, possibly in the crew's down time; e.g., the use of firearms on scavenging species, damage/mortality to organisms through contact with the gear that the crew use to fish during their down time. This does not include impacts on predator species of removing their prey through fishing.
	Gear loss	Direct impacts (damage or mortality), without capture on organisms due to gear that has been lost from the fishing boat. This includes damage/mortality to species when the lost gear contacts them or if species swallow the lost gear.

Table A.1: ***(continued)***

Direct impact of Fishing	Fishing Activity	Examples of activities include
	Anchoring/ mooring	Direct impact (damage or mortality) that occurs and when anchoring or mooring. This includes damage/mortality due to physical contact of the anchor, chain or rope with organisms, e.g., an anchor damaging live coral.
	Navigation/ steaming	Direct impact (damage or mortality) without capture may occur while vessels are navigating or steaming. This includes collisions with marine organisms or birds.
Addition/ movement of biological material		Any activities that result in the addition or movement of biological material to the ecosystem of the fishery.
	Translocation of species	The translocation and introduction of species to the area of the fishery, through transportation of any life stage. This transport can occur through movement on boat hulls or in ballast water as boats move throughout the fishery or from outside areas into the fishery.
	On board processing	The discarding of unwanted sections of target after on board processing introduces or moves biological material, e.g., heading and gutting, retaining fins but discarding trunks.
	Discarding catch	The discarding of unwanted organisms from the catch can introduce or move biological material. This includes individuals of target and byproduct species due to damage (e.g., shark or marine mammal predation), size, high grading and catch limits. Also includes discarding of all non-retained bycatch species. This also includes discarding of catch resulting from incidental fishing by the crew. The discards could be alive or dead.
	Stock enhancement	The addition of larvae, juveniles or adults to the fishery or ecosystem to increase the stock or catches.
	Provisioning	The use of bait or berley in the fishery.
	Organic waste disposal	The disposal of organic wastes (e.g., food scraps, sewage) from the boats.
Addition of non-biological material		Any activities that result in non-biological material being added to the ecosystem of the fishery, this includes physical debris, chemicals (in the air and water), lost gear, noise and visual stimuli.
	Debris	Debris from non-fishing activities can also contribute to this e.g., crew rubbish – discarding or food scraps, plastics or other rubbish. Discarding at sea is regulated by MARPOL,which forbids the discarding of plastics.
	Chemical pollution	Chemicals can be introduced to water, sediment and atmosphere through: oil spills, detergents other cleaning agents, any chemicals used during processing or fishing activities.
	Exhaust	Exhaust can be introduced to the atmosphere and water through operation of fishing vessels.

Table A.1: *(continued)*

Direct impact of Fishing	Fishing Activity	Examples of activities include
	Gear loss	The loss of gear will result in the addition of non-biological material, this includes hooks, line, sinkers, nets, otter boards, light sticks, buoys etc.
	Navigation/ steaming	The navigation and steaming of vessels will introduce noise and visual stimuli into the environment. Boat collisions and/or sinking of vessels. Echo-sounding may introduce noise that may disrupt some species (e.g., whales, Orange Roughy).
	Activity/ presence on water	The activity or presence of fishing vessels on the water will noise and visual stimuli into the environment.
Disturb physical processes		Any activities that will disturb physical processes, particularly processes related to water movement or sediment and hard substrate (e.g., boulders, rocky reef) processes.
	Bait collection	Bait collection may disturb physical processes if the gear contacts seafloor-disturbing sediment, or if the gear disrupts water flow patterns.
	Fishing	Fishing activities may disturb physical processes if the gear contacts seafloor-disturbing sediment, or if the gear disrupts water flow patterns.
	Boat launching	Boat launching may disturb physical processes, particularly in the intertidal regions, if dredging is required, or the boats are dragged across substrate. This would also include foreshore impacts where fishers drive along beaches to reach fishing locations and launch boats.Impacts of boat launching that occurs within established marinas are outside the scope of this assessment.
	Anchoring/ mooring	Anchoring/mooring may affect the physical processes in the area that anchors and anchor chains contact the seafloor.
	Navigation/ steaming	Navigation /steaming may affect the physical processes on the benthos and the pelagic by turbulent action of propellers or wake formation.
External Hazards		Any outside activities that will result in an impact on the component in the same location and period that the fishery operates. The particular activity as well as the mechanism for external hazards should be specified.
	Other capture fishery methods	Take or habitat impact by other commercial, indigenous or recreational fisheries operating in the same region as the fishery under examination.
	Aquaculture	Capture of feed species for aquaculture. Impacts of cages on the benthos in the region.
	Coastal development	Sewage discharge, ocean dumping, agricultural runoff.

Table A.1: ***(continued)***

Direct impact of Fishing	Fishing Activity	Examples of activities include
	Other extractive activities	Oil and gas pipelines, drilling, seismic activity.
	Other non-extractive activities	Defense, shipping lanes, dumping of munitions, submarine cables.
	Other anthropogenic activities	Recreational activities, such as scuba diving leading to coral damage, power boats colliding with whales, dugongs, turtles. Shipping, oil spills.

B APPENDIX Level 1 Description of Consequences for Each Component

Table B.1: Key/secondary commercial species. Description of consequences for each component and each sub-component. Use table as a guide for scoring the level of consequence for target species (Modified from Fletcher et al., 2002).

Sub-component	Score/level 1 (Negligible)	Score/level 2 (Minor)	Score/level 3 (Moderate)	Score/level 4 (Major)	Score/level 5 (Severe)	Score/level 6 (Intolerable)
Population size	Insignificant change to population size/growth rate (r). Unlikely to be detectable against background variability for this population.	Possible detectable change in size/growth rate (r) but minimal impact on population size and none on dynamics.	Full exploitation rate but long-term recruitment dynamics not adversely damaged.	Affecting recruitment state of stocks and/or their capacity to increase.	Likely to cause local extinctions if continued in longer term.	Local extinctions are imminent/immediate.
Geographic range	No detectable change in geographic range. Unlikely to be detectable against background variability for this population.	Possible detectable change in geographic range but minimal impact on population range and none on dynamics, change in geographic range up to 5 % of original.	Change in geographic range up to 10 % of original.	Change in geographic range up to 25 % of original.	Change in geographic range up to 50 % of original.	Change in geographic range > 50 % of original.
Genetic structure	No detectable change in genetic structure. Unlikely to be detectable against background variability for this population.	Possible detectable change in genetic structure. Any change in frequency of genotypes, effective population size or number of spawning units up to 5%.	Change in frequency of genotypes, effective population size or number of spawning units up to 10%.	Change in frequency of genotypes, effective population size or number of spawning units up to 25%.	Change in frequency of genotypes, effective population size or number of spawning units, change up to 50%.	Change in frequency of genotypes, effective population size or number of spawning units > 50%.
Age/size/sex structure	No detectable change in age/size/sex structure. Unlikely to be detectable against background variability for this population.	Possible detectable change in age/size/sex structure but minimal impact on population dynamics.	Impact on population dynamics at maximum sustainable level, long-term recruitment dynamics not adversely affected.	Long-term recruitment dynamics adversely affected. Time to recover to original structure up to 5 generations free from impact.	Long-term recruitment dynamics adversely affected. Time to recover to original structure up to 10 generations free from impact.	Long-term recruitment dynamics adversely affected. Time to recover to original structure > 100 generations free from impact.

Table B.1: ***(continued)***

Sub-component	Score/level 1 (Negligible)	Score/level 2 (Minor)	Score/level 3 (Moderate)	Score/level 4 (Major)	Score/level 5 (Severe)	Score/level 6 (Intolerable)
Reproductive capacity	No detectable change in reproductive capacity. Unlikely to be detectable against background variability for this population.	Possible detectable change in reproductive capacity but minimal impact on population dynamics.	Impact on population dynamics at maximum sustainable level, long-term recruitment dynamics not adversely affected.	Change in reproductive capacity adversely affecting long-term recruitment dynamics. Time to recovery up to 5 generations free from impact.	Change in reproductive capacity adversely affecting long-term recruitment dynamics. Time to recovery up to 10 generations free from impact.	Change in reproductive capacity adversely affecting long-term recruitment dynamics. Time to recovery > 100 generations free from impact.
Behaviour/movement	No detectable change in behaviour/ movement. Unlikely to be detectable against background variability for this population. Time taken to recover to pre-disturbed state on the scale of hours.	Possible detectable change in behaviour/ movement but minimal impact on population dynamics. Time to return to original behaviour/ movement on the scale of days to weeks.	Detectable change in behaviour/ movement with the potential for some impact on population dynamics. Time to return to original behaviour/ movement on the scale of weeks to months.	Change in behaviour/ movement with impacts on population dynamics. Time to return to original behaviour/ movement on the scale of months to years.	Change in behaviour/ movement with impacts on population dynamics. Time to return to original behaviour/ movement on the scale of years to decades.	Change to behaviour/ movement. Population does not return to original behaviour/ movement.

Table B.2: Bycatch species. Description of consequences for each component and each sub-component. Use table as a guide for scoring the level of consequence for by-catch/byproduct species (Modified from Fletcher et al., 2002).

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

Table B.2: *(continued)*

Sub-component	Score/level 1 (Negligible)	Score/level 2 (Minor)	Score/level 3 (Moderate)	Score/level 4 (Major)	Score/level 5 (Severe)	Score/level 6 (Intolerable)
Genetic structure	No detectable change in genetic structure. Unlikely to be detectable against background variability for this population.	Possible detectable change in genetic structure. Any change in frequency of genotypes, effective population size or number of spawning units up to 5%.	Detectable change in genetic structure. Change in frequency of genotypes, effective population size or number of spawning units up to 10%.	Change in frequency of genotypes, effective population size or number of spawning units up to 25%.	Change in frequency of genotypes, effective population size or number of spawning units up to 50%.	Change in frequency of genotypes, effective population size or number of spawning units > 50%.
Age/size/sex structure	No detectable change in age/size/sex structure. Unlikely to be detectable against background variability for this population.	Possible detectable change in age/size/sex structure but minimal impact on population dynamics.	Detectable change in age/size/sex structure. Impact on population dynamics at maximum sustainable level, long-term recruitment dynamics not adversely damaged.	Long-term recruitment dynamics adversely affected. Time to recover to original structure up to 5 generations free from impact.	Long-term recruitment dynamics adversely affected. Time to recover to original structure up to 10 generations free from impact.	Long-term recruitment dynamics adversely affected. Time to recover to original structure > 100 generations free from impact.
Reproductive capacity	No detectable change in reproductive capacity. Unlikely to be detectable against background variability for this population.	Possible detectable change in reproductive capacity but minimal impact on population dynamics.	Detectable change in reproductive capacity, impact on population dynamics at maximum sustainable level, long-term recruitment dynamics not adversely damaged.	Change in reproductive capacity adversely affecting long-term recruitment dynamics. Time to recovery up to 5 generations free from impact.	Change in reproductive capacity adversely affecting long-term recruitment dynamics. Time to recovery up to 10 generations free from impact.	Change in reproductive capacity adversely affecting long-term recruitment dynamics. Time to recovery > 100 generations free from impact.

Table B.2: ***(continued)***

Sub-component	Score/level 1 (Negligible)	Score/level 2 (Minor)	Score/level 3 (Moderate)	Score/level 4 (Major)	Score/level 5 (Severe)	Score/level 6 (Intolerable)
Behaviour/movement	No detectable change in behaviour/ movement. Unlikely to be detectable against background variability for this population. Time taken to recover to pre-disturbed state on the scale of hours.	Possible detectable change in behaviour/ movement but minimal impact on population dynamics. Time to return to original behaviour/ movement on the scale of days to weeks.	Detectable change in behaviour/ movement with the potential for some impact on population dynamics. Time to return to original behaviour/ movement on the scale of weeks to months.	Change in behaviour/ movement with impacts on population dynamics. Time to return to original behaviour/ movement on the scale of months to years.	Change in behaviour/ movement with impacts on population dynamics. Time to return to original behaviour/ movement on the scale of years to decades.	Change to behaviour/ movement. Population does not return to original behaviour/ movement.

Table B.3: Protected species. Description of consequences for each component and each sub-component. Use table as a guide for scoring the level of consequence for protected species (Modified from Fletcher et al., 2002).

Sub-component	Score/level 1 (Negligible)	Score/level 2 (Minor)	Score/level 3 (Moderate)	Score/level 4 (Major)	Score/level 5 (Severe)	Score/level 6 (Intolerable)
Population size	Almost none are killed.	Insignificant change to population size/growth rate (r). Unlikely to be detectable against background variability for this population.	State of reduction on the rate of increase are at the maximum acceptable level. Possible detectable change in size/ growth rate (r) but minimal impact on population size and none on dynamics of protected species.	Affecting recruitment state of stocks or their capacity to increase.	Local extinctions are imminent/immediate.	Global extinctions are imminent/immediate.
Geographic range	No interactions leading to impact on geographic range.	No detectable change in geographic range. Unlikely to be detectable against background variability for this population.	Possible detectable change in geographic range but minimal impact on population range and none on dynamics. Change in geographic range up to 5 % of original.	Change in geographic range up to 10% of original.	Change in geographic range up to 25% of original.	Change in geographic range up to 25% of original.
Genetic structure	No interactions leading to impact on genetic structure.	No detectable change in genetic structure. Unlikely to be detectable against background variability for this population.	Possible detectable change in genetic structure but minimal impact at population level. Any change in frequency of genotypes, effective population size or number of spawning units up to 5%.	Moderate change in genetic structure. Change in frequency of genotypes, effective population size or number of spawning units up to 10%.	Change in frequency of genotypes, effective population size or number of spawning units up to 25%.	Change in frequency of genotypes, effective population size or number of spawning units up to 25%.

Table B.3: ***(continued)***

Sub-component	Score/level 1 (Negligible)	Score/level 2 (Minor)	Score/level 3 (Moderate)	Score/level 4 (Major)	Score/level 5 (Severe)	Score/level 6 (Intolerable)
Age/size/sex structure	No interactions leading to change in age/size/sex structure.	No detectable change in age/size/sex structure. Unlikely to be detectable against background variability for this population.	Possible detectable change in age/size/sex structure but minimal impact on population dynamics.	Detectable change in age/size/sex structure. Impact on population dynamics at maximum sustainable level, long-term recruitment dynamics not adversely damaged.	Severe change in age/size/sex structure. Impact adversely affecting population dynamics. Time to recover to original structure up to 5 generations free from impact.	Impact adversely affecting population dynamics. Time to recover to original structure > 10 generations free from impact.
Reproductive capacity	No interactions resulting in change to reproductive capacity.	No detectable change in reproductive capacity. Unlikely to be detectable against background variability for this population.	Possible detectable change in reproductive capacity but minimal impact on population dynamics.	Detectable change in reproductive capacity, impact on population dynamics at maximum sustainable level, long-term recruitment dynamics not adversely damaged.	Change in reproductive capacity, impact adversely affecting recruitment dynamics. Time to recover to original structure up to 5 generations free from impact.	Change in reproductive capacity, impact adversely affecting recruitment dynamics. Time to recover to original structure > 10 generations free from impact.
Behaviour/movement	No interactions resulting in change to behaviour/ movement.	No detectable change in behaviour/ movement. Time to return to original behaviour/ movement on the scale of hours.	Possible detectable change in behaviour/ movement but minimal impact on population dynamics. Time to return to original behaviour/ movement on the scale of days to weeks.	Detectable change in behaviour/ movement with the potential for some impact on population dynamics. Time to return to original behaviour/ movement on the scale of weeks to months.	Change in behaviour/ movement, impact adversely affecting population dynamics. Time to return to original behaviour/ movement on the scale of months to years.	Change in behaviour/ movement. Impact adversely affecting population dynamics. Time to return to original behaviour/ movement on the scale of years to decades.

Table B.3: *(continued)*

Sub-component	Score/level 1 (Negligible)	Score/level 2 (Minor)	Score/level 3 (Moderate)	Score/level 4 (Major)	Score/level 5 (Severe)	Score/level 6 (Intolerable)
Interaction with fishery	No interactions with fishery.	Few interactions and involving up to 5% of population.	Moderate level of interactions with fishery involving up to10 % of population.	Major interactions with fishery, interactions and involving up to 25% of population.	Frequent interactions involving ~ 50% of population.	Frequent interactions involving the entire known population negatively affecting the viability of the population.

Table B.4: Habitats. Description of consequences for each component and each sub-component. Use table as a guide for scoring the level of consequence for habitats. Note that for sub-components Habitat types and Habitat structure and function, time to recover from impact scales differ from substrate, water and air. Rationale: structural elements operate on greater timeframes to return to pre-disturbance states (Modified from Fletcher et al., 2002).

Sub-component	Score/level 1 (Negligible)	Score/level 2 (Minor)	Score/level 3 (Moderate)	Score/level 4 (Major)	Score/level 5 (Severe)	Score/level 6 (Intolerable)
Substrate quality	Reduction in the productivity (similar to the intrinsic rate of increase for species) on the substrate from the activity is unlikely to be detectable. Time taken to recover to pre-disturbed state on the scale of hours.	Detectable impact on substrate quality. At small spatial scale time taken to recover to pre-disturbed state on the scale of days to weeks, at larger spatial scales recovery time of hours to days.	More widespread effects on the dynamics of substrate quality but the state are still considered acceptable given the percent area affected, the types of impact occurring and the recovery capacity of the substrate. For impacts on non-fragile substrates this may be for up to 50% of habitat affected, but for more fragile habitats, e.g., reef substrate, to stay in this category the % area affected needs to be smaller up to 25%.	The level of reduction of internal dynamics of habitats may be larger than is sensible to ensure that the habitat will not be able to recover adequately, or it will cause strong downstream effects from loss of function. Time to recover from local impact on the scale of months to years, at larger spatial scales recovery time of weeks to months.	Severe impact on substrate quality with 50 - 90% of the habitat affected or removed by the activity which may seriously endanger its long-term survival and result in changes to ecosystem function. Recovery period measured in years to decades.	The dynamics of the entire habitat is in danger of being changed in a major way, or > 90% of habitat destroyed.

Table B.4: *(continued)*

Sub-component	Score/level 1 (Negligible)	Score/level 2 (Minor)	Score/level 3 (Moderate)	Score/level 4 (Major)	Score/level 5 (Severe)	Score/level 6 (Intolerable)
Water quality	No direct impact on water quality. Impact unlikely to be detectable. Time taken to recover to pre-disturbed state on the scale of hours.	Detectable impact on water quality. Time to recover from local impact on the scale of days to weeks, at larger spatial scales recovery time of hours to days.	Moderate impact on water quality. Time to recover from local impact on the scale of weeks to months, at larger spatial scales recovery time of days to weeks.	Time to recover from local impact on the scale of months to years, at larger spatial scales recovery time of weeks to months.	Impact on water quality with 50 - 90% of the habitat affected or removed by the activity which may seriously endanger its long-term survival and result in changes to ecosystem function. Recovery period measured in years to decades.	The dynamics of the entire habitat is in danger of being changed in a major way, or > 90% of habitat destroyed.
Air quality	No direct impact on air quality. Impact unlikely to be detectable. Time taken to recover to pre-disturbed state on the scale of hours.	Detectable impact on air quality. Time to recover from local impact on the to recover to pre-disturbed state on the scale of hours.	Detectable impact on air quality. Time to recover from local impact on the scale of days to weeks, at larger spatial scales recovery time of hours to days.	Time to recover from local impact on the scale of months to years, at larger spatial scales recovery time of weeks to months.	Impact on air quality with 50 - 90% of the habitat affected or removed by the activity, which may seriously endanger its long-term survival and result in changes to ecosystem function. Recovery period measured in years to decades.	The dynamics of the entire habitat is in danger of being changed in a major way, or > 90% of habitat destroyed.

Table B.4: ***(continued)***

Sub-component	Score/level 1 (Negligible)	Score/level 2 (Minor)	Score/level 3 (Moderate)	Score/level 4 (Major)	Score/level 5 (Severe)	Score/level 6 (Intolerable)
Habitat types	No direct impact on habitat types. Impact unlikely to be detectable. Time taken to recover to pre-disturbed state on the scale of hours to days.	Detectable impact on distribution of habitat types. Time to recover from local impact on the scale of days to weeks, at larger spatial scales recovery time of days to months.	Impact reduces distribution of habitat types. Time to recover from local impact on the scale of weeks to months, at larger spatial scales recovery time of months to < one year.	The reduction of habitat type areal extent may threaten ability to recover adequately, or cause strong downstream effects in habitat distribution and extent. Time to recover from impact on the scale of > one year to < decadal timeframes.	Impact on relative abundance of habitat types resulting in severe changes to ecosystem function. Recovery period likely to be > decadal.	The dynamics of the entire habitat is in danger of being changed in a catastrophic way. The distribution of habitat types has been shifted away from original spatial pattern. If reversible, will require a long-term recovery period, on the scale of decades to centuries.

Table B.4: *(continued)*

Sub-component	Score/level 1 (Negligible)	Score/level 2 (Minor)	Score/level 3 (Moderate)	Score/level 4 (Major)	Score/level 5 (Severe)	Score/level 6 (Intolerable)
Habitat structure and function	No detectable change to the internal dynamics of habitat or populations of species making up the habitat. Time taken to recover to pre-disturbed state on the scale of hours to days.	Detectable impact on habitat structure and function. Time to recover from impact on the scale of days to months, regardless of spatial scale.	Impact reduces habitat structure and function. For impacts on non-fragile habitat structure this may be for up to 50% of habitat affected, but for more fragile habitats, to stay in this category the % area affected needs to be smaller up to 20%. Time to recover from local impact on the scale of months to < one year, at larger spatial scales recovery time of months to < one year.	The level of reduction of internal dynamics of habitat may threaten ability to recover adequately, or it will cause strong downstream effects from loss of function. For impacts on non-fragile habitats this may be for up to 50% of habitat affected, but for more fragile habitats, to stay in this category the % area affected up to 25%. Time to recover from impact on the scale of > one year to < decadal timeframes.	Impact on habitat function resulting from severe changes to internal dynamics of habitats. Time to recover from impact likely to be > decadal.	The dynamics of the entire habitat is in danger of being changed in a catastrophic way which may not be reversible. Habitat losses occur. Some elements may remain but will require a long-term recovery period, on the scale of decades to centuries.

Table B.5: Communities. Description of consequences for each component and each sub-component. Use table as a guide for scoring the level of consequence for communities (Modified from Fletcher et al., 2002).

Sub-component	Score/level 1 (Negligible)	Score/level 2 (Minor)	Score/level 3 (Moderate)	Score/level 4 (Major)	Score/level 5 (Severe)	Score/level 6 (Intolerable)
Species composition	Interactions may be occurring which affect the internal dynamics of communities leading to change in species composition not detectable against natural variation.	Impacted species do not play a keystone role – only minor changes in relative abundance of other constituents. Changes of species composition up to 5%.	Detectable changes to the community species composition without a major change in function (no loss of function). Changes to species composition up to 10%.	Major changes to the community species composition (~25%) (involving keystone species) with major change in function. Ecosystem function altered measurably and some function or components are locally missing/declining/in-creasing outside of historical range and/or allowed/facilitated new species to appear. Recovery period measured in years.	Change to ecosystem structure and function. Ecosystem dynamics currently shifting as different species appear in fishery. Recovery period measured in years to decades.	Total collapse of ecosystem processes. Long-term recovery period required, on the scale of decades to centuries.
Functional group composition	Interactions which affect the internal dynamics of communities leading to change in functional group composition not detectable against natural variation.	Minor changes in relative abundance of community constituents up to 5%.	Changes in relative abundance of community constituents, up to 10% chance of flipping to an alternate state/ trophic cascade.	Ecosystem function altered measurably and some functional groups are locally missing/de-clining/increasing outside of historical range and/or allowed/facilitated new species to appear. Recovery period measured in months to years.	Ecosystem dynamics currently shifting, some functional groups are missing and new species/groups are now appearing in the fishery. Recovery period measured in years to decades.	Ecosystem function catastrophically altered with total collapse of ecosystem processes. Recovery period measured in decades to centuries.

Table B.5: *(continued)*

Sub-component	Score/level 1 (Negligible)	Score/level 2 (Minor)	Score/level 3 (Moderate)	Score/level 4 (Major)	Score/level 5 (Severe)	Score/level 6 (Intolerable)
Distribution of the community	Interactions which affect the distribution of communities unlikely to be detectable against natural variation.	Possible detectable change in geographic range of communities but minimal impact on community dynamics change in geographic range up to 5 % of original.	Detectable change in geographic range of communities with some impact on community dynamics. Change in geographic range up to 10 % of original.	Geographic range of communities, ecosystem function altered measurably and some functional groups are locally missing/de-clining/increasing outside of historical range. Change in geographic range for up to 25 % of the species. Recovery period measured in months to years.	Change in geographic range of communities, ecosystem function altered and some functional groups are currently missing and new groups are present. Change in geographic range for up to 50 % of species including keystone species. Recovery period measured in years to decades.	Change in geographic range of communities, ecosystem function collapsed. Change in geographic range for >90% of species including keystone species. Recovery period measured in decades to centuries.
Trophic/size structure	Interactions which affect the internal dynamics unlikely to be detectable against natural variation.	Change in mean trophic level, biomass/ number in each size class up to 5%.	Changes in mean trophic level, biomass/ number in each size class up to 10%.	Changes in mean trophic level. Ecosystem function altered measurably and some function or components are locally missing/de-clining/increasing outside of historical range and/or allowed/facilitated new species to appear. Recovery period measured in years to decades.	Changes in mean trophic level. Ecosystem function severely altered and some function or components are missing and new groups present. Recovery period measured in years to decades.	Ecosystem function catastrophically altered as a result of changes in mean trophic level, total collapse of ecosystem processes. Recovery period measured in decades to centuries.

Table B.5: ***(continued)***

Sub-component	Score/level 1 (Negligible)	Score/level 2 (Minor)	Score/level 3 (Moderate)	Score/level 4 (Major)	Score/level 5 (Severe)	Score/level 6 (Intolerable)
Bio-geochemical cycles	Interactions which affect bio- & geochemical cycling unlikely to be detectable against natural variation.	Only minor changes in relative abundance of other constituents leading to minimal changes to bio- & geochemical cycling up to 5%.	Changes in relative abundance of other constituents leading to minimal changes to bio- & geochemical cycling, up to 10%.	Changes in relative abundance of constituents leading to major changes to bio- & geochemical cycling, up to 25%.	Changes in relative abundance of constituents leading to Severe changes to bio- & geochemical cycling. Recovery period measured in years to decades.	Ecosystem function catastrophically altered as a result of community changes affecting bio- and geo-chemical cycles, total collapse of ecosystem processes. Recovery period measured in decades to centuries.

C APPENDIX Reproducibility Details

C.1 Date and time of execution

2025-04-03 09:56:50.771059

C.2 Execution environment

R Version: R version 4.4.0 (2024-04-24 ucrt)

A list of versions of all the R packages used can be found in the following file: renv.lock

pandoc Version: 3.1.1

LaTeX distribution: MiKTeX-pdfTeX 4.19 (MiKTeX 24.4) © 1982 D. E. Knuth, © 1996-2023 Hàn Thế Thành TeX is a trademark of the American Mathematical Society. using bzip2 version 1.0.8, 13-Jul-2019 compiled with curl version 8.4.0; using libcurl/8.4.0 Schannel compiled with expat version 2.5; using expat_2.5.0 compiled with jpeg version 9.5 compiled with liblzma version 50040002; using 50040002 compiled with libpng version 1.6.39; using 1.6.39 compiled with libressl version LibreSSL 3.8.1; using LibreSSL 3.8.1 compiled with MiKTeX Application Framework version 4.8; using 4.8 compiled with MiKTeX Core version 4.24; using 4.24 compiled with MiKTeX Archive Extractor version 4.1; using 4.1 compiled with MiKTeX Package Manager version 4.10; using 4.10 compiled with uriparser version 0.9.7 compiled with xpdf version 4.04 compiled with zlib version 1.2.13; using 1.2.13

C.3 Version Control

C.3.1 Bitbucket

Repository: https://bitbucket.csiro.au/scm/era/eraef-ar_npf.git

Branch: NPF_Redleg

Commit Number: 31ea700883b9d135767c9eda65bb7a06f9b7b8e5

C.3.2 Data Sources

Table C.1: Version control for data sources.

Item No.	Aspect	Version No./Git ID	Comments
1.	Bioregionalization information	2023	
1.1	New species distribution information added manually	08/03/2024	Date of last added species
2	Update of species attributes from FishBase	Jan. 2024	
3	Manual updates to ERAEF species attributes	08/03/2024	Date of last added species
4	Database snapshots for fishery ERAEF extracts	10/03/2024	Fishery species table, species table and species attributes
5	Version front end tables snapshot	01/03/2022	Scoring tables - calculate productivity, susceptibility for each sub-fishery Intermediate information used for PSA and SAFE plots

Table C.1: *(continued)*

Item No.	Aspect	Version No./Git ID	Comments
6	PLSQL for generating PSA and SAFE calculations	v1.3, git commit: 3er330fdskek	
7	Effort overlaps	12/10/2023; 16/02/2024	

C.3.3 Excel templates

Table C.2: Version control for Excel templates. Lists current version of Excel files with a 'Changelog' sheet.

File	Version	Date
ManualInput/Appendix/Appendices.xlsx	1.2.1	2024-03-04
ManualInput/Level1/HazardsTemplateAFMA.xlsm	1.2	2024-06-05
ManualInput/Scoping/GeneralFisheryCharacteristics.xlsx	1.2.1	2024-03-04

C.4 Parameters

C.4.1 index.Rmd

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## [10,1]     value:
## [11,1]       run_sql: false
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## [13,1]       dsn: "aqua"
## [14,1]
## [15,1]    evaluation:
## [16,1]     value:
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## [22,1]       level2: true
## [23,1]       level3: false
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## [26,1]
## [27,1]
## [28,1]    recreateAppendixRmdFile: true
## [29,1]
## [30,1]
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## [47,1] sansfont: Calibri
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## [51,1] link-citations: yes
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## [61,1] author: "M. Sporcic, T. van der Velde, A. Donovan, C. Gerber, M. Fuller, G.
## [61,2]  Fry, M. Roos"
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## [62,2]  %Y', '%d %B %Y')), ifelse(rmarkdown::metadata$draft, ifelse(!knitr::is_lat
## [62,3] ex_output(),ifelse(knitr::is_html_output(),'<br>Commercial in Confidence',
## [62,4] '  \\n Commercial in Confidence'),'') ,''))`"
## [63,1] year: "`r format(Sys.Date(), '%Y')`"
## [64,1] subtitle: "Draft Report for the Northern Prawn Fishery: Redleg Banana Prawn
## [64,2]  sub-fishery, 2017 - 2021"
## [65,1] citation: "Sporcic, M.\\footnote{Affiliation: CSIRO Environment, Hobart Aus
## [65,2] tralia}, van der Velde, T.\\footnote{Affiliation: CSIRO Environment, Brisba
## [65,3] ne Australia}, Donovan, A.\\footnotemark[\\value{footnote}], Gerber, C.\\fo
## [65,4] otnote{Affiliation: CSIRO Environment, Adelaide Australia}, Fuller, M.\\foo
## [65,5] tnotemark[\\value{footnote}], Fry, G.\\footnotemark[\\value{footnote}], Roo
## [65,6] s, M.\\footnote{Affiliation: Marjoleine Roos (company), Queensland, Austral
## [65,7] ia} (`r format(Sys.Date(), '%Y')`). `r rmarkdown::metadata$title`. `r rmark
## [65,8] down::metadata$subtitle`. Report for the Australian Fisheries Management Au
## [65,9] thority."
## [66,1]
## [67,1]
## [68,1] description: This is a technical report detailing an ecological risk assesm
## [68,2] ent for the effects of fishing.
## [69,1] ---
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C.4.2 _bookdown.yml

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##  [5] "  ui:"                             "    appendix_name: \"Chapter \""
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## [31] "- 07-results-level2.Rmd"           "- 08-discussion.Rmd"
## [33] "- 09-references.Rmd"               "- 10-glossary.Rmd"
## [35] "- 11-appendix-automated.Rmd"       "- 12-appendix-manual.Rmd"
## [37] "- 13-backmatters.Rmd"
```

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