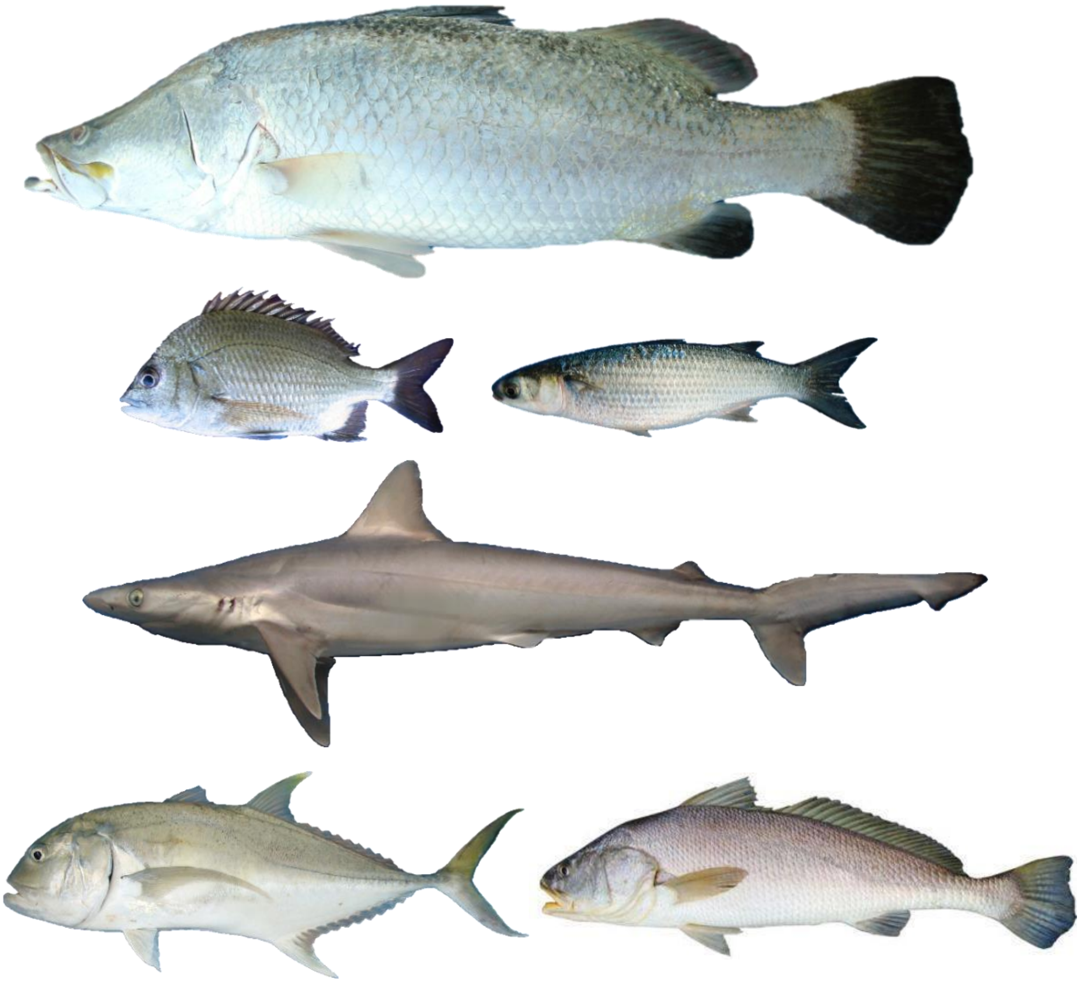
Department of Agriculture and Fisheries

Sustainable Fisheries Strategy
2017–2027

Level 2 Ecological Risk Assessment

East Coast Inshore Fishery – Large Mesh Nets

Target & Byproduct Species



Queensland Government

Level 2 Ecological Risk Assessment
East Coast Inshore Fishery – Large Mesh Nets
Target & Byproduct Species

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Executive Summary

In May 2019, a whole-of-fishery or Level 1 Ecological Risk Assessment (ERA) was released for the *East Coast Inshore Fishery* (Jacobsen *et al.*, 2019a). The Level 1 ERA provided a broad risk profile for the ECIF, identifying key drivers of risk and the ecological components most likely to experience an undesirable event. As part of this process, the Level 1 ERA considered both the current fishing environment and what can occur under the current management regime. In doing so, the outputs of the Level 1 ERA helped to differentiate between low and high-risk elements and established a framework that can be built upon in subsequent ERAs.

The Level 1 ERA identified a number of high-risk elements that are to be progressed to a finer scale or species-specific Level 2 ERA. One of these high-risk elements was the target & byproduct species ecological component (Jacobsen *et al.*, 2019a). As the ECIF incorporates multiple sub-fisheries and apparatus, the risks posed to this ecological component were assessed separately for large mesh nets, tunnel nets and ocean beach fishing. The focus of this assessment being large mesh net operations utilising gillnets and ring nets under the N1, N2 and N4 fishery symbols (Department of Agriculture and Fisheries, 2019f). These symbols account for the majority of the catch and effort reported from the ECIF and this sector will be the main contributor of risk for a number of the target species (Jacobsen *et al.*, 2019a; Department of Agriculture and Fisheries, 2019f). Risk assessments for the remaining sub-fisheries and ecological components (bycatch, marine turtles, dugongs, dolphins, batoids and sharks) will be addressed in separate ERAs (Jacobsen *et al.*, 2021a; b; c).

The Level 2 ERA was compiled using a *Productivity & Susceptibility Analysis* (PSA) and takes into consideration a range of biological (*age at sexual maturity*, *maximum age*, *fecundity*, *maximum size*, *size at sexual maturity*, *reproductive strategy*, and *trophic level*) and fisheries-specific attributes (*availability*, *encounterability*, *selectivity, post-capture mortality, management strategy, sustainability assessments* and *recreational desirability / other fisheries*). As the PSA can overestimate risk for some species (Zhou *et al.*, 2016), this Level 2 ERA also included a *Residual Risk Analysis* (RRA). The RRA gives further consideration to risk mitigation measures that were not explicitly included in the PSA and/or any additional information that may influence the risk status of a species (Australian Fisheries Management Authority, 2017). The primary purpose of the RRA is to minimise the number of false positives or instances where the risk level has been overestimated.

The scope of the Large Mesh Net Target & Byproduct Species Level 2 ERA was based on data compiled through the logbook program and considered catch reported against individual species and multi-species catch categories (Department of Agriculture and Fisheries, 2019f). A review of logbook records showed that around 95% of the catch (2017–2019 inclusive) was recorded against 33 different catch categories. These categories produced a preliminary list of 82 species that were considered for inclusion in the Level 2 ERA. This list was reduced to 50 species (35 teleosts and 15 sharks) through a subsequent rationalisation process. The remaining species had comparatively low catch rates and a limited or low potential to interact with this sector of the ECIF.

When the outputs of the PSA and RRA were taken into consideration, the majority of the species (*n* = 26, 52%) including all of the sharks were classified as high risk. Scores for the remaining 24 teleosts fell within the medium (*n* = 18, 36%) and low (*n* = 6, 12%) risk categories. Teleost risk profiles were heavily influenced by the *susceptibility* component with most species being assigned higher scores for the *selectivity*, *encounterability* and *post-capture mortality* attributes. While these risks also applied to sharks, biological constraints were identified as a significant risk factor for this subgroup. Across the study, management limitations and restricted sustainability assessments contributed to the production of more conservative risk assessments. While not uniform, data deficiencies were a factor of influence in a number of the risk profiles. These deficiencies were most evident in assessments involving the *sustainability assessments* and *recreational desirability / other fisheries* attributes.

Of the species classified as high risk, 19 ratings were viewed as *precautionary* and were considered more representative of the potential risk. **Management of the risk posed to species with *precautionary* risk ratings, beyond what is already being undertaken as part of the *Queensland Sustainable Fisheries Strategy 2017–2027* (Department of Agriculture and Fisheries, 2017), is not considered an immediate priority.** In most instances, these risks are best addressed through the *Monitoring & Research Plan* or the harvest strategy development process. With improved information, a number of the species with precautionary risk ratings could be excluded from future iterations of the Large Mesh Net Target & Byproduct Species Level 2 ERA.

Final risk ratings for the remaining species (*n* = 30) are more representative of the risk posed by large mesh nets in the current fishing environment. They are viewed as higher priorities and the management of risk may require more formal arrangements *e.g.* species or complex-specific harvest strategies. The outputs of the Level 2 ERA will assist in this process and the following recommendations have been identified as areas where the risk profiles can be refined or the level of risk reduced. These recommendations are complimented within the report by complex-specific recommendations aimed at reducing risk or improving the accuracy of assessments involving individual species. The need or immediacy of progressing some of these complex-specific recommendations will vary between species. Similarly, some recommendations are already being considered and progressed as part of the *Queensland Sustainable Fisheries Strategy 2017–2027*. This includes through the development and implementation of an ECIF-specific harvest strategy.

General recommendations

1. *Review management arrangements employed in the fishery (e.g. minimum, maximum legal size limits) and identify areas where biological risks can be minimised for key species.*
2. *Establish a mechanism to manage and minimise the long-term sustainability risk for key target and byproduct species, preferably through the introduction of a fishery-specific harvest strategy with clearly defined harvest control rules and sustainability assessment protocols.*
3. *Identify avenues/mechanisms that can be used to monitor the catch of target and byproduct species (preferably in real or near-real time) and minimise the risk of non-compliance.*
4. *Review the suitability, applicability, and value of data submitted through the logbook program on the dynamics of the fishery (the type of gear being used, net configurations, soak times, etc.). As part of this process, it is recommended that reporting requirements be extended to include information on what fishing symbol is being used.*
5. *Investigate how black jewfish management reforms may impact the marketability and demand of swim bladders from other species (particularly threadfins, jewfish, and barramundi), including the potential for catch to increase rapidly over the short-term, and avenues that may reduce the risk of regional stocks becoming overfished across sectors.*

6. *Establish a measure to estimate the gear-affected area and, when available, reassess the risk posed to teleost species using a more quantitative ERA method like base Sustainability Assessment for Fishing Effects (bSAFE).*

Summary of the outputs from the Large Mesh Net (ECIF) Target & Byproduct Species Level 2 Ecological Risk Assessment.

***** *Species whose risk score was just above or in close proximity to the medium-risk / high-risk threshold (3.18).*

Common name	Species Name	Productivity	Susceptibility	Risk Rating
Mullet				
Sea mullet	*Mugil cephalus*	1.29	2.29	Low
Bluespot mullet	*Valamugil seheli*	1.14	2.14	Low
Fantail mullet	*Paramugil georgii*	1.29	2.14	Low
Diamondscale mullet	*Liza vaigiensis*	1.29	2.14	Low
Flathead				
Dusky flathead	*Platycephalus fuscus*	1.57	2.43	Medium
Bartail flathead*	*Platycephalus australis*	1.67	2.71	Precautionary High*
Northern sand flathead	*Platycephalus endrachtensis*	1.50	2.71	Precautionary Medium
Yellowtail flathead	*Platycephalus westraliae*	1.43	2.71	Precautionary Medium
Trevally—Carangidae				
Turrum (gold spot)	*Carangoides fulvoguttatus*	2.14	2.86	Precautionary High
Bigeye trevally	*Caranx sexfasciatus*	2.00	2.86	Precautionary High
Giant trevally	*Caranx ignobilis*	1.86	2.71	Precautionary High
Golden trevally	*Gnathanodon speciosus*	1.86	2.71	Precautionary High
Yellowtail scad	*Trachurus novaezelandiae*	1.29	2.43	Precautionary Medium
Snubnose dart	*Trachinotus blochii*	1.57	2.57	Precautionary Medium
Swallowtail dart	*Trachinotus coppingeri*	1.29	2.57	Precautionary Medium
Giant queenfish	*Scomberoides commersonnianus*	1.86	2.71	Precautionary High
Mackerel				
Grey mackerel	*Scomberomorus semifasciatus*	1.71	2.43	Medium
Spotted mackerel	*Scomberomorus munroi*	1.57	2.43	Medium
School mackerel	*Scomberomorus queenslandicus*	1.71	2.43	Precautionary Medium
Jewfish				
Black jewfish	*Protonibea diacanthus*	1.71	2.57	Medium
Silver jewfish	*Nibea soldado*	2.14	2.86	High
Mulloway	*Argyrosomus japonicus*	1.86	2.86	Precautionary High
Other teleosts				
Trumpeter whiting	*Sillago maculata*	1.43	2.71	Precautionary Medium
Sand whiting	*Sillago ciliata*	1.29	2.29	Low
Yellowfin bream	*Acanthopagrus australis*	1.29	2.29	Low

Common name	Species Name	Productivity	Susceptibility	Risk Rating
Tarwhine	*Rhabdosargus sarba*	1.43	2.71	Precautionary Medium
Snubnose garfish	*Arrhamphus sclerolepis*	1.29	2.57	Precautionary Medium
Three-by-two garfish	*Hemiramphus robustus*	1.29	2.43	Precautionary Medium
Barred javelin*	*Pomadasys kaakan*	1.71	2.71	Precautionary High*
Silver javelin	*Pomadasys argenteus*	1.57	2.71	Precautionary Medium
King threadfin	*Polydactylus macrochir*	1.86	2.71	High
Blue threadfin	*Eleutheronema tetradactylum*	1.43	2.71	Precautionary Medium
Barramundi	*Lates calcarifer*	2.00	2.14	Medium
Golden snapper	*Lutjanus johnii*	2.00	2.57	Precautionary High
Scribbled rabbitfish	*Siganus spinus*	1.29	2.71	Precautionary Medium
Whaler sharks				
Graceful shark	*Carcharhinus amblyrhynchoides*	2.57	2.43	Precautionary High
Common blacktip shark	*Carcharhinus limbatus*	2.43	2.43	High
Australian blacktip shark	*Carcharhinus tilstoni*	2.43	2.57	High
Spot-tail shark	*Carcharhinus sorrah*	2.29	2.43	Precautionary High
Pigeye shark	*Carcharhinus amboinensis*	2.71	2.57	Precautionary High
Bull shark	*Carcharhinus leucas*	2.86	2.57	Precautionary High
Spinner shark	*Carcharhinus brevipinna*	2.71	2.43	Precautionary High
Blacktip reef shark	*Carcharhinus melanopterus*	2.43	2.57	Precautionary High
Hardnose shark	*Carcharhinus macloti*	2.29	2.29	Precautionary High
Milk shark	*Rhizoprionodon acutus*	2.14	2.57	Precautionary High
Australian sharpnose shark	*Rhizoprionodon taylori*	2.00	2.57	Precautionary High
Hammerhead sharks				
Winghead shark	*Eusphyra blochii*	2.43	2.29	High
Scalloped hammerhead shark	*Sphyrna lewini*	2.86	2.29	High
Great hammerhead shark	*Sphyrna mokarran*	2.86	2.29	High
Smooth hammerhead shark	*Sphyrna zygaena*	2.86	2.14	Precautionary High

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Definitions & Abbreviations

AFMA	–	Australian Fisheries Management Authority.
bSAFE	–	*base Sustainability Assessment for Fishing Effects*. One of the two ERA methodologies that can be used as part of the Level 2 assessment. This method can be separated into a base SAFE (bSAFE) and enhanced SAFE (eSAFE). The data requirements for eSAFE are higher than for a bSAFE, which aligns more closely to a PSA.
CAAB	–	*Codes for Australian Aquatic Biota.*
CMS	–	*Convention on the Conservation of Migratory Species of Wild Animals.*
CITES	–	*Convention on International Trade in Endangered Species of Wild Fauna and Flora.*
CSIRO	–	*Commonwealth Scientific and Industrial Research Organisation.*
ECIF	–	*East Coast Inshore Fishery.*
Ecological Component	–	Broader assessment categories that include *Target & Byproduct* (harvested) species, *Bycatch*, *Species of Conservation Concern*, *Marine Habitats* and *Ecosystem Processes.*
Ecological Subcomponent	–	Species, species groupings, marine habitats and categories included within each Ecological Component.
EPBC Act	–	*Environment Protection and Biodiversity Conservation Act 1999*
ERA	–	Ecological Risk Assessment.
ERAEF	–	*Ecological Risk Assessment for the Effects of Fishing*. A risk assessment strategy established by (Hobday *et al.*, 2011) and employed by the AFMA.
False positive	–	The situation where a species at low risk is incorrectly assigned a higher risk rating due to the method being used, data limitations *etc.* In the context of an ERA, false positives are preferred over false negatives.
False negative	–	The situation where a species at high risk is assigned a lower risk rating. When compared, false-negative results are considered to be of more concern as the impacts/consequences can be more significant.
ITQ	–	Individual Transferrable Quota.
MEY	–	Maximum Economic Yield.
MSY	–	Maximum Sustainable Yield.

PSA	–	*Productivity & Susceptibility Analysis.* One of the two ERA methodologies that can be used as part of the Level 2 assessment.
RRA	–	Residual Risk Analysis.
SAFE	–	*Sustainability Assessment for Fishing Effects*. One of the two ERA methodologies that can be used as part of the Level 2 assessment. This method can be separated into a base SAFE (bSAFE) and enhanced SAFE (eSAFE). The data requirements for eSAFE are higher than for a bSAFE, which aligns more closely to a PSA.
SAFS	–	The National *Status of Australian Fish Stocks*. Refer to www.fish.gov.au for more information.
SCP	–	*Shark Control Program*
SOCC	–	*Species of Conservation Concern*. Term used in the Level 1 and Level 2 ERA to categorise the list of species with ongoing concern. The SOCC includes both no-take species and species that are targeted within the ECIF.
SOCI	–	*Species of Conservation Interest.* No-take species that are subject to additional reporting requirements if caught in a commercial fishery operating in Queensland.
TACC	–	Total Allowable Commercial Catch limit
TEP	–	Threatened, Endangered & Protected species
The Strategy	–	*Queensland Sustainable Fisheries Strategy 2017–2027*

1 Introduction

Ecological Risk Assessments (ERAs) are important tools for sustainable natural resource management and are being used increasingly in commercial fisheries to monitor long-term risk trends for target and non-target species. In Queensland, ERAs have previously been developed on an as-needs basis and these assessments have often employed alternate methodologies (Department of Agriculture and Fisheries, 2019c). This process has now been formalised as part of the *Queensland Sustainable Fisheries Strategy 2017–2027* (the Strategy) and risk assessments are being completed for priority fisheries (Department of Agriculture and Fisheries, 2018b). Once completed, the ERAs will inform a range of Strategy initiatives including the development of harvest strategies, identifying key research needs and implementing detailed bycatch mitigation strategies (Department of Agriculture and Fisheries, 2018b; a; 2020d; 2018c).

In May 2019, a whole-of-fishery or Level 1 ERA was released for the East Coast Inshore Fishery (ECIF; Jacobsen *et al.*, 2019a).[1] The Level 1 ERA provided a broad-scale assessment of the risks posed by this fishery including the key drivers of risk and the ecological components most likely to experience an undesirable event. These outputs were based on considerations given to the current fishing environment (*e.g.* catch and effort levels, participation rates) and actions that are permissible under the current management regime (*e.g.* shifting effort, increasing fishing mortality). In the context of the broader ERA, these results were used to differentiate between low and high-risk elements and determine what ecological components should be progressed to a finer-scale or species-specific ERA (Department of Agriculture and Fisheries, 2018b).

For the Level 2 ERA, the focus of the analysis shifts to a species-specific level and the scope of the assessment is refined to the current fishing environment. Applying more detailed assessment tools, Level 2 ERAs establish risk profiles for individual species using one of two methods: the semi-quantitative *Productivity & Susceptibility Analysis* (PSA) or the quantitative *Sustainability Assessment for the Fishing Effects* (SAFE) (Hobday *et al.*, 2007; Zhou & Griffiths, 2008; Department of Agriculture and Fisheries, 2018b). While both methods have been developed for use in data-limited fisheries, the use of the PSA or SAFE method will be dependent on the species being assessed, the level of information on gear effectiveness, and the distribution of the species in relation to fishing effort (Hobday *et al.*, 2011).

As the ECIF incorporates multiple sub-fisheries and apparatus, risk was assessed separately for the large mesh nets (gillnets and ring nets), tunnel nets, and ocean beach fishing. The focus of this assessment being large mesh net operations utilising gillnets and ring nets under the N1, N2 and N4 fishery symbols (Department of Agriculture and Fisheries, 2019f). The scope of this Level 2 assessment was based on the outputs of the Level 1 ERA (Jacobsen *et al.*, 2019a) and examines the risks posed to key target & byproduct species. Risk assessments for the remaining sub-fisheries (*i.e.* Tunnel Net Fishery and Ocean Beach Fishery) and ecological components (bycatch, marine turtles, dugongs, dolphins, batoids and sharks) will be addressed in separate ERAs (Jacobsen *et al.*, 2021a; b; c).

[1] *The East Coast Inshore Fishery (ECIF) has historically been referred to as the East Coast Inshore Fin Fish Fishery or ECIFFF including in the Level 1 ERA (Jacobsen et al., 2019a).*

2 Methods

2.1 The Fishery

The ECIF is one of the more complicated commercial fisheries operating on the Queensland east coast. The management system incorporates multiple fishing symbols and the fishery operates across a wide range of habitats and bathymetric ranges. Despite this variability, the fishery has historically been assessed and monitored as a single entity for *Wildlife Trade Operation* (WTO) approvals, annual fisheries summaries *etc.* (Department of Environment and Energy, 2019; Department of Agriculture and Fisheries, 2018e; 2019f). Even so, the ECIF can be subdivided into a number of informal sub-fisheries based on the apparatus being used: large mesh nets (general purpose mesh nets, set nets and ring nets), tunnel nets, the ocean beach fishing, small mesh nets and a line fishery (Department of Agriculture and Fisheries, 2019f).

In Queensland, large mesh nets are mostly used by fishers operating under the N1,[2] N2 or N4 fishery symbols (Department of Agriculture and Fisheries, 2019f). Management of these fishing activities includes a mixture of input and output controls; although the majority of species are not subject to species-specific quotas or Total Allowable Commercial Catch (TACC) limits. Some of the more notable exceptions being black jewfish (*Protonibea diacanthus*), grey mackerel (*Scomberomorus semifasciatus*), spotted mackerel (*S. munroi*), tailor (*Pomatomus saltatrix*) and the shark complex (Department of Agriculture and Fisheries, 2019f).

The management regime for the entire ECIF is being reviewed as part of the *Queensland Sustainable Fisheries Strategies 2017–2027* (Department of Agriculture and Fisheries, 2017). As part of this process, alternate management strategies are being developed and considered for the fishery *e.g.* regional management, increased use of species-specific quotas and establishing an *East Coast Inshore Protected Species Management Strategy* (Department of Agriculture and Fisheries, 2019a). This review is ongoing and a number of the alternative strategies are still in development, have yet to be adopted and/or fully implemented. For these reasons, the Large Mesh Net Target & Byproduct Species Level 2 ERA only considered arrangements that were in place at the time of the assessment.

In addition to the management reforms, the Level 2 ERA includes species that may interact with the recreational and charter fishing sectors or be impacted upon by other marine-based activities. These cumulative risks were taken into consideration as part of the Level 1 ERA (Jacobsen *et al.*, 2019a) and, when and where appropriate, will be given further consideration as part of this assessment. It is noted though that these impacts or cumulative risks involve a wider range of stakeholders and can be difficult to address through a fisheries management framework. Accordingly, cumulative risk comparisons will only be used to provide further context on the extent of the risk posed by commercial fishing activities to key species or species complexes.[3]

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[2] *While they are separate symbols with their own regulations, fishers with a N2 or K1–K8 symbol are permitted use of any net described under the N1 fishery symbol. These provisions also apply to the N4 symbol but exclude set pock nets, prawn seine nets and Noosa Lakes mesh nets (Department of Agriculture and Fisheries, 2019f).*

[3] *A number of the species caught in the ECIF attract significant levels of attention from the recreational fishing sector (Webley et al., 2015). The use of nets in the recreational fishing sector is regulated (i.e. only permitted for bait fishing) and the key risks for this fishery will relate to line fishing.*

2.2 Information sources / baseline references

Where possible, baseline information on the life history constraints and habitat preferences for each species were obtained from peer-reviewed articles. In the absence of peer-reviewed data, additional information was sourced from grey literature and publicly accessible databases such as *FishBase* (www.fishbase.org), *SeaLifeBase* (www.sealifebase.ca), *Fishes of Australia* (www.fishesofaustralia.net.au), *Seamap Australia* (www.seamapaustralia.org) and the *IUCN Red List of Threatened Species* (www.iucnredlist.org). Additional information including on the distribution of key seabirds, fish and endangered species was obtained through the *Atlas of Living Australia* (www.ala.org.au), *Species Profile and Threats Database* (Department of Environment and Energy, www.environment.gov.au/cgi-bin/sprat/public/sprat.pl) and resources associated with the management and regulation of marine national parks *e.g.* the *Moreton Bay Marine Park* and *Great Sandy Marine Park.* Where possible regional distribution maps were sourced for direct comparison with effort distribution data (Whiteway, 2009).

Fisheries data used in the Level 2 ERA were obtained through the fisheries logbook program, a previous *Fisheries Observer Program* (FOP), the *Fishery Monitoring Program* (FMP)[4] and the *Statewide Recreational Fishing Survey* (Department of Agriculture and Fisheries, 2020c; Webley *et al.*, 2015; Department of Agriculture and Fisheries, 2021).

2.3 Species Rationalisation Processes

The scope of the Large Mesh Net Target & Byproduct Species Level 2 ERA was determined by the outcomes of the whole-of-fishery (Level 1) assessment (Jacobsen *et al.*, 2019a). This assessment identified a number of high-risk elements that were to be progressed to a finer-scale (Level 2) ERA including target & byproduct species, bycatch, marine turtles, dugongs, dolphins, batoids and sharks (Table 1). Only the target & byproduct ecological component was included in this assessment. The risk posed to the remaining ecological components (marine turtles, dugongs, dolphins, batoids and sharks) will be evaluated in a separate Level 2 ERA (Jacobsen *et al.*, 2021a).

A preliminary list of target & byproduct species was compiled using catch data submitted through commercial logbooks from 2017–2019 (inclusive). Catch reported against each species or species complex was summed across years and ranked from highest to lowest. Cumulative catch comparisons were then used to identify the species and species complexes that made up 95% of the total catch. *Codes for Australian Aquatic Biota* (CAAB; http://www.cmar.csiro.au/caab/) were used to expand multi-species catch categories. A secondary review was then undertaken to remove duplicates, species with low or negligible catches, species that have limited potential to interact with the fishery, and species where risk is being effectively managed through harvest strategies or output controls (*e.g.* TACC limits linked to detailed stock assessments and biomass reference points). Any species not contained within the 95% cumulative catch records that has conservation or vulnerability concerns were also considered for inclusion in the Level 2 ERA.

While this assessment does not cover all species that interact with the Large Mesh Net Fishery, the structure of the Level 2 ERA allows for additional species to be included when and where appropriate. For example, additions can be made if catch and effort increases for a particular species, the

[4] *The Fishery Monitoring Program was previously known as the Long-Term Monitoring Program (LTMP*).

marketability of a bycatch species increases substantially, or if the *East Coast Inshore Fishery Working Group* identifies the need for further assessments.

A full overview of the species rationalisation process for target & byproduct species and the key considerations have been provided in Appendix A and B respectively

Table 1. *Summary of the outputs from the Level 1 (whole-of-fishery) Ecological Risk Assessment for the East Coast Inshore Fishery (ECIF). * Does not include Species of Conservation Concern or target & byproduct species that were returned for to the water due to (e.g.) regulations, product quality etc.*

Ecological Component	Level 1 Risk Rating	Progression
Target & Byproduct	High	Level 2 ERA (this report)
Bycatch*	Medium / High	Level 2 ERA
Species of Conservation Concern (SOCC)		
Marine turtles	High	Level 2 ERA
Dugongs	Medium / High	Level 2 ERA
Whales	Low / Medium	Not progressed further.
Dolphins	High	Level 2 ERA
Sea Snakes	Low	Not progressed further.
Crocodiles	Low	Not progressed further.
Protected Teleosts	Low	Not progressed further.
Batoids	High	Level 2 ERA
Sharks	High	Level 2 ERA
Syngnathids	Negligible	Not progressed further.
Seabirds	Low	Not progressed further.
Terrestrial mammals	Negligible	Not progressed further.
Marine habitats	Low	Not progressed further.
Ecosystem Processes	Precautionary High	Level 1 ERA – Monitoring & Research Plan

2.4 ERA Methodology

Methodology used to construct the Level 2 ERA aligns closely with the *Ecological Risk Assessment for the Effects of Fishing* (ERAEF) and includes two assessment options: the *Productivity & Susceptibility Analysis* (PSA) and the *Sustainability Assessment for Fishing Effects* (SAFE) (Hobday *et al.*, 2011; Australian Fisheries Management Authority, 2017; Zhou & Griffiths, 2008). Data inputs for the two methods are similar and both were designed to assess fishing-related risks for data-poor species (Zhou *et al.*, 2016). Similarly, both methods include precautionary elements that limit the potential for false negatives, or high-risk species being incorrectly assigned a lower risk rating. However, the PSA tends to be more conservative, and research has shown that it has a higher potential to produce false positives. That is, low-risk species being assigned a higher risk score due to the conservative nature of the method, data deficiencies *etc.* (Zhou *et al.*, 2016; Hobday *et al.*, 2011; Hobday *et al.*, 2007).

In the PSA, the level of risk (low, medium, or high) is defined through a finer scale assessment of the life-history constraints of the species (*productivity*), the potential for the species to interact with the fishery and the associated consequences (*susceptibility*). In comparison, the SAFE method quantifies risk by comparing the rate of fishing mortality against key reference points including the level of fishing mortality associated with *Maximum Sustainable Fishing Mortality* (F_{msm}), the point where biomass is assumed to be half that required to support a maximum sustainable fishing mortality (F_{lim}) and fishing mortality rates that, in theory, will lead to population extinction in the long term (F_{crash}) (Zhou *et al.*, 2016; Zhou & Griffiths, 2008; Zhou *et al.*, 2011). As SAFE is a quantitative assessment, the method provides an absolute measure of risk or a continuum of values that can be compared directly to the above reference points (Hobday *et al.*, 2011). This contrasts with the PSA which provides an indicative measure (low, medium, high) of the potential risk (Hobday *et al.*, 2007).

While research has shown that SAFE produces fewer false positives, it requires a sound understanding of the fishing intensity and the degree of overlap between a species' distribution and fishing effort (Hobday *et al.*, 2011; Zhou *et al.*, 2009). These requirements mean that SAFE may not be suitable for species with insufficient data; typically protected species (*e.g.* especially mammals, reptiles and seabirds) and marine invertebrates (Australian Fisheries Management Authority, 2017). The method also requires a sound understanding of the gear-affected area (Zhou & Griffiths, 2008) or the proportion of the fished area that a species resides in that is impacted on by the apparatus (Zhou *et al.*, 2019; Zhou *et al.*, 2014).

In the ECIF, the ability to determine the gear-affected area is limited by the complexity of the fishery. Unlike other commercial fisheries, operators can access the ECIF using a variety of net and line fishing symbols (Department of Agriculture and Fisheries, 2019f). While legislative provisions governing the use of the net symbols are similar, there are key differences in terms of the maximum net length permitted for use under each symbol and the minimum/maximum mesh sizes (Department of Agriculture and Fisheries, 2019f). Net operators on the Queensland east coast are also permitted to use more than one net providing that the total net length does not exceed that permitted under each symbol or within a particular region (Department of Agriculture and Fisheries, 2019f). This is considered to be of some importance as the number of nets being used, their configuration, the distance between each net, and the extent of any overlap will all influence the gear-affected area.

In addition to management nuances, there is a degree of uncertainty surrounding the type and configuration of nets used in the fishery. In the ECIF, commercial fishers are only required to submit information on the dominant mesh size used, total net length (or combined net length), and soak times if using a drift or set gillnet. Further, net logbooks only record the location of the net where the majority of the catch was caught. This is of considerable importance as net operators may set in one location and relocate if, for example, fishing conditions deteriorate or a location is viewed as less profitable. These factors limit the amount of available information on net configurations used in the ECIF and the total amount of net used across the fishery (*i.e.* net length reported through logbooks plus failed setting events). These operational nuances are of some importance as the number of nets being used, their configuration, the distance between each net and the extent of any overlap will have a bearing on the gear-affected area.

Given the complexity of the current fishing arrangements, data deficiencies, and uncertainty in determining the gear-affected area, the PSA was adopted for the first phase of the Large Mesh Net Target & Byproduct Species Level 2 ERA. This decision aligns with a corresponding assessment involving species with conservation concerns (Jacobsen *et al.*, 2021a); meaning the entire Large Mesh

Net Fishery will be assessed under a single methodology. As a high number of the initiatives instigated under the *Queensland Sustainable Fisheries Strategy 2017–2027* are designed to improve information levels (Department of Agriculture and Fisheries, 2017), there may be more avenues to apply SAFE in subsequent ERAs.

2.4.1 Productivity & Susceptibility Analysis (PSA)

The PSA was largely aligned with the ERAEF approach employed for Commonwealth fisheries (Australian Fisheries Management Authority, 2017; Hobday *et al.*, 2011). As a detailed overview of the methodology and the key assumptions are provided in Hobday *et al*. (2007), only an abridged version will be provided here.

The *productivity* component of the PSA examines the life-history constraints of a species and the potential for an attribute to contribute to the overall level of risk. These attributes are based on the biology of the species and include the *size and age at sexual maturity*, *maximum size and age*, *fecundity*, *reproductive strateg*y and *trophic level* (Table 2). *Productivity* attributes used in the Level 2 assessment were consistent with the ERAEF (Hobday *et al.*, 2011) and were applied across all ecological components assessed using the PSA. Criteria used to assign each attribute a score of low (1), medium (2) or high (3) risk are outlined in Table 2.

Table 2. *Scoring criteria for the productivity component of the Productivity & Susceptibility Analysis (PSA) utilised as part of the Large Mesh Net Target & Byproduct Species Level 2 ERA. Attributes and scores/criteria align with national (ERAEF) approach (Hobday et al., 2011).*

Attribute	High Productivity (Low risk, score = 1)	Medium Productivity (Medium risk, score = 2)	Low Productivity (High risk, score = 3)
Age at sexual maturity*	<5 years	5–15 years	>15 years
Maximum age*	<10 years	10–25 years	>25 years
Fecundity**	>20,000 eggs per year	100–20,000 eggs per year	<100 eggs per year
Maximum size*	<100cm	100–300cm	>300cm
Size at sexual maturity*	<40cm	40–200cm	>200cm
Reproductive strategy	Broadcast spawner	Demersal egg layer	Live bearer (& birds)
Trophic Level	<2.75	2.75–3.25	>3.25

** Where attributes differed between sexes, the most precautionary measure was used. **Fecundity for broadcast spawners was assumed to be >20,000 eggs per year (Miller & Kendall, 2009).*

For the *susceptibility* component of the PSA, ERAEF attributes were used as the baseline of the assessment and included *availability*, *encounterability*, *selectivity* and *post-capture mortality* (Hobday *et al.,* 2007; Hobday *et al.,* 2011). The following provides an overview of the *susceptibility* attributes used in the PSA with Table 3 detailing the criteria used to assign scores for this part of the analysis.

- **Availability**—Where possible, *availability* scores were based on the overlap between fishing effort and the proportion of the species range that occurs within the broader geographical spread of the fishery. To account for inter-annual variability, percentage overlaps were calculated for three years (2017, 2018 and 2019) and the highest value used as the basis of the *availability* assessment. Regional distribution maps were sourced from the *Atlas of Living Australia*, the *Species Profile and*

Threats Database (Department of Environment and Energy, www.environment.gov.au/cgi-bin/sprat/public/sprat.pl), the *Commonwealth Scientific and Industrial Research Organisation* (CSIRO) and, where possible, refined using bathymetry and topographical data (Whiteway, 2009).

In instances where a species did not have a distribution map, *availability* scores were initially based on a broader geographic distribution assessment (global, southern hemisphere, Australian endemic) described in Hobday *et al.* (2007) (Table 3). A full summary of the overlap percentages used to assess availability has been provided in Appendix C.

- **Encounterability**—*Encounterability* considers the likelihood that a species will encounter the fishing gear when it is deployed within the known geographical range (Hobday *et al.*, 2007). The *encounterability* assessment is based on the behaviour of the species as an adult and takes into consideration information on the preferred habitats and bathymetric ranges. For the PSA, both parameters (adult habitat overlap and bathymetric range overlap) are assigned an individual risk score with the highest value used as the basis of the *encounterability* assessment. The notable exceptions to this are air breathing species which, under the ERAEF framework, are assigned the highest score due to their need to access the surface and their potential to interact with the gear during the deployment and retrieval process (Hobday *et al.*, 2007).
- **Selectivity**—*Selectivity* is a measure of the likelihood that a species will get caught in the apparatus. Factors that will influence the *selectivity* score include the fishing method, the apparatus used, and the body size of the species in relation to the mesh size. As the maximum mesh size used in the ECIF is comparable to a Commonwealth managed shark gillnet fishery (Australian Fisheries Management Authority, 2018b), the same criteria were applied to large mesh net operations in the ECIF (Table 3).
- **Post-capture mortality**—*Post-capture mortality* is one of the more difficult attributes to assess in a marine environment. In the PSA, this assessment has been simplified for target & byproduct species with all retainable product being assigned a high (3) risk rating for this attribute (Hobday *et al.*, 2011). The premise being that survival rates for these species will be zero as they will (most likely) be retained for sale.

In addition to the four baseline attributes, the Large Mesh Net Target & Byproduct Species Level 2 ERA included three additional *susceptibility* attributes: *management strategy*, *sustainability assessments* and *recreational desirability / other fisheries*. These attributes were included in the assessment to address risks associated with other fishing sectors (recreational and charter fisheries) and management limitations for key species (*e.g.* an absence of effective controls on catch or effort). While the additional attributes are not included in the ERAEF, variations of all three have been used in risk assessments involving species experiencing similar fishing pressures (Patrick *et al.*, 2010; Furlong-Estrada *et al.*, 2017).

Table 3. *Scoring criteria and cut-off scores for the susceptibility component of the PSA. Attributes and the corresponding scores / criteria are largely aligned with ERAEF approach (Hobday et al., 2011).*

Attribute	**Low Susceptibility (Low risk, score = 1)**	**Medium Susceptibility (Medium risk, score = 2)**	**High Susceptibility (High risk, score = 3)**
Availability			
Option 1. Overlap of species range with fishing effort.	<10% overlap.	10–30% overlap.	>30% overlap.
Option 2. Global distribution & stock proxy considerations.	Globally distributed.	Restricted to same hemisphere / ocean basin as fishery.	Restricted to same country as fishery.
Encounterability			
Option 1. Habitat type	Low overlap with fishery area.	Medium overlap with fishery area.	High overlap with fishery area.
Option 2. Depth check	Low overlap with fishery area.	Medium overlap with fishery area.	High overlap with fishery area.
Selectivity	Low susceptibility to gear selectivity.	Moderate susceptibility to gear selectivity.	High susceptibility to gear selectivity.
Post-capture mortality	Evidence of post-capture release and survival.	Released alive with uncertain survivability.	Retained species, majority dead when released, interaction likely to result in death or life-threatening injuries.
Management strategy	Species-specific management of catch or effort (*e.g.* TACC limits) based on biomass estimates / reference points. Management regime able to actively address emerging issues within the current framework.	Catch or effort restricted in some capacity (*e.g.* species-specific TACC limits or analogous arrangements), restrictions based on arbitrary or outdated biomass estimates / reference points. Limited capacity to address emerging catch and effort trends without legislative amendments or reforms.	Harvested species do not have species-specific catch limits or robust input & output controls. Management regime based at the whole-of-fishery level.
Sustainability assessments	Sustainability confirmed through stock assessments / biomass estimates.	Sustainability confirmed through indicative sustainability assessments & weight-of-evidence approach *e.g.* national SAFS.	Not assessed, biomass depleted, declining or not conducive to meeting long-term targets outlined in the QLD Sustainable Fisheries Strategy 2017–2027.
Recreational desirability / other fisheries	<33% retention.	33–66% retention.	>66% retention.

In the Level 2 ERA, the three additional attributes will be used to further reduce the influence of false positives or risk overestimations for key species. Summaries for the three additional attributes have been provided below:

- **Management strategy**—Considers the suitability of the current management arrangements including the ability to manage risk through time *e.g.* the presence of an effective control on total catch or effort (if appropriate), regional management, biomass estimates that are directly linked to species-specific TACC limits. This attribute was considered of particular relevance to multi-species fisheries where the management regime often lacks species-specific control measures. Alternatively, this attribute provides the assessment with greater scope to assess risk mitigation measures including the use of quotas based on biomass reference points like *Maximum Sustainable Yield* (MSY) and *Maximum Economic Yield* (MEY).

- **Sustainability assessments**—The *sustainability assessments* attribute is directly linked to the level of information that is available on the stock structure and status of harvested species. Species where sustainability status has been confirmed through stock assessments or the national *Status of Australian Fish Stocks* (SAFS) will be assigned a lower risk score. Conversely, species that are being fished above key biomass reference points (*e.g.* MSY), have been assessed as depleting, overfished, or recovering in the most recent SAFS assessment and/or have no assessment will be assigned more precautionary risk scores.

- **Recreational desirability / other fisheries**—This attribute is specifically included in the PSA to account for the risk posed by other sectors of the fishery (recreational and charter fisheries) or other commercial fisheries that can retain the species for sale. In the PSA, preliminary risk ratings are based on retention rate estimates obtained through recreational fishing surveys (Webley *et al.*, 2015; Department of Agriculture and Fisheries, 2020c). Under the criteria used (Table 3), species with higher retention rates will be assigned more conservative risk scores.

  For the purpose of this ERA, recreational retention rates were used as an indicative assessment of a species' popularity across sectors. It is however acknowledged that the charter fishery is monitored and managed as a separate entity. When and where appropriate these impacts and those of other commercial fisheries will be given further consideration as part of the *Residual Risk Analysis* (RRA).

2.4.2 PSA Scoring

Each attribute was assigned a score of 1 (low risk), 2 (medium risk) or 3 (high risk) based on the criteria outlined in Table 2 and Table 3 (Brown *et al.*, 2013; Hobday *et al.*, 2011; Patrick *et al.*, 2010). In instances where an attribute has no available data, and in the absence of credible information to the contrary, a default rating of high risk (3) was used (Hobday *et al.*, 2011). This approach introduces a precautionary element into the PSA and helps to minimise the potential occurrence of false-negative assessments. The inherent trade off with this approach is that the outputs of the Level 2 ERA can be conservative and may include a number of false positives (Zhou *et al.*, 2016). Issues associated with false positives and the overestimation of risk will be examined further as part of the RRA.

Risk ratings (*R*) were based on a two-dimensional graphical representation of the *productivity* (*x*-axis) and *susceptibility* (*y*-axis) scores (Figure 1). Cross-referencing of the *productivity* and *susceptibility* scores provides each species with a graphical location that can be used to calculate the Euclidean distance or the distance between the species reference point and the origin (*i.e.* 0, 0 on Figure 1). This distance is calculated using the formula $R = ((P - X_0)^2 + (S - Y_0)^2)^{1/2}$ where P represents the *productivity* score, S represents the *susceptibility* score and X_0 and Y_0 are the respective x and y origin coordinates (Brown *et al.*, 2013). The further a species is from the origin, the more at risk it is considered to be. For the purpose of this ERA, cut offs for each risk category were aligned with previous assessments with scores below 2.64 classified as low risk, scores between 2.64 and 3.18 as medium risk and scores >3.18 classified as high risk (Brown *et al.*, 2013; Zhou *et al.*, 2016; Hobday *et al.*, 2007).

As the PSA includes an *uncertainty* assessment and RRA (refer to section *2.4.3 Uncertainty* and *2.4.4 Residual Risk Analysis*), the initial risk ratings may be subject to change. To this extent, scores assigned as part of the PSA analysis can be viewed as a measure of the potential risk for each species (Hobday *et al.*, 2007) with the final risk scores determined on the completion of the RRA.

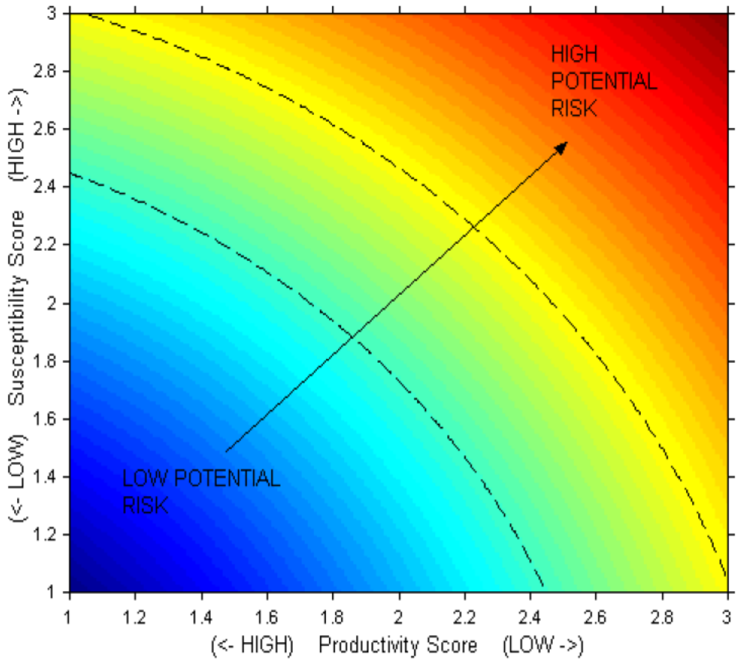

Figure 1. PSA plot demonstrating the two-dimensional space which species units are plotted. PSA scores for species units represent the Euclidean distance or the distance between the origin and the *productivity* (x axis), *susceptibility* (y axis) intercept (Hobday *et al.*, 2007)

2.4.3 Uncertainty

A number of factors including imprecise or missing data and the use of averages or proxies can contribute to the level of uncertainty surrounding the PSA. Examples of which include the use of a default high (3) score for attributes missing data and the use of values based at a higher taxon *i.e.* genera or family level (Hobday *et al.*, 2011). In the Level 2 ERA uncertainty is examined through a baseline assessment of each risk profile to determine the proportion of attributes assigned a precautionary high-risk rating due to data deficiencies. As species with greater data deficiencies are more likely to attract the default high-risk rating, their profiles are more likely to fall on the conservative side of the spectrum. In these instances, it may be more appropriate to address these risks and data deficiencies through measures like the *Queensland Sustainable Fisheries Strategy—Monitoring and Research Plan* (Department of Agriculture and Fisheries, 2018c).

2.4.4 Residual Risk Analysis (RRA)

Precautionary elements in the PSA combined with an undervaluation of some management arrangements can result in more conservative risk assessments and a higher number of false positives. Similarly, the effectiveness of some attributes may be exaggerated and subsequent risks could be underestimated (false negatives). To address these issues, PSA results were subjected to a RRA. The RRA gives further consideration to risk mitigation measures that were not explicitly included in the attributes and any additional information that may influence the risk status of a species (Australian Fisheries Management Authority, 2017). In doing so, the RRA provides management with greater capacity to differentiate between potential and actual risks (Department of Agriculture and Fisheries, 2018b) and helps refine risk management strategies.

The RRA framework was based on guidelines established by CSIRO and the *Australian Fisheries Management Authority* (AFMA) (Australian Fisheries Management Authority, 2018a). These guidelines identify six avenues where additional information may be given further consideration as part of a Level 2 assessment. Given regional nuances and data variability, a degree of flexibility was required with respect to how the RRA guidelines were applied to commercial fisheries in Queensland and the justifications used. The RRA was also expanded to include a seventh guideline titled *Additional Scientific Assessment & Consultation*. While a version of this guideline has been used in previous risk assessments involving Commonwealth Fisheries, it has since been removed as part of a broader RRA procedural review (Australian Fisheries Management Authority, 2018a). In Queensland, this guideline was retained as the broader ERA framework includes a series of consultation steps that aid in the development and finalisation of both the whole-of-fishery (Level 1) and species-specific (Level 2) ERAs (Department of Agriculture and Fisheries, 2018b).

In instances where the RRA resulted in an amendment to the preliminary score, full justifications were provided including the guidelines in which the amendments were considered (Appendix D). A brief summary of each guideline and the RRA considerations is provided in Table 4.

Table 4. *Guidelines used to assess residual risk including a brief overview of factors taken into consideration. Summary represents a modified excerpt from the revised AFMA Ecological Risk Assessment, Residual Risk Assessment Guidelines (Australian Fisheries Management Authority, 2018a).*

Guidelines	**Summary**
Guideline 1*: Risk rating due to missing, incorrect or out of date information.*	Considers if *susceptibility* and/or *productivity* attribute data for a species is missing or incorrect for the fishery assessment and is correct using data from a trusted source or another fishery.
Guideline 2*: Additional Scientific assessment & consultation.*	Considers any additional scientific assessments on the biology or distribution of the species and the impact of the fishery. This may include verifiable accounts and data raised through key consultative processes including but not limited to targeted consultation with key experts and oversite committees established as part of the *Queensland Sustainable Fisheries Strategy 2017–2027 including Fisheries Working Groups* and the *Sustainable Fisheries Expert Panel*.

Guidelines	Summary
Guideline 3*: At risk with spatial assumptions.*	Provides further consideration to the spatial distribution data, habitat data and any assumptions underpinning the assessment.
Guideline 4*: At risk in regards to level of interaction/capture with a zero or negligible level of susceptibility.*	Considers observer or expert information to better calculate susceptibility for those species known to have a low likelihood or no record of interaction nor capture with the fishery.
Guideline 5*: Effort and catch management arrangements for Target & Byproduct species.*	Considers current management arrangements based on effort and catch limits set using a scientific assessment for key species.
Guideline 6*: Management arrangements to mitigate against the level of bycatch.*	Considers management arrangement in place that mitigate against bycatch by the use of gear modifications, mitigation devices and catch limits.
Guideline 7*: Management arrangements relating to seasonal, spatial and depth closures.*	Considers management arrangements based on seasonal, spatial and/or depth closures.

3 Results

3.1 PSA

The majority of the ECIF catch (95%) was reported against 33 categories including a range of teleost and shark species. These 33 catch categories produced a preliminary list of 82 target & byproduct species that were considered for inclusion in the Level 2 ERA (Appendix A). A subsequent species rationalisation process reduced this list to 35 teleosts and 15 sharks (Appendix B). Complexes with the highest representation were whaler sharks (*n* = 11 species), mullet, flathead, trevally and hammerhead sharks (*n* = 4 species each, total 16 species) (Table 5; Appendix A). A secondary review of the data did not identify any species below the 95% catch threshold that should be included in the assessment as a precautionary measure (Appendix B).

As expected, shark species scored more highly across the seven *productivity* attributes with the complex recording an average score of 2.53 *verse* 1.74 for teleosts. At 1.14, bluespot mullet recorded the lowest *productivity* score of the assessment. Bull sharks and the three hammerhead sharks all registered an assessment high score of 2.86 (Table 5). *Trophic level* (*average* = 2.74) and *maximum age* (*average* = 2.32) were assigned the highest overall scores. Conversely, *reproductive strategy* (*average* = 1.62) and *fecundity* (*average* = 1.62) had the lowest average *productivity* scores.

In the *susceptibility* analysis, all species registered scores between 2.00 and 3.00 with the assessment recording a 2.70 average for this component of the PSA (Table 5). Two teleost species, the snubnose garfish and the scribbled rabbitfish, were assigned the maximum score (3) across all seven *susceptibility* attributes. Of the attributes assessed, *encounterability* and *post-capture mortality* had the highest average score (3.00), followed by *selectivity* (2.96) and *management strategy* (2.94). *Sustainability assessments* and *recreational desirability / other fisheries* displayed the most interspecific variability (Table 5).

Table 5. *Preliminary risk ratings compiled as part of the Productivity & Susceptibility Analysis (PSA) and the scores assigned to each attribute used in the assessment. Final PSA values are calculated using the scores assigned to each attribute and in accordance with the methods outlined in Hobday et al. (2007). Pink boxes with '*' represent attributes that were assigned precautionary score due to an absence of species-specific data.*

Common name	Species Name	Age at sexual maturity	Maximum age	Fecundity	Maximum size	Size at sexual maturity	Reproductive strategy	Trophic level	Productivity	Availability	Encounterability	Selectivity	Post-capture mortality	Management strategy	Sustainability assessments	Recreational desirability / other fisheries	Susceptibility	*PSA score*
Mullet																		
Sea mullet	*Mugil cephalus*	1	2	1	2	2	1	1	1.43	3	3	3	3	3	1	3*	2.71	**3.07**
Bluespot mullet	*Valamugil seheli*	1	1	1	1	2	1	1	1.14	2	3	3	3	3	3*	3*	2.86	**3.08**
Fantail mullet	*Paramugil georgii*	3*	3*	1	1	3*	1	1	1.86	2	3	3	3	3	3*	3*	2.86	**3.41**
Diamondscale mullet	*Liza vaigiensis*	3*	3*	1	1	3*	1	1	1.86	2	3	3	3	3	3*	3*	2.86	**3.41**
Flathead																		
Dusky flathead	*Platycephalus fuscus*	1	2	1	1	2	1	3	1.57	3	3	3	3	3	1	2	2.57	**3.01**
Bartail flathead	*Platycephalus australis*	3*	3*	1	2	3*	1	3	2.29	2	3	3	3	3	3*	3*	2.86	**3.66**
Northern sand flathead	*Platycephalus endrachtensis*	3*	3*	1	1	3*	1	3	2.14	2	3	3	3	3	3*	2	2.71	**3.46**
Yellowtail flathead	*Platycephalus westraliae*	3*	3*	1	1	1	1	3	1.86	2	3	3	3	3	3*	3*	2.86	**3.41**
Trevally / Family Carangidae																		
Turrum (gold spot)	*Carangoides fulvoguttatus*	2	3*	1	2	3*	1	3	2.14	2	3	3	3	3	3*	3*	2.86	**3.57**
Bigeye trevally	*Caranx sexfasciatus*	2	3*	1	2	1	1	3	1.86	2	3	3	3	3	3*	3*	2.86	**3.41**
Giant trevally	*Caranx ignobilis*	1	3	1	2	2	1	3	1.86	2	3	3	3	3	3*	2	2.71	**3.29**
Golden trevally	*Gnathanodon speciosus*	2	2	1	2	2	1	3	1.86	2	3	3	3	3	3*	1	2.57	**3.17**
Yellowtail scad	*Trachurus novaezelandiae*	1	2	1	1	1	1	2	1.29	2	3	3	3	3	2	3*	2.71	**3.00**

Common name	Species Name	Age at sexual maturity	Maximum age	Fecundity	Maximum size	Size at sexual maturity	Reproductive strategy	Trophic level	Productivity	Availability	Encounterability	Selectivity	Post-capture mortality	Management strategy	Sustainability assessments	Recreational desirability / other fisheries	Susceptibility	*PSA score*
Snubnose dart	*Trachinotus blochii*	3*	3*	1	2	3*	1	3	2.29	2	3	3	3	3	3*	3*	2.86	**3.66**
Swallowtail dart	*Trachinotus coppingeri*	1	1	1	1	1	1	3	1.29	2	3	3	3	3	3*	3*	2.86	**3.13**
Giant queenfish	*Scomberoides commersonnianus*	2	2	1	2	2	1	3	1.86	2	3	3	3	3	3*	3*	2.86	**3.41**
Mackerel																		
Grey mackerel	*Scomberomorus semifasciatus*	1	2	1	2	2	1	3	1.71	2	3	3	3	2	1	3*	2.43	**2.97**
Spotted mackerel	*Scomberomorus munroi*	1	1	1	2	2	1	3	1.57	2	3	3	3	2	1	3*	2.43	**2.89**
School mackerel	*Scomberomorus queenslandicus*	1	2	1	2	2	1	3	1.71	2	3	3	3	3	1	3*	2.57	**3.09**
Jewfishes																		
Silver jewfish	*Nibea soldado*	3*	3*	1	1	3*	1	3	2.14	2	3	3	3	3	3*	3*	2.86	**3.57**
Black jewfish	*Protonibea diacanthus*	1	2	1	2	2	1	3	1.71	2	3	3	3	2	3*	1	2.43	**2.97**
Mulloway	*Argyrosomus japonicus*	1	3	1	2	2	1	3	1.86	2	3	3	3	3	3*	2	2.71	**3.29**
Other																		
Trumpeter whiting	*Sillago maculata*	1	2	1	1	1	1	3	1.43	2	3	3	3	3	3*	3*	2.86	**3.19**
Sand whiting	*Sillago ciliata*	1	2	1	1	1	1	2	1.29	2	3	3	3	3	1	3*	2.57	**2.87**
Yellowfin bream	*Acanthopagrus australis*	1	2	1	1	1	1	2	1.29	2	3	3	3	3	1	1	2.29	**2.62**
Tarwhine	*Rhabdosargus sarba*	1	2	1	1	1	1	3	1.43	2	3	3	3	3	3*	1	2.57	**2.94**
Snubnose garfish	*Arrhamphus sclerolepis*	1	1	1	1	1	1	3*	1.29	3	3	3	3	3	3*	3*	3.00	**3.26**
Three-by-two garfish	*Hemiramphus robustus*	3*	3*	1	1	3*	1	3	2.14	2	3	3	3	3	3*	3*	2.86	**3.57**

Common name	Species Name	Age at sexual maturity	Maximum age	Fecundity	Maximum size	Size at sexual maturity	Reproductive strategy	Trophic level	Productivity	Availability	Encounterability	Selectivity	Post-capture mortality	Management strategy	Sustainability assessments	Recreational desirability / other fisheries	Susceptibility	*PSA score*
Barred javelin	*Pomadasys kaakan*	3*	3	1	1	2	1	3	2.00	2	3	3	3	3	3*	1	2.57	**3.26**
Silver javelin	*Pomadasys argenteus*	3*	2	1	1	1	1	3	1.71	2	3	3	3	3	3*	2	2.71	**3.21**
King threadfin	*Polydactylus macrochir*	2	2	1	2	2	1	3	1.86	3	3	3	3	3	2	3*	2.86	**3.41**
Blue threadfin	*Eleutheronema tetradactylum*	1	1	1	1	2	1	3	1.43	2	3	3	3	3	2	3*	2.71	**3.07**
Barramundi	*Lates calcarifer*	2	3	1	2	2	1	3	2.00	2	3	3	3	3	1	1	2.29	**3.04**
Golden snapper	*Lutjanus johnii*	2	3	1	2	2	1	3	2.00	1	3	3	3	3	3*	2	2.57	**3.26**
Scribbled rabbitfish	*Siganus spinus*	1	3*	2	1	3*	2	1	1.86	3	3	3	3	3	3*	3*	3.00	**3.53**
Sharks																		
Graceful shark	*Carcharhinus amblyrhynchoides*	3*	3*	3	2	2	3	3	2.71	1	3	3	3	3	3*	3*	2.71	**3.84**
Common blacktip shark	*Carcharhinus limbatus*	2	2	3	2	2	3	3	2.43	2	3	3	3	3	1	3*	2.57	**3.54**
Australian blacktip shark	*Carcharhinus tilstoni*	2	2	3	2	2	3	3	2.43	2	3	3	3	3	3*	3*	2.86	**3.75**
Pigeye shark	*Carcharhinus amboinensis*	2	3	3	2	3	3	3	2.71	2	3	3	3	3	3*	3*	2.86	**3.94**
Bull shark	*Carcharhinus leucas*	2	3	3	3	3	3	3	2.86	2	3	3	3	3	3*	3*	2.86	**4.04**
Spinner shark	*Carcharhinus brevipinna*	2	3	3	2	3	3	3	2.71	2	3	3	3	3	1	3*	2.57	**3.74**
Blacktip reef shark	*Carcharhinus melanopterus*	2	2	3	2	2	3	3	2.43	2	3	3	3	3	3*	3*	2.86	**3.75**
Spot-tail shark	*Carcharhinus sorrah*	1	2	3	2	2	3	3	2.29	2	3	3	3	3	1	3*	2.57	**3.44**
Hardnose shark	*Carcharhinus macloti*	1	2	3	2	2	3	3	2.29	1	3	3	3	3	1	3*	2.43	**3.34**
Milk shark	*Rhizoprionodon acutus*	1	1	3	2	2	3	3	2.14	2	3	3	3	3	3*	3*	2.86	**3.57**

Common name	Species Name	Age at sexual maturity	Maximum age	Fecundity	Maximum size	Size at sexual maturity	Reproductive strategy	Trophic level	Productivity	Availability	Encounterability	Selectivity	Post-capture mortality	Management strategy	Sustainability assessments	Recreational desirability / other fisheries	Susceptibility	*PSA score*
Australian sharpnose shark	*Rhizoprionodon taylori*	1	1	3	1	2	3	3	2.00	2	3	3	3	3	3*	3*	2.86	**3.49**
Hammerhead Sharks																		
Winghead shark	*Eusphyra blochii*	2	2	3	2	2	3	3	2.43	1	3	3	3	3	3*	3*	2.71	**3.64**
Scalloped hammerhead shark	*Sphyrna lewini*	2	3	3	3	3	3	3	2.86	1	3	3	3	3	1	3*	2.43	**3.75**
Great hammerhead shark	*Sphyrna mokarran*	2	3	3	3	3	3	3	2.86	1	3	1	3	3	1	3*	2.14	**3.57**
Smooth hammerhead shark	*Sphyrna zygaena*	2	3	3	3	3	3	3	2.86	1	3	3	3	3	3*	3*	2.71	**3.94**

When the *productivity* and *susceptibility* scores were taken into consideration, 15 sharks and 20 teleosts were assigned preliminary high-risk ratings (Table 5). Preliminary risk scores for the remaining 15 teleosts all fell within the medium (*n* = 14) and low (*n* = 1) risk categories. Bull sharks (4.04) registered the highest preliminary score, followed by the smooth hammerhead shark (3.94), pigeye shark (3.94) and graceful shark (3.84). At 3.66, the snubnose dart and the bartail flathead recorded the highest preliminary risk score for a teleost (Table 5).

3.2 Uncertainty

Productivity assessments for all sharks and the majority of teleosts were supported by scientific evidence. Data deficiencies were most prevalent in *productivity* assessments involving trevally, garfish and javelin (Table 5 & 6). For these species, their status as low priorities for biological assessments and/or inclusion in monitoring programs contributed to the observed data deficiencies.

At a species level, data deficiencies involving assessments of the *age at sexual maturity, size at maturity,* and *maximum age* would have exerted greater influence on the preliminary risk ratings (Table 6). For example, 12 teleosts were assigned precautionary high (3) scores for *age at sexual maturity* and/or *size at maturity* (Table 5). It can be inferred from analogous datasets that true values for these species, if they were available, would not exceed the ‘high’ risk threshold (Table 2). For this reason, there is a high probability that precautionary high-risk scores assigned to *age* and *size at sexual maturity* are an overestimate.

In the *susceptibility* component, all scores assigned to the *encounterability* and *selectivity* attributes were supported by information on their morphology and habitat/bathymetric preferences (Table 6). Similarly, scores assigned to the *availability* and *management strategy* were based on a sound understanding of the available data and the current management regime. However, data sets for the *sustainability assessments* and *recreational desirability / other fisheries* attributes were less advanced (Table 6). In these two instances, over half of the species (sharks and teleosts) were assigned precautionary high scores for at least one of these attributes (Table 5).

As a number of the assessed species have comparatively low harvest rates and attracted limited attention from the non-commercial fishing sectors, precautionary high scores assigned to *sustainability assessments* and *recreational desirability / other fisheries* attributes are likely overestimates. In the context of the broader ERA, precautionary high-risk scores assigned to these two attributes contributed to the production of more conservative risk profiles.

3.3 Residual Risk Analysis

The Large Mesh Net Target & Byproduct Species Level 2 ERA covers a wide array of species with varying life-history traits, habitat preferences and information gaps (Appendix A & B). This complexity was reflected in the RRA where a number of the risk profiles were amended to take into account additional information and mitigation measures that were not explicitly considered as part of the PSA. The following provides an overview of the changes that were adopted as part of the RRA (Table 7). However, a full overview of the RRA including the key considerations for each species has been provided in Appendix D.

Table 6. *Summary of the number of attributes that were assigned a precautionary high (3) score due to data deficiencies.*

Species	**Productivity**							**Susceptibility**							
	Age at sexual maturity	**Maximum age**	**Fecundity**	**Maximum size**	**Size at sexual maturity**	**Reproductive strategy**	**Trophic level**	**Availability**	**Encounterability**	**Selectivity**	**Post-capture mortality**	**Management strategy**	**Sustainability assessments**	**Rec. desirability / other fisheries**
Teleosts (n = 35)														
Species with data	25	24	35	35	26	35	34	35	35	35	35	35	11	12
Species missing data	10	11	0	0	9	0	1	0	0	0	0	0	24	23
% Unknown	29%	31%	0%	0%	26%	0%	3%	0%	0%	0%	0%	0%	69%	66%
Sharks (n = 15)														
Species with data	14	14	15	15	15	15	15	15	15	15	15	15	6	0
Species missing data	1	1	0	0	0	0	0	0	0	0	0	0	9	15
% Unknown	7%	7%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	60%	100%
All (n = 50)														
Species with data	39	38	50	50	41	50	49	50	50	50	50	50	17	12
Species missing data	11	12	0	0	9	0	1	0	0	0	0	0	33	38
% Unknown	22%	24%	0%	0%	18%	0%	2%	0%	0%	0%	0%	0%	66%	76%

3.3.1 Teleosts

A high proportion of amendments made as part of the teleost RRA, involved *productivity* attributes that were assigned precautionary high (3) risk scores due to data deficiencies; namely *maximum size, maximum age, size at sexual maturity* and *age at sexual maturity* (Table 5). In the RRA, a number of these precautionary scores were replaced with proxies from species with similar morphologies and life-history traits (Table 7; Appendix D). As a result of these changes, *productivity* scores for 11 of the assessed teleosts were reduced (Table 7).

The RRA of the *susceptibility* attributes produced more substantive amendments with over half (*n* = 23) of the preliminary risk profiles being altered (Table 7). Almost all of the RRA amendments involved a downgrading of scores assigned to the *management strategy* and *recreational desirability / other fisheries* attributes (Appendix D). Other notable changes include a reduction in the king threadfin *sustainability assessments* score to account for new data, and a *selectivity* score reduction for garfish in recognition of their reduced enmeshment potential (Table 7; Appendix D).

The RRA produced changes that lowered the overall risk rating for 13 teleosts *i.e.* high to medium, medium to low, high to low. Conversely, the RRA increased the risk rating of a single species, golden trevally, from medium (Table 5) to high (Table 7).

3.3.2 Whaler sharks

Only one of the whaler sharks, the graceful shark, had a *productivity* attribute score altered as part of the RRA. In this instance, the precautionary high (3) risk score assigned to *age at sexual maturity* was replaced with a proxy commensurate with what is known about the biology of the broader blacktip shark complex (Table 7; Appendix D). All of the remaining shark *productivity* attribute scores were supported by biological data and were not altered as part of the RRA.

The RRA of the *susceptibility* attributes resulted in amendments being made to all 11 whaler shark species. While the majority of these amendments involved the *recreational desirability / other fishery attribute*, four additional amendments were made to scores assigned to the *sustainability assessments* attribute. These amendments recognise that while MSY estimates are available for these species, further advancements are required in terms of quantifying individual rates of fishing mortality (Table 7).

Adjustments made as part of the RRA did not alter the risk ratings for the whaler shark complex.

3.3.3 Hammerhead sharks

No changes were made to *productivity* scores assigned to hammerhead sharks as part of the PSA (Table 7). In the *susceptibility* component, the largest reductions were achieved through a review and refinement of the *recreational desirability / other fisheries* attribute*.* However, research has shown that the morphology of the hammerhead shark cephalofoil makes them highly susceptible to net entanglements across a wide range of size classes (Harry *et al.*, 2011b; Ellis *et al.*, 2017). Due to this increased susceptibility, the great hammerhead shark *selectivity* score was increased from low to high (Appendix D). The RRA also reduced the *encounterability* score for the smooth hammerhead shark. The frequency and extent of interactions with this species will be lower than the rest of the complex (Appendix D).

Amendments made as part of the RRA did not alter the final risk ratings for any of the hammerhead shark species (Table 5 & 7).

Table 7. *Residual Risk Analysis (RRA)* of the preliminary scores assigned as part of the *Productivity and Susceptibility Analysis (PSA). Pink shaded squares represent the attribute scores that were amended as part of the RRA. Refer to Appendix D for a full account of the RRA including key justifications.*

Common name	Species Name	Age at sexual maturity	Maximum age	Fecundity	Maximum size	Size at sexual maturity	Reproductive strategy	Trophic level	Productivity	Availability	Encounterability	Selectivity	Post-capture mortality	Management strategy	Sustainability assessments	Recreational desirability / other fisheries	Susceptibility	*PSA score*
Mullet																		
Sea mullet	*Mugil cephalus*	1	2	1	1	2	1	1	1.29	3	3	3	3	1	1	2	2.29	**2.62**
Bluespot mullet	*Valamugil seheli*	1	1	1	1	2	1	1	1.14	2	3	3	3	1	1	2	2.14	**2.43**
Fantail mullet	*Paramugil georgii*	1	2	1	1	2	1	1	1.29	2	3	3	3	1	1	2	2.14	**2.50**
Diamondscale mullet	*Liza vaigiensis*	1	2	1	1	2	1	1	1.29	2	3	3	3	1	1	2	2.14	**2.50**
Flathead																		
Dusky flathead	*Platycephalus fuscus*	1	2	1	1	2	1	3	1.57	3	3	3	3	2	1	2	2.43	**2.89**
Bartail flathead	*Platycephalus australis*	1	2	1	2	2	1	3	1.67	2	3	3	3	3	3	2	2.71	**3.19**
Northern sand flathead	*Platycephalus endrachtensis*	1	2	1	1	2	1	3	1.50	2	3	3	3	3	3	2	2.71	**3.10**
Yellowtail flathead	*Platycephalus westraliae*	1	2	1	1	1	1	3	1.43	2	3	3	3	3	3	2	2.71	**3.07**
Trevally / Family Carangidae																		
Turrum (gold spot)	*Carangoides fulvoguttatus*	2	3	1	2	3	1	3	2.14	2	3	3	3	3	3	3	2.86	**3.57**
Bigeye trevally	*Caranx sexfasciatus*	2	3	1	2	2	1	3	2.00	2	3	3	3	3	3	3	2.86	**3.49**
Giant trevally	*Caranx ignobilis*	1	3	1	2	2	1	3	1.86	2	3	3	3	3	3	2	2.71	**3.29**

Common name	Species Name	Age at sexual maturity	Maximum age	Fecundity	Maximum size	Size at sexual maturity	Reproductive strategy	Trophic level	Productivity	Availability	Encounterability	Selectivity	Post-capture mortality	Management strategy	Sustainability assessments	Recreational desirability / other fisheries	Susceptibility	*PSA score*
Golden trevally	*Gnathanodon speciosus*	2	2	1	2	2	1	3	1.86	2	3	3	3	3	3	2	2.71	**3.29**
Yellowtail scad	*Trachurus novaezelandiae*	1	2	1	1	1	1	2	1.29	2	3	3	3	2	2	2	2.43	**2.75**
Snubnose dart	*Trachinotus blochii*	1	2	1	1	2	1	3	1.57	2	3	3	3	2	3	2	2.57	**3.01**
Swallowtail dart	*Trachinotus coppingeri*	1	1	1	1	1	1	3	1.29	2	3	3	3	2	3	2	2.57	**2.87**
Giant queenfish	*Scomberoides commersonnianus*	2	2	1	2	2	1	3	1.86	2	3	3	3	3	3	2	2.71	**3.29**
Mackerel																		
Grey mackerel	*Scomberomorus semifasciatus*	1	2	1	2	2	1	3	1.71	2	3	3	3	2	1	3	2.43	**2.97**
Spotted mackerel	*Scomberomorus munroi*	1	1	1	2	2	1	3	1.57	2	3	3	3	2	1	3	2.43	**2.89**
School mackerel	*Scomberomorus queenslandicus*	1	2	1	2	2	1	3	1.71	2	3	3	3	2	1	3	2.43	**2.97**
Jewfish																		
Silver jewfish	*Nibea soldado*	3	3	1	1	3	1	3	2.14	2	3	3	3	3	3	3	2.86	**3.57**
Black jewfish	*Protonibea diacanthus*	1	2	1	2	2	1	3	1.71	2	3	3	3	2	3	2	2.57	**3.09**
Mulloway	*Argyrosomus japonicus*	1	3	1	2	2	1	3	1.86	2	3	3	3	3	3	3	2.86	**3.41**
Other																		
Trumpeter whiting	*Sillago maculata*	1	2	1	1	1	1	3	1.43	2	3	3	3	2	3	3	2.71	**3.07**

Common name	Species Name	Age at sexual maturity	Maximum age	Fecundity	Maximum size	Size at sexual maturity	Reproductive strategy	Trophic level	Productivity	Availability	Encounterability	Selectivity	Post-capture mortality	Management strategy	Sustainability assessments	Recreational desirability / other fisheries	Susceptibility	*PSA score*
Sand whiting	*Sillago ciliata*	1	2	1	1	1	1	2	1.29	2	3	3	3	2	1	2	2.29	**2.62**
Yellowfin bream	*Acanthopagrus australis*	1	2	1	1	1	1	2	1.29	2	3	3	3	2	1	2	2.29	**2.62**
Tarwhine	*Rhabdosargus sarba*	1	2	1	1	1	1	3	1.43	2	3	3	3	3	3	2	2.71	**3.07**
Snubnose garfish	*Arrhamphus sclerolepis*	1	1	1	1	1	1	3	1.29	3	3	2	3	1	3	3	2.57	**2.87**
Three-by-two garfish	*Hemiramphus robustus*	1	1	1	1	1	1	3	1.29	2	3	2	3	1	3	3	2.43	**2.75**
Barred javelin	*Pomadasys kaakan*	2	2	1	1	2	1	3	1.71	2	3	3	3	3	3	2	2.71	**3.21**
Silver javelin	*Pomadasys argenteus*	2	2	1	1	1	1	3	1.57	2	3	3	3	3	3	2	2.71	**3.14**
King threadfin	*Polydactylus macrochir*	2	2	1	2	2	1	3	1.86	3	3	3	3	3	1	3	2.71	**3.29**
Blue threadfin	*Eleutheronema tetradactylum*	1	1	1	1	2	1	3	1.43	2	3	3	3	3	2	3	2.71	**3.07**
Barramundi	*Lates calcarifer*	2	3	1	2	2	1	3	2.00	2	3	3	3	2	1	1	2.14	**2.93**
Golden snapper	*Lutjanus johnii*	2	3	1	2	2	1	3	2.00	1	3	3	3	3	3	2	2.57	**3.26**
Scribbled rabbitfish	*Siganus spinus*	1	1	2	1	1	2	1	1.29	3	3	3	3	3	3	1	2.71	**3.00**
Sharks																		
Graceful shark	*Carcharhinus amblyrhynchoides*	2	3	3	2	2	3	3	2.57	1	3	3	3	3	3	1	2.43	3.54
Common blacktip shark	*Carcharhinus limbatus*	2	2	3	2	2	3	3	2.43	2	3	3	3	3	2	1	2.43	3.43

Common name	Species Name	Age at sexual maturity	Maximum age	Fecundity	Maximum size	Size at sexual maturity	Reproductive strategy	Trophic level	Productivity	Availability	Encounterability	Selectivity	Post-capture mortality	Management strategy	Sustainability assessments	Recreational desirability / other fisheries	Susceptibility	*PSA score*
Australian blacktip shark	*Carcharhinus tilstoni*	2	2	3	2	2	3	3	2.43	2	3	3	3	3	3	1	2.57	**3.54**
Pigeye shark	*Carcharhinus amboinensis*	2	3	3	2	3	3	3	2.71	2	3	3	3	3	3	1	2.57	**3.74**
Bull shark	*Carcharhinus leucas*	2	3	3	3	3	3	3	2.86	2	3	3	3	3	3	1	2.57	**3.84**
Spinner shark	*Carcharhinus brevipinna*	2	3	3	2	3	3	3	2.71	2	3	3	3	3	2	1	2.43	**3.64**
Blacktip reef shark	*Carcharhinus melanopterus*	2	2	3	2	2	3	3	2.43	2	3	3	3	3	3	1	2.57	**3.54**
Spot-tail shark	*Carcharhinus sorrah*	1	2	3	2	2	3	3	2.29	2	3	3	3	3	2	1	2.43	**3.34**
Hardnose shark	*Carcharhinus macloti*	1	2	3	2	2	3	3	2.29	1	3	3	3	3	2	1	2.29	**3.23**
Milk shark	*Rhizoprionodon acutus*	1	1	3	2	2	3	3	2.14	2	3	3	3	3	3	1	2.57	**3.35**
Australian sharpnose shark	*Rhizoprionodon taylori*	1	1	3	1	2	3	3	2.00	2	3	3	3	3	3	1	2.57	**3.26**
Hammerhead Sharks																		
Winghead shark	*Eusphyra blochii*	2	2	3	2	2	3	3	2.43	1	3	3	3	3	3	1	2.43	**3.43**
Scalloped hammerhead shark	*Sphyrna lewini*	2	3	3	3	3	3	3	2.86	1	3	3	3	3	2	1	2.29	**3.66**
Great hammerhead shark	*Sphyrna mokarran*	2	3	3	3	3	3	3	2.86	1	3	3	3	3	2	1	2.29	**3.66**
Smooth hammerhead shark	*Sphyrna zygaena*	2	3	3	3	3	3	3	2.86	1	1	3	3	3	3	1	2.14	**3.57**

4 Risk Evaluation

4.1 Large Mesh Nets

Risk profiles compiled as part of the Level 2 assessment were based on management arrangements applied to the fishery at the time of writing. This assessment did not consider management reforms being proposed for the fishery including those contained within the draft ECIF harvest strategy—released September 2020 (Department of Agriculture and Fisheries, 2020d). The draft ECIF harvest strategy places greater emphasis on regional management, establishes a three-tiered system transitioning key species to output controls, and contains harvest control rules to manage the long-term take of secondary target species.

Once finalised and implemented, the ECIF harvest strategy will (likely) result in a risk score reduction (Table 7) for a number of species included in this assessment (Table 7). In a large number of instances, this reduction will facilitate the lowering of individual risk ratings *e.g.* from high to medium or medium to low. For example, the introduction of a quota-based harvest strategy with supporting harvest control rules, could facilitate the assignment of a low (1) risk rating for the *management strategy* attribute. If this were to occur across the ecological component, all but three of the teleosts assessed would be reclassified as low or medium risk in the Large Mesh Net Fishery.

As a draft harvest strategy has already been released for the ECIF (Department of Agriculture and Fisheries, 2020d), the outputs of the current assessment could be considered or viewed as a worst case scenario. The expectation being that an updated Level 2 ERA will take into consideration the content of any harvest strategy implemented at the time of the assessment. If and when this occurs, this ERA will provide a baseline assessment that can be compared to future ERAs. By extension, the outputs of this assessment will be of importance when determining the effectiveness of measures implemented as part of the *Queensland Sustainable Fisheries Strategy 2017–2027* (Department of Agriculture and Fisheries, 2017).

When the results of the PSA and RRA were taken into consideration, the Level 2 ERA indicates that fishing activities in the Large Mesh Net Fishery present a medium or high risk to most of the target & byproduct species (Table 7). Biological and life-history constraints were a key driver of risk for a proportion of the species assessed and, in the case of sharks, was the main contributor of risk. If for example, all of the *susceptibility* attributes were assigned the lowest value possible (1), almost half of the shark species (n = 7 out of 15) would still register a medium-risk rating. If the same standard was applied to the teleosts, all 35 species would fall into the low-risk category. This *ad-hoc* assessment highlights a) inherent challenge of managing fishing-related risks for species with *k*-selected life histories (sharks) and b) areas where risk minimisation could be effectively achieved over a shorter time frame (teleosts).

In the *susceptibility* analyses, the drivers of risk were more varied and were often dependent on a combination of the *management strategy*, *sustainability assessments*, and *recreational desirability / other fisheries* attributes. However, a number of common themes emerged from the study that increased the level of risk and/or uncertainty across multiple subgroups. These included the absence of an effective mechanism to monitor catch compositions, limited capacity to validate data submitted through the logbook program, and the absence of sustainability assessments across the ecological component (Table 7). In most of these instances, these risks will need to be managed across the entire ECIF and through the *Queensland Sustainable Fisheries Strategy 2017–2027* (Department of Agriculture and Fisheries, 2017).

The Level 2 ERA did identify a number of areas where risk levels could be reduced across multiple species or subgroups. As most of these measures relate to the collection of data, catch monitoring and validation, their implementation would benefit a wide range of species—not just those included in the Large Mesh Net Target & Byproduct Species Level 2 ERA. A number of these risks are already being addressed as part of the *Queensland Sustainable Fisheries Strategy 2017–2027* including mandating the use of *Vessel Tracking*, the establishment of a *Fisheries Data Validation Plan*, exploring the use of new or improved monitoring tools (*e.g.* electronic logbooks), and implementing fisheries-specific harvest strategies (Department of Agriculture and Fisheries, 2018a; c; h). Many of these changes represent a significant step forward in terms of managing the long-term risk posed to these species. These initiatives though will take time to develop and implement; particularly in a multidimensional, multifaceted fishery like the ECIF.

General recommendations

1. *Establish a mechanism to manage and minimise the long-term sustainability risk for key target & byproduct species, preferably through the introduction of a fishery-specific harvest strategy with clearly defined harvest control rules and sustainability assessment protocols.*

2. *Identify avenues/mechanisms that can be used to monitor the catch of target & byproduct species (preferably in real or near-real time) and minimise the risk of non-compliance.*

3. *Review the suitability, applicability and value of data submitted through the logbook program on the dynamics of the fishery (gear types, net configurations, soak times etc.). As part of this process, it is recommended that the logbook reporting requirements be extended to include information on what fishing symbol is being used.*

4. *Implement measures to improve the level of information on fine-scale effort movements, with particular emphasis on increasing our understanding of how large mesh nets are utilised at a regional level and in habitats critical to the survival of key species.*

5. *Investigate how black jewfish management reforms may impact the marketability and demand of swim bladders from other species (particularly threadfins, jewfish, and barramundi), including the potential for catch to increase rapidly over the short-term and avenues that may reduce the risk of regional stocks becoming overfished across sectors.*

6. *Establish a measure to estimate the gear-affected area and, when available, reassess the risk posed to teleosts species using a more quantitative ERA method like bSAFE.*

4.2 Species-Specific Assessments

The Large Mesh Net Fishery has an extensive effort footprint and this sector of the ECIF interacts with a wide range of species. This is reflected in the catch data where more than one hundred species and species complexes (including *unspecified* categories) have been reported through the logbook system (Department of Agriculture and Fisheries, 2019f; 2020c). A high proportion of these species have small catch quantities and were excluded from the analysis as part of the species rationalisation process (Appendix A). However, a number of species had catch quantitates that, while smaller, warranted their inclusion in the Level 2 ERA (Appendix B). Similarly, a number of the generic catch categories required the inclusion of secondary species. For example, *Mullet—unspecified* was expanded to include sea mullet (*M. cephalus*), the bluespot (*V. seheli*), fantail (*P. georgii*) and diamondscale (*L. vaigiensis*) mullet.

For most of these secondary species, the Large Mesh Net Fishery will be a contributor of risk *verse* the main driver of risk. Harvest rates for most secondary species are comparatively low and the full extent of their interactions (retained plus discards) with the ECIF are less understood (Jacobsen *et al.*, 2021b; c; Jacobsen *et al.*, 2019a; Department of Agriculture and Fisheries, 2019f). The inclusion of these species provides the Level 2 ERA with additional scope and will assist management if the current fishing environment changes significantly. This approach also minimises the potential of an at-risk species being omitted from the analysis due to misidentifications.

The inherent trade off with the above approach is that the final ratings for some species may reflect a potential risk *verse* the actual risk. In other words, the risk posed to these species may be overestimated due to data deficiencies and/or the conservative nature of the PSA methodology (Zhou *et al.*, 2016; Hobday *et al.*, 2011; Zhou & Griffiths, 2008). For the purpose of this assessment, these ratings were classified as *precautionary* and management of these risks, beyond what is already being undertaken as part of the *Queensland Sustainable Fisheries Strategy 2017–2027*, are viewed as less of a priority. This decision was supported by an ad-hoc *Likelihood & Consequence Analysis* which provided further insight into the probability of the risk coming to fruition over the short to medium term (Appendix E).[5] With improved information, a number of these species could be excluded from future iterations of the Large Mesh Net Target & Byproduct Species Level 2 ERA.

The following provides an overview of the key drivers of risk for all species included in the Large Mesh Net Target & Byproduct Species Level 2 ERA. Where possible, these evaluations include recommendations on where risk may be reduced within a particular subgroup and avenues that could be used to improve the accuracy of the risk assessments for key species. When and where appropriate, precautionary high risks have also been identified.

4.2.1 Teleosts

While the drivers of risk for teleosts varied, there were a number of common themes that emerged across the complex. The resolution of the catch data and an inability to quantify total rates of fishing mortality (retained plus discards) were factors of influence in a number of the risk profiles. These deficiencies and risks were largely attributed to the absence of an effective measure to monitor catch and effort, and a limited capacity to validate data submitted through commercial logbooks (Jacobsen *et al.*, 2019a). Similarly, an absence of information on sustainability reference points and the potential for catch and effort to increase through time were considered key drivers of risk for most teleosts.

For a number of species, the above information gaps are intimately linked with their status as secondary target or byproduct species. These species often have smaller harvest rates, are reported in broader catch categories, and are generally viewed as lower priorities for stock assessments or quota management. In the Level 2 ERA, these deficiencies (data and management) resulted in the production of more conservative risk assessments. It is recognised that harvest rates for a number of

[5] *In the Level 2 ERA, the Likelihood & Consequence Analysis (LCA) was used to provide further insight into the probability of the risk coming to fruition over the short to medium term (Appendix E). The LCA is a fully qualitative assessment and was used to provide an indicative assessment of how conservative an assessment might be. As the LCA is qualitative and lacks the detail of the PSA, the outputs should not be viewed as an alternate or competing risk assessment and the results of the PSA/RRA will take precedence over the LC*A.

these species may not warrant the introduction of a more restrictive management regime or output controls. However, improving the level of information on catch compositions and interaction rates would allow for a more refined assessment of the *management strategy* attribute. There are also clear benefits to improving the level of information on the status of regional stocks; particularly for species where market demand may increase into the future (*e.g.* threadfins, jewfish).

Improving the quality of the fishing data would allow for refinements to be made to individual risk profiles and provide clearer separation between *real* and *potential* risks (Department of Agriculture and Fisheries, 2017). It is anticipated that datasets and management regimes for these species will improve with the continued rollout of the *Queensland Sustainable Fisheries Strategy 2017–2027* and the introduction of an ECIF-specific harvest strategy. When this occurs, there may be sufficient grounds to reduce the number of species included in future ERAs. This would be most applicable to low-harvest species and secondary species that were included in the assessment as a precautionary measure (Appendix B).

4.2.1.1 Mullet

Common name	Sub-fishery	Risk rating
Sea mullet (*M. cephalus*)	N1 & N2 fishery symbols	**Low**
Bluespot mullet (*V. seheli*)	N1 & N2 fishery symbols	**Low**
Fantail mullet (*P. georgii*)	N1 & N2 fishery symbols	**Low**
Diamondscale mullet (*L. vaigiensis*)	N1 & N2 fishery symbols	**Low**

Mullet makes a significant contribution to the total ECIF catch (Department of Agriculture and Fisheries, 2019f) with the majority being retained in the Ocean Beach Fishery. Ocean beach fishers utilise seine nets and actively target near-shore schools of fish between 1 April and 31 August (Department of Agriculture and Fisheries, 2019f). This sector of the ECIF harvests over three times the amount of mullet reported from the Large Mesh Net Fishery (2016–2019 inclusive) and it will be the key driver of risk for this complex (Jacobsen *et al.*, 2021b; c). However, mullet catch in the Large Mesh Net Fishery is not inconsequential and this sector of the ECIF will be a contributing factor in terms of the cumulative fishing pressures exerted on this complex.

Mullet catch in the broader ECIF has poor species resolution with the majority reported as *unspecified* (Department of Agriculture and Fisheries, 2019f; 2020c). A high percentage of this catch will consist of sea mullet (*M. cephalus*; Lovett *et al.*, 2018) and this species is viewed as a good indicator for the rest of the complex. Despite not being managed under output controls (*i.e.* a TACC limit), evidence suggests that sea mullet stocks are being managed effectively on the Queensland east coast. Sea mullet has a long catch history on the Queensland east coast and stock sustainability has been confirmed through multiple assessments and indicative sustainability evaluations (Lovett *et al.*, 2018; Smith & Deguara, 2002; Stewart *et al.*, 2018; Virgona *et al.*, 1998). Cumulative fishing pressures will also be lower for this species as it is not a primary target for recreational fishers (Department of Agriculture and Fisheries, 2020c; 2021). These factors were given significant weighting in the RRA and were reflected in scores assigned to the *management strategy*, *sustainability assessments*, and *recreational desirability / other fisheries* attributes (Table 7; Appendix D).

The inclusion of bluespot (*V. seheli*), fantail (*P. georgii*), and diamondscale (*L. vaigiensis*) mullet recognises the fact that these species will be caught in conjunction with sea mullet (Table 7; Appendix B). When compared to sea mullet, data sets for secondary mullet species are less developed and their risk profiles needed to account for a number of data deficiencies (Table 5). Where possible, these deficiencies were addressed in the RRA through the use of sea mullet proxies (Appendix D). The use of proxies helped to refine a number of the risk profiles and produced ratings that were more reflective of the actual risk *verse* the potential risk. As proxies were based on the highest attribute score assigned to the complex (Appendix D), it is unlikely that the RRA would have contributed to the production of a false-negative result or a risk underestimation.

While difficult to quantify without additional information, expectations are that all four species will display a similar resilience to regional fishing pressures. Bluespot, fantail, and diamondscale mullet are targeted with less frequency, and rates of fishing mortality will be lower for these species. For these reasons, it is likely that the risk posed to bluespot, fantail and diamondscale mullet will be equal to if not lower than sea mullet (Table 7). However, future ERAs would benefit from additional information on mullet catch compositions (commercial, recreational and charter) and improved biological data. This information would reduce the reliance of the ERA on sea mullet data (Appendix D), enable refinements to be made to the scope of the Level 2 ERA, and facilitate the removal of low-risk species.

The Level 2 ERA indicates that mullet are at low risk of being fished unsustainably within the current fishing environment. In the absence of output controls, there is a longer-term risk that catch levels will increase beyond key sustainability reference points. This longer-term risk is now being addressed through the harvest strategy development process (Department of Agriculture and Fisheries, 2020d). Under the draft ECIF harvest strategy, sea mullet are classified as a *Tier 2* species and will be transitioned to a management system that relies on the use of output controls (TACC limits) in south-east Queensland (Department of Agriculture and Fisheries, 2020d). The draft strategy lists secondary species like the bluespot, fantail and diamondscale mullet in *Tier 3* as they are viewed as lower priorities for quota management. They will however be subject to increased monitoring to ensure that shifting fishing pressures do not present an unacceptable level of risk over the longer term (Department of Agriculture and Fisheries, 2020d).

Species-specific recommendations

1. *Implement output-based management for mullet that minimises the long-term risk of overfishing—noting the cross-jurisdictional nature of the sea mullet stocks and the targeting of the species in both QLD and NSW.*

2. *If output controls are not viable, maintain a stock assessment regime that upholds a high level of certainty that key stocks are being sustainably fished within Queensland and across jurisdictions.*

3. *Improve catch composition data and identify mechanisms to improve data on harvest rates for secondary species; allowing for further ERA refinements and the (potential) removal of low-risk species.*

4.2.1.2 Flathead

Common name	**Sub-fishery**	**Risk rating**
Dusky flathead (*P. fuscus*)	N1 & N2 fishery symbols	**Medium**
Bartail flathead (*P. australis*)*	N1 & N2 fishery symbols	**Precautionary High***
Nth. sand flathead (*P. endrachtensis*)	N1 & N2 fishery symbols	**Precautionary Medium**
Yellowtail flathead (*P. westraliae)*	N1 & N2 fishery symbols	**Precautionary Medium**

** The risk score for the bartail flathead was 3.19 which is just above the medium-risk / high-risk threshold (3.18).*

The situation surrounding flathead is similar to mullet in that a single species, the dusky flathead (*P. fuscus*), will be responsible for the majority of the catch (Leigh *et al.*, 2019). The remainder of the catch will consist of smaller quantities of bartail (*P. australis*), northern sand (*P. endrachtensis*) and yellowtail (*P. westraliae*) flathead.

Morphological similarities among flathead species limits the potential for species-specific reporting and leads to coarse-scale species compositions. For example, all of the flathead catch from the ECIF is reported as *unspecified* (Department of Agriculture and Fisheries, 2019f). This lack of resolution creates uncertainty surrounding species-specific rates of fishing mortality and limits the scope of any sustainability assessment. Improving the level of information on flathead catch compositions would assist with this process and provide further avenues to reduce scores assigned to one or more of the *susceptibility* attributes *e.g. management strategy, encounterability* and *recreational desirability / other fisheries*. A score reduction in any one of these attributes would see all four species assessed as a medium risk in the Large Mesh Net Fishery (Table 7).

As flathead are not managed under output controls, catch and effort can increase under the current management regime. This was a notable risk factor for flathead and was assessed accordingly as part of the *management strategy* evaluation (Table 7). In the mullet RRA, a weight-of-evidence approach supported the assignment of lower scores for the *management strategy* attribute (Appendix D). In the flathead assessment, the weight-of-evidence was viewed as more circumstantial and resulted in fewer amendments (Appendix D).[6] This was due, in part, to the cross-sector appeal of flathead and greater uncertainty surrounding total rates of harvest for individual species (Table 7; Appendix D).

Unlike mullet, flathead are viewed as a primary target for recreational fishers and harvest rates in this sector are roughly equal to that reported from the commercial net fishery (Webley *et al.*, 2015; McGilvray *et al.*, 2018a; Leigh *et al.*, 2019; Department of Agriculture and Fisheries, 2019f). Flathead stocks are highly accessible (Broadhurst *et al.*, 2003; Gray & Barnes, 2015) and these species are at higher risk of experiencing a regional overfishing event due to cumulative fishing pressures. This is more likely to occur in regions with higher populations, including in south-east Queensland where areas like the Moreton Bay and Great Sandy Marine Parks remain popular recreational fishing locations. Given their habitat preferences, the risk posed to these species will be more pronounced in inshore areas and areas where there is a greater overlap between commercial and recreational fishing effort.

[6] In the mullet RRA, the management strategy score was reduced from high (3) to low (1) across the complex. This compares to the flathead RRA where only the dusky flathead management strategy attribute score was reduced from high (3) to medium (2).

Of the four species assessed, only the dusky flathead has been the subject of a detailed quantitative stock assessment (Leigh *et al.*, 2019). The stock assessment considered cumulative fishing pressures and determined that regional stocks were being sustainably fished across sectors. Outputs of the stock assessment also revealed that the dusky flathead will meet long-term targets under the *Queensland Sustainable Fisheries Strategy 2017–2027* (Department of Agriculture and Fisheries, 2017; Leigh *et al.*, 2019). In the Level 2 ERA, this resulted in the species being assigned a low-risk (1) rating for the *sustainability assessments* attribute (Table 7). There were, however, limited grounds to extend this evaluation across the entire complex due to data deficiencies, namely on species compositions and cumulative fishing pressures.

With improved information on flathead catch compositions, the current suite of sustainability assessments could be extended to include one or more of the secondary species. For these species, indicative sustainability evaluations are viewed as a more appropriate course of action—when compared to a resource intensive quantitative stock assessment. This information would improve the accuracy of future ERAs and inform the need to undertake more extensive management reforms. It is recognised though that secondary flathead species may be viewed as lower priorities for stock sustainability evaluations or assessments.

Management of regional flathead stocks will improve with the introduction of an ECIF-specific harvest strategy. Under the draft harvest strategy, dusky flathead will be classified as a *Tier 2* species and will be transitioned to a management system that includes output controls for *Management Region 5—Baffle Creek to the Queensland / New South Wales border* (Department of Agriculture and Fisheries, 2020d). For this species, the outputs of the Level 2 ERA can be viewed as the worst case scenario. The situation surrounding the bartail, northern sand and yellowtail flathead is less certain as all three will be classified as *Tier 3* species. *Tier 3* species are viewed as lower priorities in terms of stock assessments and will not be transitioned to output controls. They will, however, be subject to increased monitoring, and catch triggers will be used to manage shifting fishing pressures (Department of Agriculture and Fisheries, 2020d).

In terms of future assessments, this complex would derive benefit from additional assessment using SAFE (Zhou & Griffiths, 2008). Comparisons have shown that the SAFE method produces fewer false positives and may provide greater differentiation in terms of the risks posed to each species (Zhou *et al.*, 2016; Zhou & Griffiths, 2008). The ability to assess these species using bSAFE will be predicated on management's ability to quantify gear-affected area across the Large Mesh Net Fishery. If this cannot be achieved, future PSA-based ERAs would benefit from improved information on the biology of these species, flathead catch compositions, a more refined assessment of regional fishing pressures and fine-scale assessment of effort movements. A number of these information gaps are already being actively addressed as part of the *Queensland Sustainable Fisheries Strategy 2017–2027* (Department of Agriculture and Fisheries, 2018b; a; c; 2020d; 2018h; 2017).

Species-specific recommendations

1. *Improve flathead catch composition data and identify mechanisms to improve data on harvest rates for secondary species, allowing for refinements to be made to the ERA process and facilitate the removal of some species.*

2. *Increase the level of understanding on fishing pressures for secondary flathead species and explore the need for their inclusion in a stock assessment or indicative sustainability evaluations.*

3. *Implement measures to address regional cumulative fishing pressures and consider the need for fine-scale or regional fisheries management to manage the risk posed to flathead species in key areas of the ECIF.*

4.2.1.3 Bream & Tarwhine

Common name	Sub-fishery	Risk rating
Yellowfin bream (*A. australis*)	N1 & N2 fishery symbols	**Low**
Tarwhine (*R. sarba*)	N1 & N2 fishery symbols	**Precautionary Medium**

Similarities in morphology and habitat/distribution among bream and tarwhine has led to the reporting of these species under a complex with coarse-scale species compositions *e.g. Bream—unspecified* (Department of Agriculture and Fisheries, 2019f; 2020c). While lacking species resolution, anecdotal evidence suggests that the majority of this catch consists of yellowfin bream (*A. australis*) with tarwhine (*R. sarba*) accounting for a smaller albeit consistent proportion of the catch (*pers. comm.* T. Ham).

As expected, bream and tarwhine scored highly across the *availability*, *selectivity* and *post-capture mortality* attributes (Table 7). Both species are actively targeted across their known distributions/habitats and they are readily retained in the Large Mesh Net Fishery. These risks will be difficult to countenance in future ERAs as bream will continue to be a key target species in the ECIF. These risks are unlikely to be uniform and will be most prevalent in inshore waters and areas where there is a greater overlap between commercial and recreational fishing effort (Department of Agriculture and Fisheries, 2021). Under the draft ECIF harvest strategy, regional fishing risks will be addressed through the introduction of a yellowfin bream south-east Queensland (Management Region 5) TACC limit (Department of Agriculture and Fisheries, 2020d; a).

As bream are not currently managed under output controls, catch and effort for both species can increase under the current management regime. However, the Level 2 ERA indicates that the risk posed to yellowfin bream is being managed in the current fishing environment (Table 7; Appendix B). This inference is supported by a stock assessment and indicative sustainability evaluations which confirm yellowfin bream are being sustainably fished on the Queensland east coast (McGilvray *et al.*, 2018b; Leigh *et al.*, 2019). These assessments considered the cumulative fishing pressures exerted on this species including those originating from the recreational and charter fishing sectors (Leigh *et al.*, 2019). This was considered to be of significant importance as harvest share for this species (commercial *verse* recreational and charter fishing) is roughly equal (McGilvray *et al.*, 2018b).

Best available information for yellowfin bream indicates that current fishing pressures, while sustainable, are not ideal for stock rebuilding. For example, the yellowfin bream stock assessment estimates that the species will take around 25 years to reach long-term objectives (B_{60}) outlined in the *Queensland Sustainable Fisheries Strategy 2017–2027* (Department of Agriculture and Fisheries, 2018c; Leigh *et al.*, 2019). This timeframe assumes that total catch and effort will not increase substantially over the short to medium term; something that can occur under the current management regime. If this were to occur, the above timeframes would likely increase. This issue is being addressed through the ECIF harvest strategy development process where yellowfin bream has been assigned a *Tier 2* species classification. Under the draft ECIF harvest strategy, *Tier 2* species will be prioritised for transition to a more complex management system based on regionalised output (TACC) controls (Department of Agriculture and Fisheries, 2020d). If this were to occur, the outputs of the Level 2 ERA could be viewed as the high water mark for this species.

While the fishing profile of tarwhine is similar, there is more uncertainty in terms of the risks posed to this species over the longer term. Unlike yellowfin bream, tarwhine has not been the subject of a detailed stock assessment or an indicative sustainability evaluation. As a consequence, there is less information on the structure of the stocks on the Queensland east coast and/or what level of fishing mortality is required to meet long-term targets under the *Queensland Sustainable Fisheries Strategy 2017–2027* (Department of Agriculture and Fisheries, 2017). In the Level 2 ERA, these deficiencies were reflected in scores assigned to the *management strategy*, *sustainability assessments*, and *recreational desirability / other fisheries* attributes (Table 7; Appendix D).

Fishing pressures exerted on regional tarwhine stocks are likely to be smaller than that inferred for yellowfin bream. The accuracy of this inference though is difficult to validate given the lack of data on species compositions and sustainability reference points. As a low-harvest species, it is recognised that tarwhine is not viewed as a stock assessment priority. There may however be some benefit in subjecting the species to a weight-of-evidence evaluation of stock sustainability analogous to SAFS. As the accuracy of this assessment is predicated on the available information, efforts would need to be undertaken to improve the level of information on bream catch compositions in the Large Mesh Net Fishery and across the broader ECIF (Department of Agriculture and Fisheries, 2019f; Jacobsen *et al.*, 2021c).

As with yellowfin bream, tarwhine will benefit from the introduction of an ECIF-specific harvest strategy. These benefits will be smaller for tarwhine due to its classification as a *Tier 3* species (Department of Agriculture and Fisheries, 2020d). *Tier 3* species are viewed as lower priorities for stock assessment / indicative sustainability evaluations and are unlikely to be transitioned to output controls over the short to medium term. Instead, they will be subject to increased monitoring with catch triggers used to manage shifting fishing pressures (Department of Agriculture and Fisheries, 2020d). How these changes influence future risk ratings will be highly dependent on the quality of the catch composition data and/or managements capacity to employ alternate ERA methodologies like SAFE.

Species-specific recommendations

1. *Explore mechanisms to improve the level of information on bream catch compositions, and avenues to improve our understanding of the stock status of secondary species.*

2. *Implement measures to address regional cumulative fishing pressures and consider the need for fine-scale or regional fisheries management to minimise the risk posed to bream species in key areas of the ECIF.*

3. *Depending on the outcomes of the above recommendations, review the inclusion of bream in future ERAs, with consideration given to removing one or both species as low-risk elements.*

4.2.1.4 Whiting

Common name	Sub-fishery	Risk rating
Sand whiting (*S. ciliata*)	N1 & N2 fishery symbols	**Low**
Trumpeter whiting (*S. maculata*)	N1 & N2 fishery symbols	**Precautionary Medium**

The whiting complex incorporates a range of species that have the potential to interact with fishers on the Queensland east coast including sand (*S. ciliata*), trumpeter (winter) (*S. maculata*), goldenline (*S. analis*) and northern (*S. sihama*) whiting. As the majority of the commercial and recreational catch consists of sand and trumpeter whiting, these two species were prioritised for assessment (Appendix B). When and where appropriate, additional species will be assessed in subsequent ERAs.

Of the two primary species, sand whiting will be retained in larger quantities across the commercial and recreational fishing sectors (Department of Agriculture and Fisheries, 2020c; 2019f). While trumpeter whiting may interact with large mesh nets, they are more likely to be encountered and retained by recreational fishers (*pers. comm.* T. Ham). Sand whiting are subject to more stringent management restrictions and their take is limited by a 23cm minimum legal size (MLS) limit and a 30-fish multi-species (combined) recreational possession limit.[7] The take of trumpeter whiting is not subject to any size restrictions and the species has a larger recreational possession limit (n = 50 fish). This translates to a higher rate of retention (Webley *et al.*, 2015; Department of Agriculture and Fisheries, 2020c; 2021) and, from an ERA perspective, was one of the reasons why trumpeter whiting were assigned a higher risk rating (Table 7).

While sand whiting is not managed through output controls, the Level 2 ERA indicates that the risk posed to this species is being managed within the current fishing environment (Table 7). Stock assessments and indicative sustainability evaluations have confirmed the sustainability of sand whiting stocks (Leigh *et al.*, 2019; McGilvray & Hall, 2018), and *productivity* scores suggest that the species can withstand higher rates of fishing mortality (Table 7). As the sand whiting harvest is dominated by commercial fishing (77%), cumulative fishing pressures may be lower for this species (McGilvray & Hall, 2018). In the Level 2 ERA, these factors were considered as part of the *susceptibility* RRA and resulted in the species receiving a low overall risk rating (Table 7).

While trumpeter whiting received an elevated risk rating, the risk profile for this species was heavily influenced by data deficiencies (*e.g.* stock sustainability), the conservative nature of the ERA methodology (Zhou *et al.*, 2016) and the use of precautionary high-risk (3) scores (Table 7). These factors contributed to the species receiving a risk rating that does not reflect current sustainability concerns. For this reason, the final risk rating for trumpeter whiting is viewed as a false positive or an overestimation of risk. Any future reforms that refine the management of this species, confirm stock sustainability, and/or provide further insight into the cumulative fishing pressures (*e.g.* improved catch data) will result in a downgrading of the risk for this species. This in turn will provide a more accurate representation of the potential risk posed to this species by large mesh net operations.

As with bream and flathead, the whiting complex will benefit from the introduction of an ECIF-specific harvest strategy. Under the draft strategy, whiting will be classified as a *Tier 2* complex and will be transitioned to a management system that is underpinned by the use of output controls in

[7] *Recreational fishers are permitted a combined total of 30 goldenline whiting, sand whiting and northern whiting.*

Management Region 5 (south-east Queensland). Unlike bream and flathead, this limit will be applied across the entire complex and will include both sand and trumpeter whiting (Department of Agriculture and Fisheries, 2020d). While difficult to predict without knowing the final construct of the ECIF harvest strategy, reforms instigated as part of this process will more than likely result in a risk score reduction for both sand (2.62) and trumpeter (3.07) whiting (Table 7).

At a complex level, future ERAs would benefit from improved data on the catch composition of whiting across the commercial, recreational and charter fishing sectors (Department of Agriculture and Fisheries, 2019f; Jacobsen *et al.*, 2019a). While both whiting are reported at the species level, these reports are less frequent and underestimate individual rates of fishing mortality. Both species are reported more consistently as *unspecified* whiting and there is particularly poor resolution in the commercial catch data (Department of Agriculture and Fisheries, 2019f; 2020c). Mechanisms to improve species differentiation (commercially and recreationally) would promote more accurate risk assessments and provide further avenues to reduce scores assigned to one or more of the attributes. This information would also facilitate a more rapid transition to the SAFE assessment; an ERA approach that has been shown to produce fewer false-positive results (Zhou *et al.*, 2016).

Species-specific recommendations

1. *Improve catch composition data and identify mechanisms to improve data on species-specific harvest rates, allowing for refinements to be made to the ERA process and facilitate the removal of some species.*
2. *Explore the need for the inclusion of trumpeter whiting in a stock assessment or indicative sustainability evaluations such as SAFS.*
3. *Assess the suitability, applicability and effectiveness of the restrictions for trumpeter whiting and the extent of the need to manage or mitigate cumulative fishing risks.*

4.2.1.5 Trevally / Family *Carangidae*

Common name	Sub-fishery	Risk rating
Turrum (*C. fulvoguttatus*)	N1 & N2 fishery symbols	**Precautionary High**
Bigeye trevally (*C. sexfasciatus*)	N1 & N2 fishery symbols	**Precautionary High**
Giant trevally (*C. ignobilis*)	N1 & N2 fishery symbols	**Precautionary High**
Golden trevally (*G. speciosus*)	N1 & N2 fishery symbols	**Precautionary High**

The *Carangidae* complex contains a high number of morphologically similar species that are often caught during the same fishing event. It can be difficult to differentiate between species in an active fishing environment and this portion of the catch is generally reported with generic identifiers *e.g. Trevally—unspecified* (Department of Agriculture and Fisheries, 2019f; Fowler *et al.*, 2018). While some trevally are reported to species level, this occurs with less frequency (Appendix B) and underestimates harvest rates for individual species. In the mullet and flathead complex, where similar catch reporting trends were observed, inferences could be drawn in terms of the dominant species caught. This is more difficult to do in this complex as the catch tends to be more multidimensional (*pers. comm.* T. Ham).

The multi-species nature of the trevally catch combined with identification issues has inhibited management's ability to conduct stock assessments and/or compile indicative sustainability evaluations (Fowler *et al.*, 2018; Department of Agriculture and Fisheries, 2018f). As such, there is limited information on how current harvest levels compare to key sustainability reference points (Department of Agriculture and Fisheries, 2017). These deficiencies make it difficult to assess the suitability of the current management arrangements or evaluate the effectiveness of alternate strategies *e.g.* the use of species or complex-specific TACC limits. Introducing mechanisms to improve catch compositions (commercially and recreationally) would facilitate the development of more accurate risk assessments and provide further insight into the suitability and applicability of alternate management arrangements.

In the Level 2 ERA, the above issues were compounded by a lack of information on the biology of key species, an absence of information on post-capture mortality and uncertainty surrounding the extent of the cumulative fishing pressures (recreational plus commercial) (Table 5, Table 7). Improved information in one or more of these areas would improve the accuracy of the Level 2 assessment and (potentially) result in a risk-rating reduction for one or more of the species assessed. For example, a score reduction to the lowest potential (1) for just one of the *susceptibility* attributes (*e.g. recreational desirability / other fisheries*) would result in half of the complex falling into the medium-risk category. Any further reductions would see all of the trevally species reclassified as a medium-risk (Fig. 1).

While the outputs of the Level 2 ERA indicate that the trevally complex is at a high risk in the current fishing environment (Appendix D), these results are more representative of the potential risk. The absence of sustainability assessments increases the uncertainty surrounding harvest levels and the efficacy of the current regime. These issues are compounded by biological data deficiencies and a limited capacity to validate catch compositions in real or near-real time. These risks are being addressed through the *Queensland Sustainable Fisheries Strategy 2017–2027* and the harvest strategy development process. For example, the trevally complex is classified as a *Tier 3* complex under the draft ECIF harvest strategy. While *Tier 3* species are low priorities for transition to an output-controlled management system, they will be subject to increased monitoring with catch triggers used to manage shifting fishing pressures (Department of Agriculture and Fisheries, 2020d).

Species-specific recommendations

1. *Improve catch composition data and identify mechanisms to improve data on harvest rates for individual species, allowing for further ERA refinements and the (potential) removal of low-risk species.*

2. *Improve species-specific biological data across the complex and information on how these species interact with the ECIF, including on total rates of fishing mortality (retained plus post-capture mortality).*

3. *Explore the need for the inclusion of the listed trevally species in indicative sustainability evaluations to improve the level of information on the stock status of key species.*

4. *Evaluate the suitability and applicability of transitioning the trevally complex to an output-controlled management system, noting that the effectiveness of this system will be dependent on management's ability to identify and establish an appropriate limit.*

4.2.1.6 Mackerels

Common name	Sub-fishery	Risk rating
Grey mackerel (*S. semifasciatus*)	N1, N2 & N4 fishery symbols	**Medium**
Spotted mackerel (*S. munroi*)	N1, N2 & N4 fishery symbols	**Medium**
School mackerel (*S. queenslandicus*)	N1, N2 & N4 fishery symbols	**Precautionary Medium**

Grey (*S. semifasciatus*), spotted (*S. munroi*), and school mackerel (*S. queenslandicus*) were included in the Level 2 ERA due to their prevalence as target & byproduct species in the Large Mesh Net Fishery. Grey and spotted mackerel are managed under TACC limits (250t, grey mackerel; 140t, spotted mackerel) which minimise the risk of an overfishing event and help to preserve their long-term sustainability (Helmke *et al.*, 2018; Litherland *et al.*, 2018b). These TACCs are supported by decision rules that restrict the take of each species as the limit is approached and/or reached (*Fisheries Declaration 2019*). However, there are no overarching rules that prevent fishers from retaining grey and spotted mackerel once the quota has been exhausted. Instead, the fishery employs allowances that permit a limited incidental take of each species once the TACC has been reached.

The use of in-possession limits *verse* no-take provisions relates to the multi-species, multi-apparatus nature of the ECIF (Department of Agriculture and Fisheries, 2019f). The key objectives of the in-possession limit are to minimise wastage (discarding of dead or moribund fish) and prevent the species from being targeted in higher quantities. The inherent trade-off with this approach is that grey and spotted mackerel can still be harvested once the TACC limit is reached. This issue is compounded by the inability of the current management regime to effectively redress a TACC overfishing event. While this is unlikely to occur in the current fishing environment, it was identified as a risk area for these species and was one of the reasons why they were assessed as medium risk for the *management strategy* attribute (Table 7; Appendix D).

Unlike grey and spotted mackerel, school mackerel are not subject to a catch limit and their harvest is managed within the broader confines of the ECIF (Department of Agriculture and Fisheries, 2019f). While school mackerel make up a smaller proportion of the overall catch, the absence of output controls means that catch can increase more rapidly under the current management regime. While this again is unlikely to occur within the current fishing environment, it was identified as a risk for this species. It was also the reason why school mackerel received a high preliminary risk rating for the *management strategy* attribute (Table 5; Appendix D). It is recognised though that school mackerel has fewer sustainability concerns and may be viewed as a lower priority for transition to output controls (see below).

The sustainability of all three species has been confirmed through stock assessments and multiple indicative sustainability evaluations (Bessell-Browne *et al.*, 2019; Lovett *et al.*, 2019; Bessell-Browne *et al.*, 2018; Helmke *et al.*, 2018; Litherland *et al.*, 2018b; Litherland *et al.*, 2018c). Harvest rates for grey and spotted mackerel are below MSY and conducive to stock rebuilding over the short to medium term (Appendix D). These results support the inference that key risks for these species are being managed within the current fishing environment. However, both stock assessments recommend that a catch reduction be considered to assist the species meet long-term objectives outlined in the *Queensland Sustainable Fisheries Strategy 2017–2027* (Department of Agriculture and Fisheries, 2017). From an ERA perspective, any mechanism that promotes continued biomass growth will provide further support for a reduction in risk scores. Additional information on discard rates and post-release fates would further improve the accuracy of future risk assessments.

Though school mackerel are not managed under a TACC limit, standing biomass estimates place the species at around 65% of an unfished stock; a value that already exceeds the long-term Strategy objectives (Appendix D; Lovett *et al.*, 2019). This research indicates that the fishery is in a good position to maintain high biomass levels over the medium to long term (Department of Agriculture and Fisheries, 2017). The tendency of school mackerel to avoid aggregating (Begg, 1998) may also reduce the targeting of this species in higher quantities and increase stock resilience in terms of regional fishing pressures. For the aforementioned reasons, it is likely that the outputs of the Level 2 ERA overestimate the risk posed to this species by large mesh net fishing (Table 7).

Going forward, the development of an ECIF-specific harvest strategy will be a positive step for the management of mackerel stocks on the Queensland east coast. Under the proposed ECIF harvest strategy, grey (*Tier 1*), school (*Tier 1*) and spotted (*Tier 2*) mackerel have been prioritised for transition to a more complex system of output controls (Department of Agriculture and Fisheries, 2020d). To this extent, the outputs of the Level 2 ERA could be viewed as a worst case scenario in terms of their risk evaluation. This inference assumes though that the current harvest rates and cumulative fishing pressures do not increase significantly before the introduction of the harvest strategy.

Species-specific recommendations

1. *Improve the integrity of the quota management system by exploring additional mechanisms to manage and (if applicable) redress within year quota over-runs.*

4.2.1.7 Jewfish

Common name	Sub-fishery	Risk rating
Black jewfish (*P. diacanthus*)	N1 & N2 fishery symbols	**Medium**
Silver jewfish (*N. soldado*)	N1 & N2 fishery symbols	**High**
Mulloway (*A. japonicas*)	N1 & N2 fishery symbols	**Precautionary High**

Similarities in morphology and habitat/distribution among jewfish has led to the reporting of these species in catch categories with coarse-scale species compositions *e.g. Jewfish—Unspecified* (Department of Agriculture and Fisheries, 2019f). Though lacking species resolution, anecdotal evidence suggests that catch is dominated by black jewfish (*P. diacanthus*). Demand for this species has increased in recent times due to the increased marketability of their swim bladders and they are considered a high-value species in the Large Mesh Net Fishery. When compared, silver jewfish (*N. soldado*) and mulloway (*A. japonicus*) make smaller contributions to the overall harvest. The inclusion of these secondary species is precautionary and reflects the potential for market demand to spread from black jewfish to other species (Appendix D).

As expected, all three jewfish scored highly across the *availability*, *selectivity* and *post-capture mortality* attributes (Table 7). The listed species are actively targeted across their known distributions/habitats and, in the case of black jewfish, are readily retained in the Large Mesh Net Fishery. Risk score reductions for these attributes will be difficult to justify in future ERAs as market demand will remain a key driver of risk for this complex. These risks are unlikely to be uniform and will be most prevalent in inshore waters and in areas where cumulative fishing pressures are more pronounced. Improving the level of information on jewfish species compositions would assist in determining the extent of this risk in regional areas and inform discussions surrounding the need, suitability, and applicability of alternate management arrangements.

Black jewfish have a more advanced management system due to their position as a high-value species.[8] On the Queensland east coast, the commercial take of this species is restricted by a 20t TACC limit and take of this species in any sector (commercial, charter and recreational) is not permitted once this limit has been reached (Department of Agriculture and Fisheries, 2019d). This is of considerable significance as black jewfish is the first ECIF species to have a catch limit that impacts their catch across multiple sectors. These extended restrictions are primarily due to the high marketability and value of the species and the risk posed by illegal, unreported and unregulated fishing *e.g.* black marketing of saleable product. In the Level 2 ERA, these restrictions contributed to the species receiving a lower *management strategy* score and a lower overall risk rating (Table 7).

While the RRA considered a score reduction in the *management strategy* attribute for black jewfish (Appendix D), the above restrictions were only introduced in September 2019 and, as such, additional time is required to determine the efficacy of these measures and the mechanisms used to monitor their take. Moreover, the species has not been the subject of a detailed stock assessment and it is unclear how this limit relates to the current stock structure or key sustainability reference points. These limitations are now being addressed through a study aimed at improving our understanding of black jewfish stock and age structures, genetic connectivity, and spawning.[9] This information may be used in a weight-of-evidence approach to facilitate potential score reductions in future ERAs.

Management of mulloway and silver jewfish aligns more closely with other teleosts, and their take is principally managed through input controls (mesh size restrictions, net length restrictions *etc.*), minimum legal size limits (mulloway) and in-possession limits for recreational fishers (Queensland Government, 2018b; d). Given that mulloway is harvested in lower quantities and has a predominantly southern distribution, the final risk score for this species is likely to be an overestimate. Based on the available data, this species is more likely to experience an overfishing event in temperate waters where they are actively targeted across sectors. This inference is supported by a New South Wales stock status assessment which lists the species as *depleted*—the Queensland stock remains *undefined* (Earl *et al.*, 2018).

As with mulloway, the risk rating for silver jewfish may be overestimated as they are (generally) targeted and harvested in lower quantities. At present, there is limited evidence to suggest that the marketability of this species is following the same trajectory as black jewfish. However, there is a degree of uncertainty surrounding how management reforms introduced for black jewfish will impact the marketability of other species. For example, it is currently unclear if markets will shift towards other jewfish species to account for any potential shortfall in black jewfish product. This uncertainty is compounded by an absence of information on catch compositions and total rates of fishing mortality (retained plus discards). This was a key driver of risk for both silver jewfish and mulloway and it was given significant weighting in scores assigned to the *management strategy*, *sustainability* and *recreational desirability / other fisheries* attributes (Table 7; Appendix D).

[8] *The market value of black jewfish has increased exponentially in recent years with swim bladders from this species reaching >$600 per kilogram.*
[9] https://statements.qld.gov.au/statements/89924

Outside of the commercial fishing sector, this complex experiences variable cumulative fishing pressures (Webley *et al.*, 2015; Department of Agriculture and Fisheries, 2020c). The mulloway catch is dominated by recreational/charter fishers but the silver jewfish catch is more evenly split between the two (*i.e.* commercial and recreational/charter). On a proportionate basis, these two species are more likely to experience additional fishing pressures from non-commercial sectors. Cumulative fishing pressures (retained plus discards) on black jewfish are less quantifiable, although the species is considered to be at higher risk from black marketing. This risk has been addressed on the Queensland east coast through the introduction of boat limits for nine priority black market species including black jewfish (Department of Agriculture and Fisheries, 2019d).

In addition to management limitations, a lack of sustainability assessments was identified as an underlying risk factor for this subgroup. None of the species possess a stock assessment and stock status evaluations for the black jewfish and mulloway are *undefined* (Earl *et al.*, 2018; Penny *et al.*, 2018b). However, evidence from adjacent jurisdictions suggests that regional stocks for both species are susceptible to overfishing. For example, the mulloway stock in New South Wales is classified as *depleted* and the Northern Territory black jewfish stock is classified as *recovering* (Penny *et al.*, 2018b; Earl *et al.*, 2018).

All three species would benefit from additional information on the structure and status of their stocks on the Queensland east coast. For black jewfish, their marketability arguably advocates for the production of a more detailed, quantitative stock assessment. Harvest rates for mulloway and silver jewfish indicate that a weight-of-evidence approach is a more appropriate course of action. In all three instances, sustainability assessments would benefit from improved information on catch compositions, mechanisms to aid in the validation of logbook data, discard rates and market trends; particularly secondary jewfish species. Without this information, it will be difficult to assess how the harvest of these species compares to key sustainability reference points and/or what level of fishing mortality is required to meet long-term targets under the *Queensland Sustainable Fisheries Strategy 2017–2027* (Department of Agriculture and Fisheries, 2017).

While noting the above issues, significant advancements have been made in the overall management of black jewfish. These measures are being built upon through the draft harvest strategy which classifies black jewfish as a *Tier 2* species and mulloway / silver jewfish as *Tier 3* species. These measures will assist in managing the long-term risk for all three species and aid in the early detection of catch/effort increases for secondary species. Given the current marketability of swim bladders and their distribution, the monitoring of silver jewfish catch should be prioritised as part of the harvest strategy development process.

Species-specific recommendations

1. *Identify mechanisms to assist/improve catch composition data, and avenues to improve data on harvest rates, total fishing mortality (retained plus discarded) and cumulative fishing pressures (commercial, recreational and charter).*

2. *Explore mechanisms to improve our understanding of the stock status for secondary jewfish species (e.g.) through species-specific monitoring programs, with consideration given to the inclusion of these species in indicative sustainability evaluations or population biology studies.*

3. *Investigate how black jewfish management reforms may impact the marketability and demand of swim bladders of secondary species and the potential for catch to increase rapidly over the short to medium term.*

4.2.1.8 Barramundi

Common name	Sub-fishery	Risk rating
Barramundi (*L. calcarifer*)	N1 & N2 fishery symbols	**Medium**

The significance of barramundi in Queensland is demonstrated through a long history of sustained catches across multiple sectors (Department of Agriculture and Fisheries, 2020c). The species holds considerable significance in the commercial, recreational and charter fishing sectors, and cumulative fishing pressures are a key driver of risk for this species (Table 7). Based on the available data, the commercial sector is responsible for around two thirds of the total (state-wide) barramundi harvest with recreational fishers harvesting an estimated 131–166t per year (Webley *et al.*, 2015; Department of Agriculture and Fisheries, 2019f; 2020c; Saunders *et al.*, 2018; Grubert *et al.*, 2020).

As expected, barramundi scored highly across the *availability*, *selectivity,* and *post-capture mortality* attributes (Table 7). The species is actively targeted across the known distribution/habitats and it is readily retained in the Large Mesh Net Fishery. Risk score reductions for these attributes will be difficult to justify as demand for this species will remain high over the short to medium term. Fishing-related risks will be higher in inshore waters, estuaries, and rivers (Balston, 2009; Streipert *et al.*, 2019; Saunders *et al.*, 2018) and in areas where there is greater overlap between commercial and recreational effort. These risks will be more prevalent in central and northern Queensland where the species is targeted by commercial fishers operating under the N1 and N2 fishery symbols (Department of Agriculture and Fisheries, 2019f; 2020c).[10]

When compared to other species, barramundi has a more complicated stock structure. There are five known stocks on the Queensland east coast and at least two in the Gulf of Carpentaria (Saunders *et al.*, 2018). Stock assessments and indicative sustainability evaluations indicate that stocks across Queensland are being sustainably fished (Streipert *et al.*, 2019; Campbell *et al.*, 2008; Saunders *et al.*, 2018; Grubert *et al.*, 2020). However, at least one of the Gulf of Carpentaria stocks has previously been classified as *depleting* (Saunders *et al.*, 2018). While the biomass of this stock has recovered (Streipert *et al.*, 2019), historical assessments demonstrate that barramundi stocks are susceptible to overfishing at a regional level; particularly when recruitment rates are impacted on by adverse environmental conditions and poor water flows.

Barramundi are not currently managed under a quota system and there is some capacity for catch and effort to increase through time. While noting these limitations, the Level 2 ERA indicates that the risk posed to this species is being managed within the current fishing environment. Barramundi is one of the few ECIF species with a minimum and maximum legal size limit, and their take is restricted through seasonal closures, spatial closures and in-possession limits for non-commercial fishers (Department of Agriculture and Fisheries, 2018g; 2019f). While the current minimum legal size (58 cm) is below the size at sexual maturity (64–90 cm), this risk is partially mitigated by a fisheries-wide spawning/seasonal closure from 1 November to 31 January. Natural recruitment processes on the Queensland east coast are also supplemented through a dedicated fish stocking program. This program helps to reduce the risk of a regional overfishing event.

[10] *Barramundi data including catch distributions available through Qfish (https://qfish.fisheries.qld.gov.au/)*

The risk posed to this species on the Queensland east coast will be further reduced with the introduction of an ECIF-specific harvest strategy (Department of Agriculture and Fisheries, 2020a). Under the draft strategy, barramundi are classified as a *Tier 1* species and will be prioritised for transition to a more complicated system of output controls. This change should facilitate a score reduction in the *management strategy* attribute and would see the overall risk score for the species drop to the cusp of a low-risk rating (Table 7; Fig. 1). Under this assumption, the outputs of the Level 2 ERA likely represent the worst case scenario for this species. This assessment though relies on the species being transitioned to an output-controlled management system that effectively manages catch and effort across sectors. Without this measure, the risk of catch and effort increasing across sectors will remain.

While not viewed as an immediate priority, future ERAs would benefit from an up-to-date synthesis of information on the distribution of large mesh net effort in biologically important areas and habitats. This information may open up further avenues to refine risk scores assigned to key *susceptibility* attributes like *availability* and *encounterability or* facilitate a move towards a more quantitative ERA.

Species-specific recommendations

Not applicable at the species level. However, future ERAs would benefit from the collection of additional data surrounding total fishing mortality across sectors (retained plus discarded) and the collection of regional distribution data. This data would allow for further refinement of the risk scores and provide greater insight into regional risk variability.

4.2.1.9 Threadfin

Common name	Sub-fishery	Risk rating
King threadfin (*P. macrochir*)	N1 & N2 fishery symbols	**High**
Blue threadfin (*E. tetradactylum*)	N1 & N2 fishery symbols	**Medium**

The threadfin complex incorporates a range of species that interact with fishers on the Queensland east coast including king (*P. macrochir*), blue (*E. tetradactylum*), flat (*P. multiradiatus*) and striped (*P. plebeius)* threadfin. As the majority of the commercial and recreational catch consists of king and blue threadfin, these two species were prioritised for assessment in the Level 2 ERA (Appendix B). When and where appropriate, additional species will be assessed in subsequent ERAs.

Based on the PSA, the king threadfin is at a higher risk from fishing activities in the Large Mesh Net Fishery (Table 7). With that said, the risk score for this species (3.29) is in close proximity to the medium-risk / high-risk threshold (3.18; Fig. 1). In the event that information levels improved to the point where one of the *susceptibility* scores could be reduced, king threadfin would be reclassified as medium risk. Based on the available data, a change of this magnitude could be achieved with an improved estimate of the recreational harvest and/or the introduction of a harvest strategy that minimises the risk of catch or effort increasing significantly over the short to medium term.

The sustainability of both threadfin species has been confirmed through indicative evaluations (Leigh *et al.*, 2019; McGilvray *et al.*, 2018a), and a stock assessment is being developed for king threadfin. Preliminary results from the king threadfin assessment indicate that the biomass of the east coast stock sits above MSY (*pers. comm.* G. Leigh). The key caveat being that the report has still to be finalised and these preliminary results may be subject to change. As a stock assessment has not been completed for blue threadfin, there is less information on the structure of this stock or key sustainability reference points. Without this information it is difficult to ascertain how harvest rates may impact regional stocks and/or if the species is on track to meet long-term objectives outlined in *Queensland Sustainable Fisheries Strategy 2017–2027* (Department of Agriculture and Fisheries, 2017).

Neither of the threadfin species are managed under output controls meaning catch and effort can increase under the current management regime. These risks are compounded by minimum legal size limits which are set below the size at sexual maturity for both species. This discrepancy will expose juveniles to additional fishing pressures and (may) undermine long-term rates of recruitment. Of note, these factors are being considered as part of the harvest strategy development process and alternate size limits are being considered for both species (Department of Agriculture and Fisheries, 2019b). This process though is complicated by confounding factors, and any decision will need to consider how best to increase the MLS limit whilst minimising discard waste for species with higher rates of post-capture mortality (Welch *et al.*, 2010a). From an ERA perspective, the above were considered to be notable risk factors and were evaluated accordingly as part of the *management strategy* and *sustainability assessments* attributes (Table 7).

King threadfin has experienced a notable increase in demand in the Gulf of Carpentaria due to the marketability of their swim bladders (Bayliss *et al.*, 2014). While there is limited evidence to suggest that this demand has spread to the Queensland east coast, the probability of this occurring is high. The potential for catch to increase over the short term resulted in a number of the *susceptibility* attributes receiving more conservative risk scores (Table 7). This was considered to be an appropriate and proactive course of action given the similar situation found with black jewfish (*P. diacanthus*). Circumstances surrounding blue threadfin mirror that of silver jewfish (*N. soldado*) in that the species may have lower marketability, possibly due to the species reaching a smaller maximum size (Queensland Government, 2018d). The marketability of these species though may shift through time with the demand for swim bladders potentially broadening into the future.

Any advancements in the management of these species and improved information on their stock status would likely result in a reduced risk rating. For example, an improved understanding on the sustainability of blue threadfin stocks or a move to output controls would contribute to a lowering of scores assigned to key *susceptibility* attributes. This in turn would likely result in king threadfin being reclassified as a medium risk. As the draft ECIF harvest strategy classifies king threadfin as a *Tier 1* species (Department of Agriculture and Fisheries, 2020d), a future score reduction of this nature is viewed as realistic. While management reforms proposed for blue threadfin are smaller, it will be included in any monitoring regime established for *Tier 3* species (Department of Agriculture and Fisheries, 2020d).

While the recreational sector harvests both threadfin species, cumulative fishing pressures will be lower when compared to other ECIF species. Harvest rates for the blue threadfin are higher, with almost three-quarters of the recreationally caught fish being retained. Harvest rates for king threadfin are lower with around 45% of the 11,000 fish caught being retained in this sector (Teixeira *et al.*, 2021; Department of Agriculture and Fisheries, 2021). Retention rate estimates for king threadfin though have a higher margin of error. This, combined with uncertainty surrounding post-release mortalities and the composition of the *unspecified* recreational finfish catch, limited the potential for any RRA score reductions (Table 7; Appendix D). Going forward, risk score reductions could be achieved by improving the level of information on recreational catch and harvest rates, particularly for king threadfin. If this were to occur, it is likely that both species would be classified as medium risk in the Large Mesh Net Fishery.

With ECIF transitioning to a harvest strategy, the outputs of the Level 2 ERA could be viewed as the worst case scenario for these species. This inference assumes that current harvest rates and cumulative fishing pressures will not increase significantly before the introduction of an ECIF-specific harvest strategy. Once implemented, the harvest strategy will provide clear benefits to king threadfin due to their status as a *Tier 1* species. The situation with blue threadfin is less certain as it is considered to be a *Tier 3* species and will be a lower priority in terms of stock assessments and output controls. Instead, it will be subject to increased monitoring with catch triggers used to ensure that any increases or shifts in fishing pressures do not present an unacceptable level of risk. This inference assumes that the broader framework of the draft ECIF harvest strategy is adopted and implemented (Department of Agriculture and Fisheries, 2020d).

Species-specific recommendations

1. *Investigate how recent reforms to black jewfish may impact the marketability and demand of threadfin on the Queensland east coast, including the potential for catch to increase rapidly over the short term, and avenues that may reduce the risk of regional stocks becoming overfished across sectors and through time.*

2. *Explore mechanisms to improve our understanding of the stock status of secondary threadfin species through (e.g.) indicative sustainability evaluations or their (potential) inclusion in future stock assessments.*

3. *Implement measures that help to quantify and assess regional cumulative fishing pressures and the need for fine-scale fisheries management (e.g. regionally specific management to address the non-uniform distribution of the risk posed to threadfin species in the ECIF).*

4.2.1.10 Javelin / Grunter

Common name	Sub-fishery	Risk rating
Barred javelin (*P. kaakan*)	N1 & N2 fishery symbols	**Precautionary High**
Silver javelin (*P. argenteus*)	N1 & N2 fishery symbols	**Precautionary Medium**

Morphological similarities and overlapping habitat/distribution preferences has led to the reporting of javelin in catch categories with coarse-scale species compositions *e.g. Grunter—Unspecified* (Department of Agriculture and Fisheries, 2019f). Though lacking species resolution, anecdotal evidence suggests that the commercial catch is dominated by barred javelin (*P. kaakan*). The barred javelin is a larger species and recreational harvests for this species tend to be higher (Webley *et al.*, 2015; Department of Agriculture and Fisheries, 2020c). Silver javelin (*P. argenteus*) is expected to make a smaller contribution to the total catch (commercial and recreational) and it will be subject to lower cumulative fishing pressures (*pers. comm.* T. Ham). As neither of the javelin are managed under output controls, catch and effort can increase under the current management regime.

Without an effective mechanism to validate commercial catch, it is difficult to quantify species contributions and individual rates of harvest. These deficiencies have inhibited previous attempts from management to conduct indicative sustainability evaluations (Department of Agriculture and Fisheries, 2018f). As the species are caught and harvested in relatively low quantities they are also viewed as lower priority for stock assessment. While the absence of a stock assessment is understandable, it increases the level of uncertainty and (potential) risk due to an absence of biomass reference points. The above deficiencies translated to the production of more conservative risk assessments (Table 7).

While barred javelin is viewed as a high risk, this assessment is precautionary. In the Level 2 ERA, management limitations were compounded by a lack of data on the biology of this species and an absence of information on long-term catch trends and post-capture mortality (Table 7). Improved information in one or more of these areas would enable refinements to be made to the risk assessment and (potentially) facilitate an overall rating reduction. For example, a score reduction to the lowest potential (1) in just one of the *susceptibility* attributes (*e.g. recreational desirability / other fisheries*) would see both species fall into the medium-risk category. Any further reductions would drive both javelin species towards the threshold of a low-risk rating (Figure 1).

The introduction of mechanisms to improve species composition data would allow for a more accurate assessment of risk. This information could also be used to provide further insight into the suitability and applicability of alternate management arrangements. Without a cap on catch/effort there is a risk that fishing pressures will increase to a point where it impacts on their long-term sustainability. This is considered unlikely over the short to medium term and will be addressed further as part of the harvest strategy development process. If the draft harvest strategy is adopted, javelin will be classified as *Tier 3* species and will be monitored using catch triggers to ensure that increases or shifts in fishing pressures do not present an unacceptable level of risk (Department of Agriculture and Fisheries, 2020a). The benefits of these measures will only be realised once the harvest strategy is fully implemented along with an effective measure to validate ECIF catch compositions.

Species-specific recommendations

1. *Improve catch composition data and identify mechanisms to improve data on harvest rates across sectors—allowing for further refinements to be made to the ERA process.*

2. *Increase the level of biological information and information on how these species interact with the broader ECIF including on total rates of fishing mortality (retained plus post-capture mortality).*

3. *Explore the need for the inclusion of the listed javelin species in indicative sustainability evaluations (e.g. SAFS).*

4.2.1.11 Garfish & Yellowtail Scad

Common name	Sub-fishery	Risk rating
Snubnose garfish (*A. sclerolepis*)	N1 & N2 fishery symbols	**Precautionary Medium**
Three-by-two garfish (*H. robustus*)	N1 & N2 fishery symbols	**Precautionary Medium**
Yellowtail scad (*T. novaezelandiae*)	N1 & N2 fishery symbols	**Precautionary Medium**

Garfish are one of the more prominent components of the ECIF catch with >100t retained in the fishery each year (Department of Agriculture and Fisheries, 2019f). While garfish are retained in other ECIF sub-fisheries (Tunnel Net Fishery, Ocean Beach Fishery), the majority of the catch is retained by large mesh net operations (Appendix B). For the most part, this catch is reported as *Garfish—unspecified* with limited quantities reported to the species level (Department of Agriculture and

Fisheries, 2019f). Expectations are that the majority of this catch will consist of the snubnose garfish (*A. sclerolepis*) and the three-by-two garfish (*H. robustus*).

When compared, the catch of scad in the ECIF is smaller and displays more within year variability: 10–30t each year (Department of Agriculture and Fisheries, 2019f). This catch is again reported at a higher taxonomic level (*Scad—unspecified*) with only small amounts being classified to the species level (Department of Agriculture and Fisheries, 2019f). As with garfish, the majority of this catch is expected to be made up of a small number of species, with yellowtail scad (*T. novaezelandiae*) being one of the main components.

While the demand for garfish outweighs scad, the drivers of risk for all three species are similar. All three have biological traits that limit the risks posed by this fishery. Conversely, all three are managed under broad-scale management arrangements which includes larger in-possession limits for the charter and recreational fishing sectors (Department of Agriculture and Fisheries, 2018g). In the PSA, these management limitations are given considerable weighting and contributed to the species receiving higher risk ratings (Table 7). While noting these results, there are fewer sustainability concerns surrounding garfish and scad and the outputs of the Level 2 ERA are likely to be a risk overestimate.

Outside of the commercial sector, garfish and scad will be harvested to varying degrees. While not viewed as primary targets, these species (particularly garfish) will be retained when targeting other inshore species like whiting, bream and flathead (Department of Agriculture and Fisheries, 2021). In-possession limits for these species are less stringent and will contribute to higher rates of fishing mortality and increased cumulative risks. It is important to note though that *productivity* scores for all three species suggest that they can withstand higher rates of fishing mortality (Table 7). For this reason, more prescriptive or stringent in-possession limits may not be required.

Information gaps regarding catch compositions, key sustainability reference points (Department of Agriculture and Fisheries, 2017), total fishing mortality, and the absence of output controls all contributed to the production of more conservative risk assessments. These deficiencies, by extension, produced risk ratings that do not reflect the current sentiment surrounding the sustainability of garfish and scad stocks. Improving the level of information in any one of the above areas would improve the accuracy of this assessment and likely result in a risk reclassification. For example, a score reduction to the lowest potential (1) in just one of the *susceptibility* attributes (*e.g. sustainability assessments*) would result in all three species falling into or near the low-risk category. Assessing risk using a quantitative ERA method may also yield results that are more commensurate with the low level of concern surrounding the sustainability of these species.

Species-specific recommendations

1. *Improve catch composition data and identify mechanisms to improve data on harvest rates for garfish and scad, allowing for refinements to be made to the ERA process and facilitate the removal of some species.*

2. *Depending on the outcomes of the harvest strategy development process, assess the need to include garfish and scad in subsequent ERAs involving the Large Mesh Net Fishery.*

4.2.1.12 Dart

Common name	Sub-fishery	Risk rating
Snubnose dart (*T. blochii*)	N1 & N2 fishery symbols	**Precautionary Medium**
Swallowtail dart (*T. coppingeri*)	N1 & N2 fishery symbols	**Precautionary Medium**

The snubnose (*T. blochii*) and swallowtail (*T. coppingeri*) dart are viewed as secondary target species in the Large Mesh Net Fishery and are subject to a less-prescriptive set of management controls. Combined with data deficiencies, this resulted in the species being assigned ratings that are more representative of the potential risk *verse* the actual risk (Table 7). With improved information, it is likely that ratings for both species could be refined and potentially reduced. The extent of these refinements may be limited as dart are viewed as a low priority for transition to output controls and stock sustainability assessments (Department of Agriculture and Fisheries, 2020d). This can be attributed to these species having comparatively low harvest rates across the ECIF including within the Large Mesh Net Fishery. As they are retained with more frequency in the Ocean Beach Fishery, the risk posed to dart species will be given further consideration as part of the Level 2 ERA for this sector of the ECIF (Department of Agriculture and Fisheries, 2019f; Jacobsen *et al.*, 2021b).

The *management strategy* and *sustainability assessments* attributes arguably provide the greatest avenues to reduce risk for these species. The management regime for dart is less refined and does not include the use of ITQs or TACC limits. As the use of output controls formed the basis of the assessment (Table 3), these species were assigned a precautionary high (3) risk score in the PSA (Table 5). A weight-of-evidence approach was applied to these species to demonstrate that the risk was being managed to a moderate degree without the use of a quota system (Table 7; Appendix D). There was however less capacity to reduce scores assigned to this attribute due to an absence of data on species compositions, total fishing mortality, and comparisons to key biomass reference points (Table 7). Similarly, there is room within the current management regime for catch/effort to increase for both of these species.

Dart have not been the subject of a detailed stock assessment or indicative sustainability evaluations. These deficiencies resulted in the group receiving high (3) risk scores for *sustainability assessments* and it was a major contributor to their overall risk ratings (Table 7). While noting these assessments, catch rates for these species are comparatively small which, when considered in isolation, present as a lower sustainability risk. This fact was difficult to account for in the RRA due to the broader uncertainty surrounding current stock structures, cumulative fishing pressures and catch compositions. This situation is unlikely to change in the short to medium term as a) other species will be prioritised for assessment and b) there are fewer concerns surrounding the long-term sustainability of this complex.

The Level 2 ERA highlights the difficulty of assessing risk for secondary target species. As secondary targets, these species have lower harvest rates and are often viewed as lower priorities for stock status evaluations. This leads to data deficiencies and contributes to the production of more conservative risk ratings (Table 7). The final ratings for these species are viewed as precautionary and may be more applicable to the entire ECIF. There are a number of areas where the risk profiles could be refined, and where the complex would derive benefit from additional assessment using the SAFE approach. Comparisons have shown that bSAFE method produces fewer false positives and may provide greater differentiation in terms of the risk posed to each species (Zhou *et al.*, 2016; Zhou & Griffiths, 2008). The ability to assess these species using bSAFE will be predicated on management's ability to quantify gear-affected area across the fishery.

Species-specific recommendations

1. *Improve catch composition data and identify mechanisms to improve data on harvest rates for dart across sectors of the ECIF.*

2. *Depending on the outcomes of the harvest strategy development process and Ocean Beach Fishery Level 2 ERA (Jacobsen et al., 2021b), assess the need to include dart in subsequent ERAs for the Large Mesh Net Fishery.*

4.2.1.13 Queenfish

Common name	Sub-fishery	Risk rating
Giant queenfish (*S. commersonnianus*)	N1 & N2 fishery symbols	**Precautionary High**

Queenfish data has poor species resolution and the majority of the catch is reported with generic identifiers (*Queenfish—unspecified*) (Department of Agriculture and Fisheries, 2019). This coarse-scale reporting extends to the recreational sector and, given their popularity as a recreational sport-fishing species, creates uncertainty in terms of the cumulative fishing pressures. While noting these deficiencies, expectations are that a notable proportion of this catch will consist of the giant queenfish (*S. commersonnianus*). The remainder will comprise smaller catches of secondary species like the lesser (*S. lysan*), needleskin (*S. tol*), and barred queenfish (*S. tala*) (*pers. comm*. M. Keag; T. Ham). Based on this advice and the available data, the giant queenfish was prioritised for assessment. When and where appropriate, secondary queenfish species will be considered for inclusion in future Level 2 assessments.

Without an effective mechanism to validate catch, it can be difficult to quantify individual rates of fishing mortality or evaluate the sustainability of regional queenfish stocks. These limitations are compounded by the use of a minimum legal size (MLS) limit that is set below the size at sexual maturity for females. This MLS may not sufficiently protect a proportion of the spawning population prior to harvest and it will be a risk that extends to non-commercial sectors. While a proportion of this catch will be discarded, current knowledge of post-capture mortality rates is limited. As such, total fishing mortality may be higher than what is reported through the logbook program and recreational fisher surveys (Webley *et al.*, 2015; Department of Agriculture and Fisheries, 2020c).

While difficult to predict, improving the level of information on queenfish catch compositions and discard rates may facilitate a risk rating reduction for this species. For example, a score reduction to the lowest potential (1) in just one of the *susceptibility* attributes (*e.g. recreational desirability / other fisheries*) would see the species downgraded to medium-risk rating. Any further reductions would see the giant queenfish risk rating decline further into the bounds of the medium-risk category (Fig. 1). In future ERAs, any mechanism that improves the level of information on the take of these species in the ECIF would assist with the production of more accurate risk assessments.

Species-specific recommendations

1. *Identify mechanisms to improve data on queenfish harvest/discard rates across sectors, including release fates.*

2. *Improve species-specific biological data and information on how queenfish interact with the ECIF including on total rates of fishing mortality (retained plus post-capture mortality).*

3. *Explore the need to include queenfish in indicative sustainability evaluations (e.g. SAFS) to improve the level of information on their stock status.*

4.2.1.14 Other Teleosts

Common name	Sub-fishery	Risk rating
Golden snapper (*L. johnii*)	N1 & N2 fishery symbols	**Precautionary High**
Scribbled rabbitfish (*S. spinus*)	N1 & N2 fishery symbols	**Precautionary Medium**

The golden snapper (*L. johnii*) and the scribbled rabbitfish (*S. spinus*) make up a small but consistent component of the large mesh net catch (Department of Agriculture and Fisheries, 2020c; 2019f). The catch of both species tends to be opportunistic with operators retaining golden snapper and scribbled rabbitfish while targeting more valuable species. They are subject to less-stringent management regimes and are viewed as a low priority for stock assessments or indicative sustainability evaluations. These factors contributed to the production of more conservative risk profiles and their ratings are more representative of the potential risk (Table 7). With improved information, it is likely that risk ratings for one or both of these species could be reduced in future ERAs.

As expected, the *productivity* component of the PSA was the key factor in mitigating the risk posed to these species (Table 7). As teleosts, these species display typical *r-selected* life-history traits including more rapid rates of growth, reaching sexual maturity at a (comparatively) early age and increased fecundity (King & McFarlane, 2003). These traits translated to *productivity* scores of low (1) or medium (2) for the majority of the attributes assessed (Table 7). While proxies were used for *maximum size* and *size at sexual maturity* for scribbled rabbitfish (*S. spinus*), values assigned as part of the RRA provide a reasonable account of their *productivity* limitations (Appendix D). With additional information on the biology of individual species, scores assigned to some attributes could be reduced further.

Of the remaining attributes, *management strategy* and *sustainability assessments* arguably provide the greatest avenues to reduce risk for these species. The management regime for both teleosts is less specific and does not include the use of ITQs or TACC limits. As the use of output controls formed the basis of the assessment, these species were assigned a precautionary high (3) risk score in the PSA (Table 5). The inherent challenge being that a) harvest rates for these species may not warrant management intervention, and b) they are unlikely to become priorities for stock assessments or indicative sustainability evaluations unless catch or effort increases. Based on current catch and effort trends this is not expected to occur over the short to medium term (Department of Agriculture and Fisheries, 2019f).

Many of the risks posed to ECIF target & byproduct species are being actively addressed as part of the *Queensland Sustainable Fisheries Strategy 2017–2027* (Department of Agriculture and Fisheries, 2017). As *Tier 3* species, scribbled rabbitfish and golden snapper would remain a lower priority for transition to output controls and/or the development of a stock assessment. They will, however, be subject to increased monitoring, and catch triggers will be used to ensure that increases or shifts in fishing pressures do not present an unacceptable level of risk (Department of Agriculture and Fisheries, 2020d). When implemented, the harvest strategy will be supported by a range of other initiatives which include the extended use of *Vessel Tracking,* identifying key monitoring/research priorities and the establishment of a *Data Validation Plan* (Department of Agriculture and Fisheries, 2018a; 2020d; 2018h).

Going forward, these species would derive benefit from additional assessment using the SAFE approach. Comparisons have shown that the SAFE method produces fewer false positives and may provide greater differentiation in terms of the risk posed to each species (Zhou *et al.*, 2016; Zhou & Griffiths, 2008). The ability to assess these species using bSAFE will still be predicated on management's ability to quantify gear-affected area across the fishery. Alternatively, improved information on catch rates, discards and release fates may allow the species to be excluded from future iterations of the Large Mesh Net Target & Byproduct Species Level 2 ERA.

Species-specific recommendations

Not applicable at the species level. However, future ERAs would benefit from the collection of additional data on total fishing mortality across sectors (retained plus discarded), species-compositions (rabbitfish complex) and the collection of specific regional distribution data to explore avenues for refinement of risk scores within the *availability* attribute.

4.2.2 Sharks

When the results of the PSA and RRA were taken into consideration, the Level 2 ERA indicates that fishing activities in the Large Mesh Net Fishery presents a high risk to the majority of the listed shark species (Table 7). Biological and life-history constraints were key drivers of risk for most species and, in some instances, were the main contributors of risk. If for example, all of the *susceptibility* attributes were assigned the lowest value possible (1), around 50% (n = 7 out of 15) of the assessed shark species would still register a medium-risk rating. This highlights the inherent challenge of managing fishing-related risks for species with *k*-selected life histories.

Promisingly, the level of information on shark biology has increased through time and the majority of the *productivity* assessments were informed by species-specific data (Table 7). Despite these improvements, management of this complex would benefit from additional information on the dynamics of the shark catch in the Large Mesh Net Fishery including on species compositions, sex ratios, size distributions and maturity status. In Queensland, these deficiencies are being actively addressed by the *Queensland Sustainable Fisheries Strategy 2017–2027* through a dedicated shark monitoring project (Department of Agriculture and Fisheries, 2019h; 2017). The primary purpose of this program is to improve our understanding of the exploited shark biomass through the collection of additional biological data, genetic samples and taxonomic analyses.

While operators in the ECIF can harvest all 15 shark species, the extent to which each is targeted, retained, and discarded will differ. Hammerhead sharks (*Sphyrnidae*) and whaler sharks (*Carcharhinidae*) will also differ with respect to the key drivers of risk and how they interact with the fishery. These differences influence how risk can be addressed and how best to manage this risk through the reform process. For example, gear selectivity for large sharks and post-capture mortalities are understood to be significant risk factors for the hammerhead shark complex (Harry *et al.*, 2011a;

Harry *et al.*, 2011b). It is recognised though that *availability*, *selectivity* and *encounterability* will all be risk factors for the shark complex as they are targeted in the Large Mesh Net Fishery (Table 7).

The targeted take of sharks in the ECIF is permitted through the use of an S fishery symbol and is restricted using a TACC limit (Department of Agriculture and Fisheries, 2019f). The primary purpose of the S fishery symbol is to limit the number of operators that can target and retain sharks in larger quantities. Commercial net and line operators who do not hold an S fishery symbol are restricted by a combined in-possession limit of 10 sharks and/or rays (Department of Agriculture and Fisheries, 2019f). These provisions are used to support the 600t TACC limit which incorporates a 100t hammerhead shark TACC limit.[11] Under the harvest strategy being drafted for the ECIF, this TACC would be reduced to 500t and separated into two distinct groups: hammerhead sharks (100t) and other sharks (400t) (Department of Agriculture and Fisheries, 2020d).

Multi-species TACCs are useful for groups where morphological similarities make it difficult to differentiate between species in an active fishing environment. The disadvantage of this approach is that multi-species TACCs may not be flexible enough to respond to a changing fishing environment or detect overfishing events for individual species. The potential for the catch of a single species to increase beyond sustainability reference points is a key risk factor for this fishery. Moreover, the TACC limit does not account for or include discards as this portion of the catch is reported as shark numbers not weights. This has the potential to undermine the effectiveness of the TACC limit and creates uncertainty surrounding total fishing mortality. This is viewed as a secondary risk factor and the extent of this risk will vary between complexes.

In 2015, a stock assessment was completed for a range of whaler and hammerhead shark species that are retained for sale on the Queensland east coast (Leigh, 2015). This assessment provided each species with two MSY estimates: one representing the most likely value for MSY and a more conservative estimate representing one of the lowest values produced by the population model.[12] The completion of this assessment was a significant step forward for the management of the resources as it allowed for the first direct comparison of shark harvest rates and key biomass reference points. These comparisons suggest that harvest rates for the assessed species were below MSY (Leigh, 2015). While noting these results, the stock assessment also recognised concerns surrounding the quality of data for some species, the level of information on shark discards and a lack of species composition data outside the period of time where a *Fisheries Observer Program* was in operation (2006–2012) (Leigh, 2015).

In the Level 2 ERA, the absence of species-specific catch data, discard rates and an inability to quantify individual rates of fishing mortality were all identified as key factors of influence for the shark complex. This was of particular relevance to assessments involving the *management strategy* and *sustainability assessments* attributes (Table 7). These deficiencies are largely attributed to the absence of an effective measure to monitor shark catch in real or near-real time and a limited capacity to validate data submitted through the logbooks (Jacobsen *et al.*, 2019a). Of significance, these data limitations are being addressed through an improved logbook monitoring program and the *Queensland*

[11] *These in-possession limits apply to licence holders without an S fishery symbol. These arrangements were updated as part of a broader management review announced on 30 September 2020. Both the broader shark TACC limit and the hammerhead shark TACC are being reviewed as part of the harvest strategy development process (Department of Agriculture and Fisheries).*

[12] *Leigh (2015) recognised the limitations of commercial shark catch data and provided a lower MSY estimate as a precaution.*

Sustainable Fisheries Strategy 2017–2027. For example, all ECIF operators are now required to report their shark catch through a dedicated *Shark & Ray Logbook* (Queensland Government, 2018a). This logbook contains updated species-specific catch categories and facilities the collection of more detailed information on whaler and hammerhead shark discards (Queensland Government, 2018a).

There are a number of areas where the risk posed to this subgroup could be further reduced and risk profiles refined across the complex. Subsequent ERAs would benefit from improved information on catch compositions, catch dynamics (*e.g.* sex ratios, size classes, etc.), species-specific discard rates and catch variability amongst the N1, N2, and N4 fisheries. This information would be most beneficial when assessing the suitability of the current management system, the species most likely to interact with large mesh nets, and any regional variability. This information would also improve the accuracy of future stock assessments and allow for the expanded use of indicative sustainability evaluations such as SAFS. As *sustainability assessments* are an attribute in the Level 2 ERA, it is an area where risk can be addressed directly through improved monitoring and assessment.

In the ECIF, the above improvements are most likely to be achieved through the harvest strategy development process (Queensland Government, 2018a). However, other initiatives being implemented as part of the *Queensland Sustainable Fisheries Strategy 2017–2027* will benefit the management of sharks in this fishery. This includes identifying mechanisms to improve data on shark catch compositions, quantifying discard rates for key species and the fine-scale movements of effort. As with teleosts, the shark complex may also derive benefit from additional assessment using the SAFE method. As SAFE tends to produce fewer false positives (Zhou *et al.*, 2016; Zhou & Griffiths, 2008), a move to this assessment method may provide further differentiation between low, medium, and high-risk species. This move though would be predicated on management's ability to quantify gear-affected area across the fishery.

4.2.2.1 Hammerhead sharks

Common name	Sub-fishery	Risk rating
Scalloped hammerhead shark (*S. lewini*)	N1, N2 & N4 fishery symbols	**High**
Great hammerhead shark (*S. mokarran*)	N1, N2 & N4 fishery symbols	**High**
Smooth hammerhead shark (*S. zygaena*)	N1, N2 & N4 fishery symbols	**Precautionary High**
Winghead shark (*E. blochii*)	N1 & N2 fishery symbols	**High**

Outputs of the Level 2 ERA classified all four hammerhead sharks as being at high risk from large mesh net operations (Table 7). While acknowledging these results, the risk posed to this subgroup is not expected to be as uniform. This variability was partly addressed through the RRA (Appendix D); although the extent of these refinements were limited by data deficiencies and uncertainty surrounding species compositions and total interaction rates (retained plus discards).

Of the species assessed, the smooth hammerhead shark (*S. zygaena*) has the smallest overlap with the ECIF. This species prefers temperate waters and it is more likely to interact with gillnets located in south-east Queensland (Last & Stevens, 2009). While the species has been observed north of these areas, they are generally found in lower numbers and in smaller densities (*pers. comm.* C. Simpfendorfer). The high-risk rating for this species is viewed as *precautionary* and direct management of this risk is considered to be less of a priority. This risk is arguably greater in New

South Wales where the species occurs in larger numbers and interacts more regularly with commercial and recreational fishers.

Of the three remaining species, the more immediate risks and sustainability concerns involve the scalloped hammerhead shark (*S. lewini*) and the great hammerhead shark (*S. mokarran*). These two have widespread distributions and, as migratory species, have sustainability concerns that extend to waters outside of Australia (Rigby *et al.*, 2019b; Rigby *et al.*, 2019a). Evidently, the targeting of scalloped and great hammerhead sharks across jurisdictions was the catalyst for their inclusion on Appendix II of CITES and their listing as a migratory species under the *Convention on the Conservation of Migratory Species* (CMS). As seen with the EPBC listing of scalloped hammerhead sharks, these global concerns can affect commercial fisheries operating in Queensland. By extension, the management of the species will be considered as part of third-party assessments including threatened species assessments conducted under the EPBC Act and *Wildlife Trade Operation* (WTO) approvals.

Datasets for the winghead shark (*E. blochii*) are less complete, however research suggests that the species has a patchy localised distribution (Smart & Simpfendorfer, 2016). Given this, the risk profile for the winghead shark may be of more relevance when considering regional fishing pressures and risks. As winghead sharks are faster growing and experience lower levels of fishing pressure, there is also the possibility that the Level 2 ERA overestimates the collective level of risk posed to this species (Table 7). Even so, winghead shark interactions are expected to be higher than the smooth hammerhead shark and the species will be encountered across key stretches of the Queensland coastline. As the ECIF is moving towards regional management, it will be in a better position to address the risk posed to this species once a harvest strategy is implemented (Department of Agriculture and Fisheries, 2020d).

As with most shark species included in the Level 2 ERA, life-history constraints were highly influential in the final risk ratings. These constraints were sufficient to assign the great hammerhead shark and the scalloped hammerhead shark with the highest risk score for all but one of the *productivity* attributes (Table 7). In addition to their biology, there are a number of traits that increase the susceptibility of hammerhead sharks to net fishing activities. For example, the distinctive shape of the hammerhead shark cephalofoil makes them highly susceptible to net entanglements across a wide range of size classes (Department of the Environment and Energy, 2014; Harry *et al.*, 2011b). In other shark species, this risk is often mitigated by body size as larger animals tend to outgrow the selectivity of the net; therefore helping to minimise the number of entanglements. This risk is further compounded by the fact that hammerhead sharks have a low tolerance for net entanglements and are more likely to die without relatively rapid intervention (Harry *et al.*, 2011b).

In the Large Mesh Net Fishery, the take of hammerhead sharks is managed through a combined 100t TACC limit. This limit is based on a CITES-linked Non-Detriment Finding (Department of the Environment and Energy, 2014; Convention on International Trade in Endangered Species of Wild Fauna and Flora, 2019) and considered biological reference points contained within a multi-species shark stock assessment (Leigh, 2015). It is applied to all *Sphyrna* species including the scalloped, great, and smooth hammerhead shark but does not include winghead sharks[13]. The winghead shark belongs to a different genus (*Eusphyra*) and the take of this species is recorded against a more

[13] *Catch reported as 'Hammerhead shark - unspecified' is also accounted for in the annual hammerhead shark TACC.*

generic 600t shark TACC limit.[14] This difference is important as it theoretically allows the retention of winghead shark to increase to levels not permitted under the hammerhead shark TACC. While this is unlikely to occur in the current fishing environment (Department of Agriculture and Fisheries, 2019f), it is a risk that can be actively addressed through the management reform framework.

Depending on catch compositions, the use of a multi-species TACC could lead to a scenario where the fishery is operating within the prescribed catch limits but still overfishing a hammerhead shark stock. This risk will increase as annual catch levels approach and reach the TACC limit. As the TACC only accounts for retained catch, this situation will be exacerbated by an inability to account for discards in annual catch limits. This again has the potential to undermine the effectiveness of the TACC as total catch, effort, and fishing mortality (*e.g*. the commercial catch, non-commercial catch plus discards) will be higher than what is reported through the logbook program. While noting these risks, the best available data indicates that this is not currently occurring on the Queensland east coast (Leigh, 2015; Department of the Environment and Energy, 2014; Department of Agriculture and Fisheries, 2018f).

Catch data for the Large Mesh Net Fishery (gillnets and ring nets) is dominated by scalloped hammerheads and interaction rates for this species are expected to be higher than for the other three (Department of Agriculture and Fisheries, 2019f; Department of the Environment and Energy, 2014). The remainder of the identified catch consists of great hammerhead sharks and smaller amounts of winghead shark. To date, there have been no reports of the smooth hammerhead shark being retained for sale in the ECIF. Historical data for this complex though has poor species resolution and a high proportion of the reported catch is classified as *Hammerhead shark –unspecified* (Department of Agriculture and Fisheries, 2019f)**.** The *unspecified* catch category will include multiple species and records from south-east Queensland may incorporate unidentified smooth hammerhead sharks.

Uncertainties in the catch data makes it difficult to quantify individual rates of fishing mortality and assess the likelihood that one or more of the hammerhead sharks are being fished beyond sustainability reference points. However, the 2015 stock assessment indicates that a) harvest mortality rates for the scalloped and great hammerhead shark are below the most conservative MSY estimate, and b) these species are being fished sustainably under the current fishing environment (Leigh, 2015). For the smooth hammerhead and winghead shark, MSY estimates could not be derived due to insufficient species-specific data (Leigh, 2015). These deficiencies contributed to the species receiving more precautionary scores for the *sustainability assessments* attribute (Table 7).

Catch data deficiencies are being addressed through the management framework and fishers are now required to report all retained hammerhead shark catch to species level and document discards (Department of Agriculture and Fisheries, 2018d). These measures are being built upon through the *Queensland Sustainable Fisheries Strategy 2017–2027* and efforts are being undertaken to validate the composition of the hammerhead shark catch, assess the sustainability of regional stocks, and document fine-scale catch and effort movements. This includes through the draft ECIF harvest strategy where hammerhead sharks are classified as a *Tier 2* complex (Department of Agriculture and Fisheries, 2020d). Under this strategy, *Tier 2* species/complexes will be managed under output controls that are informed by regular stock assessments.

[14] *This 600t TACC limit incorporates the 100t hammerhead shark TACC. If for example, the 100t hammerhead shark TACC was exhausted, only 500t of other shark species could be retained.*

Risk profiles for the four hammerhead sharks reflect their status as target species, their low biological productivity, and their high susceptibility to net entanglements. This risk has been well documented and resulted in additional protections for at least one of the species; the scalloped hammerhead. Considering that a draft harvest strategy has been released for the ECIF, the outputs of the Level 2 ERA should represent a 'high-water mark' for this complex. It will however take time to implement these measures and obtain the level of data needed to refine and inform the ERA process. As a consequence, some of the more prominent sustainability risks will remain for this subgroup. From an ERA perspective, there are a number of areas where the accuracy of risk profiles could be improved with additional data and areas where risk could potentially be reduced for this subgroup.

Species-specific recommendations

1. *Include the winghead shark in management arrangements targeted specifically at hammerhead sharks e.g. the 100t TACC limit.*
2. *Implement measures that improve the effectiveness of the hammerhead shark catch reporting program, and that assist in quantifying total rates of fishing mortality (retained plus discards) for individual species.*
3. *Move towards species-specific TACC limits or introduce measures to minimise the risk that one or more of the species are being fished above sustainability reference points.*
4. *Undertake a review of the resources made available to licence holders to assist in the identification of hammerhead shark species.*

4.2.2.2 Blacktip sharks

Common name	Sub-fishery	Risk rating
Common blacktip shark	N1, N2 & N4 fishery symbols	**High**
Australian blacktip shark	N1, N2 & N4 fishery symbols	**High**
Graceful shark	N1, N2 & N4 fishery symbols	**Precautionary High**
Spot-tail shark	N1, N2 & N4 fishery symbols	**Precautionary High**

Blacktip sharks[15] are one of the largest non-teleost catch components reported from the Large Mesh Net Fishery. This is to be expected given that their preferred habitats and distributions overlap with a number of the teleosts targeted in this fishery (Appendix D). Across the broader ECIF, blacktip sharks are retained as both target species and byproduct (Department of Agriculture and Fisheries, 2019f). As they are not managed at a species or complex level, key risks for this subgroup relate to harvest rates and the potential for catch to increase to a point where it exceeds key sustainability reference points (Leigh, 2015; Jacobsen *et al.*, 2019a). This could occur under the current management regime without the TACC limit being reached. As the Australian (*C. tilstoni*) and common blacktip (*C.*

[15] *For the purposes of this ERA, use of the term 'blacktip sharks' collectively refers to Carcharhinus tilstoni, C. limbatus, C. sorrah, and C. amblyrhynchoides. Several commercial logbook categories will make up total blacktip shark catch, including 'Blacktip whaler shark', 'Shark - Australian blacktip', and 'Shark—sorrah'. It is recognised that this definition may differ from that used in the fishery, at a regional level or other reporting mechanisms. However, the risks posed to these species are similar and support their assessment as a collective grouping.*

limbatus) shark make up a high proportion of this catch, this risk will arguably be of most relevance to these two species.

A key challenge with the blacktip shark complex is that the species can be difficult to differentiate between in an active fishing environment. This is reflected in historical catch data which contains a number of generic catch categories such as *blacktip whaler* and *blacktip whaler & graceful shark* (Department of Agriculture and Fisheries, 2019f). For the Australian and common blacktip shark, visual identification in the field is difficult as species differentiation (until recently) primarily relies on genetic analysis, vertebral counts, and a broader understanding of their regional distributions (Morgan *et al.*, 2011; Morgan *et al.*, 2012; Leigh, 2015; Johnson *et al.*, 2017). While the spot-tail shark (*C. sorrah*) and graceful shark (*C. amblyrhynchoides*) can be identified more readily, they share morphological traits that are similar to other blacktip sharks, especially as juveniles. These identification issues present challenges for determining the composition of the blacktip shark catch and quantifying individual rates of harvest.

Resolution of the blacktip shark catch composition data has improved with the implementation of the *Shark & Ray Logbook*. First implemented in 2009, the *Shark & Ray Logbook* has been refined and now requires fishers to provide a more detailed account of the blacktip shark catch (Queensland Government, 2018a). For example, the current logbook now requires this portion of the catch to be reported as graceful shark, spot-tail shark and blacktip sharks (Australian, common) (Queensland Government, 2018). Issues pertaining to blacktip shark identification are also being addressed through the *Queensland Sustainable Fisheries Strategy 2017–2027* including through a dedicated shark catch monitoring program and the *Data Validation Plan* (Department of Agriculture and Fisheries, 2017; 2018a; 2019h).

Interestingly, there is evidence that hybridisation is occurring between the Australian and common blacktip shark in the central-east coast region; the cause of which is currently unknown (Morgan *et al.* 2012). From an ERA perspective, there would be some benefit in collecting additional information on the species compositions in this area, hybrid fitness and life-history traits compared to the parental species. This information may assist in defining the distribution of both species on the Queensland east coast, the extent of the hybridisation zone and the potential for it to impact stock assessments / MSY estimates (Leigh, 2015). In a management context, this information could be used to evaluate the suitability of alternate management arrangements and provide valuable insight into the viability of introducing species-specific catch controls for the common blacktip and Australian blacktip shark.

When compared to the Australian and common blacktip shark, graceful and spot-tail sharks are caught with less frequency on the Queensland east coast. This can be attributed, in part, to the two having a more northern distribution where net effort tends to be lower (Last & Stevens, 2009; Department of Agriculture and Fisheries, 2019f). There is however some potential for catch rates to be underestimated due to misidentifications with one of the aforementioned blacktip shark species. This situation is expected to improve with the continued monitoring of commercial shark catches on the Queensland east coast which includes the collection of genetic, taxonomic and biological data (Department of Agriculture and Fisheries, 2019h). This information can be used in subsequent ERAs to refine the risk profiles of all four species and compare the risk posed by this fishery to net operations in the Gulf of Carpentaria and Northern Territory (Northern Territory Government, 2020; Department of Agriculture and Fisheries, 2019g).

Best available data indicates that at least three of the blacktip shark species are being fished sustainably on the Queensland east coast (Leigh, 2015). The 2015 stock assessment provided MSY estimates for the common blacktip, spot-tail shark and Australian blacktip shark. This assessment indicates that a) harvest mortalities for these species are below the most conservative MSY estimate, and b) these species are being fished sustainably within the current fishing environment (Leigh, 2015). For the graceful shark, MSY estimates could not be derived due to insufficient species-specific data and for the purposes of the stock assessment it was grouped with the Australian blacktip shark. These deficiencies, combined with the likelihood of over/underreporting, contributed to the species receiving a more precautionary score for the *sustainability assessments* attribute (Table 7).

As catch rates are below conservative MSY estimates for at least three of the blacktip sharks, outputs of the Level 2 ERA may overestimate the risk for some species (Table 7). This inference is partly supported by the results of a previous quantitative risk assessment examining the impacts of fishing in the Great Barrier Reef Marine Park (Tobin *et al.*, 2010). Outputs from this assessment categorised the spot-tail shark and the common blacktip shark as medium risk. However, the same report indicated that the Australian blacktip shark was at a very high risk from net fishing activities within this area. It is difficult to draw linkages between the two ERAs as the studies use different methods and have different sample areas. These types of broad-scale comparisons though provide further insight into where priority risk areas might lie for this complex.

Going forward, the risk posed to blacktip sharks on the Queensland east coast is expected to be reduced with the introduction of an ECIF-specific harvest strategy (Department of Agriculture and Fisheries, 2020a). Under the draft ECIF harvest strategy, sharks and rays are classified as a *Tier 2* grouping and will be prioritised for transition to a more complicated system of output controls *e.g.* regional management and a TACC supported by detailed harvest control rules. This change will likely facilitate a score reduction in the *management strategy* attribute and would see the risk score for these species drop to the cusp of a medium-risk rating (Table 7).

Species-specific recommendations

1. *Improve catch composition data for blacktip sharks and identify mechanisms to improve data on harvest rates and fine-scale effort movements.*

2. *Update the shark stock assessment to account for any additional information collected through the Shark & Ray logbook and initiatives instigated under the Queensland Sustainable Fisheries Strategy 2017–2027.*

3. *Review shark management arrangements and implement measures that will assist in the management of individual species and minimise the long-term sustainability risk; preferably through a harvest strategy.*

4. *Investigate the extent of hybridisation of blacktip sharks on the Queensland central east coast, with specific reference to the reproductive capacity and susceptibility of these species to fishing pressures.*

4.2.2.3 Pigeye & Bull sharks

Common name	Sub-fishery	Risk rating
Pigeye shark (*C. amboinensis*)	N1 & N2 fishery symbols	**Precautionary High**
Bull shark (*C. leucas*)	N1 & N2 fishery symbols	**Precautionary High**

Outputs of the Level 2 ERA classified the pigeye (*C. amboinensis*) and bull (*C. leucas*) shark as high risk in the Large Mesh Net Fishery (Table 7). While the two species have risk traits expected of any target species (increased *availability*, *encounterability*, and *post-capture mortality*), biological and life-history constraints were identified as the key drivers of risk. If for example all of the *susceptibility* attribute scores were reduced to the lowest potential (1), both species would still fall into the medium-risk category.

As with blacktip sharks, operators may have difficulty differentiating between bull and pigeye sharks in an active fishing environment. This is acknowledged in previous assessments and in the *Shark & Ray Logbook* where the two are monitored as a single entity (Leigh, 2015; Queensland Government, 2018a). While this amalgamation comes out of necessity, it will be difficult to quantify individual rates of fishing mortality without a mechanism to validate data submitted through the logbook program. In stock assessments, this issue will be magnified by the fact that the catch history of both species includes generic identifiers like *Shark—Unspecified* and *Whaler—Unspecified* (Department of Agriculture and Fisheries, 2019f). While this issue has also been partly addressed through the *Shark & Ray Logbook* it will take a period of time before these changes yield benefits in terms of acquiring an MSY estimate for both species (Leigh, 2015).[16]

A 2015 stock assessment indicated that the combined harvest mortality for pigeye and bull sharks was below the most conservative MSY estimate (Leigh, 2015). This by extension suggests that the complex is being fished sustainably within the current fishing environment. However, further information on individual catch compositions will be required before the fishery can accurately determine how individual harvest rates are tracking against species-specific MSY estimates. These deficiencies combined with the likelihood of over or underreporting due to misidentifications contributed to the species receiving more precautionary scores for the *sustainability assessments* attribute (Table 7).

With limited research on post-capture mortalities and in the absence of detailed net-discard information, fishing mortality may be higher than is currently reported through the logbook program. In the Large Mesh Net Fishery, discards are expected to be higher in inshore waters where teleosts species are targeted with more regularity. These operations are less likely to target bull sharks and, if required (*e.g.* due to space constraints), will preference the retention of higher-value teleosts (Leigh, 2015). This potential for increased discarding was a contributing factor when considering the suitability of the current management system and unreported mortalities.

When the outputs of the most recent stock assessment and the key drivers of risk were taken into consideration, it is likely that the outputs of the Level 2 ERA overestimate the risk posed to these species. While biological constraints were identified as a key driver of risk, data deficiencies contributed to the production of more conservative risk profiles (Table 7). With the introduction of an

[16]The bull shark and pigeye shark were assessed as a single entity in the 2015 stock assessment; therefore have a combined Maximum Sustainable Yield (MSY) estimate. At that point in time, the available data did not facilitate the production of two separate estimates.

ECIF-specific harvest strategy there is some potential for this risk to be reduced. The extent of any benefit though may be difficult to quantify without species-specific MSY estimates.

Species-specific recommendations

1. *Improve catch composition data for this complex and identify mechanisms to improve data on harvest rates to assist with the production of species-specific MSY estimates.*

2. *Update the shark stock assessment to account for any additional information collected through the Shark & Ray Logbook and initiatives instigated under the Queensland Sustainable Fisheries Strategy 2017–2027.*

4.2.2.4 Milk, Hardnose & Sharpnose sharks

Common name	Sub-fishery	Risk rating
Milk shark (*R. acutus*)	N1 & N2 fishery symbols	**Precautionary High**
Hardnose shark (*C. macloti*)	N1 & N2 fishery symbols	**Precautionary High**
Australian sharpnose shark (*R. taylori*)	N1 & N2 fishery symbols	**Precautionary High**

The Level 2 ERA classified milk (*R. acutus*), hardnose (*C. macloti*), and Australian sharpnose (*R. taylori*) sharks as being at high risk from fishing activities in the Large Mesh Net Fishery. As retainable product with wide distributions, all three received high scores for the *availability*, *encounterability*, and *post-capture mortality* attributes (Table 7). However, the PSA indicates that the biological risks (*productivity*) for these species are at the lower end of the spectrum (Table 7). For example, the milk shark and Australian sharpnose shark are two of the more productive whaler species found in Australian waters, and their reported *age at sexual maturity* is 2–3 years and 1 year respectively (Harry *et al.*, 2010; Baje & Simpfendorfer, 2019; Baje *et al.*, 2018). Age at sexual maturity of the hardnose shark is marginally higher at 4 years (Smart *et al.*, 2013).

Improved productivity, more rapid growth, and smaller rates of harvest suggest that the risk posed to these species will be lower than that observed in other complexes. This by extension suggests that a) high-risk ratings are false positives, and b) final risk ratings are precautionary. One reason for this is that the PSA is designed to assess risk across a range of species groups with varying life-history traits (*e.g.* teleosts, sharks, batoids, marine reptiles and mammals). As a consequence, biological nuances found within a particular subgroup may be understated. While difficult to predict without an accurate account of the gear-affected area, it is hypothesised that milk, hardnose and Australian sharpnose shark would all register lower risk ratings if they were are assessed under the SAFE method (Zhou *et al.*, 2016). This inference is partly supported by the results of an analogous ERA undertaken in the GBRMP which classified the Australian sharpnose and milk shark as being at low risk from net fishing activities within this area (Tobin *et al.*, 2010).[17]

Historical catch data for the milk, sharpnose and hardnose shark is largely based on coarse-scale catch categories (Department of Agriculture and Fisheries, 2019f). They are still reported as a complex in the *Shark & Ray Logbook* and all three have limited species-specific data (Queensland Government, 2018a; Department of Agriculture and Fisheries, 2019f). The 2015 stock assessment

[17] The hardnose shark was not included in this assessment and the species does not have an analogous risk assessment for the Queensland east coast or part thereof.

demonstrated that harvest rates for milk/sharpnose sharks and the hardnose shark sit below MSY (Leigh, 2015). These results support the hypothesis that all three are being fished sustainably on the Queensland east coast. These results are consistent with external threatened species assessments that indicate the milk, sharpnose and hardnose shark have fewer conservation concerns (Baje & Simpfendorfer, 2019; Simpfendorfer, 2003; Simpfendorfer & Stevens, 2003).

Based on the above considerations, there is a high probability that the PSA overestimated the risk posed to all three species (Table 7). Risk levels for all three species will (likely) reduce with the introduction of an ECIF-specific harvest strategy and they will benefit from additional assessment using the SAFE method (Department of Agriculture and Fisheries, 2020d; Zhou *et al.*, 2016; Zhou & Griffiths, 2008). Under the draft strategy, the risk of catch increasing significantly for one or more of these species will be managed through harvest control rules. For fast-growing species with higher fecundities, these measures will assist in maintaining and (potentially) building regional stocks through time. This hypothesis though requires further investigation and may only be tested on completion of an updated stock assessment and the acquisition of species-specific MSY estimates.

Species-specific recommendations

1. *Improve catch composition data within the milk and Australian sharpnose shark complex and identify mechanisms to improve data on harvest rates for individual species.*

2. *Review MSY estimates for all three species and consider the value of additional information collected through the Shark & Ray Logbook and initiatives instigated under the Queensland Sustainable Fisheries Strategy 2017–2027 e.g. species-specific sustainability assessments.*

4.2.2.5 Other Whaler sharks

Common name	Sub-fishery	Risk rating
Spinner shark (*C. brevipinna*)	N1, N2 & N4 fishery symbols	**Precautionary High**
Blacktip reef shark (*C. melanopterus*)	N1 & N2 fishery symbols	**Precautionary High**

The remaining whaler shark species were assigned precautionary high-risk scores (Table 7). Catch data indicates that both species are retained in smaller quantities with the spinner (*C. brevipinna*) and blacktip reef shark (*C. melanopterus*) registering an average annual catch of approximately 27t and 10t respectively (Department of Agriculture and Fisheries, 2019f; 2020c).[18] The overall risk rating was heavily influenced by the *productivity* assessment which negated a large proportion of the risk mitigation measures already in place. If, for example, all of the *susceptibility* scores were reduced to their lowest potential (1), both would still be classified as medium risk. For reference, a quantitative ERA examining the risk posed by net fishing in the GBRMP classified the blacktip reef shark as high risk and the spinner shark as low risk (Tobin *et al.*, 2010).

Maximum Sustainable Yield estimates contained in a 2015 stock assessment indicate that the spinner shark is being fished sustainably on the Queensland east coast (Leigh, 2015). Harvest rates for this species were below the most conservative MSY estimate and have remained below this limit for the proceeding years (Department of Agriculture and Fisheries, 2020c; Leigh, 2015). While noting these

[18] *Based on 2009–2019 data (inclusive). In 2009 the ECIF underwent significant reforms which included the introduction of the shark (S) fishing symbol, a 600t TACC limit and a dedicated Shark & Ray Logbook.*

results, the stock assessment included a number of caveats and identified a need to collect improved data on shark catch compositions and discards. Similarly, the assessment did not include the blacktip reef shark, and further research is required on the key sustainability points for this species (Leigh, 2015). This introduced a degree of uncertainty into the blacktip reef shark risk assessment and contributed to the species receiving a more precautionary score for the *sustainability assessments* attribute (Table 7).

The quality of historic catch data varies for both species with the majority reported as *Shark—Unspecified*, *Whaler—Unspecified* or in a more generic blacktip shark catch category (Department of Agriculture and Fisheries, 2019f). Since the introduction of the *Shark & Ray Logbook*, catch data for both species has improved as they are now reported to species level (Department of Agriculture and Fisheries, 2020c; 2019f). Information on discards still remains an issue and further information is required on the total rates of fishing mortality (retained plus discards). These factors were taken into consideration as part of the Level 2 ERA and contributed to the production of more conservative risk scores.

While difficult to quantify, it is hypothesised that the risk posed to these species will be reduced and/or partially mitigated through initiatives instigated under the *Queensland Sustainable Fisheries Strategy 2017–2027*. Under the draft ECIF harvest strategy, both species will be included in the *Tier 2* complex and be subject to more detailed harvest control rules. As harvest rates for these species are lower than the blacktip shark complex (*C. tilstoni*, *C. limbatus*), the immediate benefits to these species may be smaller. In the longer term, a harvest strategy will minimise the risk of catch increasing substantially for these two species, requiring more detailed monitoring and improved assessments of stock health. In subsequent ERAs, these measures are likely to result in lowering of the risk scores for the *management strategy* and *sustainability assessments* attributes (Table 7). Monitoring information will also inform assessments relating to their *encounterability* in the Large Mesh Net Fishery. The ultimate aim being to develop datasets to a point where these species can be assessed using a more quantitative ERA method.

Species-specific recommendations

1. *Identify mechanisms to improve data on harvest rates, fine-scale effort movements, and discards for the spinner shark and the blacktip reef shark.*

2. *Explore the suitability of the inclusion of the blacktip reef shark in future stock assessments and long-term monitoring programs to improve the spread of data outside of the Fishery Observer Program.*

5 Summary

The Level 2 ERA provides additional depth to the risk profiles of these species and further differentiates between potential and actual risks (Department of Agriculture and Fisheries, 2018b). Outputs from the Level 2 ERA will help to inform initiatives instigated under the *Queensland Sustainable Fisheries Strategy 2017–2027* (Department of Agriculture and Fisheries, 2017) and the ECIF-specific harvest strategy (Department of Agriculture and Fisheries, 2020d). It will also strengthen linkages between the ERA process and the remaining areas of reform (Department of Agriculture and Fisheries, 2017).

Precautionary elements included in the methodology combined with data deficiencies contributed to the development of more conservative risk profiles for some species. Final risk ratings for a proportion of the teleost and shark species were considered precautionary and are unlikely to result in significant species-specific reforms. There were however a number of species where the risk requires further attention and the management of the risk is viewed as a higher priority. This will need to occur at both a whole-of-fishery and species-specific level.

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7 Appendices

Appendix A – *Species Rationalisation Process Overview.*

Appendix B – *Species Rationalisation Process: Key Justifications & Considerations.*

Appendix C – *Overlap percentages used in the Productivity and Susceptibility Analysis (PSA).*

Appendix D – *Residual Risk Analysis.*

Appendix E – *Supplementary Risk Assessment: Likelihood & Consequence Analysis.*

Appendix A—Species Rationalisation Process Overview

1. Overview

Catch data submitted through the commercial logbook system was used to construct a preliminary list of target & byproduct species that were considered for inclusion in the Level 2 ERA. Logbook data was considered over a three year period (2017–2019 inclusive) with the final species list refined using the following steps.

1. Data for each catch category (*i.e.* species or species groupings) was summed across the relevant period (2017–2019 inclusive) and ranked in order from highest to lowest.

2. Cumulative catch analysis was used to identify the categories that made up 95% of the total catch reported from the fishery over this period.

3. Species that fell below the 95% catch threshold were reviewed and, if no anomalies were detected, omitted from the initial list of target & byproduct species. Retention rates for most of these species are low and they are generally viewed as secondary and byproduct species. When and where appropriate, these secondary species will be considered for inclusion in subsequent ERAs.

4. Species above the 95% catch threshold (*i.e.* those that were not omitted from the analysis) were then reviewed and the following steps undertaken:

   a. Where possible, multi-species catch categories were expanded using the relevant CAAB codes (*e.g.* blacktip shark CAAB code 37 018903 includes *Carcharhinus limbatus* and *C. tilstoni*). All additions took into consideration the operating area of the fishery and the potential for the species to interact with the fishery. In some instances, this required the re-inclusion of species that fell below the initial 95% cut-off.

   b. Duplications resulting from expansion of multi-species catch categories were then removed.

   c. Catch categories that could not be refined to the species level such as '*Unspecified fish'* were excluded from the analysis.

   d. Species managed under TACC limits that are directly linked to biomass estimates or managed under harvest strategies were removed. The premise being that the risk posed to this species is already being managed/addressed through controls. As a precautionary measure, any species whose TACC was not based on a stock assessment or had a stock assessment >5 years old was retained in the assessment.

5. A summary of the species rationalisation process was then completed and justifications provided for why each target or byproduct species was included or omitted from the analysis.

The following provides a summary of the species that were considered for inclusion in the Level 2 ERA. All species with green squares and a 'Y' were included in the ECIF Level 2 ERA. Red squares with an 'N' are those that were considered for inclusion but omitted from the analysis. This list is not exhaustive and, when and where appropriate, additional species will be considered for inclusion in subsequent assessments.

Table A1*—Summary of the species that were considered for inclusion in the ECIF Large Mesh Net Fishery Target & Byproduct Species Level 2 ERA.*

Common name / Catch category	Scientific name	CAAB	Included
Mullet			
Sea mullet	*Mugil cephalus*	*(37 381002)*	**Y**
Fantail (silver) mullet	*Paramugil georgii*	(37 381009)	**Y**
Goldspot (tiger / flat tail) mullet	*Liza argentea*	*(37 381004)*	**N**
Diamondscale mullet	*Liza vaigiensis*	*(37 381008)*	**Y**
Pinkeye mullet	*Trachystoma petardi*	*(37 381011)*	**N**
Bluespot mullet / Sand mullet	*Valamugil seheli*	*(37 381017)*	**Y**
Flathead			
Dusky flathead	*Platycephalus fuscus*	*(37 296004)*	**Y**
Bartail flathead	*Platycephalus australis*	*(37 296033)*	**Y**
Northern sand flathead	*Platycephalus endrachtensis*	*(37 296021)*	**Y**
Yellowtail flathead	*Platycephalus westraliae*	*(37 296020)*	**Y**
Whiting			
Sand (summer) whiting	*Sillago ciliata*	*(37 330010)*	**Y**
Trumpeter (winter) whiting	*Sillago maculata*	*(37 330015)*	**Y**
Northern whiting	*Sillago sihama*	*(37 330006)*	**N**
Goldenline whiting	*Sillago analis*	*(37 330003)*	**N**
Bream			
Yellowfin bream	*Acanthopagrus australis*	*(37 353004)*	**Y**
Tarwhine	*Rhabdosargus sarba*	*(37 35013)*	**Y**
Luderick	*Girella tricuspidata*	*(37 361007)*	**N**
Bony bream	*Nematalosa erebi*	*(37 085019)*	**N**
Pikey bream	*Acanthopagrus pacificus*	*(37 353011)*	**N**
Diamondfish / Butter bream	*Monodactylus argenteus*	*(37 356002)*	**N**
Garfish			
Snubnose garfish	*Arrhamphus sclerolepis*	*(37 234006)*	**Y**
Three-by-two garfish	*Hemiramphus robustus*	*(37 234013)*	**Y**
Trevally			
Golden trevally	*Gnathanodon speciosus*	*(37 337012)*	**Y**
Giant trevally	*Caranx ignobilis*	*(37 337027)*	**Y**
Bigeye trevally	*Caranx sexfasciatus*	*(37 337039)*	**Y**
Turrum (gold spot)	*Carangoides fulvoguttatus*	*(37 337037)*	**Y**
Thicklip trevally	*Carangoides orthogrammus*	*(37 337057)*	**N**
Bludger trevally	*Carangoides gymnostethus*	*(37 337022)*	**N**
Blue spot trevally	*Caranx bucculentus*	*(37 337016)*	**N**

Common name / Catch category	Scientific name	CAAB	Included
Diamond trevally	*Alectis indica*	*(37 337038)*	**N**
Silver trevally	*Pseudocaranx georgianus*	*(37 337062)*	**N**
Grunter / Javelin			
Barred javelin	*Pomadasys kaakan*	*(37 350011)*	**Y**
Silver javelin	*Pomadasys argenteus*	*(37 350009)*	**Y**
Blotched javelin	*Pomadasys maculatus*	*(37 350002)*	**N**
Bluecheek javelin	*Pomadasys argyreus*	*(37 350026)*	**N**
Black-ear javelin	*Pomadasys trifasciatus*	*(37 350008)*	**N**
Queenfish			
Giant queenfish	*Scomberoides commersonnianus*	*(37 337032)*	**Y**
Lesser queenfish	*Scomberoides lysan*	*(37 337046)*	**N**
Needleskin queenfish	*Scomberoides tol*	*(37 337044)*	**N**
Barred queenfish	*Scomberoides tala*	*(37 337045)*	**N**
Threadfin			
Blue threadfin	*Eleutheronema tetradactylum*	*(37 383004)*	**Y**
King threadfin	*Polydactylus macrochir*	(37 383005)	**Y**
Flat threadfin / Aust. threadfin	*Polydactylus multiradiatus*	*(37 383002)*	**N**
Striped threadfin	*Polydactylus plebeius*	*(37 383009)*	**N**
Jewfish			
Black jewfish	*Protonibea diacanthus*	*(37 354003)*	**Y**
Mulloway	*Argyrosomus japonicas*	(37 354001)	**Y**
Silver jewfish	*Nibea soldado*	*(37 354019)*	**Y**
Scaly jewfish	*Nibea squamosa*	*(37 354024)*	**N**
Mackerel			
Grey mackerel	*Scomberomorus semifasciatus*	*(37 441018)*	**Y**
Spotted mackerel	*Scomberomorus munroi*	*(37 441015)*	**Y**
School mackerel	*Scomberomorus queenslandicus*	*(37 441014)*	**Y**
Frigate mackerel	*Auxis thazard*	*(37 441009)*	**N**
Shark mackerel	*Grammatorcynus bicarinatus*	*(37 441025)*	**N**
Scad			
Yellowtail scad	*Trachurus novaezelandiae*	*(37 337003)*	**Y**
Common jack mackerel	*Trachurus declivis*	*(37 337002)*	**N**
Other teleosts			
Barramundi	*Lates calcarifer*	*(37 310006)*	**Y**
Golden snapper	*Lutjanus johnii*	(37 346030)	**Y**
Tailor	*Pomatomus saltatrix*	*(37 334002)*	**N**
Scribbled rabbitfish (spinefoot)	*Siganus spinus*	*(37 438013)*	**Y**

Common name / Catch category	Scientific name	CAAB	Included
Dorab wolf herring	*Chirocentrus dorab*	*(37 087001)*	**N**
Snubnose dart	*Trachinotus blochii*	*(37 337075)*	**Y**
Swallowtail dart	*Trachinotus coppingeri*	*(37 337076)*	**Y**
Sharks			
Graceful shark	*Carcharhinus amblyrhynchoides*	*(37 018033)*	**Y**
Common blacktip shark	*Carcharhinus limbatus*	*(37 018039)*	**Y**
Australian blacktip shark	*Carcharhinus tilstoni*	(37 018014)	**Y**
Pigeye shark	*Carcharhinus amboinensis*	*(37 018026)*	**Y**
Bull shark	*Carcharhinus leucas*	*(37 018021)*	**Y**
Spinner shark	*Carcharhinus brevipinna*	*(37 018023)*	**Y**
Creek whaler	*Carcharhinus fitzroyensis*	*(37 018035)*	**N**
Blacktip reef shark	*Carcharhinus melanopterus*	*(37 018036)*	**Y**
Spot-tail shark	*Carcharhinus sorrah*	(37 018013)	**Y**
Hardnose shark	*Carcharhinus macloti*	*(37 018025)*	**Y**
Milk shark	*Rhizoprionodon acutus*	*(37 018006)*	**Y**
Australian sharpnose shark	*Rhizoprionodon taylori*	*(37 018024)*	**Y**
Scalloped hammerhead	*Sphyrna lewini*	*(37 019001)*	**Y**
Great hammerhead	*Sphyrna mokarran*	*(37 019002)*	**Y**
Winghead shark	*Eusphyra blochii*	*(37 019003)*	**Y**
Smooth hammerhead	*Sphyrna zygaena*	*(37 019004)*	**Y**
Tiger shark	*Galeocerdo cuvier*	*(37 018022)*	**N**
Batoids			
Bottlenose wedgefish	*Rynchobatus australiae*	*(37 026005)*	**N**
Eyebrow wedgefish	*Rynchobatus palpebratus*	*(37 026004)*	**N**
Giant shovelnose ray	*Glaucostegus typus*	*(37 027010)*	**N**

Appendix B—Species Rationalisation Process: Key Justifications and Considerations

The following provides a detailed overview of the key justifications and considerations used to omit or include a species in the *Large Mesh Net Target & Byproduct Species Level 2 ERA*. All species with green squares and a ‘Y’ were included in the ECIF Level 2 ERA. Red squares with an ‘N’ are those that have been omitted from the analysis.

Common Name	Scientific name (CAAB)	Include	Notes, Comments & Catch Data
Teleosts			
Bream			
Yellowfin bream	*Acanthopagrus australis* (37 353004)	Y	***<u>Notes</u>***—The bream complex shares similarities with whiting in that multiple species were considered for inclusion in the level 2 ERA. This includes the two key species yellowfin bream (*A. australis*) and tarwhine (*R. sarba*) along with secondary species like luderick (*G. tricuspidata*), bony bream (*N. erebi*), pikey bream (*A. pacificus*) and diamondfish or butter bream (*M. argenteus*). While most bream have small species-specific harvests, a considerable portion of the bream catch is reported as *Bream—unspecified*. As with whiting, the catch is expected to be dominated by a single species (yellowfin bream) with the remaining species making smaller contributions (Leigh *et al.*, 2019). One of these species is likely to be tarwhine, a morphologically similar species that is often caught in conjunction with *A. australis* (*pers. comm*. T. Ham). Both the yellowfin bream and tarwhine were viewed as primary targets within the bream complex and were included in the Level 2 assessment. Species specific data for the remaining species is more limited. Luderick catches peaked in 2006 and 2007 at 26 and 33t respectively, although most years report catches of between 6 and 12t. When compared to the other bream species, luderick are more easily identifiable and they are less likely to be included in the *Bream—unspecified* catch category. This partly explains why the annual catch values for this species are higher than yellowfin bream and tarwhine. When caught in commercial gillnet or ring net operations it will be retained for sale as byproduct. It will however have higher
Tarwhine	*Rhabdosargus sarba* (37 353013)	Y	
Luderick	*Girella tricuspidata* (37 361007)	N	
Bony bream	*Nematalosa erebi* (37 085019)	N	

Common Name	Scientific name (CAAB)	Include	Notes, Comments & Catch Data
Pikey bream	*Acanthopagrus pacificus* (37 353011)	**N**	rates of fishing mortality in New South Wales, Victoria and Tasmania where it is targeted with more regularity (Bray, 2017a; Conron *et al.*, 2018).Given these factors and the prevalence of yellowfin bream and tarwhine, luderick was excluded from this analysis. Further consideration will be given to including luderick in subsequent ERAs involving the Large Mesh Net Fishery. Bony bream is a widespread species that can tolerate a wide range of water temperatures and pH levels (Australian Museum, 2019a; Gomon, 2019). The species is frequently encountered in freshwater but also inhabits riverine, estuarine, and marine environments. The species will be retained as byproduct with catch data suggesting the majority are taken waters between Fraser Island and the Queensland / New South Wales border. While the species will be retained for sale in the Large Mesh Net Fishery, it was viewed as secondary species and was omitted from the Level 2 ERA. While species-specific catch data is not available for pikey bream, it will be retained in the fishery and be reported as part of the *Bream—unspecified* catch category (Department of Agriculture and Fisheries, 2020c; 2019f). Distribution data indicate that pikey bream are more prominent in northern Australia and the Great Barrier Reef (Bray, 2018a). While not uniform, a high proportion of the bream catch on the Queensland east coast occurs south of the known distribution for this species (Qfish: http://qfish.fisheries.qld.gov.au/query/062b20c0-55be-4b2b-8781-c9ddadc9f294/map). Expectations are that a high percentage of the reported catch in this area is misidentified as yellowfin bream (*A. australis*) (McGilvray *et al.*, 2018b; Leigh *et al.*, 2019). In the absence of additional data on catch compositions, pikey bream was considered to be a secondary target species and omitted from this initial Level 2 ERA. The situation surrounding diamondfish/butterbream (*M. argenteus*) will be similar to that observed for bony bream and pikey bream. The species will be retained in smaller quantities but are generally viewed as a low-value species. This species is not considered to be a primary target in the Large Mesh Net Fishery (*pers. comm.* T. Ham) and was omitted from the initial target and byproduct species Level 2 ERA. The inclusion of the species in subsequent ERAs will be dependent on the level of information that is available on bream catch compositions.
Diamondfish / Butter bream	*Monodactylus argenteus* (37 356002)	**N**	

Common Name	Scientific name (CAAB)	Include	Notes, Comments & Catch Data
			Commercial Catch Data Summary *Gillnet / ring net fishing (only)* - Catch reported as *Bream—unspecified (CAAB 37 53000): historical average (20 years)* = 50t (*range* = 21.6–87.7t). Catch 2017–2019 (inclusive) = 91.7t total at an average of 30.6t. - Catch reported as *Bream—yellowfinned (CAAB 37 353004)*: *historical average (20 years)* = 1.9t (*range* = 0–7.2t). Catch 2017–2019 (inclusive) = 0.8t total. - Catch reported as *Bream—tarwhine (CAAB 37 353013)*: *historical average (20 years)* = 0.5t (*range* = 0–1.7t). Catch 2017–2019 (inclusive) = 2.2t total. - Catch reported as *Bream—black (luderick) (CAAB 37 361007)*: *historical average (20 years)* = 11t (*range* = 3–23.2t). Catch 2017–2019 (inclusive) = 10.6t total at an average of 3.5t. - Catch reported as *Bream—bony (herring) (CAAB 37 085019)*: *historical average (20 years)* = 10.6t (*range* = 1.7–32.9t). Catch 2017–2019 (inclusive) = 23.7t total at an average of 7.9t. - Catch reported as *Pikey bream (CAAB 37 353011)*: no species-specific catch reported. - Catch reported as *Bream—butter (CAAB 37 356002)*: *historical average (20 years)* = 0.9t (*range* = 0.2–3.5t). Catch 2017–2019 (inclusive) = 8.3t total at an average of 2.8t. *Net fishing (all)* - Catch reported as *Bream—unspecified (CAAB 37 53000): historical average (20 years)* = 151.9t (*range* = 52–248.6t). Catch 2017–2019 (inclusive) = 213.6t total at an average of 71.2t. - Catch reported as *Bream—yellowfinned (CAAB 37 353004)*: *historical average (20 years)* = 3.2t (*range* = 0.2–17.5t). Catch 2017–2019 (inclusive) = 1.4t total.

Common Name	Scientific name (CAAB)	Include	Notes, Comments & Catch Data
			- Catch reported as *Bream—tarwhine (CAAB 37 353013)*: *historical average (20 years)* = 3.8t (*range* = 0.5–6.8t). Catch 2017–2019 (inclusive) = 13.6t total. - Catch reported as *Bream—black (luderick) (CAAB 37 361007)*: *historical average (20 years)* = 12.7t (*range* = 3.6–25.1t). Catch 2017–2019 (inclusive) = 13t total at an average of 4.3t. - Catch reported as *Bream—bony (herring) (CAAB 37 085019)*: *historical average (20 years)* = 10.8t (*range* = 1.7–33t). Catch 2017–2019 (inclusive) = 23.7t total at an average of 7.9t. - Catch reported as *Pikey bream (CAAB 37 353011)*: no species-specific catch reported. - *Catch reported as Bream—butter (CAAB 37 356002)*: *historical average (20 years)* = 2.7t (*range* = 0.6–9.3t). Catch 2017–2019 (inclusive) = 20.1t total at an average of 6.7t. *Line fishing (all)* - Catch reported as *Bream—yellowfinned (CAAB 37 353004)*: *historical average (20 years)* = 0.1t (*range* = 0–0.5t). Catch 2017–2019 (inclusive) = 0.3t total. - Catch reported as *Bream—tarwhine (CAAB 37 353013)*: *historical average (20 years)* = <0.1t (*range* = 0–01t). Catch 2017–2019 (inclusive) = 0t total. - Catch reported as *Bream—unspecified (CAAB 37 53000): historical average (20 years)* = 1.6t (*range* = 0.6–8.7t). Catch 2017–2019 (inclusive) = 3.3t total. - Catch reported as *Bream—black (luderick) (CAAB 37 361007)*: *historical average (20 years)* = <0.1t (*range* = 0–0.6t). Catch 2017–2019 (inclusive) = <0.1t total. - Catch reported as *Bream—bony (herring) (CAAB 37 085019)*: *historical average (20 years)* = <0.1t (*range* = 0–0.1t). Catch 2017–2019 (inclusive) = 0t total. - Catch reported as *Pikey bream (CAAB 37 353011)*: no species-specific catch reported.

<table>
<tr><th>Common Name</th><th>Scientific name (CAAB)</th><th>Include</th><th>Notes, Comments & Catch Data</th></tr>
<tr><td></td><td></td><td></td><td>- Catch reported as Bream—butter (CAAB 37 356002): historical average (20 years) = <0.1t (range = 0–<0.1t). Catch 2017–2019 (inclusive) = 0t total.</td></tr>
<tr><td colspan="4">Flathead</td></tr>
<tr><td>Dusky flathead</td><td>Platycephalus fuscus
(37 296004)</td><td>Y</td><td rowspan="4"> <u>Notes</u>—The flathead complex consists of four morphologically similar species: the bartail flathead (P. australis), northern sand flathead (P. endrachtensis), the dusky flathead (P. fuscus) and yellowtail flathead (P. westraliae). The distribution and depth profiles of all four species overlaps with the ECIF effort footprint (Fishes of Australia, 2019a) and they are all likely to be caught in large mesh nets. However, it is anticipated that the majority of this catch (commercial and recreational) will consist of dusky flathead (P. fuscus) (Leigh et al., 2019; McGilvray et al., 2018a). While P. fuscus is considered to be the primary species, catch data for this complex has poor species resolution. All of the reported catch from the commercial net and line fishery is classified as Flathead—unspecified and the key information sources provide little information on species compositions (Leigh et al., 2019; McGilvray et al., 2018a; Department of Agriculture and Fisheries, 2018e). From an ERA perspective, these deficiencies create a level of uncertainty in terms of individual rates of fishing mortality. Due to the above uncertainty, all four species were included in the Level 2 ERA. As dusky flathead is the dominant species, the decision to include the bartail, northern sand and yellowtail flathead is viewed as precautionary. <u>Commercial Catch Data Summary</u> Gillnet / ring net fishing (only)—All species - Catch reported as Flathead—unspecified (CAAB 37 296000): historical average (20 years) = 44.2t (range = 20.3–74.9t). Catch 2017–2019 (inclusive) = 86t total at an average of 28.7t. - Species-specific catch data not available for this complex in the net fishery. Net fishing (all)—All species </td></tr>
<tr><td>Bartail flathead</td><td>Platycephalus australis
(37 296033)</td><td>Y</td></tr>
<tr><td>Northern sand flathead</td><td>Platycephalus endrachtensis
(37 296021)</td><td>Y</td></tr>
<tr><td>Yellowtail flathead</td><td>Platycephalus westraliae
(37 296020)</td><td>Y</td></tr>
</table>

Common Name	Scientific name (CAAB)	Include	Notes, Comments & Catch Data
			- *Catch reported as Flathead—unspecified (CAAB 37 296000): historical average (20 years)* = 59.2t (*range* = 23.6–98.1t). Catch 2017–2019 (inclusive) = 105.5t total at an average of 35.2t. - Species-specific catch data not available for this complex in the net fishery. *Line fishing (all)—All species* - *Catch reported as Flathead—unspecified (CAAB 37 296000): historical average (20 years)* = 0.3t (*range* = 0–1.5t). Catch 2017–2019 (inclusive) = 0.5t. - Species-specific catch data not available for this complex in the commercial line fishery.
Garfish			
Snubnose garfish	*Arrhamphus sclerolepis* (37 234006)	**Y**	***Notes***—The average annual catch of garfish in the gillnet and ring net fisheries frequently exceeds 100t. There is limited information on the composition of the garfish catch, and snubnose (*A. sclerolepis*) is the only garfish with species-specific data (Department of Agriculture and Fisheries, 2019f; 2020c). The complex though is likely to include a number of species from the *Family Hemiramphidae*. As there is limited information on the number of species that are retained for sale in the ECIF, two of the more prominent species were included in the Level 2 ERA: the snubnose garfish and the three-by-two garfish (*H. robustus*). When and where appropriate, other garfish species will be considered for inclusion in subsequent ERAs involving the Large Mesh Net Fishery. ***Commercial Catch Data Summary*** *Gillnet / ring net fishing (only)* - Catch reported as *Garfish—unspecified (CAAB 37 234000): historical average (20 years)* = 117.1t (*range* = 71.2–201.6t). Catch 2017–2019 (inclusive) = 245.1t total at an average of 81.7t.
Three-by-two garfish	*Hemiramphus robustus* (37 234013)	**Y**	

Common Name	Scientific name (CAAB)	Include	Notes, Comments & Catch Data
			- Catch reported as *Garfish—snubnose (CAAB 37 234006)*: *historical average (20 years)* = 0.6t (*range* = 0–1.3t). Catch 2017–2019 (inclusive) = 0t total. - Catch reported as *Three-by-two garfish*: no species-specific catch reported. *Net fishing (all)* - Catch reported as *Garfish—unspecified (CAAB 37 234000): historical average (20 years)* = 151.3t (*range* = 93.6–260.7t). Catch 2017–2019 (inclusive) = 299t total at an average of 99.7t. - Catch reported as *Garfish—snubnose (CAAB 37 234006)*: *historical average (20 years)* = 0.5t (*range* = 0–1.3t). Catch 2017–2019 (inclusive) = 0t. - Catch reported as *Three-by-two garfish*: no species-specific catch reported. *Line fishing (all)* - Catch reported as *Garfish—unspecified (CAAB 37 234000): historical average (20 years)* = 1.5t (*range* = 0.1–7.3t). Catch 2017–2019 (inclusive) = 0.7t total. - Catch reported as *Snubnose garfish*: no species-specific catch reported. - Catch reported as *Three-by-two garfish*: no species-specific catch reported.
Grunter / Javelin			
Barred javelin	*Pomadasys kaakan* (37 350011)	**Y**	***Notes***—The grunter or javelin complex incorporates five species: the barred javelin (*P. kaakan*), the silver javelin (*P. argenteus*), bluecheek javelin (*P. argyreus*), the botched javelin (*P. maculatus*) and the black-ear Javelin (*P. trifasciatus*). All of the catch for this complex is reported under a generic identifier (*Grunter—unspecified*) and it is difficult to ascertain

Common Name	Scientific name (CAAB)	Include	Notes, Comments & Catch Data
Silver javelin	*Pomadasys argenteus* (37 350009)	**Y**	individual catch contributions. However, anecdotal evidence suggests that the barred (*P. kaakan*) and silver javelin (*P. argenteus*) make up a high proportion of this catch (Department of Agriculture Fisheries and Forestry, 2012). Of the remaining species, comparisons between the distribution of effort and the known range for black-ear javelin, blotched javelin and the bluecheek javelin (Fishes of Australia, 2019d; c; Department of Agriculture and Fisheries, 2019f) suggest that these three species will interact less frequently with the ECIF. If and when this situation changes, these species will be considered for inclusion in subsequent Level 2 ERAs involving the Large Mesh Net Fishery. ***<u>Commercial Catch Data Summary</u>*** *Gillnet / ring net fishing (only)—All species* - *Catch reported as Grunter—unspecified (CAAB 37 350902)*: *historical average (20 years)* = 23.6t (*range* = 5.3–35.2t). Catch 2017–2019 (inclusive) = 43.6t total at an average of 14.5t. - *Total catch*: no species-specific data reported for javelin / grunter species. *Net fishing (all)—All species* - *Catch reported as Grunter—unspecified (CAAB 37 350902)*: *historical average (20 years)* 23.6t (*range* = 5.3–35.1t). Catch 2017–2019 (inclusive) = 71.8t total at an average of 18t. - *Total catch*: no species-specific data reported for javelin / grunter species. *Line fishing (all)—All species* - *Catch reported as Grunter—unspecified (CAAB 37 350902)*: *historical average (20 years)* 2.1t (*range* = 0.4–7.9t). Catch 2017–2019 (inclusive) = 8.6t at an average of 2.9t. - *Total catch*: no species-specific data reported for javelin / grunter species.
Blotched javelin	*Pomadasys maculatus* (37 350002)	**N**	
Bluecheek javelin	*Pomadasys argyreus* (37 350026)	**N**	
Black-ear javelin	*Pomadasys trifasciatus* (37 350008)	**N**	

Common Name	Scientific name (CAAB)	Include	Notes, Comments & Catch Data
Jewfish			
Black jewfish	*Protonibea diacanthus* (37 354003)	**Y**	***Notes***—When compared to other ECIF species, black jewfish (*P. diacanthus*) has a history of comparatively small catches. Annual catch for this species though has increased across both the net and line fishing sectors. This increase is in direct response to market demand for black-jewfish swim bladders which have increased in price exponentially. High marketability and demand was the primary driver behind the introduction of new management arrangements on 26 April 2019 (Department of Agriculture and Fisheries, 2019e). Given this demand, cumulative fishing pressures and the ongoing market appeal of the species, *P. diacanthus* was classified as a primary target species and included in the initial Level 2 ERA. Catch and demand are less for mulloway (*A. japonicas*), silver jewfish (*N. soldado*) and scaly jewfish (*N. squamosa*). However, there is some potential for the marketability of all three species to increase if (*e.g.*) the demand for swim bladders were to extend to similar species. Small quantities of mulloway have been reported by gillnet and ring net operators and annual catches (combined) are below 1t (Department of Agriculture and Fisheries, 2020c; 2019f). The historical mulloway catch has been higher with the pre-2000 period registering catches of up to 35t per year (1990). While noting these peaks, the size of the ECIF (since 2000) has reduced in terms of the number of licences, participation rates and total effort (Department of Agriculture and Fisheries, 2019f). These factors combined with management reforms (higher minimum legal size limits, reduced maximum allowable mesh size) suggest that the mulloway catch will not reach or exceed historic levels over the short to medium term. To date it is difficult to tell if market demand has increased for mulloway—as seen for black jewfish (*P. diacanthus*). Catch data for mulloway shows that only 7.3t were retained by net operators on the Queensland east coast in 2018 and 1.8t in 2019 (incomplete). Catch data for silver jewfish displays some within year fluctuations and varies between 1t and 12t (1990–2019 data) (Department of Agriculture and Fisheries, 2020c; 2019f). Unlike mulloway, the reported catch of *N. soldado* does not display a significant temporal decline and/or period of elevated catch. This species though will contribute to the *Jewfish—unspecified* catch category.
Mulloway	*Argyrosomus japonicas* (37 354001)	**Y**	
Silver jewfish	*Nibea soldado* (37 354019)	**Y**	
Scaly jewfish	*Nibea squamosa* (37 354024)	**N**	

Common Name	Scientific name (CAAB)	Include	Notes, Comments & Catch Data
			Given the interest in black jewfish (*P. diacanthus*) and the potential for this to extend to other jewfish species, mulloway and silver jewfish were included in the initial phase of the target and byproduct species Level 2 ERA. This decision is considered to be precautionary in nature. A fourth species, scaly jewfish, was considered for inclusion in the assessment as it formed part of the *Jew fish—unspecified* complex (CAAB 37 337000). The distribution of the scaly jewfish though is largely based in northern Australia (Atlas of Living Australia, https://www.ala.org.au/; Fishes of Australia, 2019b) and the species has not been reported from the ECIF. Accordingly, the species was excluded from the first iteration of the Large Mesh Net Target & Byproduct Species Level 2 ERA. ***<u>Commercial Catch Data Summary</u>*** *Gillnet / ring net fishing (only)* - Catch reported as *Jew fish—unspecified (CAAB 37 337000): historical average (20 years)* = 13.5t (*range* = 0–9.3t). Catch 2017–2019 (inclusive) = 12t total at an average of 4t. - Catch reported as *Jew fish—black (CAAB 37 354003): historical average (20 years)* = 3.8 (*range* = 0–22.6). Catch 2017–2019 (inclusive) = 41.4t total at an average of 13.8t. - Catch reported as *Jew fish—mulloway (CAAB 37 354001): historical average (20 years)* = 0.8t (*range* = 0–7t). Catch 2017–2019 (inclusive) = 10.3t total at an average of 3.4t. - *Catch reported as Jew fish—silver (CAAB 37 354019)*: *historical average (20 years)* = 3.3t (*range* = 0.1–10.1t). Catch 2017–2019 (inclusive) = 1.4t total at an average of 0.5t. *Net fishing (all)* - Catch reported as *Jew fish—unspecified (CAAB 37 337000): historical average (20 years)* = 14.1t (*range* = 0.1–30t). Catch 2017–2019 (inclusive) = 12.6t total at an average of 4.2t. - Catch reported as *Jew fish—black (CAAB 37 354003): historical average (20 years)* = 3.9t (*range* = 0–22.6t). Catch 2017–2019 (inclusive) = 43.1t total at an average of 14.4t.

Common Name	Scientific name (CAAB)	Include	Notes, Comments & Catch Data
			- Catch reported as *Jew fish—mulloway (CAAB 37 354001): historical average (20 years)* = 0.9t (*range* = 0.1–7.3t). Catch 2017–2019 (inclusive) = 10.6t total at an average of 3.6t. - *Catch reported as Jew fish—silver (CAAB 37 354019)*: *historical average (20 years)* = 3.4t (*range* = 0–10.1t). Catch 2017–2019 (inclusive) = 4.3t total at an average of 1.4t. *Line fishing (all)* - Catch reported as *Jew fish—unspecified (CAAB 37 337000): historical average (20 years)* = 4.1t (*range* = 0.1–12.9t). Catch 2017–2019 (inclusive) = 22.8t total at an average of 7.6t. - Catch reported as *Jew fish—black (CAAB 37 354003): historical average (20 years)* = 10.4t (*range* = 0–100.2t). Catch 2017–2019 (inclusive) = 168t total at an average of 56t. - Catch reported as *Jew fish—mulloway (CAAB 37 354001): historical average (20 years)* = 1.3t (0–4.21t). Catch 201 –2019 (inclusive) = 8.8t total. - *Catch reported as Jew fish—silver (CAAB 37 354019)*: *historical average (20 years)* = 2.5t (0–4.9t). Catch 2017–2019 (inclusive) = 6.6t total at an average of 2.2t.
Mackerel			
Grey mackerel	*Scomberomorus semifasciatus* (37 441018)	**Y**	***Notes***—The grey mackerel (*S. semifasciatus*) along with the spotted (*S. munroi*) and school mackerel (*S. queenslandicus*) make up the majority of the ECIF mackerel catch. Over 95% of this catch is reported from gillnet operations. Due to the prevalence of these species in the catch data, all three were included in the Level 2 ERA as primary targets. Two additional mackerel species were considered for inclusion in the Level 2 ERA: shark mackerel (*G. bicarinatus*) and frigate mackerel (*A. thazard*). These two species have comparatively small catches but were considered for inclusion in the assessment as they formed part of the *Mackerel—Unspecified* catch category (CAAB 37 441911).
Spotted mackerel	*Scomberomorus munroi* (37 441015)	**Y**	

<table>
<tr><th>Common Name</th><th>Scientific name (CAAB)</th><th>Include</th><th>Notes, Comments & Catch Data</th></tr>
<tr><td>School mackerel</td><td>Scomberomorus queenslandicus
(37 441014)</td><td>Y</td><td rowspan="3">The annual catch of shark mackerel has only exceeded 1t three times in the Large Mesh Net Fishery: 1999 (~2t), 2004 (~8t) and 2010 (1t) (Department of Agriculture and Fisheries, 2019f). Higher quantities of shark mackerel are reported from the line fishery, with annual catches in this sector ranging from 25 to 65t at an average of 38t (Department of Agriculture and Fisheries, 2020c; 2019f). One possible explanation for the prevalence of line caught shark mackerel in the data is that the species is retained as byproduct by fishers targeting Spanish mackerel in the East Coast Spanish Mackerel Fishery. While caught by operators targeting Spanish mackerel, this catch will be recorded against the ECIF. For this reason, shark mackerel was excluded from the first iteration of the Large Mesh Net Target & Byproduct Species Level 2 ERA. When and where appropriate, further consideration will be given to including this species in subsequent ERAs.

Less than 0.5t of frigate mackerel has been retained by gillnet and ring net fishers since 1990. The last reported catch of the species occurred in 2010 and the contribution it makes to the total ECIF catch is considered to be negligible. The frigate mackerel was not progressed to a Level 2 ERA.

<u>Commercial Catch Data Summary</u>

Gillnet / ring net fishing (only)

- Catch reported as Mackerel—unspecified (CAAB 37 441911): historical average (20 years) = 14.7t (range = 0–91t). Catch 2017–2019 (inclusive) = <0.1t total at an average of <0.1t.

- Catch reported as Mackerel—grey (CAAB 37 441018): historical average (20 years) = 197.1t (range = 43.2–384.3t). Catch 2017–2019 (inclusive) = 384t at an average of 128t.

- Catch reported as Mackerel—spotted (CAAB 37 441015): historical average (20 years) = 51.1t (range = 3.9–391t). Catch 2017–2019 (inclusive) = 15.9t total at an average of 5.3t.

- Catch reported as Mackerel—school (CAAB 37 441014): historical average (20 years) = 83.8t (range = 30–139.3t). Catch 2017–2019 (inclusive) = 184.7t total at an average of 61.6t.</td></tr>
<tr><td>Frigate mackerel</td><td>Auxis thazard
(37 441009)</td><td>N</td></tr>
<tr><td>Shark mackerel</td><td>Grammatorcynus bicarinatus
(37 441025)</td><td>N</td></tr>
</table>

Common Name	Scientific name (CAAB)	Include	Notes, Comments & Catch Data
			- Catch reported as *Mackerel—shark (CAAB 37 441025)*: *historical average (20 years)* = 1t (*range* = 0–8.1t). Catch 2017–2019 (inclusive) = 0.6t total. - Catch reported as *Frigate Mackerel* (*CAAB* 37 441009) = <1t since 1990. *Net fishing (all)* - Catch reported as *Mackerel—unspecified (CAAB 37 441911)*: *historical average (20 years)* = 13.4t (*range* = 0–91.5t). Catch 2017–2019 (inclusive) = <0.2 total at an average of 0.4t. - Catch reported as *Mackerel—grey (CAAB 37 441018)*: *historical average (20 years)* = 201.6t (*range* = 43.4–385.1t). Catch 2017–2019 (inclusive) = 388.57t at an average of 129.5t. - Catch reported as *Mackerel—spotted (CAAB 37 441015)*: *historical average (20 years)* = 51.4t (*range* = 4.1–390.8t). Catch 2017–2019 (inclusive) = 16t total at an average of 5.3t. - Catch reported as *Mackerel—school (CAAB 37 441014)*: *historical average (20 years)* = 86.2t (*range* = 30–140.6t). Catch 2017–2019 (inclusive) = 187.5t total at an average of 62.5t. - Catch reported as *Mackerel—shark (CAAB 37 441025)*: *historical average (20 years)* = 13.4t (*range* = 0–91.5t). Catch 2017–2019 (inclusive) = <0.2 total. *Line fishing (all)* - Catch reported as *Mackerel—unspecified (CAAB 37 441911)*: *historical average (20 years)* = 5.5t (*range* = 0–12.3t). Catch 2017–2019 (inclusive) = 6.8t total at an average of 2.3t. - Catch reported as *Mackerel—grey (CAAB 37 441018)*: *historical average (20 years)* = 5.7t (*range* = 2.3–10t). Catch 2017–2019 (inclusive) = 15.8t total at an average of 5.3t. - Catch reported as *Mackerel—spotted (CAAB 37 441015)*: *historical average (20 years)* = 5.7t (*range* = 2.3–10t). Catch 2017–2019 (inclusive) = 15.8t total at an average of 5.3t.

Common Name	Scientific name (CAAB)	Include	Notes, Comments & Catch Data
			- Catch reported as *Mackerel—school (CAAB 37 441014)*: *historical average (20 years)* = 20.5t (*range* = 6.4–45t). Catch 2017–2019 (inclusive) = 56.3t total at an average of 18.8t. - Catch reported as *Mackerel—shark (CAAB 37 441025)*: *historical average (20 years)* = 37.8t (*range* = 25.4–64.9t). Catch 2017–2019 (inclusive) = 86.8t total at an average of 28.9t. *Note—Line caught shark mackerel is likely retained by operators targeting Spanish mackerel. While technically caught in a different fishery, this component of the catch is reported against the ECIF.*
Mullet			
Sea mullet	*Mugil cephalus* (37 381002)	**Y**	***<u>Notes</u>***— Sea mullet is a key target in a number of the ECIF sub-fisheries including the Ocean Beach Fishery. The Ocean Beach Fishery targets near-shore schools of fish using beach seines and this sector is responsible for the majority of the Queensland east coast mullet catch. Catch data for gillnets and ring nets indicates that large mesh nets make a smaller contribution to the total mullet catch. It is however still considered a key target in the Large Mesh Net Fishery and it was included in the Level 2 ERA. While sea mullet will be the dominant species, a number of secondary species will be caught in conjunction with *M. cephalus* including the fantail (*P. georgii*) and diamondscale (*L. vaigiensis*) mullet. Anecdotal evidence suggests that these species will make smaller contributions to the total mullet catch. The true extent of this catch though will be masked by the prominence of the *Mullet—unspecified* catch category. *Mullet—unspecified* accounts for >600t of the mullet catch reported from the ECIF. Given this and the uncertainty surrounding individual rates of fishing mortality, the fantail mullet and diamondscale mullet were both included in the Level 2 ERA. While limited information is available on the distribution and habitat preferences of the bluespot / sand mullet (*V. seheli*), further consultation suggests that this species will be encountered in the ECIF. The species has a distribution that extends north from the QLD/NSW border; although catch data suggests that it is caught in smaller quantities. The inclusion of this species is viewed as precautionary but will aid in ruling out secondary mullet species from future
Fantail (silver) mullet	*Paramugil georgii* (37 381009)	**Y**	
Goldspot (tiger / flat tail) mullet	*Liza argentea* (37 381004)	**N**	
Diamondscale mullet	*Liza vaigiensis* (37 381008)	**Y**	
Pinkeye mullet	*Trachystoma petardi*	**N**	

Common Name	Scientific name (CAAB)	Include	Notes, Comments & Catch Data
	(37 381011)		assessments. The species is also referred to as *Moolgarda seheli* and, on occasions, referenced as a sand mullet which is a different species (*Myxus elongatus*). *Note—referred to as Mullet—sand (blue-tailed) in catch data* (Department of Agriculture and Fisheries, 2019f).
Bluespot mullet / Sand mullet	*Valamugil seheli* *(aka Moolgarda seheli)* (37 381017)	**Y**	Research indicates that the pinkeye mullet has a more southern distribution with data suggesting that it is more prominent in New South Wales. The species also has a preference for deeper freshwater coastal streams and estuarine environments (Australian Museum, 2019b; Threatened Species Scientific Committee, 2018). Given these factors, the pinkeye mullet was viewed as a secondary target species and excluded from this round of assessments. Further consideration will be given to the inclusion of this species in subsequent ERAs. Consideration has been given to the inclusion of goldspot mullet (*L. argentea*) in the Level 2 assessment. However the species was viewed as lower priority for assessment in the Large Mesh Net Fishery. Instead, the risk posed to this species will be assessed as part of the Ocean Beach Fishery Level 2 ERA. This sector accounts for the majority of the mullet catch on the Queensland east coast and is the key driver of risk for this complex (Jacobsen *et al.*, 2021b). ***<u>Commercial Catch Data Summary</u>*** *Gillnet / ring net fishing (only)* - *Catch reported as Mullet—unspecified (CAAB 37 381000): historical average (20 years)* = 771.6t (*range* = 310–1316.1t). Catch 2017–2019 (inclusive) = 1356t at an average of 452t. - *Sea mullet catch (Mullet—sea/flathead) (CAAB 37 381002): historical average (20 years)* = 12.3t (*range* = 0–45t). Catch 2017–2019 (inclusive) = 6.1t total. - *Catch reported as Mullet—fantail/silver (CAAB 37 381009): historical average (20 years)* = 3.5t (*range* = 0.4–11.1t). Catch 2017–2019 (inclusive) = 8.2t total. - *Catch reported as Mullet—tiger/flat tail (Goldspot) (CAAB 37 381004):* historical average 1.7t (*range* = 0–8.8t). Catch 2017–2019 (inclusive) = <0.3t total.

Common Name	Scientific name (CAAB)	Include	Notes, Comments & Catch Data
			- *Catch reported as Mullet—diamondscale (CAAB 37 381008):* historical average = 3.2t (*range* = 1.4–5.6t). Catch 2017–2019 (inclusive) = 8.8t total. - *Catch reported as Mullet—pinkeye (CAAB 37 381011): historical average (20 years)* = 2.5t (*range* = 0.1–11.8t). Catch 2017–2019 (inclusive) = 20.9t total. - *Catch reported as Mullet—sand (blue-tailed) (CAAB 37 381017)*: *historical average (20 years)* = 0.8t (*range* = 0.0–3.2t). Catch 2017–2019 (inclusive) = 0.2t total. *Net fishing (all)* - *Catch reported as Mullet—unspecified (CAAB 37 381000): historical average (20 years)* = 1774t (*range* = 739–2597t). Catch 2017–2019 (inclusive) = 3747t total at an average of 1249t. - *Sea mullet catch (Mullet—sea/flathead) (CAAB 37 381002): historical average (20 years)* = 42t (*range* = 2.2–124t). Catch 2017–2019 (inclusive) = 154.5t total at an average of 51.5t. - *Catch reported as Mullet—fantail/silver (CAAB 37 381009): historical average (20 years)* = 5.2t (*range* = 1.1–17.3t). Catch 2017–2019 (inclusive) = 10t total. - *Catch reported as Mullet—tiger/flat tail (Goldspot) (CAAB 37 381004):* historical average = 2.1t (*range* = 0–8.8t). Catch 2017–2019 (inclusive) = 5.1t total. - *Catch reported as Mullet—diamondscale (CAAB 37 381008):* historical average = 3.6t (*range* = 1.7–6.5t). Catch 2017–2019 (inclusive) = 9.7t total. - *Catch reported as Mullet—pinkeye (CAAB 37 381011): historical average (20 years)* = 0.5t (*range* = 0.1–11.9t). Catch 2017–2019 (inclusive) = 21t total. - *Catch reported as Mullet—sand (blue-tailed) (CAAB 37 381017)*: *historical average (20 years)* = 0.8t (*range* = 0–3.4t). Catch 2017–2019 (inclusive) = 0.2t total.

Common Name	Scientific name (CAAB)	Include	Notes, Comments & Catch Data
			Line fishing (all) - *Catch reported as Mullet—unspecified (CAAB 37 381000): historical average (20 years)* = 0.3t (*range* = 0–1.1t). Catch 2017–2019 (inclusive) = <0.1t. - *Sea mullet catch (Mullet—sea/flathead) (CAAB 37 381002): historical average (20 years)* = <0.2t. - *Catch reported as Mullet—fantail/silver (CAAB 37 381009):* historical average <0.2t. - *Catch reported as Mullet—tiger/flat tail (Goldspot) (CAAB 37 381004):* historical average <0.2t. - *Catch reported as Mullet—diamondscale (CAAB 37 381008):* historical average <0.2t. - *Catch reported as Mullet—pinkeye (CAAB 37 381011): historical average (20 years)* = <0.2t. - *Catch reported as Mullet—sand (blue-tailed) (CAAB 37 381017)*: *historical average (20 years)* = <0.2t.
Queenfish			
Giant queenfish	*Scomberoides commersonnianus* (37 337032)	Y	***Notes***—The ECIF queenfish catch will include a mixture of species from the *Scomberoides* genus. Preliminary consultation suggests that the majority of the catch will be giant queenfish (*S. commersonnianus*) with the lesser (*S. lysan*), needleskin (*S. tol*) and barred (*S. tala*) queenfish making smaller contributions (*pers. comm.* M. Keag; T. Ham). The distribution of giant queenfish extends along the Queensland east coast (Bray, 2018c; Smith-Vaniz & Williams, 2016a) and the species will have a comparatively high overlap with the effort footprint of the Large Mesh Net Fishery. Based on the preliminary consultation, the giant queenfish was included in the Level 2 ERA with the lesser queenfish and needleskin queenfish being considered for inclusion in subsequent ERAs. ***Commercial Catch Data Summary***
Lesser queenfish	*Scomberoides lysan* (37 337046)	N	

<table>
<tr><th>Common Name</th><th>Scientific name (CAAB)</th><th>Include</th><th>Notes, Comments & Catch Data</th></tr>
<tr><td>Needleskin queenfish</td><td>Scomberoides tol

(37 337044)</td><td>N</td><td rowspan="2">Gillnet / ring net fishing (only)—All species
- Catch reported as Queenfish—unspecified (CAAB 37 337905): historical average (20 years) = 96.7t (range = 46.92–152.2t). Catch 2017–2019 (inclusive) = 247.6t total at an average of 82.5t.
- Total Catch: no species-specific data reported for queenfish species.
Net fishing (all)—All species
- Catch reported as Queenfish—unspecified (CAAB 37 337905): historical average (20 years) = 103.9t (range = 48.2–161.7t). Catch 2017–2019 (inclusive) = 261t total at an average of 87t.
- Total catch: no species-specific data reported for queenfish species.
Line fishing (all)–All species
- Catch reported as Queenfish—unspecified (CAAB 37 337905): historical average (20 years) = 1.1t (range = 0.1–3.4t). Catch 2017–2019 (inclusive) = 1.3t.
- Total catch: no species-specific data reported for queenfish species.</td></tr>
<tr><td>Barred queenfish</td><td>Scomberoides tala

(37 337045)</td><td>N</td></tr>
<tr><td colspan="4">Scad</td></tr>
<tr><td>Yellowtail scad</td><td>Trachurus novaezelandiae

(37 337003)</td><td>Y</td><td rowspan="2"><u>Notes</u>—Scad make up a small but consistent component of the gillnet and ring net catch. In the Level 2 ERA two species were considered for inclusion: the yellowtail scad (T. novaezelandiae) and common jack mackerel (T. declivis).

Annual scad catch has increased in recent years due to increased market demand (pers. comm. T. Ham). While this catch has all been reported as Scad—Unspecified (Department of Agriculture and Fisheries, 2019f; 2020c), yellowtail scad will be a key species. The decision to include yellowtail scad in the Level 2 ERA was precautionary and the RRA will need to consider the key drivers of risk and the likelihood of the species receiving a false-positive result.</td></tr>
<tr><td>Common jack mackerel</td><td>Trachurus declivis

(37 337002)</td><td>N</td></tr>
</table>

Common Name	Scientific name (CAAB)	Include	Notes, Comments & Catch Data
			Species-specific catch data is not available for the common jack mackerel, but it was included as part of the *Scad—unspecified* CAAB code (CAAB 37 337907). The species is likely to make a small contribution to the total scad catch and was viewed as a secondary species. Common jack mackerel was omitted from the Level 2 ERA, but will be considered for inclusion in subsequent ERAs. ***<u>Commercial Catch Data Summary</u>*** *Gillnet / ring net fishing (only)* - Catch reported as *Scad—unspecified (CAAB 37 337907): historical average (20 years)* = 9.4t (*range* = 1–22.1t). Catch 2017–2019 (inclusive) = 4.3t total. - Catch reported as *Yellowtail scad (CAAB 37 337003)*: no species-specific catch reported. - Catch reported as *common jack mackerel (CAAB*: *377 337002)*: No species-specific catch reported. *Net fishing (all)* - Catch reported as *Scad—unspecified (CAAB 37 337907): historical average (20 years)* = 13.1t (*range* = 0–27.3). Catch 2017–2019 (inclusive) = 5t total at an average of 1.7t. - Catch reported as *Yellowtail scad (CAAB 37 337003)*: no species-specific catch reported. - Catch reported as *common jack mackerel (CAAB*: *377 337002)*: No species-specific catch reported. *Line fishing (all)* - Catch reported as *Scad—unspecified (CAAB 37 337907): historical average (20 years)* = 3.4t (*range* = 0.2–6.5t). Catch 2017–2019 (inclusive) = 6t total at an average of 2t. - Catch reported as *Yellowtail scad (CAAB 37 337003)*: no species-specific catch reported. - Catch reported as *common jack mackerel (CAAB*: *377 337002)*: No species-specific catch reported.

<table>
<tr><th>Common Name</th><th>Scientific name (CAAB)</th><th>Include</th><th>Notes, Comments & Catch Data</th></tr>
<tr><td colspan="4">Threadfins</td></tr>
<tr><td>Blue threadfin</td><td>Eleutheronema tetradactylum

(37 383004)</td><td>Y</td><td rowspan="4"><u>Notes</u>—Blue threadfin (E. tetradactylum) is a key target species for operators in the ECIF. While the majority of catch is retained by gillnet operations, between 5 and 26t has been reported from ring net operations each year since 2000 (Department of Agriculture and Fisheries, 2020c; 2019f). Due to this cross-apparatus appeal and the potential increases in marketability (e.g. due to swim bladders), blue threadfin was included in the Level 2 assessment as a primary target species.

King threadfin (P. macrochir), along with the blue threadfin (E. tetradactylum), make up the majority of the Queensland east coast threadfin catch. Catch data for the fishery indicates that the vast majority of the reported catch comes from anchored (36–126t) or drifting gillnets (10–80t). A smaller proportion (2–13t) is reported from ring net operations. King threadfin was included in the Level 2 ERA as a primary target species.

Small but consistent flat threadfin (P. multiradiatus) catches are reported from this sector of the ECIF. The catch series for this species extends to 2001 and averages around 2t per year. Only 2008 and 2009 registered annual catches above 4t, and catch levels over the last five years have fluctuated at or around 1t (Department of Agriculture and Fisheries, 2019f; 2020c). The assessment for striped threadfin (P. plebeius) is similar to flat threadfin (P. multiradiatus) in that the species registers very low catches (Department of Agriculture and Fisheries, 2019f; 2020c). Due to these comparatively low harvests, P. multiradiatus and P. plebeius were omitted from the assessment. These species will be considered for inclusion in subsequent ERAs involving the Large Mesh Net Fishery.

<u>Commercial Catch Data Summary</u>

Gillnet / ring net fishing (only)

- Catch reported as Threadfin—unspecified (CAAB 37 383000): historical average (20 years) = 1t (range = 0.2–2.8t). Catch 2017–2019 (inclusive) = 0.5t total.</td></tr>
<tr><td>King threadfin</td><td>Polydactylus macrochir

(37 383005)</td><td>Y</td></tr>
<tr><td>Flat threadfin

aka Australian threadfin</td><td>Polydactylus multiradiatus

(37 383002)</td><td>N</td></tr>
<tr><td>Striped threadfin</td><td>Polydactylus plebeius

(37 383009)</td><td>N</td></tr>
</table>

Common Name	Scientific name (CAAB)	Include	Notes, Comments & Catch Data
			- Catch reported as *Threadfin—blue (CAAB 37 383004)*: *historical average (20 years)* = 128.6t (*range* = 52.2–193.7t). Catch 2017–2019 (inclusive) = 169t total at an average of 56.4t. - Catch reported as *Threadfin—king (CAAB 37 383005)*: *historical average (20 years)* = 137t (*range* = 49–218.8t). Catch 2017–2019 (inclusive) = 219.8 total at an average of 73.3t. - Catch reported as *Threadfin—flat (CAAB 37 383002)*: *historical average (20 years)* = 2.1t (*range* = 0.3–5.5t). Catch 2017–2019 (inclusive) = 0.3t total. - Catch reported as *Threadfin—striped (CAAB 37 383009)*: *historical average (20 years)* = 0.1t (*range* = 0–0.5t). Catch 2017–2019 (inclusive) = 0.5t total. *Net fishing (all)* - Catch reported as *Threadfin—unspecified (CAAB 37 383000): historical average (20 years)* = 2.3t (*range* = 0.2–9.0t). Catch 2017–2019 (inclusive) = 0.6t total. - Catch reported as *Threadfin—blue (CAAB 37 383004)*: *historical average (20 years)* = 134.8t (*range* = 53.6–200.2t). Catch 2017–2019 (inclusive) = 174t total at an average of 57.9t. - Catch reported as *Threadfin—king (CAAB 37 383005)*: *historical average (20 years)* = 140.1t (*range* = 49.4–222.7t). Catch 2017–2019 (inclusive) = 222t total at an average of 74t. - Catch reported as *Threadfin—flat (CAAB 37 383002)*: *historical average (20 years)* = 2.5t (*range* = 0.3–6.2t). Catch 2017–2019 (inclusive) = 0.3t total. - Catch reported as *Threadfin—striped (CAAB 37 383009)*: *historical average (20 years)* = 0.1t (*range* = 0–0.5t). Catch 2017–2019 (inclusive) = 0.5t total. *Line fishing (all)*

Common Name	Scientific name (CAAB)	Include	Notes, Comments & Catch Data
			- Catch reported as *Threadfin—unspecified (CAAB 37 383000): historical average (20 years)* = 0.7t (*range* = 0–2.2t). Catch 2017–2019 (inclusive) = 1t. - Catch reported as *Threadfin—blue (CAAB 37 383004)*: *historical average (20 years)* = 0.2t (*range* = 0–0.8t). Catch 2017–2019 (inclusive) = 0.2t total. - Catch reported as *Threadfin—king (CAAB 37 383005)*: *historical average (20 years)* = <0.2t (*range* = 0–0.6t). Catch 2017–2019 (inclusive) = <0.2t total. - Catch reported as *Threadfin—flat (CAAB 37 383002)*: *historical average (20 years)* = <0.1t. - Catch reported as *Threadfin—striped (CAAB 37 383009)*: *historical average (20 years)* = <0.1t (*range* = 0–0.1t). Catch 2017–2019 (inclusive) = 0t total.
Trevally			
Golden trevally	*Gnathanodon speciosus* (37 337012)	**Y**	***<u>Notes</u>***—Defining the scope and extent of the trevally ERA can be difficult as catch data has poor species resolution. This deficiency is partly attributed to a) difficulties in differentiating between morphologically similar species, and b) the fact that multiple trevally may be caught in a single fishing event. The majority of catch for this complex is reported as *Trevally—unspecified* with a few key species recording smaller individual catches. Of the trevally that are caught in the ECIF, the majority of the catch is expected to consist of golden trevally (*G. speciosus*), giant trevally (*C. ignobilis*), bigeye trevally (*C. sexfasciatus*) and turrum (*C. fulvoguttatus*) (*pers. comm.* M. Keag). These species were viewed as assessment priorities and were included in the Level 2 ERA. Distribution data for silver trevally (*P. georgianus*) suggests that the species is more prominent in temperate waters (Australian Museum, 2018; Bray, 2018b); although small proportions have been reported from the ECIF (Department of Agriculture and Fisheries, 2019f). Given the distribution of the species, these interactions are more likely to occur in
Giant trevally	*Caranx ignobilis* (37 337027)	**Y**	
Bigeye trevally	*Caranx sexfasciatus* (37 337039)	**Y**	

Common Name	Scientific name (CAAB)	Include	Notes, Comments & Catch Data
Turrum (gold spot) ***Note: referred to as Trevally—gold spot in catch data.***	*Carangoides fulvoguttatus* (37 337037)	**Y**	south-east Queensland. However, it is plausible that these records are the result of species misidentifications (*pers. comm.* M. Keag). Overall, silver trevally are not expected to make a significant contribution to total ECIF catch and were excluded from the Level 2 ERA. Similarly, the thicklip trevally (*C. orthogrammus*), bludger trevally (*C. gymnostethus*), blue spot trevally (*C. bucculentus*) and the diamond trevally (*A. indica*) were all viewed as secondary species and omitted from the analysis. When and where appropriate, these secondary trevally species will be considered for inclusion in subsequent ERAs. ***<u>Commercial Catch Data Summary</u>*** *Gillnet / ring net fishing (only)* - Catch reported as Trevally—*unspecified (CAAB 37 337000): historical average (20 years)* = 29.8t (*range* = 17.2–53.3t). Catch 2017–2019 (inclusive) = 135t total at an average of 45t. - *Catch reported as Trevally—silver (CAAB 37 337062):* historical average = <0.2 (*range* = 0–0.4t). Catch 2017–2019 (inclusive) = 0.5t total. - Catch reported as *Trevally—golden (CAAB 37 337012)*: *historical average (20 years)* = 2.9 (*range* = 0.3–6.7t). Catch 2017–2019 (inclusive) = 5.2t total at an average of 1.7t. - Catch reported as *Trevally—giant (CAAB 37 337027)*: *historical average (20 years)* = 0.4t (*range* = 0.0–1.4t). Catch 2017–2019 (inclusive) = 0.3t total. - Catch reported as *Trevally—bigeye (CAAB 37 337039)*: *historical average (20 years)* = 0.4t (*range* = 0.0–0.9t). Catch 2017–2019 (inclusive) = 0t total. - Catch reported as *Trevally—gold spot (CAAB 37 337037)*: *historical average (20 years)* = 0.2 (*range* = 0–1.1t). Catch 2017–2019 (inclusive) = 1.3t total. - *Catch reported as Trevally—thicklip (CAAB 37 337057)*: *historical average (20 years)* = 0.1t (*range* = 0.0–0.3t). Catch 2017–2019 (inclusive) = 1t total.
Thicklip trevally	*Carangoides orthogrammus* (37 337057)	**N**	
Bludger trevally	*Carangoides gymnostethus* (37 337022)	**N**	
Blue spot trevally	*Caranx bucculentus* (37 337016)	**N**	
Diamond trevally	*Alectis indica* (37 337038)	**N**	
Silver trevally	*Pseudocaranx georgianus*	**N**	

Common Name	Scientific name (CAAB)	Include	Notes, Comments & Catch Data
	(37 337062)		- *Catch reported as Trevally—bludger (CAAB 37 337022)*: *historical average (20 years)* = <0.4 (*range* = 0–0.9t). Catch 2017–2019 (inclusive) = 0t total. - *Catch reported as Trevally—blue spot (CAAB 37 337016)*: *historical average (20 years)* = 0.4 (*range* = 0–2t). Catch 2017–2019 (inclusive) = <0.1t total. - *Catch reported as Trevally—diamond (CAAB 37 337038)*: *historical average (20 years)* = 0.1 (*range* = 0–0.5t). Catch 2017–2019 (inclusive) = 1.5t total. *Net fishing (all)* - Catch reported as *Trevally—unspecified (CAAB 37 337000)*: *historical average (20 years)* = 46.1t (*range* = 27.6–69.5t). Catch 2017–2019 (inclusive) = 174.1t total at an average of 58t. - *Catch reported as Trevally—silver (CAAB 37 337062):* historical average = 0.7 (*range* = 0–2t). Catch 2017–2019 (inclusive) = 2.3t total. - Catch reported as *Trevally—golden (CAAB 37 337012)*: *historical average (20 years)* = 7.3t (*range* = 0.6–18.7t). Catch 2017–2019 (inclusive) = 20.8t total at an average of 6.9t. - Catch reported as *Trevally—giant (CAAB 37 337027)*: *historical average (20 years)* = 0.9t (*range* = 0–2.4t). Catch 2017–2019 (inclusive) = 0.7t total. - Catch reported as *Trevally—bigeye (CAAB 37 337039)*: *historical average (20 years)* = 0.3t (*range* = 0–0.9t). Catch 2017–2019 (inclusive) = <0.2t total. - Catch reported as *Trevally—gold spot (CAAB 37 337037)*: *historical average (20 years)* = 0.4t (*range* = 0.1–3.3t). Catch 2017–2019 (inclusive) = 1.4t total. - *Catch reported as Trevally—thicklip (CAAB 37 337057)*: *historical average (20 years)* = 0.1t (*range* = 0.0–0.4t). Catch 2017–2019 (inclusive) = 1t total.

Common Name	Scientific name (CAAB)	Include	Notes, Comments & Catch Data
			- *Catch reported as Trevally—bludger (CAAB 37 337022)*: *historical average (20 years)* = 0.3 (*range* = 0–0.9t). Catch 2017–2019 (inclusive) = 0t total. - *Catch reported as Trevally—blue spot (CAAB 37 337016)*: *historical average (20 years)* = 0.4t (*range* = 0–1.8t). Catch 2017–2019 (inclusive) = <0.1t total. - *Catch reported as Trevally—diamond (CAAB 37 337038)*: *historical average (20 years)* = 0.2 (*range* = 0–0.5t). Catch 2017–2019 (inclusive) = 2t total. *Line fishing (all)* - Catch reported as *Trevally—unspecified (CAAB 37 337000): historical average (20 years)* = 58.9t total at an average of 76.9t. - Catch reported as *Trevally—golden (CAAB 37 337012)*: *historical average (20 years)* = <0.2t. - *Catch reported as Trevally—silver (CAAB 37 337062):* historical average = <0.3t. - Catch reported as *Trevally—giant (CAAB 37 337027)*: *historical average (20 years)* = 0.2t. - Catch reported as *Trevally—bigeye (CAAB 37 337039)*: *historical average (20 years)* = 0.1t. - Catch reported as *Trevally—gold spot* (turrum) *(CAAB 37 337037)*: *historical average (20 years)* = 0.2t. - *Catch reported as Trevally—thicklip (CAAB 37 337057)*: *historical average (20 years)* = <0.6t. - *Catch reported as Trevally—bludger (CAAB 37 337022)*: *historical average (20 years)* = <0.2t. - *Catch reported as Trevally—blue spot (CAAB 37 337016)*: *historical average (20 years)* = <0.2t. - *Catch reported as Trevally—diamond (CAAB 37 337038)*: *historical average (20 years)* = <0.1t.

<table>
<tr><th>Common Name</th><th>Scientific name (CAAB)</th><th>Include</th><th>Notes, Comments & Catch Data</th></tr>
<tr><td colspan="4">Whiting</td></tr>
<tr><td>Sand (summer) whiting</td><td>Sillago ciliata
(37 330010)</td><td>Y</td><td rowspan="4"><u>Notes</u>—Four whiting species were considered for inclusion in the Level 2 ERA: sand (S. maculata), trumpeter (winter) (S. maculata), northern (S. sihama) and goldenline (S. analis) whiting.

At a whole-of-fishery level, whiting is one of the more prominent components of the ECIF catch. In the Large Mesh Net Fishery, an average of 164t (range = 80.3–255.1t) of whiting were retained per year over the 2000–2020 period. The resolution of this data is poor and almost all of the catch is reported as Whiting—unspecified. Based on historical catches (Department of Agriculture and Fisheries, 2019f) a high percentage of this catch is likely to be sand whiting with trumpeter whiting making smaller contributions. This was reflected in a recent stock assessment where sand whiting was used as the primary species (Leigh et al., 2019). Both sand and trumpeter whiting were included in the Level 2 ERA.

Northern whiting (S. sihama) and goldenline whiting (S. analis) were included in the preliminary species list as they would contribute to the Whiting—unspecified catch. Distribution data suggests that both species will interact with the ECIF (Bray, 2017b; 2019) and will be retained in smaller quantities in the Large Mesh Net Fishery. Northern and goldenline whiting were considered secondary target species and were omitted from the analysis. Depending on the information available, the two species may be considered for inclusion in subsequent ERAs examining the risk posed to target and byproduct species in the ECIF.

<u>Commercial Catch Data Summary</u>

Gillnet / ring net fishing (only)

- Catch reported as Whiting—unspecified (CAAB 37 330000): historical average (20 years) = 164.3t (range = 80.3–255.1t). Catch 2017–2019 (inclusive) = 320.6t total at an average of 106.9t.

- Catch reported as Whiting—summer (sand whiting) (CAAB 37 330010): historical average (20 years) = 13.4t (range = 0.6–23.4t). Catch 2017–2019 (inclusive) = 0t total.</td></tr>
<tr><td>Trumpeter (winter) whiting</td><td>Sillago maculata
(37 330015)</td><td>Y</td></tr>
<tr><td>Northern whiting</td><td>Sillago sihama
(37 330006)</td><td>N</td></tr>
<tr><td>Goldenline whiting</td><td>Sillago analis
(37 330003)</td><td>N</td></tr>
</table>

Common Name	Scientific name (CAAB)	Include	Notes, Comments & Catch Data
			- Catch reported as *Whiting—trumpeter* (*CAAB 37 330015*): *historical average (20 years)* = 2.7t (*range* = 0–33.5). Catch 2017–2019 (inclusive) = 0t total. - Catch reported as *Whiting—Northern (CAAB 37 330006)*: N/A. - Catch reported as *Whiting—Goldenline (CAAB 37 330006)*: N/A. *Net fishing (all)* - Catch reported as *Whiting—unspecified (CAAB 37 330000): historical average (20 years)* = 266.4t (*range* = 124.6–391.3t). Catch 2017–2019 (inclusive) = 495.7t at an average of 165.2t. - Catch reported as *Whiting—summer* (sand whiting) (*CAAB 37 330010*): *historical average (20 years)* = 15.7t (*range* = 0.6–28.8t). Catch 2017–2019 (inclusive) = 0t total. - Catch reported as *Whiting—trumpeter* (*CAAB 37 330015*): *historical average (20 years)* = 2.7t (*range* = 0.0–33.5t). Catch 2017–2019 (inclusive) = 0t total. - Catch reported as *Whiting—Northern (CAAB 37 330006)*: N/A. - Catch reported as *Whiting—Goldenline (CAAB 37 330006)*: N/A. *Line fishing (all)* - Catch reported as *Whiting—unspecified (CAAB 37 330000): historical average (20 years)* = 0.5t (*range* = 0–1.1t). Catch 2017–2019 (inclusive) = 0.8t total. - Catch reported as *Whiting—summer* (sand whiting) (*CAAB 37 330010*): *historical average (20 years)* = <0.1t (*range* = 0–0.1t). Catch 2017–2019 (inclusive) = 0t total. - Catch reported as *Whiting—trumpeter* (*CAAB 37 330015*): *historical average (20 years)* = 0.2t (*range* = 0–1t). Catch 2017–2019 (inclusive) = 0.3t total.

Common Name	Scientific name (CAAB)	Include	Notes, Comments & Catch Data
			- Catch reported as *Whiting—Northern (CAAB 37 330006)*: N/A. - Catch reported as *Whiting—Goldenline (CAAB 37 330006)*: N/A.
Other Teleosts			
Tailor	*Pomatomus saltatrix* (37 334002)	**N**	***Notes***—Tailor (*Pomatomus saltatrix*) attracts a significant level of attention from both the commercial and recreational fishing sectors. On the Australian east coast, tailor is a shared stock and it is readily exploited by fishers in Queensland, New South Wales and Victoria (Litherland *et al.*, 2018a; Leigh *et al.*, 2017). The structure and health of the east coast tailor stock is well understood and the species has been included in a long-term monitoring program that gathers information on size and age classes. A tailor stock assessment completed in 2017 (Leigh *et al.*, 2017) indicated that biomass levels were around 50% of an unfished population. The stock assessment also estimated the maximum sustainable yield to be 1350t across all fishing sectors *i.e.* commercial and recreational fishing in both Queensland and New South Wales (Leigh *et al.*, 2017). This compares with current estimates that place the combined New South Wales / Queensland catch at less than 400t: commercial fisheries = ~185t, recreational fisheries = ~182t. The species was subject to a stock status evaluation as part of the national *Status of Australian Fish Stocks* (Litherland *et al.*, 2018a) process and was found to be *sustainable*. In Queensland, the commercial take of tailor is managed under a 120t TACC limit. This limit was introduced in 2002 and the fishery currently utilises around half of the available quota. While the species is not harvested and managed as a single entity (*e.g.* like Spanish mackerel), there are broader restrictions on the number of licences that can access the ECIF, and the use of seine nets in the Ocean Beach Fishery; one of the primary methods used to target tailor. In the recreational sector, fishers are restricted by an in-possession limit of 20 tailor, and the sector has a minimum legal size limit of 35cm. As research indicates that males and females have an L_{50} of 29cm TL and 31cm TL respectively, these measures ensure that a high percentage of the recreationally caught fish reproduce at least once before they are harvested.

Common Name	Scientific name (CAAB)	Include	Notes, Comments & Catch Data
			There are substantial protections in place to prevent catch increasing beyond key biomass reference points, and the take of the species across sectors is being managed effectively. Similarly, there is considerable information on the health of the east coast tailor stock, and a long-term monitoring program will help to detect broader catch trends. Given the above considerations, tailor was excluded from the Level 2 ERA as the risk is being managed effectively through the current harvest strategy. ***<u>Commercial Catch Data Summary</u>*** *Gillnet / ring net fishing (only)* - Catch reported as *Tailor (CAAB 37 334002): historical average (20 years)* = 42.6t (*range* = 9.7–154.2t). Catch 2017–2019 (inclusive) = 46.7t total at an average of 15.6t. - *Unspecified*: *N/A* *Net fishing (all)* - Catch reported as *Tailor (CAAB 37 334002): historical average (20 years)* = 101.3t (*range* = 36.8–248.5t). Catch 2017–2019 (inclusive) = 161.6t total at an average of 53.9t. - *Unspecified (Net)*: N/A. *Line fishing (all)* - Catch reported as *Tailor (CAAB 37 334002): historical average (20 years)* = 1.4t (*range* = 0.1–4.5t). Catch 2017–2019 (inclusive) = 0.6t total. - *Unspecified (line)*: N/A *Note—Most significant gillnet / ring net catches occurred prior to the introduction of quota of a 120t TACC limit in 2002. Catch in the pre-quota period (1988–2001 inclusive) averaged 151.6t compared to a post quota average of 83t.*

Common Name	Scientific name (CAAB)	Include	Notes, Comments & Catch Data
Barramundi	*Lates calcarifer* (37 310006)	**Y**	***Notes***—Barramundi (*L. calcarifer*) is a key target species for gillnet operators and significant quantities of the species are retained for sale each year. There is substantial information on the barramundi stock structure and sustainability of the fishery. However, the species is not managed through output controls and there is continued potential for catch and/or effort to increase into the future. Barramundi was included in the Level 2 ERA as a key target species. ***Commercial Catch Data Summary*** *Gillnet / ring net fishing (only)* - Catch reported as *Barramundi (CAAB 37 310006)*: *historical average (20 years)* = 281.6t (*range* = 144.2–591.7t). Catch 2017–2019 (inclusive) = 546t total at an average of 182t. - *Unspecified*: *N/A* *Net fishing (all)* - Catch reported as *Barramundi (CAAB 37 310006)*: *historical average (20 years)* = 290t (*range* = 148.8–614.4t). Catch 2017–2019 (inclusive) = 561.9t total at an average of 187.3t. - *Unspecified (Net)*: N/A. *Line fishing (all)* - Catch reported as *Barramundi (CAAB 37 310006)*: *historical average (20 years)* = <0.2t (*range* = 0–0.8t). Catch 2017–2019 (inclusive) = <0.2t total. - *Unspecified (line)*: N/A
Golden snapper	*Lutjanus johnii* (37 346030)	**Y**	***Notes***—Annual catches of golden snapper (*L. johnii*) have fluctuated between 4t and 13t and it is considered to be a byproduct species *verse* a key target (Department of Agriculture and Fisheries, 2019f; 2020c). While catches are low,

Common Name	Scientific name (CAAB)	Include	Notes, Comments & Catch Data
			they have remained relatively consistent through time. For this reason, the species was included in the Level 2 ERA. The decision to include golden snapper in the Level 2 ERA is viewed as precautionary. ***<u>Commercial Catch Data Summary</u>*** *Gillnet / ring net fishing (only)* - Catch reported as *Golden snapper (CAAB 37 346030)*: *historical average (20 years)* = 5.1t (*range* = 0.2–12.7t). Catch 2017–2019 (inclusive) = 27.3t total at an average of 9.1t. - *Unspecified*: *N/A* *Net fishing (all)* - Catch reported as *Golden snapper (CAAB 37 346030)*: *historical average (20 years)* = 5.2t (*range* = 0.2–12.7t). Catch 2017–2019 (inclusive) = 27.3t total at an average of 9.1t. - *Unspecified (Net)*: N/A. *Line fishing (all)* - Catch reported as *Golden snapper (CAAB 37 346030)*: *historical average (20 years)* = 0.6t (*range* = 0–2t). Catch 2017–2019 (inclusive) = 0.5t total. - *Unspecified (line)*: N/A
Scribbled rabbitfish (spinefoot / happy moments)	*Siganus spinus* (37 438013)	**Y**	***<u>Notes</u>***—Scribbled rabbitfish (*S. spinus*) are retained as a byproduct in the Large Mesh Net Fishery and are reported as *Spinefoot*. All of the rabbitfish catch is reported under broader catch categories, with total cates fluctuating between 12t and 118t (Department of Agriculture and Fisheries, 2020c; 2019f). Historical data for the fishery suggests that the species was retained in higher quantities in the pre-2000 period where the average annual catch was closer to 60t. The majority of this catch though would have been retained in the Tunnel Net Fishery (Jacobsen *et al.*, 2021c; Department of Agriculture and Fisheries, 2019f). While the species is retained in smaller quantities by gillnet and ring net operators, it

Common Name	Scientific name (CAAB)	Include	Notes, Comments & Catch Data
			was also included in the ERA for this sector. As there are limited concerns surrounding the sustainability of this species, the decision to include scribbled rabbitfish in the Level 2 ERA is precautionary. ***<u>Commercial Catch Data Summary</u>*** *Gillnet / ring net fishing (only)* - Catch reported as *Spinefoot (CAAB 37 438000)*: *historical average (20 years)* = 9.5t (*range* = 1.1–66.4t). Catch 2017–2019 (inclusive) = 14.4t total at an average of 4.8t. - Catch reported as *Scribbled rabbitfish*: no species-specific catch reported. *Net fishing (all)* - Catch reported as *Spinefoot (CAAB 37 438000)*: *historical average (20 years)* = 54.7t (*range* = 12.2–118.8t). Catch 2017–2019 (inclusive) = 94.4t at an average of 31.5t. - Catch reported as *Scribbled rabbitfish*: no species-specific catch reported. *Line fishing (all)* - Catch reported as *Spinefoot (CAAB 37 438000)*: *historical average (20 years)* = 0.1t (*range* = 0–0.4t). Catch 2017–2019 (inclusive) = 0t total. - Catch reported as *Scribbled rabbitfish*: no species-specific catch reported.
Dorab wolf herring	*Chirocentrus dorab* (37 087001)	**N**	***<u>Notes</u>***—Moderate to low amounts of the Dorab wolf herring (*C. dorab*) are retained by gillnet and ring net operations (range = 4–16t; Department of Agriculture and Fisheries, 2020c; 2019f). The majority of the years sampled show catches of <10t. The Dorab wolf herring is considered to be a true byproduct species and is unlikely to be targeted in significant quantities. While the species has not been included in the ERA, it will be considered for inclusion in a subsequent ERAs.

Common Name	Scientific name (CAAB)	Include	Notes, Comments & Catch Data
			Commercial Catch Data Summary *Gillnet / ring net fishing (only)* - Catch reported as *Herring—wolf (CAAB 37 087001)*: *historical average (20 years)* = 8.4t (*range* = 1.4–16.6t). Catch 2017–2019 (inclusive) = 34.5t total at an average of 11.5t. *Net fishing (all)* - Catch reported as *Herring—wolf (CAAB 37 087001)*: *historical average (20 years)* = 8.8t (*range* = 1.4–17t). Catch 2017–2019 (inclusive) = 35.3t total at an average of 11.8t. *Line fishing (all)* - Catch reported as *Herring—wolf (CAAB 37 087001)*: *historical average (20 years)* = 0.3t (*range* = 0–1t). Catch 2017–2019 (inclusive) = 1.2t total.
Sharks			
Graceful shark	*Carcharhinus amblyrhynchoides* (37 018033)	**Y**	***Notes***—The graceful shark (*C. amblyrhynchoides*), common blacktip shark (*C. limbatus*) and the Australian blacktip shark (*C. tilstoni*) share a number of morphological similarities. These similarities make it difficult to identify individual species and, as a consequence, their catch is frequently reported as part of a broader *Blacktip Whaler & Graceful Shark* complex (Department of Agriculture and Fisheries, 2019f). Of the shark species that are retained by operators in the ECIF, a high proportion will be from the *Blacktip Whaler & Graceful Shark* complex. They make up the majority of the retained shark catch and they are a key target in the Large Mesh Net Fishery. As a result, all three blacktip species were included in the Level 2 ERA. ***Commercial Catch Data Summary***
Common blacktip shark	*Carcharhinus limbatus*	**Y**	

Common Name	Scientific name (CAAB)	Include	Notes, Comments & Catch Data
Australian blacktip shark	*Carcharhinus tilstoni* (37 018014)	**Y**	*Gillnet / ring net fishing (only)* - Catch reported as *Shark—Blacktip Whalers and Graceful shark (CAAB 37 018016): historical average (20 years)* = 101t (*range* = 0–174.7t). Catch 2017–2019 (inclusive) = 123.3t total at an average of 41.1t. - Catch reported as *Blacktip whaler shark (CAAB 37 018903): historical average (20 years)* = 15.9t (*range* = 0–54.9t). Catch 2017–2019 (inclusive) = 91.5t total at an average of 30.5t. - Catch reported as *Shark—graceful (CAAB 37 018033): historical average (20 years)* = 5.9t (*range* = 0–11.4t). Catch 2017–2019 (inclusive) = 12.5t total at an average of 6.2t. - Catch reported as *Shark—Australian blacktip (CAAB 37 018014)*: *historical average (20 years)* = 133.3t (*range* = 0.2–297.6t). Catch 2017–2019 (inclusive) = 0t reported since 2009 and the introduction of the Shark & Ray logbook *Net fishing (all)* - Catch reported as *Shark—Blacktip Whalers and Graceful shark (CAAB 37 018016): historical average (20 years)* = 101t (*range* = 0–174.7t). Catch 2017–2019 (inclusive) = 123.3t total at an average of 41.1t. - Catch reported as *Blacktip whaler shark (CAAB 37 018903): historical average (20 years)* = 16.3t (*range* = 0–54.9t). Catch 2017–2019 (inclusive) = 91.6t total at an average of 30.5t - Catch reported as *Shark—graceful (CAAB 37 018033): historical average (20 years)* = 5.9t (*range* = 0–11.4t). Catch 2017–2019 (inclusive) = 12.5t total at an average of 6.2t. - Catch reported as *Shark—Australian blacktip (CAAB 37 018014)*: *historical average (20 years)* = 136t (*range* = 0.2–301.5t). Catch 2017–2019 (inclusive) = 0t reported since 2009 and the introduction of the Shark & Ray logbook *Line fishing (all)*

Common Name	Scientific name (CAAB)	Include	Notes, Comments & Catch Data
			- Catch reported as *Shark—Blacktip Whalers and Graceful shark (CAAB 37 018016): historical average (20 years)* = 3t (*range* = 1–7.4t). Catch 2017–2019 (inclusive) = 2t total. - Catch reported as *Blacktip whaler shark (CAAB 37 018903): historical average (20 years)* = 0.5t (*range* = 0–1t). Catch 2017–2019 (inclusive) = 2t total. - Catch reported as *Shark—graceful (CAAB 37 018033): historical average (20 years)* = 0.1t (*range* = 0–0.2t). Catch 2017–2019 (inclusive) = 0.4t total. - Catch reported as *Shark—Australian blacktip (CAAB 37 018014)*: *historical average (20 years)* = 3t (*range* = 0–28.4t). Catch 2017–2019 (inclusive) = 0.6t total. *Additional Notes—* *Catch data for C. tilstoni is (more than likely) conflated with C. limbatus and the two are often reported on as a single complex and/or misidentified. A new Shark & Ray Logbook was introduced in 2009 which introduced a number of new catch categories including the 'Blacktip Whaler and Graceful Shark'. This change is the reason why there is an absence of catch data for this species in the post 2009 period. The catch category 'Blacktip Whaler and Graceful Shark' has now been superseded in the Shark & Ray Logbook (SR02 Version 1). This category has now been split into a) 'Blacktip Whalers' which includes C. limbatus and C. tilstoni, and b) Graceful Shark (C. amblyrhynchoides).*
Pigeye shark	*Carcharhinus amboinensis* (37 018026)	**Y**	***Notes***—Circumstances surrounding the pigeye (*C. amboinensis*) and bull shark (*C. leucas*) are similar to that observed for the graceful shark and blacktip sharks. The pigeye and bull shark have morphological similarities that can make it difficult with species identifications. This is reflected in the monitoring program where the pigeye and bull shark are reported on as a single entity (Queensland Government, 2018a). In the ECIF, the combined catch for these two species exceeds 30t and they are a prominent component of the shark catch. Accordingly, both species will be assessed as part of the Level 2 ERA.
Bull shark	*Carcharhinus leucas*	**Y**	

Common Name	Scientific name (CAAB)	Include	Notes, Comments & Catch Data
	(37 018021)		***Commercial Catch Data Summary*** *Gillnet / ring net fishing (only)* - Catch reported as *Pigeye & bull sharks (CAAB 37 018010): historical average (20 years)* = 21.8t (*range* = 4.8–40.7t). Catch 2017–2019 (inclusive) = 50.6t total at an average of 16.9t. - Catch reported as *Shark—pigeye (CAAB 37 018026)*: *historical average (20 years)* = 0.2t (*range* = 0.1–0.5t). Catch 2017–2019 (inclusive) = 0t total. - Catch reported as *Shark—bull (CAAB 37 018021)*: *historical average (20 years)* = 8.3t (*range* = 0.2–24.9t). Catch 2017–2019 (inclusive) = 12.4t total at an average of 4.2t. *Net fishing (all)* - Catch reported as *Pigeye & bull sharks (CAAB 37 018010): historical average (20 years)* = 21.8t (*range* = 4.8–40.7t). Catch 2017–2019 (inclusive) = 50.6t total at an average of 16.9t. - Catch reported as *Shark—pigeye (CAAB 37 018026)*: *historical average (20 years)* = 0.2t (*range* = 0.1–0.5t). Catch 2017–2019 (inclusive) = 0t. - Catch reported as *Shark—bull (CAAB 37 018021)*: *historical average (20 years)* = 8.4t (*range* = 0.2–25.3t). Catch 2017–2019 (inclusive) = 12.4t total at an average of 4.2t. *Line fishing (all)* - Catch reported as *Pigeye & bull sharks (CAAB 37 018010): historical average (20 years)* = 0.8t (*range* = 0.1–3.3t). Catch 2017–2019 (inclusive) = 0.2t total. - Catch reported as *Shark—pigeye (CAAB 37 018026)*: No species-specific catch reported. - Catch reported as *Shark—bull (CAAB 37 018021)*: *historical average (20 years)* = 0.2t (*range* = 0–0.5t). Catch 2017–2019 (inclusive) = 0.1t total.

Common Name	Scientific name (CAAB)	Include	Notes, Comments & Catch Data
Spinner shark	*Carcharhinus brevipinna* (37 018023)	**Y**	***Notes***—A species that inhabits inshore waters down to 75m (Last & Stevens, 2009), the spinner shark (*C. brevipinna*) will primarily interact with gillnet operations. Prior to the introduction of the *Shark & Ray Logbook* (2009), catch of this species would have been reported as part of a generic catch category. Since 2009, the species has had reported catches ranging from 18t to 40t (Department of Agriculture and Fisheries, 2019f). These quantities were considered to be sufficient to include spinner sharks in the Level 2 ERA. ***Commercial Catch Data Summary*** *Gillnet / ring net fishing (only)* - Catch reported as *Shark—spinner (CAAB 37 018023): historical average (20 years)* = 18.3t (*range* = 0.2–40.4t). Catch 2017–2019 (inclusive) = 81t total at an average of 27t. *Net fishing (all)* - Catch reported as *Shark—spinner (CAAB 37 018023): historical average (20 years)* = 18.5t (*range* = 0.2–40.4t). Catch 2017–2019 (inclusive) = 81t total at an average of 27t. *Line fishing (all)* - Catch reported as *Shark—spinner (CAAB 37 018023): historical average (20 years)* = 0.2t (*range* = 0–0.7t). Catch 2017–2019 (inclusive) = 0.7t total.
Creek whaler	*Carcharhinus fitzroyensis* (37 018035)	**N**	***Notes***—The creek whaler (*C. fitzroyensis*) is an inshore species that inhabits water depths to at least 40m. Catch data for the species dates back to 2009 and the introduction of the *Shark & Ray Logbook*. This data indicates that the creek whaler is not a primary target with operators retaining an average of 6t annually (Department of Agriculture and Fisheries, 2020c; 2019f). The creek whaler has improved productivity, and broader sustainability assessments suggest that it can tolerate current and projected levels of fishing pressure in northern Australian fisheries (Harry *et al.*, 2019). This inference is supported

Common Name	Scientific name (CAAB)	Include	Notes, Comments & Catch Data
			by an earlier stock assessment which provided a maximum sustainable yield (MSY) estimate of 29.6t for the species (Leigh, 2015). Based on the current catch levels and the available information, the creek whaler was omitted from the Level 2 ERA. This species will be considered for inclusion in subsequent ERAs involving the Large Mesh Net Fishery. ***<u>Commercial Catch Data Summary</u>*** *Gillnet / ring net fishing (only)* - Catch reported as *Creek whaler (CAAB 37 018035)*: *historical average (20 years)* = 6.2t (*range* = 1.8–13.9t). Catch 2017–2019 (inclusive) = 7.9t total at an average of 2.6t. *Net fishing (all)* - Catch reported as *Creek whaler (CAAB 37 018035)*: *historical average (20 years)* = 6.2t (*range* = 1.8–13.9t). Catch 2017–2019 (inclusive) = 7.9t total at an average of 2.6t. *Line fishing (all)* - Catch reported as *Creek whaler (CAAB 37 018035)*: *historical average (20 years)* = 0.1t (*range* = 0–0.3t). Catch 2017–2019 (inclusive) = 0.1t total.
Blacktip reef shark	*Carcharhinus melanopterus* (37 018036)	**Y**	***<u>Notes</u>***—Catch data for the Large Mesh Net Fishery includes three species of reef shark: the blacktip reef (*C. melanopterus*), the grey reef (*C. amblyrhynchos*) and the white tip reef shark (*Triaenodon obesus*). Both the grey reef shark and the whitetip reef shark are afforded additional protections under the *Fisheries Declaration 2019* in the form of a one (1) shark in-possession limit. This restriction does not apply to the blacktip reef shark and the species can be retained for sale in larger quantities. Catch data for the blacktip shark dates back to 2009 and the introduction of a dedicated *Shark & Ray Logbook*. Data collected from this logbook shows a high degree of variability with total catch fluctuating between 3t and 23t (Department of Agriculture and Fisheries, 2019f). One possible explanation for this is that a proportion of the blacktip reef shark catch is being misidentified and reported as part of a broader complex (*e.g.* the Blacktip Whaler & Graceful shark complex

Common Name	Scientific name (CAAB)	Include	Notes, Comments & Catch Data
			prior to 2018 or in the blacktip whaler complex from 1 January 2018) or *vice versa* (*e.g.* the graceful shark (*C. amblyrhynchoides*), common blacktip shark (*C. limbatus*) or the Australian blacktip shark (*C. tilstoni*) being reported as a blacktip reef shark). The blacktip reef shark is classified as *Near Threatened* by the IUCN (Heupel, 2009); the second lowest IUCN classification category. A near threatened listing means that while the species may not be at an immediate risk, there are circumstances that may make it more vulnerable. This assessment concluded that global blacktip shark populations were not in immediate danger of significant depletions. However, it was recognised that the species has small litter sizes and long gestation periods; hence populations are vulnerable to depletion if not managed appropriately (Heupel, 2009). For these reasons and the continued take of blacktip reef sharks in the ECIF, the species was included in the Large Mesh Net Target & Byproduct Species Level 2 ERA. ***Commercial Catch Data Summary*** *Gillnet / ring net fishing (only)* - Catch reported as *Blacktip reef shark (CAAB 37 018036)*: *historical average (20 years)* = 10.4t (*range* = 3.3–22.9t). Catch 2017–2019 (inclusive) = 36.9t total at an average of 12.3t. *Net fishing (all)* - Catch reported as *Blacktip reef shark (CAAB 37 018036)*: *historical average (20 years)* = 10.4t (*range* = 3.3–22.9t). Catch 2017–2019 (inclusive) = 36.9t total at an average of 12.3t. *Line fishing (all)* - Catch reported as *Blacktip reef shark (CAAB 37 018036)*: *historical average (20 years)* = 0.9t (*range* = 0–2.3t). Catch 2017–2019 (inclusive) = 4.8t total.

Common Name	Scientific name (CAAB)	Include	Notes, Comments & Catch Data
Spot-tail shark	*Carcharhinus sorrah* (37 018013)	**Y**	***Notes***—Catch, effort and distribution data for the spot-tail shark (*C. sorrah*) shares similarities to the blacktip reef shark (*C. melanopterus*). The species is not afforded additional protections under fisheries legislation and it is classified as *Near Threatened* by the IUCN (Pillans *et al.*, 2009). The species is retained in north Australian waters and it will be more prominent in catches from the Gulf of Carpentaria and the Northern Territory. However, catch rates for the species in Australia are not expected to threaten their long-term sustainability (Pillans *et al.*, 2009). On the Queensland east coast, the distribution of *C. sorrah* does not extend as far south as some of the more prominent blacktip whaler species (*e.g. C. tilstoni / C. limbatus*). Interactions with this species and the ECIF are more likely to occur in the northern Great Barrier Reef Marine Park region where the species will be afforded additional protections *e.g.* spatial closures. There is some potential for the species to be misidentified and/or for the catch to be conflated with the Blacktip Whaler complex. Given this, the inclusion of the spot-tail shark in the Level 2 ERA was considered precautionary. ***Commercial Catch Data Summary*** *Gillnet / ring net fishing (only)* - Catch reported as *Shark—sorrah (CAAB 37 018013): historical average (20 years)* = 10t (*range* = 0.5–20.3t). Catch 2017–2019 (inclusive) = 18.5t total at an average of 6.2t. *Net fishing (all)* - Catch reported as *Shark—sorrah (CAAB 37 018013): historical average (20 years)* = 10.3t (*range* = 0.5–20.3t). Catch 2017–2019 (inclusive) = 18.5t total at an average of 6.2t. *Line fishing (all)* - Catch reported as *Shark—sorrah (CAAB 37 018013): historical average (20 years)* = <0.1t (*range* = 0–0.1t). Catch 2017–2019 (inclusive) = 0.2t total.

Common Name	Scientific name (CAAB)	Include	Notes, Comments & Catch Data
Hardnose shark	*Carcharhinus macloti* (37 018025)	**Y**	***Notes***—The hardnose shark (*C. macloti*), milk shark (*R. acutus*) and Australian sharpnose shark (*R. taylori*) are a group of smaller species with similar morphological traits (Last & Stevens, 2009). The milk and Australian sharpnose shark are classified as *Least Concern* by the IUCN (Simpfendorfer, 2003; Baje & Simpfendorfer, 2019). The situation surrounding the hardnose shark is slightly different as the species has been assessed as *Near Threatened* at a global level but *Least Concern* in Australian waters (Simpfendorfer & Stevens, 2003; Simpfendorfer *et al.*, 2019). In the ECIF, catch levels across the complex have remained relatively stable (~15t) (Department of Agriculture and Fisheries, 2019f). This data though has poor species resolution, and quantifying species compositions and individual rates of fishing mortality can be difficult. These deficiencies contributed to all three species being included in the Level 2 ERA. Given that the hardnose, milk and sharpnose shark are three of the more productive whaler species found in Australian waters, the decision to include these species in the Level 2 ERA is viewed as precautionary. The RRA may also need to consider the likelihood of one or more of these species being assigned a false-positive result. ***Commercial Catch Data Summary*** *Gillnet / ring net fishing (only)* - Catch reported as *Milk, Sharpnose & Hardnose Sharks (CAAB 37 018002): historical average (20 years)* = 14.8t (*range* = 8.6–25.3t). Catch 2017–2019 (inclusive) = 33.1t total at an average of 11t. - Catch reported as *Shark—hardnose (CAAB 37 018025)*: *historical average (20 years)* = 1.8t (*range* = 0–4.9t). Catch 2017–2019 (inclusive) = 0.1t total. - Catch reported as *Shark—milk (CAAB 37 018006)*: *historical average (20 years)* = 0.5t (*range* = 0–2.0t). Catch 2017–2019 (inclusive) = 0.4t total. - Catch reported as *Australian sharpnose shark*: no species-specific catch reported. *Net fishing (all)*
Milk shark	*Rhizoprionodon acutus* (37 018006)	**Y**	
Australian sharpnose shark	*Rhizoprionodon taylori* (37 018024)	**Y**	

Common Name	Scientific name (CAAB)	Include	Notes, Comments & Catch Data
			- Catch reported as *Milk, Sharpnose & Hardnose Sharks (CAAB 37 018002): historical average (20 years)* = 14.8t (*range* = 8.6–25.3t). Catch 2017–2019 (inclusive) = 33.1t total at an average of 11t. - Catch reported as *Shark—hardnose (CAAB 37 018025)*: *historical average (20 years)* = 0.9t (*range* = 0–4.9t). Catch 2017–2019 (inclusive) = 0.1t total. - Catch reported as *Shark—milk (CAAB 37 018006)*: *historical average (20 years)* = 0.5t (*range* = 0–2.0t). Catch 2017–2019 (inclusive) = 0.4t total. - Catch reported as *Australian sharpnose shark*: no species-specific catch reported. *Line fishing (all)* - Catch reported as *Milk, Sharpnose & Hardnose Sharks (CAAB 37 018002): historical average (20 years)* = 0.2t (*range* = 0–1.3t). Catch 2017–2019 (inclusive) = 1.5t total. - Catch reported as *Hardnose shark*: no species-specific catch reported. - Catch reported as *Shark—milk (CAAB 37 018006)*: *historical average (20 years)* = <0.1t (*range* = 0–<0.1t). Catch 2017–2019 (inclusive) = 0t total. - Catch reported as *Australian sharpnose shark*: no species-specific catch reported.
Scalloped hammerhead	*Sphyrna lewini* (37 019001)	**Y**	***Notes***—Hammerhead sharks are readily retained in the ECIF but are not targeted to the same extent as blacktip sharks. Catch from this complex though is not inconsequential and hammerhead sharks are readily retained in this sector of the ECIF. Catch data for the scalloped hammerhead (*S. lewini*) indicates that around 44t are retained in this sector each year. This species is the subject of ongoing sustainability evaluations and it has been classified as *Conservation Dependent* under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The great hammerhead (*S. mokarran*)
Great hammerhead	*Sphyrna mokarran* (37 019002)	**Y**	

Common Name	Scientific name (CAAB)	Include	Notes, Comments & Catch Data
Winghead shark	*Eusphyra blochii* (37 019003)	**Y**	makes a smaller contribution to the total amount of shark caught on the Queensland east coast. Conservation concerns for this species is similar to the scalloped hammerhead with the IUCN classifying it as *Endangered* at a global level and *Data Deficient* within Australia (Rigby *et al.*, 2019a). This species is not listed under the EPBC Act. The two remaining species, the smooth hammerhead (*S. zygaena*) and the winghead (*E. blochii*) shark are expected to make smaller contributions to the total ECIF catch (Department of Agriculture and Fisheries, 2020c; 2019f). The distribution of the smooth hammerhead is largely confined to temperate waters (Last & Stevens, 2009) and the species is more likely to interact with fisheries in New South Wales. In Queensland, any interactions with *S. zygaena* will be confined to waters in and around south-east Queensland (Simpfendorfer, 2014). This suggests that the majority of the *S. zygaena* population/stock is found in waters outside of Queensland, and that the ECIF poses a limited risk to this species. When compared to the *Sphyrna* species, datasets for the winghead shark are more limited. The distribution of *E. blochii* does overlap with the ECIF, and the species is found in coastal / nearshore waters where net fishing occurs (Smart & Simpfendorfer, 2016; Last & Stevens, 2009). As with the scalloped and great hammerhead shark, the IUCN assigns the winghead shark with a global classification of *Endangered*. At a regional level, the assessment recognises that a) the species makes up a small component of the commercial catch, and b) the population is relatively healthy. Accordingly the winghead shark was classified as *Least Concern* within Australian waters. While noting the above, total fishing mortality (retained plus discards) is likely to be higher for this complex. Research has also found that hammerhead sharks are more susceptible to net entanglements and post-interaction mortalities. Due to these factors and their continued targeting, all four species were included in Level 2 ERA. *Note—All four hammerhead shark species were included in a Level 2 ERA examining the risk posed to threatened, endangered and protected (TEP) species. The TEP Level 2 ERA also used the Productivity & Susceptibility Analysis (PSA) and was based on the ERAEF approach (Hobday et al., 2007; Hobday et al., 2011). Under this approach, only four attributes were used to assess the susceptibility component of the PSA. In the target & byproduct species Level 2 ERA, this component of the assessment was expanded to include three additional attributes. These additional attributes*
Smooth hammerhead	*Sphyrna zygaena* (37 019004)	**Y**	

Common Name	Scientific name (CAAB)	Include	Notes, Comments & Catch Data
			take into consideration sustainability assessments, management strategies and cumulative fishing risks (Patrick et al., 2010). The use of these parameters will assist in refining the hammerhead shark risk profiles. ***<u>Commercial Catch Data Summary</u>*** *Gillnet / ring net fishing (only)* - Catch reported as *Hammerhead shark (CAAB 37 019000): historical average (20 years)* = 45.1t (*range* = 0.2–161.7t). Catch 2017–2019 (inclusive) = 28.3t total at an average of 9.4t. - Catch reported as *Shark—scalloped hammerhead (CAAB 37 019001)*: *historical average (20 years)* = 38.5t (*range* = 1.8–150.3t). Catch 2017–2019 (inclusive) = 43.8t total at an average of 14.6t. - Catch reported as *Great hammerhead shark (CAAB 37 019002)*: *historical average (20 years)* = 1.1t (*range* = 0–2.1t). Catch 2017–2019 (inclusive) = 4t total. - Catch reported as *Smooth hammerhead shark (CAAB 37 019004)*: No species-specific catch reported. - Catch reported as *Winghead shark (CAAB 37 019003)*: *historical average (20 years)* = <0.2t (*range* = 0–0.3t). Catch 2017–2019 (inclusive) = 0.5t. *Net fishing (all)* - Catch reported as *Hammerhead shark (CAAB 37 019000): historical average (20 years)* = 46.2t (*range* = 0.2–164.7t). Catch 2017–2019 (inclusive) = 28.4t total at an average of 9.5t. - Catch reported as *Shark—scalloped hammerhead (CAAB 37 019001)*: *historical average (20 years)* = 39.3t (*range* = 1.8–153.4t). Catch 2017–2019 (inclusive) = 43.8t total at an average of 14.6t. - Catch reported as *Great hammerhead shark (CAAB 37 019002)*: *historical average (20 years)* = 1.1t (*range* = 0–2.1t). Catch 2017–2019 (inclusive) = 4t total. Qfish data indicates that an average of 3.4t has been reported from

Common Name	Scientific name (CAAB)	Include	Notes, Comments & Catch Data
			the ECIF (Includes 2018/19 data: http://qfish.fisheries.qld.gov.au/query/23b5afd5-c2cd-498e-8d36-e659398e42bf/table?customise=True). - Catch reported as *Smooth hammerhead shark (CAAB 37 019004)*: No species-specific catch reported. - Catch reported as *Winghead shark (CAAB 37 019003)*: *historical average (20 years)* = <0.2t (*range* = 0–0.3t). Catch 2017–2019 (inclusive) = 0.5t. *Line fishing (all)* - Catch reported as *Hammerhead shark (CAAB 37 019000): historical average (20 years)* = 0.7t (*range* = 0–2.8t). Catch 2017–2019 (inclusive) = <0.1t total. - Catch reported as *Shark—scalloped hammerhead (CAAB 37 019001)*: *historical average (20 years)* = 0.2t (*range* = 0–1t). Catch 2017–2019 (inclusive) = 0.1t total. - Catch reported as *Great hammerhead shark (CAAB 37 019002)*: No species-specific catch reported. - Catch reported as *Smooth hammerhead shark (CAAB 37 019004)*: No species-specific catch reported. - Catch reported as *Winghead shark:* no species-specific catch reported. *Note—Most of the significant S. lewini catches occur prior to 2009 and the introduction of the Shark & Ray Logbook. The drop in catch from pre-2009 to post-2009 can be attributed to the introduction of additional hammerhead shark catch categories and an uptick in unspecified hammerhead shark catch. Data collection for S. mokarran commenced after the introduction of the Shark & Ray Logbook in 2009 and would have been reported previously under generic identifies e.g. Hammerhead shark. Direct reporting of the E. blochii catch only came into effect on 1 January 2018 and catch of this species would have previously been reported at a higher taxonomic level.*
Tiger shark	*Galeocerdo cuvier*	**N**	***Notes***—Tiger shark (*G. cuvier*) data for the ECIF shows a high degree of inter-year variability with annual catches ranging from 0–18t. The species is not caught in high numbers and it is not considered to be a primary target in the

Common Name	Scientific name (CAAB)	Include	Notes, Comments & Catch Data
	(37 018022)		ECIF. Operators though will retain this species as byproduct. Outside of commercial fishing, this species will experience additional non-commercial fishing pressures. For example, the Queensland shark control program was identified as a notable source of fishing mortality for the species (Qifsh data: http://qfish.fisheries.qld.gov.au/query/731d19c2-3acf-4a20-a3b2-4315a7d93b0c/table?customise=True) (Ferreira & Simpfendorfer, 2019). When compared to this program, the ECIF will make a smaller contribution to the total rate of fishing mortality. Due to these reasons and the tiger shark falling outside of the 95% catch threshold, it was omitted from the analysis. When and where appropriate, further consideration will be given to including tiger sharks in subsequent ERAs involving the Large Mesh Net Fishery. ***Commercial Catch Data Summary*** *Gillnet / ring net fishing (only)* - Catch reported as *Shark—tiger (CAAB 37 018022)*: *historical average (20 years)* = 4.6t (*range* = 0–18t). Catch 2017–2019 (inclusive) = 9.1t total at an average of 3t. *Net fishing (all)* - Catch reported as *Shark—tiger (CAAB 37 018022)*: *historical average (20 years)* = 4.7t (*range* = 0–18t). Catch 2017–2019 (inclusive) = 9.1t total at an average of 3t. *Line fishing (all)* - Catch reported as *Shark—tiger (CAAB 37 018022)*: *historical average (20 years)* = 0.3t (*range* = 0–1.1t). Catch 2017–2019 (inclusive) = <0.1t total.
Batoids			
Bottlenose wedgefish (synonym:	*Rhynchobatus australiae*	**N**	**Notes**—In Queensland, the commercial take and possession of guitarfish (*Family Rhinidae**) and shovelnose rays (*Family Rhinobatidae*) is limited to five individuals (total) under 1.5m. Recreational fishers are limited to an in-possession limit of 1. There are no species-specific catch records for guitarfish and shovelnose rays in the ECIF as they are

Common Name	Scientific name (CAAB)	Include	Notes, Comments & Catch Data
whitespotted guitarfish)	(37 026005)		reported under a single catch category (*Guitarfish—shovelnose unspecified* (37 027000)) (Department of Agriculture and Fisheries, 2019g; Queensland Government, 2018a). Commercial catch for this complex is frequently <4t per year, particularly in recent years (2017–19; *average* = 2.1t per annum). The notable exception being 2014 when 14t were retained in the fishery (Department of Agriculture and Fisheries, 2019g; 2020c). Although *R. australiae, R. palpebratus,* and *G. typus* can be retained for sale in the Large Mesh Net Fishery, the complex did not meet the 95% cut off for inclusion in the Level 2 ERA. However, *R. australiae* is has been included in the *Convention on the Conservation of Migratory Species* (CMS) list, and the wedgefish complex (*Family Rhinidae* incl. *Rhynchobatus* spp.) and guitarfish (*Glaucostegus* spp.) are listed under the *Convention on International Trade in Endangered Species of Wild Fauna and Flora* (CITES). Due to these listings, all three species were assessed as part of the *Large Mesh Net Species of Conservation Concern Level 2 ERA* (Jacobsen *et al.*, 2021a). Within this assessment, the bottlenose wedgefish, eyebrow wedgefish, and the giant shovelnose ray were assigned precautionary high-risk ratings. Precautionary risk ratings are assigned to species whose risk profiles are heavily influenced by data deficiencies and/or where the final rating may overestimate the level of risk. In these instances, management of this risk, beyond what is already being undertaken as part of the *Queensland Sustainable Fisheries Strategy 2017–2027*, is viewed as a lower priority. As the species were assigned precautionary risk ratings in the SOCC Level 2 ERA, consideration was given to including these species in the Large Mesh Net Target & Byproduct Species Level 2 ERA. After due consideration of the catch rates and management restrictions, it was determined that other shark species should be prioritised for assessment. When and where appropriate, consideration will be given to the including these species in subsequent ERAs. Until then, risk profiles compiled as part of the ECIF SOCC Level 2 ERA provides an appropriate overview of the key risk factors for these species. **A taxonomic review of these species has resulted in a change to the nomenclature. These changes have yet to be reflected in legislation which still refers to the Family Rhynchobatidae. The intent of the legislation though still provides Rhynchobatus species with additional protections.*
Eyebrow wedgefish	*Rhynchobatus palpebratus* (37 026004)	**N**	
Giant shovelnose ray	*Glaucostegus typus* (37 027010)	**N**	

Common Name	Scientific name (CAAB)	Include	Notes, Comments & Catch Data
			Catch Data Summary *Gillnet / ring net fishing (only)* - Catch reported as *Guitarfish—Shovelnose unspecified* (CAAB 37 027000): *historical average (20 years)* = 3.5t (*range* = 0–14.6t). Catch 2017–2019 (inclusive) = 6t total at an average of 2t.

Appendix C—Overlap percentages used in the Productivity and Susceptibility Analysis

Where available, overlap percentages were based on species distribution maps sourced from the *Commonwealth Scientific and Industrial Research Organisation* (CSIRO) and, where possible, were refined using bathymetry and topographical data (Whiteway, 2009).

Common name	Species	CAAB	2016 % Overlap	2017 % Overlap	2018 % Overlap	Highest %	Risk rating
Mullet							
Bluespot mullet	*Valamugil seheli*	37 381017	26.9	22.5	20.9	26.9	2
Sea mullet	*Mugil cephalus*	37 381002	42.1	38.7	36.2	42.1	3
Fantail mullet	*Paramugil georgii*	37 381009	28.7	24.5	22.8	28.7	2
Diamondscale mullet	*Liza vaigiensis*	37 381008	28.3	24.3	22.4	28.3	2
Flathead							
Dusky flathead	*Platycephalus fuscus*	37 296004	40.6	37.5	34.6	40.6	3
Bartail flathead	*Platycephalus australis*	37 296033	22.6	19.6	17.7	22.6	2
Northern sand flathead	*Platycephalus endrachtensis*	37 296021	17.3	15.4	13.5	17.3	2
Yellowtail flathead	*Platycephalus westraliae*	37 296020	17.6	15.6	13.7	17.6	2
Bream & Whiting							
Yellowfin bream	*Acanthopagrus australis*	37 353004	21.9	20	17.6	21.9	2
Tarwhine	*Rhabdosargus sarba*	37 353013	19.5	19	16.8	19.5	2
Trumpeter whiting	*Sillago maculata*	37 330015	17.4	15.5	13.6	17.4	2
Sand whiting	*Sillago ciliata*	37 330010	19.7	17.2	15.3	19.7	2
Trevally—Carangidae							
Turrum (gold spot)	*Carangoides fulvoguttatus*	37 337037	11.1	9.8	8.5	11.1	2
Bigeye trevally	*Caranx sexfasciatus*	37 337039	11.5	10.2	8.9	11.5	2
Giant trevally	*Caranx ignobilis*	37 337027	11.5	10.2	8.9	11.5	2

Common name	Species	CAAB	2016	2017	2018	Highest %	Risk rating
			% Overlap	% Overlap	% Overlap		
Golden trevally	*Gnathanodon speciosus*	37 337012	11.1	9.7	8.5	11.1	2
Snubnosed dart	*Trachinotus blochii*	37 337075	11.5	10.2	8.9	11.5	2
Swallowtail dart	*Trachinotus coppingeri*	37 337076	13.2	12.2	10.8	13.2	2
Giant queenfish	*Scomberoides commersonnianus*	37 337032	11.6	10.2	8.9	11.6	2
Yellowtail scad	*Trachurus novaezelandiae*	37 337003	24.4	21.5	17.4	24.4	2
Mackerel							
Grey mackerel	*Scomberomorus semifasciatus*	37 441018	11.5	10.1	8.9	11.5	2
Spotted mackerel	*Scomberomorus munroi*	37 441015	11.5	10.2	8.9	11.5	2
School mackerel	*Scomberomorus queenslandicus*	37 441014	11.5	10.2	8.9	11.5	2
Jewfish							
Black jewfish	*Protonibea diacanthus*	37 354003	12.8	11.5	9.8	12.8	2
Silver jewfish	*Nibea soldado*	37 354019	28.9	24.5	22.8	28.9	2
Mulloway	*Argyrosomus japonicus*	37 354001	28.9	27	23.5	28.9	2
Threadfin							
King threadfin	*Polydactylus macrochir*	37 383005	33.2	23.2	23.1	33.2	3
Blue threadfin	*Eleutheronema tetradactylum*	37 383004	17	13.5	11.8	17	2
Javelin							
Barred javelin	*Pomadasys kaakan*	37 350011	19.6	17.1	15.1	19.6	2
Silver javelin	*Pomadasys argenteus*	37 350009	16.5	14.7	12.6	16.5	2
Garfish							
Snubnose garfish	*Arrhamphus sclerolepis*	37 234006	52	48.8	48.8	52	3
Three-by-two garfish	*Hemiramphus robustus*	37 234013	22.8	19.8	18	22.8	2

Common name	Species	CAAB	2016	2017	2018	Highest %	Risk rating
			% Overlap	% Overlap	% Overlap		
Other teleosts							
Barramundi	*Lates calcarifer*	37 310006	14.9	12	10.4	14.9	2
Golden snapper	*Lutjanus johnii*	37 346030	0.4	0.3	0	0.4	1
Scribbled rabbitfish	*Siganus spinus*	37 438013	33.5	23.6	23.4	33.5	3
Whaler sharks							
Graceful shark	*Carcharhinus amblyrhynchoides*	37 018033	8.2	6.7	4.2	8.2	1
Common blacktip shark	*Carcharhinus limbatus*	37 018039	11.5	10.2	8.9	11.5	2
Australian blacktip shark	*Carcharhinus tilstoni*	37 018014	11.2	9.2	7.9	11.2	2
Pigeye shark	*Carcharhinus amboinensis*	37 018026	11.5	10.2	8.9	11.5	2
Bull shark	*Carcharhinus leucas*	37 018021	11.9	10.5	9.2	11.9	2
Spinner shark	*Carcharhinus brevipinna*	37 018023	11.5	10.2	8.9	11.5	2
Blacktip reef shark	*Carcharhinus melanopterus*	37 018036	19.6	17.1	15.2	19.6	2
Spot-tail shark	*Carcharhinus sorrah*	37 018013	11.5	10.2	8.9	11.5	2
Hardnose shark	*Carcharhinus macloti*	37 018025	8.2	7.5	6.2	8.2	1
Milk shark	*Rhizoprionodon acutus*	37 018006	11.6	10.2	8.9	11.6	2
Australian sharpnose shark	*Rhizoprionodon taylori*	37 018024	11.5	10.1	9	11.5	2
Hammerhead sharks							
Scalloped hammerhead	*Sphyrna lewini*	37 019001	9.7	8.5	7.6	9.7	1
Great hammerhead	*Sphyrna mokarran*	37 019002	5.9	5.2	4.5	5.9	1
Winghead shark	*Eusphyra blochii*	37 019003	9.9	8.7	7.8	9.9	1
Smooth hammerhead	*Sphyrna zygaena*	37 019004	6.8	6.2	5.5	6.8	1

Appendix D—Residual Risk Analysis

The following provides an overview of the Residual Risk Analysis (RRA) of the scores assigned as part of the original *Productivity & Susceptibility Analysis* (PSA). As the target & byproduct species RRA is comprehensive, species groupings have been arranged in alphabetical order under broader teleost and shark subheading. Information contained in this appendix provides a more detailed overview of the changes summarised in Table 7 of this report.

Species	Attribute	PSA Score	RRA Score	Justifications and Considerations
Teleosts				
Barramundi				
Barramundi *(L. calcarifer)*	*Management strategy (Susceptibility)*	3	2	Barramundi (*L. calcarifer*) are managed through minimum and maximum legal size (MLS) limits, spawning closures and various other input controls (Streipert *et al.*, 2019). As the management regime for barramundi does not (currently) include a mechanism to control catch or effort (*e.g.* a TACC limit or ITQs), the species was assigned a high (3) preliminary risk score for *management strategy*. Sustainability of the east coast stocks has been confirmed through stock assessments (Streipert *et al.*, 2019) and indicative sustainability evaluations (Saunders *et al.*, 2018). Biomass estimates for the east coast stocks (North East Coast, Mackay, Central East Coast) sit between 53–71% of the exploitable biomass, and projected biomass estimates indicate that the species will reach B_{60} by 2027 (57-73%) (Streipert *et al.*, 2019). This suggests that the risk of overfishing is being managed within the current fishing environment. While noting the above, one stock located in the Gulf of Carpentaria has previously been classified as *depleting* (Saunders *et al.*, 2018). This assessment demonstrates that regional barramundi stocks can be overfished. While this situation is unlikely to be replicated on the Queensland east coast, there is some capacity for catch and effort to increase under the current management regime. If this were to occur it may result in a biomass downgrade; particularly if environmental factors have a negative impact on seasonal recruitment rates *e.g.* poor water flows (Streipert *et al.*, 2019). More broadly, barramundi remains vulnerable to cumulative fishing pressures with the recreational sector harvesting an estimated 131–166t across the state (Webley *et al.*, 2015; Saunders *et al.*, 2018; Grubert *et al.*,

Species	Attribute	PSA Score	RRA Score	Justifications and Considerations
				2020). While an in-possession limit reduces recreational fishing pressures, the current MLS limit (580mm) sits below the size at first sexual maturity (males, 640mm; females, 800–900mm). As a consequence, it may not adequately protect a proportion of the spawning population prior to harvest. This risk is partly mitigated by a spawning/seasonal closure from 1 November to 31 January that is applied across the barramundi fishery (commercial, recreational and charter) (Department of Agriculture and Fisheries, 2019f). ***Key changes to the PSA scores*** While barramundi is not managed under a TACC limit, a weight-of-evidence approach suggests that the risk of overexploitation is being managed within the current fishing environment. Accordingly, the risk score for the *management strategy* attribute was reduced to medium (2). A further risk score reduction could not be justified due to the absence of output controls, cumulative fishing pressures and environmental drivers of seasonal recruitment. This change was done in accordance with *Guideline 2: additional scientific assessment & consultation; Guideline 5: effort & catch management arrangements for target and byproduct species;* and *Guideline 7: management arrangements relating to seasonal spatial and depth closures.* *Note—Under the proposed harvest strategy, the ECIF will be subject to regional management and greater use of output controls. As a Tier 1 species, the management of regional barramundi stocks will move to a more complex system of output controls.*
<u>Bream</u>				
Yellowfin bream *(A. australis)*	*Management strategy (Susceptibility)*	3	2	Yellowfin bream (*A. australis*) are managed through a MLS limit, combined in-possession limit (recreational fishing) and various other input controls (McGilvray *et al.*, 2018b). The MLS limit (25cm) is based on the size at sexual maturity (19-21cm; Gray & Barnes, 2015) and increases the probability that a fish will spawn at least once before recruiting to the fishery. As the management regime does not include a mechanism to control catch (*e.g.* a TACC limit or ITQs), the species was assigned a high (3) preliminary risk score for *management strategy*.

Species	Attribute	PSA Score	RRA Score	Justifications and Considerations
				While bream are one of the more prominent ECIF catch components (*average* = 38t, 2010–18 gillnet and ring net), data for the complex has poor species resolution *e.g. Bream—Unspecified* (Department of Agriculture and Fisheries, 2019f). A large proportion of this catch will consist of yellowfin bream, with secondary species like tarwhine (*R. sarba*) making varying contributions (*pers. comm.* T. Ham). While some bream catch is reported to the species level, this occurs less frequently and underestimates individual rates of harvest (<4t per year, 2001–2019, *Bream—yellowfinned*, gillnet and ring net). In addition to the commercial fishing sector, yellowfin bream is a key target in the recreational fishing sector. Harvest rates in this sector are comparable to the commercial fishery with recreational fishers accounting for around 46% of the total yellowfin bream catch (Leigh *et al.*, 2019). At this level, recreational fishing will make a significant contribution to the cumulative fishing pressures exerted on this species. These risks are primarily managed through in-possession limits and a MLS aligned with the size at sexual maturity. Sustainability of the yellowfin bream stock has been confirmed through a detailed stock assessment (Leigh *et al.*, 2019) and indicative sustainability evaluations (McGilvray *et al.*, 2018b). Of notable importance, these assessments considered fishing activities / harvest rates in both the commercial and recreational fishing sectors. Based on the available data, the stock assessment indicated that the yellowfin bream MSY sits at or around 420t. This compares to an annual harvest rate (commercial plus recreational) of 242t (2013–2017). Current biomass estimates place yellowfin bream stock health at around 33.8% of the unfished biomass with current harvest rates (*i.e.* catch<MSY) assisting with stock rebuilding. In terms of objectives set out in the *Queensland Sustainable Fisheries Strategy 2017–2027*, research suggests that the stock will need to be at 50.1% to reach the long-term objective of B_{60} (Department of Agriculture and Fisheries, 2017). The stock assessment notes that, under the current conditions and rates of harvest, it will take (approximately) 25 years for the stock to reach B_{60}. Confirmation of stock sustainability through qualitative assessments and a weight-of-evidence approach suggests that the risk posed to this species is being managed within the current fishing environment. The available data indicates that the fishery is being fished below MSY and stock health will improve under the current fishing conditions. This is being done without the use of a TACC limit and suggests that criteria used

Species	Attribute	PSA Score	RRA Score	Justifications and Considerations
				in the Level 2 ERA is less suited to this species. The notable caveat being that without a cap on catch or effort, both can increase and potentially exceed MSY under the current management regime. ***Key changes to the PSA scores*** While yellowfin bream is not managed under a TACC limit, a weight-of-evidence approach suggests that the overexploitation risk is currently being managed. As a result, the risk score for the *management strategy* attribute was reduced to a medium (2). This change was done in accordance with *Guideline 2: additional scientific assessment & consultation,* and *Guideline 5: effort and catch management arrangements for target and byproduct species.* As the fishery continues to operate without a cap on catch or effort, further reductions in the risk score were not supported. The score assigned to this attribute may also need to be reviewed if or when harvest rates approach MSY limits. This need will reduce with the introduction of an ECIF-specific harvest strategy that relies more heavily on the use of management controls and output controls (Department of Agriculture and Fisheries, 2020d).
Yellowfin bream *(A. australis)* Tarwhine *(R. sarba)*	*Recreational desirability / other fisheries (Susceptibility)*	1	2	The catch of bream in the east coast recreational and charter sectors is dominated by yellowfin bream (*A. australis*), with tarwhine (*R. sarba*) targeted to a lesser extent. As both yellowfin bream and tarwhine have low retention rates (25% and 23%, respectively) they were assigned low-risk ratings for the *recreational desirability* attribute (Department of Agriculture and Fisheries, 2021). The popularity of bream in the recreational sector is reflected in the large catches of yellowfin bream and their sustained targeting across the state (2,045,000 caught in 2010–2011; 1,423,000 in 2013–2014; and 1,503,000 in 2019–2020) (Teixeira *et al.*, 2021; Department of Agriculture and Fisheries, 2021). While tarwhine contributes less to the overall recreational bream harvest, catch of this species has increased substantially between survey periods: 24,000 fish caught in 2013–2014, 185,000 in 2019–2020 (Webley *et al.*, 2015; Department of Agriculture and Fisheries, 2021). Legal sized tarwhine will also be retained in conjunction with (and potentially misidentified as) yellowfin bream. This is one of the reasons why the two are managed under a combined 30 fish in-possession limit (Department of Agriculture and Fisheries, 2018g). The

Species	Attribute	PSA Score	RRA Score	Justifications and Considerations
				MLS limit (23cm) for yellowfin bream is based on the size at sexual maturity (McGilvray *et al.*, 2018b) and increases the probability that the species will spawn at least once before recruiting to the fishery. While recreational retention rates for bream are comparatively low, they are caught in larger numbers and discard mortality will be a risk factor for this complex (Broadhurst *et al.*, 2005). Research on recreational fishing activities recorded bream mortality rates of up to 36.6%, with hook location shown to be a key predictor for survival (Broadhurst *et al.*, 2005). This risk will be of particular relevance to fish that fall below the MLS and will contribute to the total rate of fishing mortality. The majority of recreational data is obtained through voluntary localised collection of data (boat ramp survey program, Fisheries Monitoring Program) and a more expansive voluntary recreational fisher survey (Webley *et al.*, 2015; Department of Agriculture and Fisheries, 2021; Teixeira *et al.*, 2021). It can however be difficult to obtain accurate information on participation rates, regional catch trends and species assemblages for the recreational fishing sector. These limitations make it difficult to assess how recreational fishing pressures vary between and within years. From an ERA perspective, it increases a level of uncertainty that supports the adoption of a more conservative approach. ***Key changes to the PSA scores*** Based on the available information, preliminary scores assigned to the *recreational desirability / other fisheries* attribute were increased from low (1) to medium (2). The decision to increase risk scores assigned to this attribute was precautionary and takes into account the broader popularity of these species and the (current) inability to monitor catch/harvest rates effectively between and within years. While the increased score may represent a risk overestimate, it aligns with the precautionary approach adopted for the Level 2 ERA. These changes were done in accordance with *Guideline 2: additional scientific assessment & consultation,* and *Guideline 5: effort and catch management arrangements for target and byproduct species.*

Species	Attribute	PSA Score	RRA Score	Justifications and Considerations
Tarwhine *(R. sarba)*	*Management strategy (Susceptibility)*	3	3	Tarwhine (*R. sarba*) are primarily managed through a MLS limit and a combined in-possession limit (recreational fishing). The MLS limit (25cm) is based on the size at sexual maturity (15–21cm; Hughes *et al.*, 2008) and increases the probability that a fish will spawn at least once before recruiting to the fishery. As the management regime does not include a mechanism to control catch or effort, tarwhine was assigned a high (3) preliminary risk score for *management strategy*. Information on the catch of bream species presents similar issues to whiting. At a species complex level, bream are one of the more prominent components of the ECIF catch (*average* = 38t 2010–2018, large mesh nets). However, catch data for bream has poor species resolution and a considerable proportion is reported as *unspecified*. Catch reporting at the species level is less frequent and provides an incomplete account of individual harvest rates (*e.g. Bream—tarwhine* = <2t per year since 2000, large mesh nets). It is anticipated that yellowfin bream will make up a considerable component of the bream catch (*pers. comm*. T. Ham). While yellowfin bream has been the subject of a detailed stock assessment, tarwhine was not included in this evaluation. There is limited information on the sustainability of the stocks and/or how current harvest rates compare to key biological reference points. As a consequence, it is difficult to ascertain if the risk posed to this species is being managed effectively under the current management regime. ***Key changes to the PSA scores*** No changes were made to the PSA scores but it is recognised that a high (3) risk rating may be too precautionary. A score reduction could not be justified at this point in time given the current absence of output controls and information on how the take of the species compares to key sustainability reference points. These limitations are currently being addressed as part of the *Queensland Sustainable Fisheries Strategy 2017–2027* (Department of Agriculture and Fisheries, 2017). With the continued roll-out of the strategy there may be further avenues to review and (potentially) reduce this score. This is most likely to occur when an ECIF-specific harvest strategy is introduced.

Species	Attribute	PSA Score	RRA Score	Justifications and Considerations
Dart				
Snubnose dart *(T. blochii)* Swallowtail dart *(T. coppingeri)*	*Management strategy (Susceptibility)*	3	2	When compared to other species, the management regime for dart is less developed. The complex is managed at a whole-of-fishery level and they are not subject to MLS limits. However, the take of these species in the recreational fishing sector is restricted to a combined *Carangidae spp*. in-possession limit (Fisheries Declaration 2019). As the management regime does not include a mechanism to control catch or effort, dart were assigned a high (3) preliminary risk score for *management strategy*. On the Queensland east coast, the majority of the dart catch is reported from the Ocean Beach Fishery (Jacobsen *et al.*, 2021b). While dart is retained for sale in the Large Mesh Net Fishery, it is typically viewed as a byproduct. Catch data for dart has poor species resolution with most reported as *unspecified* (Department of Agriculture and Fisheries, 2019f). This portion of the catch is comparatively small with an average of 24t of dart reported from the wider ECIF each year (2017–19 inclusive). Of this catch, 19t comes from the Ocean Beach Fishery. In the Large Mesh Net Fishery, dart catches are comparatively low with 4t of snubnose dart and ~10t of *unspecified dart* reported by gillnet / ring net operators since 2007 and 2006 respectively. While dart have not been the subject of a detailed stock assessment and are not managed under a TACC limit, there are fewer concerns surrounding the sustainability of these species. For example, research has shown *Trachinotus* to be fast-growing, serial spawners that have a protracted spawning season (McPhee *et al.*, 1999). These factors combined with low (overall) catches suggest dart are less susceptible to overexploitation and are being managed effectively of the Queensland east coast. ***Key changes to the PSA scores*** The available data indicates that the risk of overexploitation is being managed on the Queensland east coast and that the PSA overestimated the risk for this attribute. Accordingly, the risk score for *management strategy* was reduced to a medium (2). These changes were done in accordance with *Guideline 2: additional scientific assessment & consultation,* and *Guideline 5: effort and catch management arrangements for target*

Species	Attribute	PSA Score	RRA Score	Justifications and Considerations
				and byproduct species. Further score reductions could not be justified given the absence of output controls and limitations in the monitoring and assessment data. These limitations are currently being addressed as part of the *Queensland Sustainable Fisheries Strategy 2017–2027* (Department of Agriculture and Fisheries, 2017).
Snubnose dart *(T. blochii)* Swallowtail dart *(T. coppingeri)*	*Recreational desirability / other fisheries (Susceptibility)*	3	2	While snubnose and swallowtail dart (*T. blochii and T. coppingeri,* respectively) were included in the *Statewide Recreational Fishing Survey*, they were assessed as part of a broader species grouping (32.4% retention) (Webley *et al.*, 2015). Due to an absence of species-specific data, both dart received a precautionary high (3) risk rating for *recreational desirability*. Recreational catch of dart has varied across survey periods (288,613 caught in 2010–2011, 352,000 caught in 2013–2014, 228,000 caught in 2019-20) (Webley *et al.*, 2015; Taylor *et al.*, 2012; Teixeira *et al.*, 2021; Department of Agriculture and Fisheries, 2021). Up until the most recent survey, dart retention rates have remained around 30–35%. In the last survey (2019–20), retention rates for the complex declined to less than 20% (Department of Agriculture and Fisheries, 2021). These values suggest that the precautionary high-risk rating is an overestimate for these species. While post-capture mortality of *Trachinotus* species is unknown, the species is most commonly found in the surf zone and shallow inshore waters where barotrauma is viewed as less of a concern. While the recreational catch has increased, dart are fast-growing and have protracted spawning seasons. This coupled with low retention rates indicate that regional stocks can withstand elevated fishing pressures. ***Key changes to the PSA scores*** The default high (3) risk scores assigned to the *recreational desirability / other fisheries* attribute was reduced to medium (2) as part of the RRA. While this score is still conservative, it is more closely aligned to data contained within the recreational fishing survey. Further reductions in risk scores could not be justified given the absence of species-specific catch and harvest estimates. These changes were done in accordance with

Species	Attribute	PSA Score	RRA Score	Justifications and Considerations
				Guideline 1: risk rating due to missing, incorrect or out of date information and *Guideline 2: additional scientific assessment & consultation.*
Snubnose dart *(T. blochii)*	*Age at sexual maturity (Productivity)*	3	1	Limited ageing data was available for the snubnose dart (*T. blochii*) and, consequently, the species was assigned a precautionary high (3) score for this attribute. In the RRA the *age at sexual maturity* attribute was reassessed using age and growth data for the swallowtail dart (*T. coppingeri*). Research indicates that the swallowtail dart is relatively fast-growing with the species reaching sexual maturity before 5 years of age (McPhee, 1999). ***Key changes to the PSA scores*** In line with the above approach, the *age at sexual maturity* risk score for the snubnose dart was reduced from a precautionary high (3) to low (1). This change was done in accordance with *Guideline 1: rating due to missing, incorrect or out of date information*, and new rating provides a better reflection of their life-history constraints.
Snubnose dart *(T. blochii)*	*Maximum age (Productivity)*	3	2	As data was not available for the snubnose dart (*T. blochii*), the swallowtail dart (*T. coppingeri*) was again considered for use as a proxy. Research indicates that the swallowtail dart is relatively fast-growing (McPhee, 1999) and maximum longevity for this species is less than 10 years. While noting this research, the snubnose dart attains a larger maximum size. This opens up the possibility that the species has a larger maximum age; warranting the adoption of a more precautionary approach. ***Key changes to the PSA scores*** The preliminary score for *maximum age* was reduced from a precautionary high (3) to medium (2). The decision to reduce this score was informed by ageing studies involving the swallowtail dart and takes into consideration a) the potential for the species to live to more than 10 years, and b) the probability of the species exceeding 25 years. Changes made as part of the RRA were done in accordance with *Guideline 1:*

Species	Attribute	PSA Score	RRA Score	Justifications and Considerations
				rating due to missing, incorrect or out of date information and Guideline 2: additional scientific assessment & consultation.
Snubnose dart *(T. blochii)*	*Size at sexual maturity (Productivity)*	3	2	Snubnose dart (*T. blochii*) were assigned a precautionary high (3) risk rating for *size at sexual maturity* due to an absence of data. Given what is known about this family, a high-risk rating is considered to be an overestimate for this species. ***Key changes to the PSA scores*** The use of proxy data resulted in a score downgrade from high (3) to medium (2) for the *size at sexual maturity* attribute. While information suggests that the swallowtail dart (*T. coppingeri*) attains sexual maturity at <40 cm, the snubnose dart attains a larger total length requiring the adoption of a more conservative approach. Changes made as part of the RRA were done in accordance with *Guideline 1: rating due to missing, incorrect or out of date information*
Snubnose dart *(T. blochii)*	*Maximum size (Productivity)*	2	1	Reports on the maximum size for snubnose dart (*T. blochii*) varied, with some estimating it to be as high as 110cm (Froese & Pauly, 2019). In the PSA, the highest reported estimate was used as the basis of the assessment for the *maximum size* attribute. This aligns well with the precautionary nature of the PSA. In the RRA, further consideration was given to the suitability of this score for the Queensland east coast. In most instances, maximum size for the snubnose dart is reported at around 65cm (Randall *et al.*, 1990; Food and Agriculture Organization (FAO), 2020; Smith-Vaniz & Williams, 2016b). In Queensland, the species has a reported maximum size of 75cm (Queensland Government, 2018e). While dart >100cm total length cannot be completely ruled out, maximum size estimates of <80cm are considered more appropriate for the Large Mesh Net Fishery. Accordingly, the *maximum size* attribute was reassessed as part of the RRA using the revised (<80 cm) estimate.

Species	Attribute	PSA Score	RRA Score	Justifications and Considerations
				Key changes to the PSA scores The score assigned to *maximum size* was reduced from medium (2) to low (1) as <100cm total length is viewed as a more appropriate estimate for this attribute. This change was done in accordance with *Guideline 1: rating due to missing, incorrect or out of date information* and *Guideline 2: additional scientific assessment & consultation.*
Flathead				
Dusky flathead *(P. fuscus)*	*Management strategy (Susceptibility)*	3	2	Dusky flathead (*P. fuscus*) are managed through minimum and maximum legal size (MLS) limits, in-possession limits (recreational fishing), and various other input controls (McGilvray *et al.*, 2018a). As the management regime for dusky flathead does not include a mechanism to control catch or effort, the species was assigned a high (3) preliminary risk score for *management strategy*. At a species complex level, flathead are one of the more prominent components of the ECIF catch (*average* = 38.5t, 2010–2018 data) (Department of Agriculture and Fisheries, 2020c; 2019f). Commercial catch data for the complex has poor resolution with all flathead species reported as *unspecified*. While noting this deficiency, market demand is expected to favour larger fish, with dusky flathead (*P. fuscus*) considered to be the dominant species (Leigh *et al.*, 2019). Outside of the commercial fishery, dusky flathead is viewed as a species of recreational significance and this sector makes a substantial contribution to the annual rate of fishing mortality (65% recreational, 35% commercial; Leigh *et al.*, 2019). For this reason, cumulative fishing pressures are expected to be higher for this species. The sustainability of the Queensland dusky flathead stock has been confirmed through a detailed stock assessment (Leigh *et al.*, 2019) and indicative sustainability evaluations (McGilvray *et al.*, 2018a). These assessments considered fishing activities / harvest rates in both the commercial and recreational fishing sectors. The results of the stock assessment highlighted some biomass variability. For example, spawning biomass in the Moreton region was estimated at 35.8% compared with a MSY of 34.6% (2017 data). This contrasts with northern regions where spawning biomass was estimated at >60% (Leigh *et al.*, 2019). Based

Species	Attribute	PSA Score	RRA Score	Justifications and Considerations
				on the above outputs, the species is likely to achieve the long-term *Queensland Sustainable Fisheries Strategy 2017–2027* target of B_{60} in around 8 years (Leigh *et al.*, 2019). From an ERA perspective, confirmation of stock sustainability through qualitative assessments and a weight-of-evidence approach suggests that the risk posed to this species is being managed within the current fishing environment. The available data indicates that the fishery is being fished below MSY, and that stocks will improve under the current fishing conditions. This is being done without the use of a TACC limit and suggests that criteria used in the Level 2 ERA is less suited to this species. The notable caveat being that without a cap on catch, it can increase and potentially exceed MSY. If this were to occur, further review of the scores assigned to the *management strategy* would be warranted. ***Key changes to the PSA scores*** While dusky flathead is not managed under a TACC limit, a weight-of-evidence approach suggests that the risk of overexploitation is being managed on the Queensland east coast. Accordingly, the *management strategy* attribute score was reduced to medium (2). This change was done in accordance with *Guideline 2: additional scientific assessment & consultation,* and *Guideline 5: effort and catch management arrangements for target and byproduct species.* As the fishery continues to operate without a cap on catch or effort, further reductions in the risk score were not supported. This is likely to change with the introduction of an ECIF-specific harvest strategy (Department of Agriculture and Fisheries, 2020d).
Dusky flathead *(P. fuscus)*	*Recreational desirability / other fisheries (Susceptibility)*	2	2	Recreational catch of flathead on the east coast is dominated by dusky flathead (*P. fuscus*) with the species tending to report large catches and lower retention rates. Current estimates place the retention rates for this species at 33% which falls just within the medium (2) risk category for this attribute (Teixeira *et al.*, 2021; Department of Agriculture and Fisheries, 2021; Webley *et al.*, 2015). Dusky flathead are a key target in the recreational and charter fishing sectors (Gray & Barnes, 2015; Broadhurst *et al.*, 2003). This popularity is reflected in large catches and sustained targeting across survey periods. While recreational surveys suggest that catch has decreased slightly since 2010–2011 (399,000

Species	Attribute	PSA Score	RRA Score	Justifications and Considerations
				caught in 2010–2011; 334,000 caught in 2019-20), harvest rates have remained relatively stable (Webley *et al.*, 2015; Teixeira *et al.*, 2021). ***Key changes to the PSA scores*** No changes were made to the PSA scores but it is recognised that a medium (2) risk rating may be precautionary. While catch rates for this species are large, retention rates are at the lower limit of this rating. With additional information on fishing intentions and retention rates for legal-sized fished, the score assigned to this attribute could be reviewed in subsequent ERAs.
Bartail flathead *(P. australis)* Northern sand flathead *(P. endrachtensis)* Yellowtail flathead *(P. westraliae)*	*Management strategy (Susceptibility)*	3	3	The management regime of the listed flathead species is less developed, with the take of these species principally managed through MLS limits and combined in-possession limits (recreational sector, includes all flathead except dusky flathead). As their management does not include a mechanism to control catch or effort, all three species were assigned a high (3) preliminary risk score for *management strategy*. At a species complex level, flathead are one of the more prominent components of the ECIF catch (*average* = 38.5t, 2010–2018 data). Flathead catch data has poor species resolution with all reported as *unspecified*. However, anecdotal evidence suggests that the majority of fishing effort is directed towards the dusky flathead (*P. fuscus*). While the bartail flathead (*P. australis*), northern sand flathead (*P. endrachtensis*) and yellowtail flathead (*P. westraliae*) will contribute to the *unspecified* catch, harvest rates for these species are expected to be lower (Department of Agriculture and Fisheries, 2019f; 2020c). At a whole-of-fishery level, there is limited information on the sustainability of secondary flathead stocks and/or how current harvest rates compare to key biological reference points. As a consequence, it is difficult to ascertain if sustainability risks posed to these species are being managed effectively under the current management regime. Insight into the sustainability of these species though can be drawn from the dusky flathead stock assessment (Leigh *et al.*, 2019). This assessment indicated that the dusky flathead was being fished below MSY and that the current fishing environment was conducive to stock rebuilding.

Species	Attribute	PSA Score	RRA Score	Justifications and Considerations
				Given that dusky flathead accounts for the majority of the catch/effort, and taking into account the shared biological characteristics with other flathead species, it is likely that the secondary species are also being fished sustainably. This inference though has yet to be fully tested and cannot be confirmed at this point in time due to an absence of information on individual rates of harvest and key sustainability reference points. ***Key changes to the PSA scores*** No changes were made to the PSA scores but it is recognised that a high (3) risk rating may be an overestimate for these species. A score reduction could not be justified at this point in time given the (current) absence of output controls and information on how the take of the species compares to key sustainability reference points. These limitations are currently being addressed as part of the *Queensland Sustainable Fisheries Strategy 2017–2027* (Department of Agriculture and Fisheries, 2017).
Bartail flathead *(P. australis)* Yellowtail flathead *(P. westraliae)*	*Recreational desirability / other fisheries (Susceptibility)*	3	2	While the listed flathead species were included in the *Statewide Recreational Fishing Survey*, recreational harvest estimates for both had a medium level of confidence and a more precautionary approach was applied in the PSA (Teixeira *et al.*, 2021; Department of Agriculture and Fisheries, 2021). Based on the best available data, around 59,000 bartail flathead (*P. australis*) are caught in the recreational fishing sector with ~15,000 being harvested (25%). Estimates suggest that around 4,000 yellowtail flathead are caught in this sector with ~1,000 being retained (25%) (Teixeira *et al.*, 2021; Department of Agriculture and Fisheries, 2021). While these species may contribute to the *Flathead–unspecified* category, catch/retention rates for this section of the catch are relatively low. As dusky flathead (*P. fuscus*) has more appeal in this sector and a large proportion of the recreational effort will be targeted at this species, the listed species are more likely to be caught by fishers targeting dusky flathead. As noted, recreational harvest data for these secondary species has lower confidence, and morphological similarities may see some species (bartail and yellowtail) included in the dusky flathead data. However, recreational catch and harvest of all flathead species has decreased over time and this trend is

Species	Attribute	PSA Score	RRA Score	Justifications and Considerations
				expected to extend to the lesser targeted species. For these reasons, a high-risk (3) score for the *recreational desirability* attribute was considered to be an overestimate for these species. ***Key changes to the PSA scores*** The default high (3) risk scores assigned to *recreational desirability / other fisheries* attribute for bartail and yellowtail flathead was reduced to medium (2). While data is limited for these species, a weight-of-evidence approach suggests that the recreational desirability score should be equal to or lower than dusky flathead. Due to the precautionary nature of the assessment, a medium-risk rating was applied to these species. With additional information, this risk score could potentially be reduced further. These changes were done in accordance with *Guideline 2: additional scientific assessment & consultation.*
Northern sand flathead *(P. endrachtensis)*	*Recreational desirability / other fisheries (Susceptibility)*	2	2	Northern sand flathead (*P. endrachtensis*) is not heavily targeted in the recreational and charter fishing sectors, and the species will be harvested in low quantities. As the species registered a retention rate of between 35% and 54% (Teixeira *et al.*, 2021; Department of Agriculture and Fisheries, 2021) it was assigned a medium (2) preliminary risk score in the *recreational desirability* attribute. Recreational harvest rates for this species have decreased over time (30,000 harvested 2010–2011, 19,000 harvested 2013–2014 and 11,000 in 2019–2020) (Webley *et al.*, 2015; Taylor *et al.*, 2012; Teixeira *et al.*, 2021; Department of Agriculture and Fisheries, 2021). This data suggests that cumulative fishing pressures exerted on the northern sand flathead are lower than that observed for other species. The extent of this risk differential is difficult to quantify given uncertainty in the data and catch compositions. ***Key changes to the PSA scores*** While no change was made to the PSA score, additional information on recreational catch compositions and fisher intentions may facilitate a score reduction in future ERAs.

Species	Attribute	PSA Score	RRA Score	Justifications and Considerations
Bartail flathead *(P. australis)* Northern sand flathead *(P. endrachtensis)* Yellowtail flathead *(P. westraliae)*	*Age at sexual maturity (Productivity)*	3	1	The popularity of the dusky flathead (*P. fuscus*) is reflected in the amount of biological data that is available for this species. In the PSA, the three secondary flathead species were all assigned a precautionary high (3) risk score for the *age at sexual maturity* attribute due to data deficiencies. While data deficiencies make it difficult to assess the consistency of *age at sexual maturity* across flathead species, a high-risk rating is considered an overestimate for this attribute. Accordingly, the *age at sexual maturity* for the dusky flathead was used as a proxy for the bartail (*P. australis*), northern sand (*P. endrachtensis*) and yellowtail (*P. westraliae*) flathead. ***Key changes to the PSA scores*** Default high (3) risk score was reduced to low (1) and now align with the dusky flathead. These changes were made in accordance with *Guideline 2: additional scientific assessment & consultation.*
Bartail flathead *(P. australis)* Northern sand flathead *(P. endrachtensis)* Yellowtail flathead *(P. westraliae)*	*Maximum age (Productivity)*	3	2	The situation surrounding the *maximum age* attribute shared similarities with the *age at sexual maturity*. For this attribute, all three species were assigned a precautionary high (3) risk rating due to data deficiencies. In the RRA, the use of proxies allowed this score to be reduced. These revised scores are considered to be more representative of their biological constraints. ***Key changes to the PSA scores*** Default high (3) risk scores assigned to *maximum age* was reduced to medium (2). This score is now consistent with what was assigned to the dusky flathead. These changes were made in accordance with *Guideline 1: Risk rating due to missing, incorrect or out of date information* and are unlikely to contribute to the production of a false-negative result.
Bartail flathead *(P. australis)*	*Size at sexual maturity (Productivity)*	3	2	Size at sexual maturity data was not available for two of the secondary flathead species: the bartail flathead (*P. australis*) and the northern sand flathead (*P. endrachtensis*). Based on their maximum size (50cm and 46cm, respectively) it is likely that the *size at sexual maturity* for both species falls within the low-risk category

Species	Attribute	PSA Score	RRA Score	Justifications and Considerations
Northern sand flathead *(P. endrachtensis)*				(<40cm). In-keeping with the precautionary nature of ERAs, data for dusky flathead (*P. fuscus*) was used as a proxy for these species. ***Key changes to the PSA scores*** Default high (3) risk scores assigned to the *size at sexual maturity* attribute was reduced to medium (2). Given their maximum size, a medium rating may still represent a risk overestimation for this species. The decision to adopt a more precautionary score though was considered appropriate and in-line with the broader approach adopted as part of the Level 2 ERA. These changes were made in accordance with *Guideline 1: Risk rating due to missing, incorrect or out of date information.*
Garfish				
Snubnose garfish *(A. sclerolepis)* Three-by-two garfish *(H. robustus)*	*Management strategy (Susceptibility)*	3	1	The garfish complex is not managed under a quota or a minimum legal size limit and has a recreational in-possession limit of 50 fish. Due to these factors, the snubnose (*A. sclerolepis*) and three-by-two (*H. robustus*) garfish were assigned a high (3) preliminary risk score for *management strategy*. At a species complex level, garfish are a prominent component of the ECIF catch (*average* = 93t in the 2010-19 period, gillnet and ring net). However, data for garfish has poor species resolution with all catch classified as *unspecified* since 2010. Prior to this, catch reporting at the species level was infrequent and it provides an incomplete account of individual rates of harvest (*Garfish—snubnose* = <2t per year 2000-2009, gillnet and ring net). It is anticipated that snubnose garfish and three-by-two garfish make up a considerable component of the unspecified catch. While these species are not managed under a TACC limit, there are fewer concerns surrounding the sustainability of these species on the Queensland east coast. Research suggests that *Hemiramphidae* are fast-growing, serial spawners and they are likely to be more resilient to regional fishing pressures (Department of Agriculture and Fisheries, 2018f). Moreover, mesh sizes used in the Large Mesh Net Fishery will be more selective of size classes above the size of sexual maturity (18cm; Stewart *et al.*, 2005). This

Species	Attribute	PSA Score	RRA Score	Justifications and Considerations
				means that there is an increased probability that the fish will spawn prior to harvest. These factors suggest that garfish are less susceptible to overexploitation and are being managed effectively under a broader management framework. ***Key changes to the PSA scores*** Available data suggests that the management regime for these species, while less developed, is well suited to their biology and commensurate with the overexploitation risk. Accordingly, the risk score for *management strategy* was reduced to a low (1). The above changes were done in accordance with *Guideline 2: additional scientific assessment & consultation,* and *Guideline 5: effort and catch management arrangements for target and byproduct species.* While the risk score reduction is notable, it is unlikely that it will contribute to a false-negative result.
Snubnose garfish *(A. sclerolepis)* Three-by-two garfish *(H. robustus)*	*Recreational desirability / other fisheries (Susceptibility)*	3	3	While garfish were included in the *Statewide Recreational Fishing Survey*, they were assessed as part of a broader species grouping (Webley *et al.*, 2015; Teixeira *et al.*, 2021; Department of Agriculture and Fisheries, 2021). This grouping recorded a retention rate of >80% and both species were assigned a precautionary high (3) risk rating for the *recreational desirability* attribute. The popularity of garfish in the recreational sector is reflected in the moderate to large catches and increased targeting across periods. Recreational catch of *Garfish—unspecified* has increased since 2010 (65,492 caught in 2010–2011, 104,000 caught in 2013–2014; Webley *et al.*, 2015; Taylor *et al.*, 2012) but declined (83,000) in the latest recreational fishing survey (Teixeira *et al.*, 2021; Department of Agriculture and Fisheries, 2021). ***Key changes to the PSA scores*** No changes were made to the PSA scores but it is recognised that a high (3) risk rating may be too precautionary for one or both of these species. With improved information on catch compositions and fisher intentions, the risk rating for one or both of these species could be reduced. At present, a reduction in risk scores could not be justified given the broader popularity of these species, a general increase recreational

Species	Attribute	PSA Score	RRA Score	Justifications and Considerations
				interest across periods, and an inability to monitor species-specific catch/harvest rates effectively between and within years.
Snubnose garfish *(A. sclerolepis)* Three-by-two garfish *(H. robustus)*	*Selectivity (Susceptibility)*	3	2	The Large Mesh Net Fishery is managed under a range of input controls including minimum and maximum mesh size limits (Department of Agriculture and Fisheries, 2019f). These mesh size restrictions are designed to improve the selectivity of the apparatus and minimise the risk posed to regulated size classes. In the RRA, further consideration was given to how these mesh size restrictions relate to garfish selectivity. Garfish are relatively small species with an exaggerated length to width ratio. These factors combined with the use of mesh size restrictions mean that a proportion of the garfish that interact with a net will pass through the mesh opening. This will include smaller cohorts and juveniles approaching sexual maturity. These factors increase the probability that the garfish catch will consist of larger, sexually mature fish. From an ERA perspective, the above suggests that net selectivity for these species will be lower than most other teleosts in this assessment. ***Key changes to the PSA scores*** The risk score for *selectivity* was reduced to a medium (2). This amendment considers the morphology of these species and the management arrangements currently in place to manage selectivity. The above changes were done in accordance with *Guideline 5: effort and catch management arrangements for target and byproduct species.*
Three-by-two garfish *(H. robustus)*	*Age at sexual maturity (Productivity)* *Maximum age (Productivity)*	3	1	Garfish data including catch records is dominated by the snubnose garfish (*A. sclerolepis*). When compared, there is limited information on secondary species like the three-by-two garfish (*H. robustus*). This was reflected in the PSA where a number of the attributes were assigned precautionary high (3) risk ratings. While some inter-specific variability will exist, it is unlikely that the *age at sexual maturity*, *maximum age* and *size at sexual maturity* for the three-by-two garfish falls within the medium (2) or high (3) risk categories. As such, preliminary scores assigned to these three productivity attributes are considered to be an overestimate.

Species	Attribute	PSA Score	RRA Score	Justifications and Considerations
	Size at sexual maturity (Productivity)			***Key changes to the PSA scores*** Default high (3) risk scores assigned to the *age at sexual maturity, maximum age* and *size at sexual maturity* attributes were reduced to low (1). While this represents a notable score reduction, it is unlikely that these amendments will lead to a false-negative result. These changes were made in accordance with *Guideline 1: Risk rating due to missing, incorrect or out of date information* and *Guideline 2: additional scientific assessment & consultation.*
Javelin				
Barred javelin *(P. kaakan)* Silver javelin *(P. argenteus)*	*Management strategy (Susceptibility)*	3	3	Barred javelin *(P. kaakan)* and silver javelin *(P. argenteus)* are principally managed through individual MLS limits and in-possession limits (recreational fishing). MLS limits (40cm and 30cm, barred and silver javelin, respectively) are based on the size at sexual maturity (barred javelin, 28–46cm, silver javelin, 22–26cm; Bade, 1989; Begg, 1998) and increase the probability that a fish will spawn at least once before recruiting to the fishery. However, the management regime for both species does not include a mechanism to control catch or effort and they were assigned a high (3) preliminary risk score for *management strategy*. On the Queensland east coast, the javelin/grunter complex makes up a small but consistent component of the commercial large mesh net catch. The majority of the catch is reported as *Grunter—unspecified* and catch data for the complex has poor species resolution (Department of Agriculture and Fisheries, 2019f). While noting this deficiency, barred javelin are a more likely target in the Large Mesh Net Fishery. Annual commercial take of the complex has remained low and stable in recent years with an average of 22t reported from the Large Mesh Net Fishery each year since 2010 (Department of Agriculture and Fisheries, 2020c; 2019f). While MLS limits protect a proportion of the population prior to spawning, size at sexual maturity estimates for these species vary between studies (Bade, 1989; Szczecinski, 2012; Kulbicki *et al.*, 2009). Moreover, these species are known to be slow-growing and display aggregating behaviours; both of which increase their *susceptibility* risk (Szczecinski, 2012). It is understood that the Fisheries Working Group (FWG) reviewed

Species	Attribute	PSA Score	RRA Score	Justifications and Considerations
				current size limits and considered implementing a common javelin MLS (due to difficulties surrounding their identification). This situation though was not resolved and requires further consultation. In the absence of a stock assessment and indicative sustainability evaluations, there is limited information on the sustainability of javelin/grunter stocks and/or how current harvest rates compare to key biological reference points. This makes it difficult to ascertain if the risks posed to these species are being managed effectively under the current management regime. ***Key changes to the PSA scores*** No changes were made to the PSA scores but it is recognised that a high (3) risk rating may be too precautionary for these species. However, a score reduction could not be justified at this point in time given the current absence of output controls, monitoring and assessment information, and information on how the take of the species compares to key sustainability reference points. With the continued roll-out of the strategy there may be further avenues to review and (potentially) reduce this score.
Barred javelin *(P. kaakan)*	*Recreational desirability / other fisheries (Susceptibility)*	1	2	Recreational javelin catch for the Queensland east coast is dominated by barred javelin (*P. kaakan*) with the species recording a retention rate of 25–28% (Webley *et al.*, 2015; Teixeira *et al.*, 2021; Department of Agriculture and Fisheries, 2021). Based on this estimate, the species was assigned a low (1) risk rating for the *recreational desirability* attribute. The recreational sector makes a notable contribution to the annual barred javelin harvest and the recreational popularity of this species is reflected in catch estimates (134,889 caught 2010–2011, 329,000 caught 2013–2014, 192,000 caught in 2019–2021) (Department of Agriculture and Fisheries, 2021). Barred javelin is retained in higher quantities in this sector and is more readily retained when compared to silver javelin (21%). While a high proportion of the recreationally caught javelin are discarded, there is limited information on post-release survival rates. Catch data for this species also varies in terms of the numbers caught, retained and discarded. This combined with uncertainty surrounding post-release mortalities supports the adoption of a more conservative approach.

Species	Attribute	PSA Score	RRA Score	Justifications and Considerations
				While the species operates under a MLS limit (40cm), their size at sexual maturity varies between studies (Bade, 1989; Szczecinski, 2012). Moreover, these species are known to be slow-growing and display aggregating behaviours; both of which increase their *susceptibility* risk (Szczecinski, 2012). It is understood that a review of size limits by the Fisheries Working Group (FWG) considered the implementation of a common MLS across javelin species due to difficulties surrounding identification. This situation though was not resolved and requires further consultation. ***Key changes to the PSA scores*** Based on the available information, the preliminary scores assigned to the *recreational desirability / other fisheries* attribute was increased from low (1) to medium (2). This decision takes into consideration the proximity of retention rates to the medium-risk category, the popularity of this species, the absence of information regarding post-capture mortality in the presence of high discard rates, and the inability of current management to monitor recreational catch within and between years. The decision to increase the risk score was precautionary and it may represent an overestimate of risk. It does however align with the precautionary approach adopted for the Level 2 assessment and minimises the risk of the assessment producing a false-negative result. These changes were done in accordance with *Guideline 1: Risk rating due to missing, incorrect or out of date information* and *Guideline 2: additional scientific assessment & consultation.*
Barred javelin *(P. kaakan)*	*Maximum age (Productivity)*	3	2	Data of the maximum age of the barred javelin (*P. kaakan*) varied and the most conservative estimate was used in the PSA. This resulted in the species being assigned a high (3) risk score for the *maximum age* attribute. The maximum age (36 years) for barred javelin was based on a limited study from Kuwait (Alhusaini *et al.*, 2002). In the RRA, further consideration was given to data contained within a regional study (Szczecinski, 2012). This analysis places the maximum age of this species on the Queensland east coast at less than 20 years.

Species	Attribute	PSA Score	RRA Score	Justifications and Considerations
				Key changes to the PSA scores Default high (3) risk scores assigned to the *maximum age* attribute was reduced to a medium (2) to better align it with what is known about the Queensland east coast population. These changes were made in accordance with *Guideline 1: Risk rating due to missing, incorrect or out of date information* and *Guideline 2: additional scientific assessment & consultation.*
Barred javelin *(P. kaakan)* Silver javelin *(P. argenteus)*	*Age at sexual maturity (Productivity)*	3	2	Data deficiencies regarding the *age at sexual maturity* of both javelin species resulted in default high (3) risk scores. However, maximum ages for both species are expected to be below 20 years. This suggests that, while still precautionary in nature, the *age at sexual maturity* will fall within the medium-risk category. ***Key changes to the PSA scores*** Default high (3) risk scores assigned to *age at sexual maturity* was reduced to medium (2). While the decision to reduce this score is qualitative, it is unlikely to lead to a false-positive result. With additional information on the biology of these species, the score assigned to this attribute could potentially be reduced further. These changes were made in accordance with *Guideline 2: additional scientific assessment & consultation.*
Jewfish				
Black jewfish *(P. diacanthus)*	*Management strategy (Susceptibility)*	2	2	Black jewfish (*P. diacanthus*) are managed through a 20t TACC limit, minimum legal size restrictions, an in-possession limit (recreational fishing), fishery closures, and other input controls (Penny *et al.*, 2018b). On the Queensland east coast, the commercial take of this species is restricted by a 20t TACC limit and take of this species in any sector (commercial, charter and recreational) is not permitted once this limit has been reached (Department of Agriculture and Fisheries, 2019f). While the TACC limit is conservative, the species has not been the subject of a detailed stock assessment and there is limited information on stock biomass levels or reference points. This absence of data creates uncertainty surrounding the suitability of the catch limits

Species	Attribute	PSA Score	RRA Score	Justifications and Considerations
				and/or the performance of the fishery in relation to sustainability targets set out in the *Queensland Sustainable Fisheries Strategy 2017–2027* (Department of Agriculture and Fisheries, 2017). As noted, black jewfish cannot be retained in the commercial, recreational or charter fishing sectors once the TACC limit is reached. As the collective fishery will still interact with this species, a proportion of the landed black jewfish will need to be discarded. As the regulations are relatively new, there is limited information on how discard rates for black jewfish will change once the TACC limit is reached. Discarded individuals will be exposed to higher rates of post-capture mortality as the species is susceptible to barotrauma, predation *etc*. (Phelan, 2008; Tobin *et al.*, 2010). This suggests that the total rate of fishing mortality may be higher than what is reported across sectors within a given year. On the Queensland east coast, black jewfish catch is reported both as *Jewfish—unspecified* and *Jewfish—black* (Department of Agriculture and Fisheries, 2019f). Subsequent validation of species compositions indicate that the unspecified portion of the catch is dominated by black jewfish (Penny *et al.*, 2018b). Annual catch and effort for this species has increased exponentially in recent years. This increase is in direct response to a higher demand (and value) for black jewfish swim bladders (Penny *et al.*, 2018b). This increase was the primary driver behind the introduction of more restrictive management arrangements (Department of Agriculture and Fisheries, 2019e). ***Key changes to the PSA scores*** Changes to the black jewfish management regime represent a significant step forward in terms of risk management. At 20t, the TACC limit is conservative and will ensure that retention rates do not increase going into the future. For this reason, some consideration was given to reducing the score assigned to the *management strategy* attribute. However, the RRA needed to consider a number of additional factors including the amount of data that was available on stock biomass levels, key biomass reference points, discard rates, and cryptic mortalities. When the above deficiencies were taken into consideration, the decision was made to retain the preliminary risk scores. It is recognised that this may represent a precautionary assessment. A reduction in the risk score

Species	Attribute	PSA Score	RRA Score	Justifications and Considerations
				for this attribute though could not be justified at this point in time. As the above limitations are currently being addressed as part of the *Queensland Sustainable Fisheries Strategy 2017–2027* (Department of Agriculture and Fisheries, 2017), this score should be reviewed in light of any new information. *Note—Under the proposed harvest strategy, the ECIF will be subject to regional management and greater use of output controls. As a Tier 2 species, the management of regional black jewfish stocks will be influenced by this process.*
Black jewfish *(P. diacanthus)*	*Recreational desirability / other fisheries (Susceptibility)*	1	2	As retention rates for this species are below 33% it was assigned a low-risk (1) score in the *recreational desirability / other fisheries* attribute (Teixeira *et al.*, 2021; Department of Agriculture and Fisheries, 2021). In the RRA, further consideration was given to two risk factors that are not easily accounted for in the PSA: 1) the comparative value of this species and the increased potential for black marketing, and 2) how cryptic mortalities may increase the impact of this sector on regional stocks. The market value of black jewfish has increased exponentially with their swim bladders fetching >$600 per kilogram. While the sale of recreationally caught product is illegal, at these prices, there is an increased risk that fish will be sold on the black market. This risk was recognised in management changes introduced in September 2019 which included boat limits for nine priority black market species (Department of Agriculture and Fisheries, 2019e). While noting these changes, cost-per-kilogram for black jewfish bladders remains high and the black marketing of this product remains a relatively unquantified risk. In addition to the boat limits, the recreational and charter fishing sectors will be impacted by the introduction of a TACC limit. When this commercial limit is reached, retention of back jewfish is prohibited across all sectors. This measure will have a direct impact on the number of black jewfish that are harvested from non-commercial sectors and may result in higher discard rates. Research suggests that discarded jewfish experience higher rates of post-capture mortality due to their susceptibility to barotrauma, predation *etc*. (Phelan, 2008; Tobin *et al.*, 2010). These factors increase the likelihood that the species will experience

Species	Attribute	PSA Score	RRA Score	Justifications and Considerations
				cryptic mortalities; therefore contributing to the total rate of fishing mortality (retained plus discards in the commercial, charter and recreational fishing sectors). ***Key changes to the PSA scores*** Changes to the black jewfish management system are a significant step forward in terms of the management of the risk posed to this species in the ECIF. However, these measures are relatively new, and further time is required to determine their broader effectiveness at managing catch across sectors and addressing the risk posed by black marketing. The risk profile of this species would also benefit from additional information on post-interaction survival rates and how cryptic mortalities contribute to total rates of fishing mortality. For these reasons, the score assigned to the *recreational desirability / other fisheries* attribute was increased from a low (1) to medium (2). The decision to increase the score for this attribute was precautionary and minimises the risk of the Level 2 ERA producing a false-negative result. This change was done in accordance with *Guideline 2: additional scientific assessment & consultation and Guideline 5: effort and catch management arrangements for target and byproduct species.*
Silver jewfish *(N. soldado)*	*Management strategy (Susceptibility)*	3	3	When compared to black jewfish (*P. diacanthus*), the management regime for silver jewfish (*N. soldado*) is less developed. This is largely due to the fact that silver jewfish are not subjected to the same commercial fishing pressures. The take of this species is not regulated by size; however the recreational harvest of silver jewfish is accounted for in a general 20 fish in-possession limit (Fisheries Declaration 2019). As the management regime does not include a mechanism to control catch or effort, silver jewfish were assigned a high (3) preliminary risk score for *management strategy*. Catch composition data for jewfish has poor species resolution with the majority classified as *Jewfish—unspecified* (*average* = 12t, 2010–18 gillnet and ring net data). Black jewfish is expected to dominate this harvest, with silver jewfish and mulloway (*A. japonicus*) contributing smaller proportions. While silver jewfish are reported to the species level, this component of the catch is small and underestimates total harvest rates (*average* = 1t, 2010–18 gillnet and ring net data). The species has not been subject to a stock assessment or

Species	Attribute	PSA Score	RRA Score	Justifications and Considerations
				indicative sustainability evaluation. As a consequence, there is limited information on the sustainability of silver jewfish stocks and/or how current harvest rates compare to key biological reference points. ***Key changes to the PSA scores*** No changes were made to the PSA scores but it is recognised that a high-risk (3) rating may be precautionary for this species. However, a score reduction could not be justified for this species given the current absence of output controls, monitoring and assessment information, and information on how the take of the species compares to key sustainability reference points. These limitations are currently being addressed as part of the *Queensland Sustainable Fisheries Strategy 2017–2027* (Department of Agriculture and Fisheries, 2017).
Silver jewfish *(N. soldado)*	*Recreational desirability / other fisheries (Susceptibility)*	3	3	Silver jewfish (*N. soldado*) will be caught by recreational fishers, with estimates indicating that around 10,000 fish are caught annually. Harvest data for this species has high error margins and a low degree of confidence, therefore could not be used in the PSA. This issue was compounded by the fact that silver jewfish would contribute to the *unspecified* category (Teixeira *et al.*, 2021; Department of Agriculture and Fisheries, 2021). This uncertainty contributed to the species being assigned a precautionary high-risk (3) rating for the *recreational desirability / other fisheries* attribute. Evidence suggests that the recreational and charter fishing sectors catch and retain comparatively small amounts of silver jewfish. This by extension suggests that a high-risk (3) rating for this attribute may be an overestimation. While the overall catch of silver jewfish is expected to be low it is unclear how catch trends may change into the future and/or if risks posed to black jewfish (*P. diacanthus*) will transition to other species. For example, black jewfish is a popular species in the recreational fishing sector and is viewed as a high-risk species in terms of black marketing (Department of Agriculture and Fisheries, 2019e).

Species	Attribute	PSA Score	RRA Score	Justifications and Considerations
				In a situation that mirrors black jewfish, there is also limited information on how this species survives a recreational fishing event and post-interaction mortality rates. These reasons support the retention of the preliminary risk rating and the adoption of a more precautionary approach. ***Key changes to the PSA scores*** No changes were made to the PSA scores, and it is recognised that a high-risk (3) rating may be too precautionary for this species. With the continued roll-out of the *Queensland Sustainable Fisheries Strategy 2017–2027* and collection of additional information there may be further avenues to review and (potentially) reduce this score.
Mulloway *(A. japonicus)*	*Management strategy (Susceptibility)*	3	3	The take of mulloway (*A. japonicus*) is principally managed through a MLS limit, in-possession limits (recreational fishing) and other input controls (Earl *et al.*, 2018). The MLS (75 cm) is based on the size at sexual maturity (Silberschneider *et al.*, 2009) and increases the probability that a fish will spawn at least once before recruiting to the fishery. The management regime for mulloway does not include a mechanism to control catch and the species was assigned a high (3) preliminary risk score for *management strategy*. The majority of the mulloway catch is reported from the recreational fishing sector with around 98t harvested in 2013–2014 (Webley *et al.*, 2015). This compares to a commercial harvest of <10t (Earl *et al.*, 2018). The reported (commercial) catch of this species has increased since 2017 and it is unclear if this is an anomaly or an emerging trend. At a complex level, catch data for jewfish/mulloway has poor species resolution and the majority are reported as *unspecified*. While black jewfish (*P. diacanthus*) will be a key component of the *unspecified* catch, mulloway will contribute to this broader catch category. Additional monitoring, assessment, and management challenges are presented through the cross-jurisdictional nature of mulloway stocks. A species targeted in both Queensland and New South Wales (NSW), a weight-of-evidence approach currently classifies the southern (NSW) mulloway stock as *depleted* (Earl *et al.*, 2018). The *depleted* status of mulloway in NSW demonstrates the potential outcome of an under-

Species	Attribute	PSA Score	RRA Score	Justifications and Considerations
				managed stock. However, recent adjustments to the NSW management regime will provide valuable insight into developing best practice management for the species in Queensland waters. In the absence of a stock assessment, the most recent SAFS assessments classified the Queensland mulloway stock as *undefined* (Earl *et al.*, 2018). Without a stock assessment it is difficult to make an informed decision about the suitability of the current management regime and/or the need for management intervention. ***Key changes to the PSA scores*** No changes were made to the PSA scores but it is recognised that a high-risk (3) rating may be too precautionary for this species. A score reduction could not be justified for mulloway given the current absence of output controls and biomass reference points. The potential for effort to shift towards this species (*e.g.*) due to increased market demand is viewed as a notable risk factor. With the continued roll-out of the strategy there may be further avenues to review and (potentially) reduce this score in future ERAs.
Mulloway *(A. japonicus)*	*Recreational desirability / other fisheries (Susceptibility)*	2	3	The majority of the Queensland mulloway catch is caught by recreational fishers, with the sector registering retention rates of around 33% (Webley *et al.*, 2015; Department of Agriculture and Fisheries, 2020c). While recreational estimates could be calculated in previous surveys (38,163 caught 2010–2011, 51,000 caught 2013–2014), data from the most recent survey had a low level of confidence and could not be used (Teixeira *et al.*, 2021; Department of Agriculture and Fisheries, 2021). As catch increased over the past two survey periods, this absence of data supported the assignment of a more precautionary score. Evidence from previous assessments indicate that the majority of the mulloway catch will be discarded (Webley *et al.*, 2015; Taylor *et al.*, 2012; Department of Agriculture and Fisheries, 2020c). This is significant as mulloway are susceptible to barotrauma and a proportion of this catch will be discarded in a dead or moribund state (Hughes & Stewart, 2013). This will lead to a higher number of cryptic mortalities and contribute to total rates of fishing mortality.

Species	Attribute	PSA Score	RRA Score	Justifications and Considerations
				Outside of post-release mortalities, there is an increased risk that the marketability of this species may follow a similar trend to black jewfish (*P. diacanthus*). As black jewfish are now the subject of more stringent management arrangements, there is a possibility that effort previously targeted at this species will be transferred to mulloway. This is most likely to occur if/when the black jewfish TACC limit is reached and becomes a no-take species across sectors. If this were to occur it may exacerbate the impact of this sector on mulloway and/or the risk posed by black marketing. ***Key changes to the PSA scores*** Based on the available information, the score assigned to the *recreational desirability / other fisheries* attribute was increased from medium (2) to high (3). This decision was based on previous increases in recreational catch, uncertainty in the current recreational estimate, an increased risk of cryptic mortality, and cumulative fishing pressures (commercial, recreational and charter) potential. This decision is precautionary but was considered an appropriate course of action as it minimises the risk of a false-negative result. This change was done in accordance with *Guideline 2: additional scientific assessment & consultation and Guideline 5: effort and catch management arrangements for target and byproduct species.*
Mackerel				
Grey mackerel *(S. semifasciatus)*	*Management strategy (Susceptibility)*	2	2	The catch of grey mackerel (*S. semifasciatus*) on the Queensland east coast is regulated through a 250t TACC limit (Department of Agriculture and Fisheries, 2019f). While the management regime for grey mackerel includes a TACC, the responsiveness of this system is limited. For example, the grey mackerel management strategy includes business rules that restrict retention rates if/when the fishery approaches the TACC limit. These rules though do not include a mechanism that prevents people from fishing for and retaining grey mackerel once the TACC limit is reached. This means that fishing for grey mackerel, albeit limited, could still occur even if the TACC limit is exceeded. This issue is compounded by the fact that discards and recreational grey mackerel catch are not included in the current TACC limit. For these reasons,

Species	Attribute	PSA Score	RRA Score	Justifications and Considerations
				the PSA assessed *management strategy* as a medium (2) risk instead of low (1). In the RRA, further consideration was given to the appropriateness of this score and the potential for it to be downgraded. The sustainability of the east coast grey mackerel stock has been confirmed through a detailed stock assessment (Bessell-Browne *et al.*, 2019) and indicative sustainability evaluations (Helmke *et al.*, 2018). Of notable importance, these assessments considered fishing activities / harvest rates in the commercial, recreational and charter fishing sectors. Based on the available data, the stock assessment indicated that the combined (commercial plus recreational) MSY for this species sits around 122t for the north east stock and 105t for the south-east stock. This compares to a combined annual harvest rate of 82t in the north east and 71t in the south east (2013–2018) (Bessell-Browne *et al.*, 2019). The biomass of the north-east and south-east stocks are estimated to be at 48% and 51% of the unfished biomass respectively. At the current exploitation rates, the stock will take (approximately) 8 years to reach the B_{60} target outlined in the *Queensland Sustainable Fisheries Strategy 2017–2027*. This inference though assumes that a) current harvest levels remain the same, and b) discards are making a comparatively small contribution to the total rate of fishing mortality. Confirmation of stock sustainability through quantitative assessments and a weight-of-evidence approach suggest that the risk posed to this species is being managed within the current fishing environment. The available data indicates that the fishery is being fished below MSY harvest and stock health will improve further under the current fishing conditions. The notable caveat to this being that, with the current in-possession limit triggered by allocation exhaustion, catch and effort can increase and potentially exceed MSY. While difficult to quantify, confounding issues including cryptic mortality may also reduce the effectiveness of key measures such as the minimum legal size limit and TACC limit. ***Key changes to the PSA scores*** A weight-of-evidence approach suggests that the risk of overexploitation for grey mackerel is being managed within the current fishing environment. There are however areas within the current management regime that increase the level of risk for this species. This includes exceeding the designated TACC limit and the

Species	Attribute	PSA Score	RRA Score	Justifications and Considerations
				(current) inability to address a quota overrun. Given these limitations, the preliminary risk score for this attribute was retained. It is however an area where risk will continue to be reduced as part of the harvest strategy development process. As this proceeds, further review of this score may be required. *Note—Under the proposed harvest strategy, the ECIF will be subject to regional management and greater use of output controls. As a Tier 1 species, the management of regional grey mackerel stocks will likely move to a more complex system of output controls.*
Grey mackerel *(S. semifasciatus)*	*Recreational desirability / other fisheries (Susceptibility)*	3	3	While grey mackerel (*S. semifasciatus*) were included in the *Statewide Recreational Fishing Survey*, estimates were relatively small (*n* = 5,000 caught) and had a medium level of confidence. As recreational data was unavailable for the species prior to the recent assessment (Teixeira *et al.*, 2021; Department of Agriculture and Fisheries, 2021; Webley *et al.*, 2015), no inferences could be drawn on the extent of any inter-survey variability. Grey mackerel are not considered to be a key target in the recreational and charter fishing sectors but will be caught and retained while targeting other pelagic species. At a sector level, it is anticipated that a proportion of grey mackerel will be discarded in a dead or moribund state and that cryptic mortalities will contribute to the total rates of fishing mortality. A moderate to high discard mortality may limit the effectiveness of size and in-possession limits and will exacerbate any cumulative fishing pressures. Discard mortality remains unknown for the species, though is assumed to be at least 50% in the grey and Spanish mackerel stock assessment (Bessell-Browne *et al.*, 2019; O'Neill *et al.*, 2018). The above factors contributed to the species receiving a high-risk rating as part of the PSA. ***Key changes to the PSA scores*** No changes were made to the PSA scores however a high-risk (3) rating may be too precautionary for this species. Additional information on recreational catch rates, within and between year catch variability, and discard mortality may facilitate a reduction in risk scores in future ERAs.

Species	Attribute	PSA Score	RRA Score	Justifications and Considerations
Spotted mackerel *(S. munroi)*	*Management strategy (Susceptibility)*	2	2	Spotted mackerel (*S. munroi*) are managed through a 140t TACC limit and a commercial net fishing in-possession limit of 50 fish (while TACC usage is <100t). Once the TACC usage exceeds 100t, the in-possession limit reduces to 15 fish. These catch limits are supported by MLS limit and in-possession limits for recreational fishers (Litherland *et al.*, 2018b). The MLS limit (60cm) is based on the size at sexual maturity (52–60cm; Begg *et al.*, 2005) and increases the probability that a fish will spawn at least once before recruiting to the fishery. Management limitations for spotted mackerel are similar to that reported for grey mackerel in that there is no overarching rule that prohibits their take once the quota limit is reached. Instead, in-possession limits are used to restrict their take as the TACC limit is reached and/or exceeded. Risks relating to a potential TACC overrun are compounded by the absence of mechanisms to redress a quota overrun in subsequent years. For these reasons, the species was assessed as a medium (2) risk for the *management strategy* attribute. The sustainability of the Queensland stocks have been confirmed through a detailed stock assessment (Bessell-Browne *et al.*, 2018) and indicative sustainability evaluations (Litherland *et al.*, 2018b). Of notable importance, these assessments considered fishing activities / harvest rates in the commercial, recreational and charter fishing sectors. Spotted mackerel is a moderately targeted recreational teleost and this sector accounts for around 45% of the total spotted mackerel catch (Bessell-Browne *et al.*, 2018). The stock assessment indicated that the combined MSY harvest for this species sits around 215t (all sectors and jurisdictions). This compares to a combined annual harvest rate of between 114–207t (2009–2017) (Bessell-Browne *et al.*, 2018). Current biomass estimates sit between 40–60% of the unfished biomass and are likely to build under current rates of harvest. In terms of the *Queensland Sustainable Fisheries Strategy 2017–2027*, research suggests that a combined harvest (commercial plus recreational) of 80–120t per year is required to reach the long-term objective of B_{60} (Department of Agriculture and Fisheries, 2017). Outputs of the stock assessment indicate that the risk posed to this species is being managed within the current fishing environment. Stocks are being fished below MSY and stock health will improve under current fishing conditions. The notable caveat being that catch and effort could increase and potentially exceed MSY

Species	Attribute	PSA Score	RRA Score	Justifications and Considerations
				even with the use of a TACC limit. While difficult to quantify, confounding issues including cryptic mortality may also reduce the effectiveness of key measures such as the MLS limit and TACC limit. ***Key changes to the PSA scores*** A weight-of-evidence approach suggests that the risk of overexploitation for spotted mackerel is being managed on the Queensland east coast. As there are areas within the current management regime that increase the level of risk for this species, the preliminary risk score was retained for this attribute. This risk however will be addressed as part of the harvest strategy development process. As this process proceeds, further review of this score will be required.
Spotted mackerel *(S. munroi)*	*Recreational desirability / other fisheries (Susceptibility)*	3	3	Spotted mackerel (*S. munroi*) are retained in the recreational fishing sector and the species was assigned a high-risk (3) rating for the *recreational desirability / other fisheries* attribute (Teixeira *et al.*, 2021; Department of Agriculture and Fisheries, 2021). East coast catch and harvest rates have remained relatively steady (60–70%) across survey periods (Webley *et al.*, 2015; Taylor *et al.*, 2012; Teixeira *et al.*, 2021; Department of Agriculture and Fisheries, 2021). However, mortality rates are likely to be higher than what is recorded *i.e.* a proportion of the discarded fish will be in a dead or moribund state. The extent of these cryptic mortalities will be tempered by the (high) rates of retention. ***Key changes to the PSA scores*** No changes were made to the PSA scores. It is however recognised that a high-risk (3) rating may be too precautionary for this species. Additional information on recreational catch rates, within and between year variability, and discard mortalities may facilitate a score reduction for this attribute.
School mackerel *(S. queenslandicus)*	*Management strategy (Susceptibility)*	3	2	School mackerel (*S. queenslandicus*) are managed through a MLS limit and in-possession limits that control their take in the recreational fishing sector. The MLS limit (50cm) is based on their size at sexual maturity (40–51 cm; Begg, 1998) and increases the probability that a fish will spawn at least once before recruiting to

Species	Attribute	PSA Score	RRA Score	Justifications and Considerations
				the fishery. As the management regime for school mackerel does not include a mechanism to control catch and effort, the species was assigned a high (3) preliminary risk score for *management strategy*. The sustainability of the Queensland stock has been confirmed through a detailed stock assessment (Lovett *et al.*, 2019) and indicative sustainability evaluations (Litherland *et al.*, 2018c). These assessments considered fishing activities / harvest rates in the commercial, recreational and charter fishing sectors. Based on the available data, the stock assessment indicated that the MSY for school mackerel sits at 104–119t. This compares to a combined annual harvest rate (commercial plus recreational, across sectors) of 98t (2013–2017) (Lovett *et al.*, 2019). Importantly, estimates place the stock at around 65% of the unfished biomass which is above long-term targets set out in the *Queensland Sustainable Fisheries Strategy 2017–2027* (Department of Agriculture and Fisheries, 2017). With harvest rates for this species sitting at or below MSY, this situation is unlikely to change over the short to medium term. Confirmation of stock sustainability through qualitative assessments and a weight-of-evidence approach suggest that the risk posed to this species is being managed effectively. The available data indicates that the school mackerel are being fished at current target indicators and stock health should be maintained under the current fishing conditions. This situation, while similar to spotted (*S. munroi*) and grey mackerel (*S. semifasciatus*), differs in that the standing biomass of school mackerel is much higher. This is despite the species not being managed under a TACC limit. This was given considerable weighting as part of the RRA. ***Key changes to the PSA scores*** While school mackerel are not managed under a TACC limit, a weight-of-evidence approach suggests that the risk of overexploitation is being managed on the Queensland east coast. As a result, the risk score for the *management strategy* attribute was reduced to a medium (2). This change was done in accordance with *Guideline 2: additional scientific assessment & consultation,* and *Guideline 5: effort and catch management arrangements for target and byproduct species.* As the fishery continues to operate without a cap on catch or effort, further reductions in the risk score were not supported. Outputs from the stock assessment though

Species	Attribute	PSA Score	RRA Score	Justifications and Considerations
				indicate that this species is in a much better position in terms of absorbing increased fishing pressures due to it having a standing biomass of approximately 65% of an unfished stock (Lovett *et al.*, 2019).
School mackerel *(S. queenslandicus)*	*Recreational desirability / other fisheries (Susceptibility)*	3	3	School mackerel (*S. queenslandicus*) are a moderately targeted and frequently retained teleost within the recreational fishing sector (Teixeira *et al.*, 2021; Department of Agriculture and Fisheries, 2021; Webley *et al.*, 2015). The east coast catch has fluctuated through time but shown a general increase across survey periods (54,422 caught 2010–2011, 31,999 caught 2013–2014, 58,831 caught 2019–2020). This species, as with other mackerels, will experience cryptic mortalities and a proportion of the school mackerel will be discarded in a dead or moribund state. ***Key changes to the PSA scores*** No changes were made to the PSA scores however a high-risk (3) rating may be too precautionary for this species. Additional information on recreational catch rates, within and between year catch variability and discard mortality may facilitate a reduction in risk scores in future ERAs.
<u>Mullet</u>				
Sea mullet *(M. cephalus)*	*Management strategy (Susceptibility)*	3	1	Sea mullet (*M. cephalus*) are managed through a MLS limit, in-possession limits (recreational fishing), limited licencing and various other input controls (Stewart *et al.*, 2018). The MLS limit (30cm) is based on the size at sexual maturity (25–45cm; Smith & Deguara, 2002) and increases the probability that a fish will spawn at least once before recruiting to the fishery. As the management regime for sea mullet does not include a mechanism to control catch or effort, it was assigned a high (3) preliminary risk score for *management strategy*. East coast mullet stocks are targeted by commercial fisheries in Queensland and New South Wales, however cross-jurisdictional comparisons highlight significant differences in commercial catch and effort (65% and 35%, respectively) (Stewart *et al.*, 2018). On the Queensland east coast, the majority of the sea mullet catch is reported from the Ocean Beach Fishery. This sector of the ECIF utilises a beach seine to target schools of

Species	Attribute	PSA Score	RRA Score	Justifications and Considerations
				mullet and it will be the key driver of risk for this species (Jacobsen *et al.*, 2021b). While sea mullet is caught in the Large Mesh Net Fishery, it is retained in smaller quantities. Similarly, recreational fishers retain smaller quantities of mullet including for use as bait (Lovett *et al.*, 2018; Department of Agriculture and Fisheries, 2021). The sustainability of the entire east coast stock has been confirmed through multiple stock assessments (Lovett *et al.*, 2018) and indicative sustainability evaluations (Stewart *et al.*, 2018). The species has a long catch history in Queensland and reductions in nominal effort, coupled with favourable biomass estimates (50%, 2016), has the fishery meeting key sustainability targets under the *Queensland Sustainable Fisheries Strategy 2017–2027* (Lovett *et al.*, 2018; Stewart *et al.*, 2018). While further reductions in catch and effort may be required to achieve the long-term objective of 60% biomass, this target aligns more closely with MEY. ***Key changes to the PSA scores*** While sea mullet is not managed under a TACC limit, a weight-of-evidence approach suggests that the risk of overexploitation is being managed on the Queensland east coast. As a result, the risk score for the *management strategy* attribute was reduced to a low (1). This change was done in accordance with *Guideline 2: additional scientific assessment & consultation,* and *Guideline 5: effort and catch management arrangements for target and byproduct species.* The RRA reduction for sea mullet is larger than that prescribed for other species. This is due to the species having an extensive history of catch monitoring and positive sustainability assessments. *Note—Under the proposed harvest strategy, the ECIF will be subject to regional management and greater use of output controls. As a Tier 2 species, the management of regional sea mullet stocks will likely move to output controls e.g. a TACC limit.*

Species	Attribute	PSA Score	RRA Score	Justifications and Considerations
Bluespot mullet *(V. seheli)* Fantail mullet *(P. georgii)* Diamondscale mullet *(L. vaigiensis)*	*Management strategy (Susceptibility)*	3	1	The majority of fishing effort for *Muglidae* is directed at sea mullet with the bluespot (*V. seheli*), fantail mullet (*P. georgii*) and diamondscale (*L. vaigiensis*) mullet all making smaller contributions to the total mullet catch. Catch of these secondary species is largely listed as part of the *Mullet—unspecified* catch category (Department of Agriculture and Fisheries, 2020c; 2019f). Management strategies for secondary mullet species are less developed and, as with sea mullet (*M. cephalus*), they are not subject to commercial catch or effort limits. For this reason, all three were assigned a high (3) preliminary risk score for *management strategy*. Given their morphological and biological similarities, sea mullet is considered a good indicator species for this complex. Sea mullet attracts the majority of the catch/effort and stock sustainability has been confirmed through a variety of mechanisms (Lovett *et al.*, 2018; Stewart *et al.*, 2018). As secondary mullet species make a lower contribution to the total catch, it is likely that regional stocks will display the same resilience to fishing pressures. ***Key changes to the PSA scores*** Following consultation with Fisheries Management, preliminary risk scores for the *management strategy* attribute were reduced to low (1) for all secondary mullet species. This change was done in accordance with *Guideline 2: additional scientific assessment & consultation, Guideline 5: effort and catch management arrangements for target and byproduct species,* and *Guideline 7: management arrangements relating to seasonal spatial and depth closures.*
Sea mullet *(M. cephalus)* Bluespot mullet *(V. seheli)*	*Recreational desirability / other fisheries (Susceptibility)*	3	2	While the listed species were included in the *Statewide Recreational Fishing Survey*, the majority were assessed as a species grouping (58% retention, high confidence) (Webley *et al.*, 2015; Teixeira *et al.*, 2021; Department of Agriculture and Fisheries, 2021). This absence of species-specific data resulted in all four species being assigned a high (3) risk score for the *recreational desirability / other fisheries* attribute. Further investigation of recreational surveys and charter fishery data indicated that the listed species were less likely

Species	Attribute	PSA Score	RRA Score	Justifications and Considerations
Fantail mullet *(P. georgii)* Diamondscale mullet *(L. vaigiensis)*				to be at risk from cumulative fishing pressures. The adjusted scores were based on a combination of the following factors: • Minimum legal size limits that are aligned reasonably well with the biology of these species; • Recreational survey data showing that the species/complex are caught and retained in (comparatively) smaller quantities; • Charter data for the most recent three calendar years indicated that the species/complex are retained in smaller quantities; • Consultation with Fisheries Monitoring scientists indicates that the species/complex are caught and retained in fewer numbers; and • These species are more inclined to be caught and used as bait. ***Key changes to the PSA scores*** Default high-risk (3) scores assigned to the *recreational desirability* attribute for the listed species were reduced to medium (2). The revised score is based on the recreational fishing data which shows retention rates for the complex sit at around 58%. It is recognised that this score may still represent an overestimate for some species and that individual retention rates are likely to be <33%. This however is difficult to confirm without additional information on recreational catch compositions. These changes were done in accordance with *Guideline 1: risk rating due to missing, incorrect or out of date information* and *Guideline 2: additional scientific assessment & consultation.*
Bluespot mullet *(V. seheli)* Fantail mullet *(P. georgii)*	*Sustainability assessments (Susceptibility)*	3	1	As noted, the majority of effort is targeted at sea mullet (*M. cephalus*). Sea mullet has been the subject of numerous stock assessments and indicative sustainability evaluations (Virgona *et al.*, 1998; Lovett *et al.*, 2018; Stewart *et al.*, 2018; Department of Primary Industries, Undated). These studies have shown that this species is being fished sustainably and has been for a considerable period of time. In the RRA, some consideration was given to the suitability and applicability of the *sustainability* scores assigned to bluespot mullet (*V. seheli*), the fantail mullet (*P. georgii*), the goldspot mullet (*L. argentea*) and the diamondscale

Species	Attribute	PSA Score	RRA Score	Justifications and Considerations
Diamondscale mullet *(L. vaigiensis)*				mullet (*L. vaigiensis*). The premise being that if sea mullet is being fished sustainably then there is a high probability that the four remaining secondary species are also fished sustainably. The challenge with the secondary mullet species is that they are unlikely to be caught in quantities that make them stock assessment priorities and/or in need of an indicative sustainability evaluation. This situation is unlikely to change in the short to medium term unless there is a shift in species compositions and a reduction in the dominance of sea mullet. While the sustainability of secondary mullet stocks is difficult to quantify, productivity scores for this complex suggest that they can withstand higher rates of fishing mortality. To this extent, they are likely to display a similar resilience to regional fishing pressures. ***Key changes to the PSA scores*** Default high-risk (3) scores assigned to the *sustainability assessments* attribute were reduced to low (1) based on recommendations made during expert consultation and the current understanding of sea mullet resilience. While the decision to reduce this attribute score was qualitative in nature, it is not expected to result in a false-negative result. These changes were done in accordance with *Guideline 1: risk rating due to missing, incorrect or out of date information* and *Guideline 2: additional scientific assessment & consultation.*
Sea mullet *(M. cephalus)*	*Maximum size (Productivity)*	2	1	Reports on the maximum size for sea mullet (*M. cephalus*) varied, with some estimating it to be as high as 120cm (Froese & Pauly, 2019). In the PSA, the highest reported estimate was used as the basis of the *maximum size* attribute. In the RRA, further consideration was given to the suitability of this score, its relevance to the fishery on the Queensland east coast, and maximum size estimates reported across the two jurisdictions: NSW = approx. 75cm total length; QLD = 91cm total length (Department of Primary Industries, Undated; Queensland Government, 2018c). When these factors were taken into consideration, it was determined that the two jurisdictional estimates provided a better representation of what was occurring on the Queensland east coast (Lovett *et al.*, 2018; Smith & Deguara, 2002; Stewart *et al.*, 2018).

Species	Attribute	PSA Score	RRA Score	Justifications and Considerations
				Key changes to the PSA scores The score assigned to the *maximum size* attribute was reduced from medium (2) to low (1). This score better reflects what is known about the stocks on the Queensland east coast and it was viewed as a more appropriate estimate for this attribute. Changes were done in accordance with *Guideline 1: rating due to missing, incorrect or out of date information* and *Guideline 2: additional scientific assessment & consultation.*
Fantail mullet (*P. georgii*) Diamondscale mullet *(L. vaigiensis*)	*Age at sexual maturity (Productivity)*	3	1	A number of the mullet species included in the Level 2 ERA are secondary targets and, when compared to sea mullet (*M. cephalus*), are harvested in smaller quantities. The dominance of sea mullet is reflected in the amount of biological information that is available for this species. Conversely, biological information on the remaining species is more limited. Due to these data deficiencies, two of the four mullet species were assigned a precautionary high-risk (3) rating for the *age at sexual maturity* attribute. As significant interspecific variability is unlikely in this complex, preliminary scores assigned to the *age at sexual maturity* attribute were viewed as an overestimate. ***Key changes to the PSA scores*** *Age at sexual maturity* estimates for sea mullet were used as a proxy for the fantail mullet (*P. georgii*) and the diamondscale mullet (*L. vaigiensis*). Based on the best available information, sea mullet attains sexual maturity in 2–4 years (Smith & Deguara, 2002; Lovett *et al.*, 2018). When incorporated into the risk profiles of these two species, scores assigned to this attribute were reduced from high (3) to low (1). These changes were done in accordance with *Guideline 1: rating due to missing, incorrect or out of date information* and *Guideline 2: additional scientific assessment & consultation.*
Fantail mullet (*P. georgii*) Diamondscale mullet *(L. vaigiensis*)	*Maximum age (Productivity)*	3	2	The situation surrounding *maximum age* is similar to *age at sexual maturity* in that the fantail (*P. georgii*) and diamondscale (*L. vaigiensis*) mullet were assigned a precautionary high-risk (3) rating due to data deficiencies. Anecdotal evidence suggests that the biology of these species will not differ markedly from sea

Species	Attribute	PSA Score	RRA Score	Justifications and Considerations
				mullet (*M. cephalus*) and that maximum age will be lower than 25 years. Accordingly, the maximum age reported for sea mullet (16 years) was used as a proxy for these two species. ***Key changes to the PSA scores*** With sea mullet used as a proxy for *maximum age*, scores assigned to this attribute were reduced from high (3) to medium (2). These changes were done in accordance with *Guideline 1: rating due to missing, incorrect or out of date information* and *Guideline 2: additional scientific assessment & consultation.*
Fantail mullet (*P. georgii*) Diamondscale mullet *(L. vaigiensis*)	*Size at sexual maturity (Productivity)*	3	2	The fantail (*P. georgii*) and diamondscale (*L. vaigiensis*) mullet received a precautionary high-risk score (3) for *size at sexual maturity* in the PSA due to data deficiencies. In the RRA, this attribute was reassessed using data on the size at sexual maturity for sea mullet (*M. cephalus*). ***Key changes to the PSA scores*** Scores assigned to the s*ize at sexual maturity* attribute were reduced from high (3) to medium (2). These changes were largely done in accordance with *Guideline 1: rating due to missing, incorrect or out of date information.* In this instance, sea mullet was used as the proxy.
<u>Queenfish</u>				
Giant queenfish *(S. commersonnianus)*	*Management strategy (Susceptibility)*	3	3	While queenfish are readily retained in the Large Mesh Net Fishery, the majority of this catch will be reported with generic identifiers like *Queenfish—unspecified* (Department of Agriculture and Fisheries, 2020c; 2019f). This catch is likely to include a mixture of species but be dominated by the giant queenfish (*S. commersonnianus*). Secondary species like the lesser (*S. lysan*) needleskin (*S. tol*) and barred (*S. tala*) queenfish will make smaller contributions to the total queenfish catch (*pers. comm.* M. Keag; T. Ham). This catch differential is one of the reasons why the giant queenfish was prioritised for assessment. As the management of species does not include a mechanism to control catch or effort it was assigned a high (3) preliminary risk score for *management strategy*.

Species	Attribute	PSA Score	RRA Score	Justifications and Considerations
				Giant queenfish are primarily managed through a MLS limit and in-possession limits for recreational fishers. The MLS limit for the giant queenfish (50cm) sits above the size at sexual maturity for males (~40cm; Griffiths *et al.*, 2005) but below that of females (63cm FL; Griffiths *et al.*, 2006). As a consequence, the MLS may not sufficiently protect a proportion of the spawning population prior to harvest. This is a risk factor that would extend beyond the commercial sector to the recreational and charter fishing sectors. While a larger proportion of the recreational catch will be discarded, current knowledge of post-interaction mortality rates is limited. As such, total fishing mortality for this species may be higher than is reported through the logbook program and recreational fisher surveys. In the absence of a stock assessment and indicative sustainability evaluations, there is limited information on the sustainability of queenfish stocks and/or how current harvest rates compare to key biological reference points. This makes it difficult to ascertain if the risks posed to the species are being managed effectively under the current management regime. ***Key changes to the PSA scores*** No changes were made to the PSA score but it is recognised that a high-risk (3) rating may be precautionary for this species. A score reduction could not be justified at this point in time given the lack of output controls, monitoring/assessment data and information on how the take of the species compares to key sustainability reference points. Improving the level of information on these parameters would allow for a more accurate assessments on the suitability of current management arrangements.
Giant queenfish *(S. commersonnianus)*	*Recreational desirability / other fisheries (Susceptibility)*	3	2	While giant queenfish (S*. commersonnianus*) was included in the *Statewide Recreational Fishing Survey*, the species was assessed as part of a broader species grouping (Teixeira *et al.*, 2021; Department of Agriculture and Fisheries, 2021). In the absence of species-specific data, the giant queenfish received a precautionary high-risk (3) rating for the *recreational desirability / other fisheries* attribute. Recreational estimates for the queenfish complex has fluctuated (25,048 caught 2010–2011, 52,000 caught 2013–2014; 33,000 caught in 2019–2020); although harvest rates have remained between 20 and 30%

Species	Attribute	PSA Score	RRA Score	Justifications and Considerations
				(Taylor *et al.*, 2012; Webley *et al.*, 2015; Teixeira *et al.*, 2021; Department of Agriculture and Fisheries, 2021). The above trends suggest that discard rates for the giant queenfish would be proportionately high. Current knowledge on the discard mortality of queenfish is limited but cumulative cryptic mortalities are viewed as a risk factor for this species. For giant queenfish, these mortalities would come in the form of predation and/or the discarding of fish in a dead/moribund state. ***Key changes to the PSA scores*** Cumulative fishing pressures for this species are expected to be lower than what was presented in the PSA. The score assigned to the *recreational desirability / other fisheries* attribute was reduced from high (3) to medium (2) as part of the RRA. This change better reflects retention rate data for the queenfish complex and provides a better representation of the situation on the Queensland east coast. While further score reductions were considered (*i.e.* to low), this approach was not supported given current limitations in the catch composition data and uncertainty surrounding post-interaction mortality rates. With additional information, this score could be reduced in future ERAs. The above change was done in accordance with *Guideline 2: additional scientific assessment & consultation*.
<u>Rabbitfish</u>				
Scribbled rabbitfish *(S. spinus)*	*Management strategy (Susceptibility)*	3	3	The commercial take of scribbled rabbitfish (*S. spinus*) is managed at a whole-of-fishery level (spatial closures, mesh size restrictions *etc*.) with the recreational take principally managed through a general in-possession limit (*n* = 20) (State of Queensland, 2019). The management regime for this species does not include a minimum legal size limit or a mechanism to control catch and effort. This was reflected in the preliminary score assigned to the *management strategy* attribute. In the Large Mesh Net Fishery, scribbled rabbitfish are considered to be a byproduct species with operators reporting low but fluctuating catches (1–10t) (Department of Agriculture and Fisheries, 2020c; 2019f). The species was retained in higher quantities in the pre-2000 period where the average annual catch was closer to 60t. While difficult to quantify, this downward trend is likely the result of management and reporting

Species	Attribute	PSA Score	RRA Score	Justifications and Considerations
				changes *verse* declining catch. This is because the Tunnel Net Fishery retains higher quantities of scribbled rabbitfish and this sector of the ECIF would be responsible for a large proportion of the pre-2000 catch. Current catch rates make the scribbled rabbitfish a low priority in terms of their transition to output controls and the development of a detailed stock assessment. However, a weight-of-evidence approach suggests that the risk posed to this species is being managed within the Large Mesh Net Fishery. This inference though has yet to be fully tested and there is limited information on how harvest rates compare to key biological reference points. ***Key changes to the PSA scores*** No changes were made to the PSA scores but it is recognised that a high-risk (3) rating may be too precautionary for this species. With further information on catch compositions, harvest rates and discards, the score assigned to this attribute could be reduced in future ERAs. This process would also benefit from additional information on the status or health of regional stocks. Given the low priority of the species, an indicative sustainability evaluation should be prioritised over a quantitative stock assessment.
Scribbled rabbitfish *(S. spinus)*	*Recreational desirability / other fisheries (Susceptibility)*	3	1	While scribbled rabbitfish were included in the *Statewide Recreational Fishing Survey* (*S. spinus*), they were assessed as part of a broader *Siganus* complex (Webley *et al.*, 2015; Teixeira *et al.*, 2021; Department of Agriculture and Fisheries, 2021). As no species-specific data were available, the scribbled rabbitfish was assigned a precautionary high-risk (3) rating for the *recreational desirability / other fisheries* attribute. There is limited information on the recreational catch of scribbled rabbitfish, however, the available data suggests very low catches and negligible harvests (Teixeira *et al.*, 2021; Department of Agriculture and Fisheries, 2021). This may be partly due to the venomous nature of the spines on the scribbled rabbitfish. Catch and retention rates for the *Siganus* complex suggest that the PSA overestimates the cumulative risk posed to this species.

Species	Attribute	PSA Score	RRA Score	Justifications and Considerations
				Key changes to the PSA scores The preliminary score assigned to the *recreational desirability / other fisheries* attribute was considered to be an overestimate and reduced to low (1). This decision was based on the broader complex having low catches and low retention rates (Department of Agriculture and Fisheries, 2021). It is recognised that mortality rates will be higher than what is reported through the surveys *e.g.* post-release mortalities, predation. Cryptic/unreported mortalities though were not viewed as sufficient justification to allocate a higher risk rating. While the decision to reduce the *recreational desirability* score was qualitative, it is unlikely to result in a false-negative result. This change was done in accordance with *Guideline 2: additional scientific assessment & consultation.*
Scribbled rabbitfish *(S. spinus)*	*Maximum age (Productivity)*	3	1	There is limited information on the age and growth of the scribbled rabbitfish (*S. spinus*) though its biology is expected to be similar to other species in the genus. Research on the forktail rabbitfish (*S. argenteus*) suggests that these species are relatively fast growing and have a maximum age of less than 10 years (Taylor *et al.*, 2016; Shakman *et al.*, 2008). Based on this data, the precautionary high (3) rating assigned to this attribute is likely to be a risk overestimation. ***Key changes to the PSA scores*** The default high (3) risk score assigned to *maximum age* was reduced to low (1). This reduction considered maximum age estimates for other species and the likelihood that the scribbled rabbitfish would differ significantly with what is already known about their age and growth. These changes were made in accordance with *Guideline 1: Risk rating due to missing, incorrect or out of date information.*
Scribbled rabbitfish *(S. spinus)*	*Size at sexual maturity (Productivity)*	3	1	As with the *age at sexual maturity* attribute, *size at sexual maturity* received a preliminary high-risk (3) rating due to data deficiencies. However, the maximum size for this species is estimated to be less than 40cm. This indicates that a high (3) rating overestimates the risk associated with this attribute.

Species	Attribute	PSA Score	RRA Score	Justifications and Considerations
				Key changes to the PSA scores The default high (3) risk score assigned to *age at size at sexual maturity* was reduced to low (1). This was based on the understanding that the maximum size for this species is comparatively small; meaning there is a high probability that the size at sexual maturity is less than 40cm. This change was made in accordance with *Guideline 2: additional scientific assessment & consultation.*
Scad				
Yellowtail scad *(T. novaezelandiae)*	*Management strategy (Susceptibility)*	3	2	The management regime for yellowtail scad (*T. novaezelandiae*) is less developed and does not include a mechanism to control catch and effort. For this reason, the species was assigned a high-risk (3) score for *management strategy* attribute. The majority of the scad catch is reported as *unspecified* and there is limited capacity to split this data into individual species (Department of Agriculture and Fisheries, 2019f). The annual take of *Scad—unspecified* has increased in recent years due to increased market demand (*pers. comm.* T. Ham) (2010–2019 *average* = 7.5t; peak = 11.7t, 2015). Catch levels for the complex though remain comparatively low. Criteria used to assess *management strategy* were based on the use of output controls and the presence of an effective control on catch and effort. While these criteria are applied effectively in assessments involving key target species, they are less suited to secondary byproduct or low-harvest species. Due to their low rates of harvest, secondary species are low priorities for transition to an output-controlled management system. This extends to the need to undertake a stock assessment and/or a detailed analysis of the standing biomass. While yellowtail scad has not been the subject of a detailed stock assessment and are not managed under quota, there are few concerns surrounding the sustainability of this species. Research suggests that *Trachurids* are fast growing and have characteristics similar to that observed in other commercially viable small pelagic species (Stewart & Ferrell, 2001). These factors combined with low overall catches and

Species	Attribute	PSA Score	RRA Score	Justifications and Considerations
				increased productivity indicate that scad are a) less susceptible to overexploitation in the current fishing environment, and b) are being effectively managed under a broader management framework. ***Key changes to the PSA scores*** The risk score for *management strategy* was reduced to a medium (2). While this score may still be precautionary, further reductions could not be justified given the poor resolution of the catch composition data and uncertainty surrounding species-specific rates of fishing mortality. Issues relating to improved data collection and monitoring are being addressed as part of the *Queensland Sustainable Fisheries Strategy 2017–2027* (Department of Agriculture and Fisheries, 2017), and the continued rollout of this program may facilitate further score reductions. The above changes were done in accordance with *Guideline 2: additional scientific assessment & consultation.*
Yellowtail scad *(T. novaezelandiae)*	*Recreational desirability / other fisheries (Susceptibility)*	3	2	While yellowtail scad (*T. novaezelandiae*) were included in the *Statewide Recreational Fishing Survey*, harvest data had high error margins and a low level of confidence (Webley *et al.*, 2015; Department of Agriculture and Fisheries, 2021; Teixeira *et al.*, 2021). This resulted in the species being assigned a precautionary high-risk (3) rating for the *recreational desirability / other fisheries* attribute. Anecdotal evidence suggests scad are targeted and kept as live bait when anglers are targeting larger prey species. While these prey species are recorded as released/harvested, it is likely that yellowtail scad used for bait have not been counted as part of the harvest. Even so, total harvest rates for this species are expected to be comparatively low and this sector is not expected to represent a high risk. ***Key changes to the PSA scores*** The preliminary rating assigned to this attribute was reduced to medium (2). Given the status of the species in the ECIF, it is likely that a medium-risk score still represents a risk overestimation. Further reductions in the score assigned to this attribute though will require additional information on recreational catch compositions and within-year catch variability. The above changes were done in accordance with *Guideline 2: additional scientific assessment & consultation.*

Species	Attribute	PSA Score	RRA Score	Justifications and Considerations
Threadfin				
King threadfin *(P. macrochir)* Blue threadfin *(E. tetradactylum)*	*Management strategy (Susceptibility)*	3	3	King threadfin (*P. macrochir*) and blue threadfin (*E. tetradactylum*) are managed through individual MLS limits and in-possession limits controlling their harvest in the recreational sector. As their management does not include a catch or effort limit, they were assigned a high (3) preliminary risk score for *management strategy*. King threadfin is considered to be a more likely target in the Large Mesh Net Fishery and annual catches for this species are higher (*large mesh net average [2010–2018]* = 156t; peak = 203t in 2015). While annual harvest rates for blue threadfin are lower, this species still makes a considerable contribution to the annual ECIF catch (*large mesh net average [2010–2018]* = 111t, peak = 162t in 2013) (Department of Agriculture and Fisheries, 2020c; 2019f). Due to their morphology and feeding habits, threadfins have a high probability of being caught in the Large Mesh Net Fishery (*pers. comm.* T. Ham). While both species operate under MLS limits, these limits are set below the size at 50% maturity for females (king threadfin: MLS = 65cm, size at maturity = +100cm; blue threadfin: MLS = 40cm, size at maturity = 21–54cm) (Whybird *et al.*, 2018b). MLS limits are currently being reviewed by the Fisheries Working Group and consideration is being given to discards, gear selectivity, and release mortality. As this review is ongoing, the Level 2 ERA could only consider the current limits. Bayliss *et al.* (2014) found that an increased demand for swim bladders in the overseas market has changed the targeting of king threadfin in the Gulf of Carpentaria. This change in fishing behaviour is expected to be a contributing factor with respect to a decline in regional discards and the increased targeting of the species (Whybird *et al.*, 2016). These trends have yet to be observed on the Queensland east coast but are viewed as a risk factor for this complex. While numerous genetically distinct stocks occur on the east coast, there is limited information on the stock boundaries, structures, and localised fishing pressures (Whybird *et al.*, 2016). This raises concerns over the varied responses of subpopulations to regional fishing pressures. Moreover, research has found variability in

Species	Attribute	PSA Score	RRA Score	Justifications and Considerations
				growth and maturity among stocks (Moore *et al.*, 2011; Welch *et al.*, 2010b); suggesting the need for further consideration of implementing regional management arrangements. Of notable importance, the SAFS process classified the king and blue threadfin east coast stocks as *sustainable* (Whybird *et al.*, 2018b; Whybird *et al.*, 2018a). This assessment is important as it supports the notion that the risk posed to this species is currently being managed. Without a stock assessment, it is difficult to determine how harvest rates compare to key biological reference points, how stocks are tracking against objectives under the *Queensland Sustainable Fisheries Strategy 2017–2027*, and/or how they might respond to increased fishing pressures. ***Key changes to the PSA scores*** No changes were made to the PSA scores and it is recognised that a high (3) risk rating may be precautionary. Data limitations are being addressed as part of the *Queensland Sustainable Fisheries Strategy 2017–2027* (Department of Agriculture and Fisheries, 2017) and a stock assessment is being developed for at least one of these species (king threadfin). With the continued roll-out of the strategy and the introduction of an ECIF-specific harvest strategies there may be further avenues to review and (potentially) reduce the score assigned to this attribute.
King threadfin *(P. macrochir)* Blue threadfin *(E. tetradactylum)*	*Recreational desirability / other fisheries (Susceptibility)*	3	3	Based on the available data, around 11,000 king threadfin are caught in the recreational fishing sector with almost half (45%) being retained (Department of Agriculture and Fisheries, 2021). However, retention rates for this species have been higher with previous surveys estimating that recreational fishers retain between 51–85% of the king threadfin catch. While retention rates for the 2019–2020 survey are smaller, the estimate has a medium confidence level, suggesting it has a higher margin of error and would benefit from additional information/data. This combined with the presence of a *Threadfin—unspecified* catch category contributed to the species receiving a high-risk (3) rating as part of the PSA. While the retention rate estimate has a higher margin of error, current (2019–2020) data suggests that the high-risk score may be an overestimate. The species is experiencing a downward trend with catch rates

Species	Attribute	PSA Score	RRA Score	Justifications and Considerations
				decreasing over the most recent survey period (41,000 caught in 2013–2014; 11,000 caught in 2019–2020) (Department of Agriculture and Fisheries, 2021). It is recognised though that cryptic / post-capture mortalities will be a factor for this species. This issue is compounded by the fact that the MLS limit (65 cm) is set below size at sexual maturity (Welch *et al.*, 2010a; Moore *et al.*, 2011). When compared to king threadfin, blue threadfin (*E. tetradactylum*) are viewed as less of a target in the recreational fishing sector. With that said, retention rates for this species are high (73%). As this estimate has a higher degree of confidence, these figures formed the basis of the *recreational desirability / other fisheries* assessment. There is little information on post-capture mortality for this species and there is a high degree of uncertainty surrounding how well this species survives a fishing event. With a MLS (40 cm) close to but below the size at sexual maturity for females (Welch *et al.*, 2010a; Bibby *et al.*, 1997), a proportion of the population also remains exposed to fishing pressure prior to spawning. ***Key changes to the PSA scores*** No changes were made to the PSA scores but it is recognised that a high-risk (3) rating may be precautionary for at least one of the species, king threadfin. A reduction in the score could not be justified at this point and time with the following viewed as key determinates for this decision: 1) Increased error margins (medium confidence) in the current king threadfin retention rate estimate and inter-survey variability in the recreational retention rates; 2) The adequacy of the king threadfin MLS and the potential for cryptic mortalities; 3) High retention rates reported for the blue threadfin; and 4) Difficulties determining if the recreational popularity extends across the threadfin complex. With additional information, there is a strong possibility that the recreational desirability score could be reduced for one or both of these species. For at least one of the species, king threadfin, a score reduction for this attribute would result in a downgrading of the final risk rating.

Species	Attribute	PSA Score	RRA Score	Justifications and Considerations
King threadfin *(P. macrochir)*	*Sustainability assessments (Susceptibility)*	2	1	The sustainability of king threadfin has been confirmed through an indicative evaluation (Whybird *et al.*, 2018b) and the species was assigned a medium-risk (2) rating for the *sustainability assessments* attribute. A stock assessment is now being developed for this species on the Queensland east coast. Preliminary results from this assessment indicate that stock biomass levels are sitting above MSY (*pers. comm.* G. Leigh). While this assessment has yet to be finalised and subject to change, there was sufficient confidence in the data to accommodate the preliminary results into the Level 2 ERA. ***Key changes to the PSA scores*** Based on preliminary results contained within the draft stock assessment, the medium-risk rating for *P. macrochir* was decreased to low (1). These changes were made in accordance with *Guideline 1: risk rating due to missing, incorrect or out of date information* and *Guideline 2: additional scientific assessment & consultation.*
Trevally				
Turrum (gold spot) *(C. fulvoguttatus)* Bigeye trevally *(C. sexfasciatus)* Giant trevally *(C. ignobilis)* Golden trevally *(G. speciosus)*	*Management strategy (Susceptibility)*	3	3	The trevally complex is not managed under minimum or maximum legal size limits and the recreational catch is principally managed through a combined limit (20 fish) for all *Carangidae* species (Fisheries Declaration 2019). As management of these species does not include a mechanism to control catch or effort; they were all assigned a high (3) preliminary risk score for *management strategy*. When caught in the Large Mesh Met Fishery, trevally are often retained as byproduct and reported at a higher taxonomic level *e.g*. *Trevally—unspecified*: *2010–18 average* = 28t (large mesh nets). Likely reasons for this include a high probability of various species being caught in a single fishing event and the difficulty in differentiating between individual species in an active fishing environment. While some of the listed trevally have species-specific data, this information does not provide a true indication of their total catch: 1–6t per year since 2000.

Species	Attribute	PSA Score	RRA Score	Justifications and Considerations
				The multi-species nature of the trevally catch combined with identification issues has inhibited management's ability to conduct stock assessments and/or compile indicative sustainability evaluations (Department of Agriculture and Fisheries, 2018f). As a consequence, there is limited information on the sustainability of trevally stocks and/or how current harvest rates compare to key biological reference points. This makes it difficult to evaluate the suitability, applicability and efficacy of the current management regime. ***Key changes to the PSA scores*** No changes were made to the PSA scores but it is recognised that a high (3) risk rating may be precautionary for some of these species. Score reductions could not be justified given the current absence of output controls, monitoring and assessment information, and information on how the take of the species compares to key sustainability reference points. With the continued roll-out of the *Queensland Sustainable Fisheries Strategy 2017–2027* (Department of Agriculture and Fisheries, 2017) there may be further avenues to review and (potentially) reduce this score for one or more of the species assessed.
Turrum (gold spot) *(C. fulvoguttatus)* Bigeye trevally *(C. sexfasciatus)*	*Recreational desirability / other fisheries (Susceptibility)*	3	3	While turrum (*C. fulvoguttatus*) and bigeye trevally (*C. sexfasciatus*) were included in the *Statewide Recreational Fishing Survey*, they were assessed as part of a broader category or had data with a large margin of error and low confidence (Department of Agriculture and Fisheries, 2021). Accordingly, both were assigned a precautionary high-risk (3) rating as part of the PSA. ***Key changes to the PSA scores*** While no changes were made to the PSA scores, there is a high probability that the risk rating for this attribute represents an overestimate. However, there is limited information on the recreational take of these species and the post-interaction mortalities. With additional information, these scores could be reduced in future ERAs.
Golden trevally *(G. speciosus)*	*Recreational desirability /*	1	2	Retention rates for the golden trevally (*G. speciosus*) were on the border of a low and medium-risk rating for the *recreational desirability / other fisheries attribute*. The recreational catch of golden trevally decreased

Species	Attribute	PSA Score	RRA Score	Justifications and Considerations
	other fisheries (Susceptibility)			markedly across survey periods (117,000 [2000–2001], 72,947 [2010–2011], 28,000 [2013–2014], and 21,000 [2019–2020]). This decline was reflected in the retention rates which also decreased (50% [2010–2011], 32% [2013–2014], and 38% [2019–2020]). Research on post-capture mortality rates in trevally have varied results. However, some trevally species experience a high rate of discard mortality and delayed mortality of up to 4 days (Broadhurst *et al.*, 2005). From an ERA perspective, there is an increased risk that a proportion of the discarded golden trevally will die as a result of their interaction. This by extension suggests that total fishing mortality (retained plus discarded) in the recreational fishing sector is higher than what is estimated. ***Key changes to the PSA scores*** While golden trevally were initially assigned a low (1) risk rating for this attribute, broader consideration of the recreational fishing data supported the adoption of a more conservative approach. The assignment of a medium (2) risk rating recognises a) that retention rates were on the border, and at times above, the low/medium risk threshold, and b) the rate of fishing mortality for this sector will be higher due to post-release mortalities. The decision to increase this score is considered precautionary and could be reversed with improved information on recreational catch compositions, effort and discard fates. This change were done in accordance with *Guideline 2: additional scientific assessment & consultation* and is supported by data that estimates a further 33,000 unspecified *Trevally* are caught in this sector (Department of Agriculture and Fisheries, 2021).
Tropical Snapper				
Golden snapper *(L. johnii)*	*Management strategy (Susceptibility)*	3	3	Golden snapper (*L. johnii*) is a byproduct species in the Large Mesh net Fishery (*2010–2019 average* = 7t) and is harvested with more regularity in the recreational fishing sector (Penny *et al.*, 2018a). These comparatively low harvests are one of the reasons why the species is viewed as a low priority for transition to output controls.

Species	Attribute	PSA Score	RRA Score	Justifications and Considerations
				Recent SAFS assessments classify the golden snapper stock as *undefined* on the Queensland east coast (Penny *et al.*, 2018a). This assessment reflects inadequacies in the current catch data and limitations in the current monitoring regime. These deficiencies make it difficult to assess how current harvest rates compare to key biological reference points and assess the efficacy of the current management regime. There are however a number of limitations within the current management regime that increase the risk for this species. For example, the minimum legal size limit (40cm) sits below the size at sexual maturity (45–65cm FL) and may not allow a proportion of the population to reach sexual maturity before recruiting to the fishery. This issue is likely compounded by poor post-release survival rates within the net fishery and recreational fishing sector *e.g.* due to barotrauma (Welch *et al.*, 2014). ***Key changes to the PSA scores*** While it is recognised that a high (3) risk rating may be precautionary, there was insufficient evidence to support a risk score reduction. With improved information on the status of the stock on the Queensland east coast, discard rates and release fates, the score assigned to this attribute could be reduced. The continued rollout of the *Queensland Sustainable Fisheries Strategy 2017–2027* (Department of Agriculture and Fisheries, 2017) will assist in this process.
<u>Whiting</u>				
Sand whiting *(S. ciliata)*	*Management strategy (Susceptibility)*	3	2	Sand whiting (*S. ciliata*) is managed through a MLS limit, combined in-possession limits (recreational fishing), and various other input controls (McGilvray *et al.*, 2018a). The MLS limit (23cm) is based on size at sexual maturity (17–24cm; McGilvray *et al.*, 2018a) and increases the probability that fish will spawn at least once before recruiting to the fishery. As the management regime for sand whiting does not include a mechanism to control catch or effort it was assigned a high (3) preliminary risk score for *management strategy*. The majority of the sand whiting catch is reported from the commercial fishery. However, the recreational fishing sector will make a notable contribution to annual harvest rates. At a complex level, whiting are one of the more prominent components of the ECIF catch (*large mesh net average* 2010–2018 = 133t). Data for this

Species	Attribute	PSA Score	RRA Score	Justifications and Considerations
				complex has poor resolution and almost all of the catch is reported as *unspecified*. While some of the whiting catch is reported to species level, this occurs with less frequency and provides an inaccurate account of the total harvest: <23t per year 2000–2005 (Department of Agriculture and Fisheries, 2020c; 2019f). The sustainability of the Queensland stock has been confirmed through a detailed stock assessment (Leigh *et al.*, 2019) and indicative sustainability evaluations (SAFS) (McGilvray *et al.*, 2018a). These assessments considered fishing activities / harvest rates in both the commercial and recreational fishing sectors. The outputs of the stock assessment indicates that the equilibrium MSY for the stock sits at or around 452t which compares to annual harvest rates (commercial plus recreational) of 272t (Leigh *et al.*, 2019). Based on these outputs, the species is likely to achieve the long-term *Queensland Sustainable Fisheries Strategy 2017–2027* target of B_{60} in around 7 years (Department of Agriculture and Fisheries, 2017). The above is significant as it shows that a) current harvest levels (if maintained) will facilitate stock rebuilding, and b) the risks posed to this species are being managed effectively within the current fishing environment. However, without an effective cap on catch and effort, both can still increase under the current management regime. ***Key changes to the PSA scores*** While sand whiting is not managed under a TACC limit, a weight-of-evidence approach suggests that the risk of overexploitation is being managed within the current fishing environment. Therefore, the risk score for the *management strategy* attribute was reduced to a medium (2). A further reduction in the risk score could not be justified due to the current absence of output controls and the potential for catch and effort to increase under the current management regime. These limitations are currently being addressed as part of the *Queensland Sustainable Fisheries Strategy 2017–2027* (Department of Agriculture and Fisheries, 2017). This change was done in accordance with *Guideline 2: additional scientific assessment & consultation,* and *Guideline 5: effort and catch management arrangements for target and byproduct species.*

Species	Attribute	PSA Score	RRA Score	Justifications and Considerations
Trumpeter whiting (*S. maculata*	*Management strategy (Susceptibility)*	3	2	The management regime for the trumpeter whiting (*S. maculata*) is less developed and reflects its status as a secondary target species. In the PSA, the use of less stringent management controls resulted in the species receiving a high-risk (3) rating for the *management strategy* attribute. In the RRA, further consideration was given to the suitability of this score, how it relates to commercial fishing pressures, and current sustainability concerns. When compared to sand whiting (*S. ciliata*), the commercial pressures exerted on trumpeter whiting are expected to be less. Anecdotal evidence also suggests that this species will be retained more readily in the recreational fishing sector (*pers. comm.* T. Ham). For this reason, this species is unlikely to experience the same levels of fishing pressure. This suggests that there is less need to implement a highly prescriptive set of management arrangements. ***Key changes to the PSA scores*** While the management regime for trumpeter whiting is less developed, a weight-of-evidence approach shows that the species attracts smaller amounts of fishing effort. The evidence further suggests that the management regime is commensurate with the current risk of overexploitation. Given this, the risk score for the *management strategy* attribute was reduced to a medium (2). A further reduction in the risk score could not be justified due to the current absence of output controls and the potential for catch and effort to increase under the current management regime. These limitations are currently being addressed as part of the *Queensland Sustainable Fisheries Strategy 2017–2027* (Department of Agriculture and Fisheries, 2017). This change was done in accordance with *Guideline 2: additional scientific assessment & consultation,* and *Guideline 5: effort and catch management arrangements for target and byproduct species.*
Sand whiting *(S. ciliata)*	*Recreational desirability / other fisheries (Susceptibility)*	3	2	While sand whiting was included in the *Statewide Recreational Fishing Survey*, they were assessed as part of a broader species grouping and were assigned a precautionary high-risk (3) rating for the *recreational desirability / other fisheries* attribute.

Species	Attribute	PSA Score	RRA Score	Justifications and Considerations
				The popularity of whiting in the recreational sector is reflected in the large catches and sustained high retention rates. The last two surveys though suggest that catch has decreased markedly across the last two periods (1,090,121 caught in 2013–2014, 787,000 caught in 2019–2020) (Teixeira *et al.*, 2021; Department of Agriculture and Fisheries, 2021; Webley *et al.*, 2015). While species-specific data is not available, retention rates for the broader whiting complex sits at 49% (Department of Agriculture and Fisheries, 2021). If assessed on this value, the *recreational desirability* attribute for sand whiting would be assigned a medium (2) risk score. The MLS limit for sand whiting (23cm) is based on the size at sexual maturity (17–24cm; McGilvray *et al.*, 2018a) and increases the probability that fish will spawn at least once before recruiting to the fishery. It is however recognised that a proportion of whiting (including undersized fish) will be discarded in a dead or moribund state and that cryptic mortalities will contribute to the total rates of fishing mortality *e.g.* predation. Current knowledge on discard mortality of sand whiting is limited to southern New South Wales and suggests that discard mortalities originating from the recreational fishing sector are relatively low (Kendall & Gray, 2009; Butcher *et al.*, 2006). ***Key changes to the PSA scores*** The default high-risk (3) scores assigned to *recreational desirability / other fisheries* was considered an overestimate and was reduced to medium (2). This score aligns better with what is known about whiting retention rates in the recreational fishing sector. The principal drivers behind this reduction include marked reductions in catch and effort over time, moderate retention rates at the species complex level, and research suggesting low discard mortality. Further reductions in risk scores could not be justified given the sustained recreational interest in the species over time, and the absence of species-specific catch and harvest estimates. These changes were done in accordance with *Guideline 1: risk rating due to missing, incorrect or out of date information and Guideline 2: additional scientific assessment & consultation.*
Sharks				

Species	Attribute	PSA Score	RRA Score	Justifications and Considerations
General (Sharks)				
Whaler sharks *(Family Carcharhinidae)* Hammerhead sharks *(Family Sphyrnidae)*	*Recreational desirability / other fisheries (Susceptibility)*	3	1	While whaler sharks (family *Carcharhinidae*) and hammerheads (family *Sphyrnidae*) were included in the *Statewide Recreational Fishing Survey*, the absence of species-specific catch estimates resulted in the assignment of a precautionary high-risk (3) score in the *recreational desirability / other fisheries* attribute. Sharks are not highly targeted within the recreational sector, with the complex registering low retention rates across survey periods (Taylor *et al.*, 2012; Webley *et al.*, 2015; Department of Agriculture and Fisheries, 2021; Teixeira *et al.*, 2021). In the 2019-2020 survey, an estimated 135,000 sharks and rays were caught with only 3,000 being retained in this sector (Department of Agriculture and Fisheries, 2021). While not universal, there has also been a general decline in the number of sharks being caught and retained in the recreational fishing sector. This decrease is attributed to management restrictions that limit the recreational fishing sector to one shark or ray (excluding hammerhead sharks). Hammerhead sharks are classified as a no-take in the recreational fishing sector. ***Key changes to the PSA scores*** Based on the available information, the preliminary score assigned to the *recreational desirability / other fisheries* attribute was reduced to low (1). The decision was based on the low and decreasing recreational interest of sharks coupled with consistently high release rates. While discard mortality remains unknown across species groupings, the release of sharks landed by hook and line is not expected to pose a significant risk in terms of post-interaction mortalities. Moreover, protections are in place for the recreational take of whalers and hammerheads, further reducing the risks posed by recreational fishing pressure. This change was done in accordance with *Guideline 1: Risk rating due to missing, incorrect or out of date information* and *Guideline 5: effort and catch management arrangements for target and byproduct species.*

Species	Attribute	PSA Score	RRA Score	Justifications and Considerations
Hammerhead Sharks				
Scalloped hammerhead shark *(S. lewini)* Great hammerhead shark *(S. mokarran)*	*Sustainability assessments* *(Susceptibility)*	1	2	The most recent stock assessment of whaler and hammerhead sharks included MSY estimates for the scalloped hammerhead (*S. lewini*) and the great hammerhead (*S. mokarran*) shark (Leigh, 2015). As harvest rates for these two species are below MSY, these species were assigned a preliminary low-risk rating (1) for the *sustainability* attribute. While both hammerhead sharks are being fished below sustainability reference points, the stock assessment recognised concerns surrounding the quality of the data for some species, the level of information on shark discards, and a lack of species composition data outside the period of time where the *Fisheries Observer Program* was in operation (2006–2012) (Leigh, 2015). From an ERA perspective, these uncertainties support the adoption of a more precautionary approach, particularly since the stock assessment was based on data from over five years ago. ***Key changes to the PSA scores*** While noting the outputs of the shark stock assessment (Leigh, 2015), low-risk (1) ratings for *S. mokarran* and *S. lewini* were increased to medium (2). The decision to increase this score is precautionary and minimises the risk of a false-negative result. Improving catch data, species identification methods, and an updated stock assessment will all assist with reducing this score. This process has already commenced for the scalloped hammerhead with an updated stock assessment scheduled to be completed in 2021. The above change was done in accordance with *Guideline 1: Risk rating due to missing, incorrect or out of date information.*
Winghead shark *(E. blochii)* Scalloped hammerhead shark *(S. lewini)*	*Management strategy* *(Susceptibility)*	3	3	The take of hammerhead shark on the Queensland east coast is managed through maximum legal size limits, no-take provisions in the recreational fishing sector, and a combined TACC limit of 100t. The TACC limit includes all *Sphyrna* species but excludes the winghead shark (*E. blochii*). This increases the potential risk for this species as total catch could theoretically exceed that permitted under the *Sphyrna* TACC limit.

Species	Attribute	PSA Score	RRA Score	Justifications and Considerations
Great hammerhead shark *(S. mokarran)* Smooth hammerhead shark *(S. zygaena)*				While the management regime for hammerhead sharks includes a combined TACC limit, the responsiveness of this system is limited. For instance, it does not include a mechanism that prevents operators from catching and retaining hammerhead sharks once the limit is reached, or a mechanism to redress a TACC overfishing event. This issue is compounded by the fact that discards are not included in the current TACC limit. For these reasons, the winghead shark, scalloped hammerhead, great hammerhead, and smooth hammerhead (*S. zygaena)* were assigned a high-risk (3) score as part of the PSA. The introduction of a shark (S) fishing symbol and TACC limit in 2009 has driven declines in hammerhead shark catch and effort. This is primarily due to the fact that only operators with an S fishery symbol can target and retain sharks in larger quantities. Operators without an S fishery symbol are limited by a 10 shark or ray in-possession limit. At a whole-of-fishery level, the total hammerhead shark catch remains well below the TACC limit and is unlikely to be exceeded in the short to medium term (Department of Agriculture and Fisheries, 2019f). At a species-specific level, catch data indicates that at least two of the species, the scalloped hammerhead and the great hammerhead shark, are being fished below MSY (Leigh, 2015). MSY estimates are not available for the two remaining species. While the complex is being fished below MSY estimates (Leigh, 2015), there are a number of limitations in the catch data including on the composition of the hammerhead shark catch and the extent of discards. There is also some potential for catch and effort to increase for one or more of the species included in this complex. As the TACC is applied at a higher taxonomic level, these species-specific increases are unlikely to be detected without additional monitoring. ***Key changes to the PSA scores*** The outputs of the stock assessment suggests that the sustainability risk posed to hammerhead sharks is being managed within the current fishing environment. There are however a number of management limitations that increase the risk posed to these species including an inability to account for discards in the TACC limit, the use of a multi-species TACC, and an inability to validate catch compositions. For these

Species	Attribute	PSA Score	RRA Score	Justifications and Considerations
				reasons, the preliminary risk score (3) for *management strategy* was retained in the final assessment. The decision not to lower this score was precautionary and may still represent overestimate the level of risk for these species. This decision though aligns with the conservative nature of the assessment and minimises the risk of the Level 2 ERA producing a false-negative result.
Great hammerhead shark *(S. mokarran)*	*Selectivity (Susceptibility)*	1	3	In the PSA, body size was used as the primary determinant for scores assigned to the *selectivity* attribute. As the great hammerhead (*S. mokarran*) has a maximum total length of 6m (Last & Stevens, 2009) the species was assessed as low-risk (1) for this attribute. However, research has shown that the morphology of the hammerhead shark cephalofoil makes them highly susceptible to net entanglements across a wide range of size classes (Harry *et al.*, 2011a; Tobin *et al.*, 2010). As a consequence, criteria used to evaluate the *selectivity* risk are less suited to this subgroup of species. ***Key changes to the PSA scores*** The preliminary score assigned to the *selectivity* attribute for the great hammerhead shark was increased from low (1) to high (3). These amendments were done in accordance with *Guideline 2: additional scientific assessment & consultation*.
Smooth hammerhead shark *(S. zygaena)*	*Encounterability (Susceptibility)*	3	1	While the distribution of the smooth hammerhead shark (*S. zygaena*) extends into Queensland it is primarily found in temperate waters (Last & Stevens, 2009). Encounters with the smooth hammerhead shark are more likely to occur in south-east Queensland and New South Wales. While the species has been observed north of these areas, they are generally found in lower numbers and smaller densities (*pers. comm.* C. Simpfendorfer). These preferences suggest that the smooth hammerhead shark will be encountered with less frequency in this fishery; particularly when compared to the scalloped hammerhead shark (*S. lewini*), great hammerhead shark (*S. mokarran*) and winghead shark (*E. blochii*).

Species	Attribute	PSA Score	RRA Score	Justifications and Considerations
				Key changes to the PSA scores The preliminary score assigned to the *encounterability* attribute was reduced to low (1). This change recognises the current distribution of effort and the fact that the species will only interact with a small proportion of the prescribed fishing area (south-east Queensland). For these reasons, large mesh net fishers are less likely to encounter this species when compared to other hammerhead shark species. Changes made as part of the RRA were done in accordance with *Guideline 2: additional scientific assessment & consultation,* and *Guideline 4: at risk in regards to level of interaction/capture with a zero or negligible level of susceptibility*.
<u>Whaler Sharks</u>				
Common blacktip shark *(C. limbatus)* Australian blacktip shark *(C. tilstoni)* Graceful shark *(C. amblyrhynchoides)* Spot-tail shark *(C. sorrah)* Pigeye shark *(C. amboinensis)* Bull shark *(C. leucas)*	*Management strategy (Susceptibility)*	3	3	The take of shark on the Queensland east coast is managed through maximum legal size (MLS) limits, in-possession limits (recreational fishing) and a combined TACC of 600t. This 600t TACC limit encompasses all whaler species and a 100t hammerhead shark TACC limit. While the management regime for sharks includes combined catch limits, the responsiveness of this system is limited as it is enforced at a higher taxonomic level. This system includes business rules that restrict catch as the TACC limit is reached and makes use of in-possession limits to slow shark retention rates. These business rules do not include a mechanism (*e.g.* a fishery closure) to prevent further take of whaler sharks once the catch limit is reached. The main reason for this is that sharks are harvested within the broader confines of the ECIF and a fishery-wide closure is impracticable. The inherent trade off with this approach is that fishing for sharks can still occur even if the TACC is exceeded. This issue is compounded by the fact that recreational shark catches and discards are not accounted for in the TACC limit. For these reasons, a number of the shark species were assigned a precautionary high-risk (3) rating for the *management strategy* attribute.

Species	Attribute	PSA Score	RRA Score	Justifications and Considerations
Spinner shark *(C. brevipinna)* Milk shark *(R. acutus)* Australian sharpnose shark *(R. taylori)* Hardnose shark *(C. macloti)*				The introduction of a combined TACC in 2009 has driven declines in combined catch and effort of whaler sharks and across species complexes. Based on the best available data (Leigh, 2015): - Pigeye and bull shark catches remain well below the most conservative (combined) east coast MSY (277.6t). - Recent and historical spinner shark catches remain well below the most conservative estimate of east coast MSY (121.9t). - Estimates place the reported (combined) catch of the Australian blacktip shark (*C. tilstoni*) and the graceful shark (*C. amblyrhynchoides*) below the combined MSY limit (143.6t) - Reported catch for the Common blacktip shark (*C. limbatus*) are well below the reported MSY estimate (approx. 213t) for the Queensland east coast. - Spot-tail shark catch is likely to be higher in northern Australia but is expected to be below current MSY estimates (~108t for Queensland east coast, 80t in the north region, 28t in the south). - The combined catch of the Australian sharpnose shark (*R. taylori*) and milk shark (*R. acutus*) is below the combined MSY (56t). - Catch rates for the hardnose shark (*C. macloti*) are below the estimated MSY (14.1t). A number of the shark MSY estimates cover multiple species (pigeye & bull sharks; sharpnose & milk shark; Australian blacktip shark & graceful shark) due to morphological similarities and limited species-specific catch data. The stock assessment (Leigh, 2015) also identified a number of concerns surrounding the quality of the available data on discard rates and species compositions. This introduces a degree of uncertainty surrounding individual rates of harvest and how they compare to key biomass reference points. This is significant as there is considerable potential for catch and effort to increase for one or more shark species under the current TACC limit *e.g.* in response to growing demands or increased marketability. This presents as a key risk for this subgroup as it increases the potential that one or more shark species will experience an overfishing event. This issue is compounded by the fact that a) historical shark catch data has poor species

Species	Attribute	PSA Score	RRA Score	Justifications and Considerations
				resolution, and b) the fishery does not have an effective measure in place to validate shark catch compositions in real or near-real time. ***Key changes to the PSA scores*** No changes were made to the PSA scores. It is recognised though that a precautionary high (3) rating may overestimate the risk posed to some species. While consideration was given to reducing the score for one or more of the species assessed, this could not be supported by the available information. From a risk management perspective, catch and effort can increase for one or more of the species under the current management regime and there remains a degree of uncertainty surrounding catch compositions and discards. Under the proposed harvest strategy, the ECIF will be subject to regional management and greater use of output controls. As a Tier 2 species grouping, the management of regional shark and ray stocks will be influenced by this process. Mechanisms to improve data on catch compositions and discards are also being investigated and implemented as part of the Strategy. Given these factors, it is likely that scores assigned to this attribute will reduce (over time) for a number of these species.
Blacktip reef shark *(C. melanopterus)*	*Management strategy (Susceptibility)*	3	3	Management arrangements for the blacktip reef shark (*C. melanopterus*) aligns with the rest of the shark complex *e.g.* maximum legal size (MLS) limits, in-possession limits (recreational fishing), and management under the combined 600t TACC limit. As with most other shark species, the blacktip reef shark was assigned a high-risk (3) score due to the absence of species-specific quota and the (limited) responsiveness of the current system. One of the notable differences between the blacktip reef shark and other species is that it has not been the subject of a detailed stock assessment. Species-specific catch data for the blacktip reef shark dates back to 2009 and the introduction of the *S* (shark) fishery symbol and *Shark & Ray Logbook*. This data shows a high degree of variability with total catch fluctuating between 3t and 23t (*2009–19 average* = 10.4t), potentially due to their reporting as part of a broader complex *e.g.* the *Blacktip Whaler & Graceful shark* complex pre-2018, or in the *Blacktip Whaler*

Species	Attribute	PSA Score	RRA Score	Justifications and Considerations
				Shark complex from 1 January 2018. The species was excluded from the shark stock assessment due to their spatial segregation from sharks caught in the inshore net fishery (Leigh, 2015) and there is no indication of where this level of catch sits in relation to MSY. While the grey reef shark (*C. amblyrhynchos*) and white tip reef shark (*T. obesus*) are afforded additional protections under the *Fisheries Declaration 2019* (in-possession limit of 1), these restrictions do not apply to *C. melanopterus* and it can be retained for sale in the ECIF. ***Key changes to the PSA scores*** No changes were made to the PSA scores; however it is recognised that a high-risk (3) rating may be too precautionary for this species. At this point in time, there is limited evidence to support a score reduction for this attribute. With further information on the structure of the stock and improved data validation, scores assigned to this attribute could (potentially) be reduced. *Note—Under the proposed harvest strategy, the ECIF will be subject to regional management and greater use of output controls. As a Tier 2 species grouping, the management of regional shark and ray stocks will be influenced by this process.*
Common blacktip shark *(C. limbatus)* Spot-tail shark *(C. sorrah)* Spinner shark *(C. brevipinna)* Hardnose shark *(C. macloti)*	*Sustainability assessments (Susceptibility)*	1	2	The most recent stock assessment of whaler and hammerhead sharks includes species-specific MSY estimates for the common blacktip (*C. limbatus*), spot-tail (*C. sorrah*), spinner (*C. brevipinna*) and hardnose (*C. macloti*) sharks (Leigh, 2015). As catch for these species remains below MSY, they were all assigned a low-risk rating (1) for the *sustainability assessments* attribute. While the stock assessment indicates that the common blacktip, spot-tail, spinner and hardnose shark were fished below sustainability reference points, data contained in this assessment is now more than five years old (Leigh, 2015). Concerns also remain with respect to the quality of the catch data and management's ability to account for discards in the TACC limit. Further, catch for one or more of these species can increase

Species	Attribute	PSA Score	RRA Score	Justifications and Considerations
				under the current management regime and (theoretically) exceed MSY. These uncertainties and management limitations lend support to the adoption of a more conservative assessment approach. ***Key changes to the PSA scores*** The low-risk rating for the common blacktip, spot-tail, spinner, and hardnose shark were increased to medium (2) as a precautionary measure. These score amendments were done in accordance with *Guideline 1: risk rating due to missing, incorrect or out of date information.* Going forward, future ERAs would benefit from additional information on shark catch compositions and discard rates. Reconfirming sustainability through an updated stock assessment would also improve the accuracy of future ERAs.
Graceful shark *(C. amblyrhynchoides)*	*Age at sexual maturity (Productivity)*	3	2	Age at sexual maturity is not known for the graceful shark (*C. amblyrhynchoides*) and the species was assigned a precautionary high-risk (3) rating for this attribute. However, the species will more than likely exhibit traits seen in other similar sized species including the two blacktip shark species (*C. tilstoni* and *C.* limbatus). Research on the age and growth of sharks and rays also suggests that a high proportion reach sexual maturity before 15 years (Cortés, 2000; Jacobsen & Bennett, 2011; Geraghty *et al.*, 2013). Based on this research, it is likely that the preliminary risk score is too high for this species. ***Key changes to the PSA scores*** The default high-risk (3) score assigned to *age at sexual maturity* was reduced to medium (2). This score better reflects what is known about the biology of whaler sharks and is viewed as more appropriate for this species. This change was made in accordance with *Guideline 1: Risk rating due to missing, incorrect or out of date information.*

Appendix E—Supplementary Risk Assessment: Likelihood & Consequence Analysis

1. Overview & Background

The *Productivity & Susceptibility Analysis* (PSA) includes a number of elements to minimise the risk of a false-negative result *e.g.* where high-risk species are incorrectly assigned a lower risk rating. However, the PSA tends to be more conservative and research has shown that it has a higher potential to produce false positives. That is, low-risk species being assigned a higher risk score due to the conservative nature of the method, data deficiencies, *etc.* (Zhou *et al.*, 2016; Hobday *et al.*, 2011; Hobday *et al.*, 2007). In the Level 2 Ecological Risk Assessment (ERA), false-positive results are addressed through the *Residual Risk Analysis* (RRA) and the assignment of 'precautionary' risk ratings.

To inform the assignment of precautionary risk ratings, each species was subjected to a *Likelihood & Consequence Analysis* (LCA). The LCA provides a closer examination of the magnitude of the potential consequence, and the probability (likelihood) that those consequences will occur given the current management regime (Fletcher, 2014; Fletcher *et al.*, 2005; Fletcher *et al.*, 2002). A flexible assessment method, the LCA can be used as a screening tool or to undertake more detailed risk assessments (Fletcher, 2014).

In the Level 2 ERA, a simplified version of the LCA was used to provide the risk profiles with further context and evaluate the applicability of the assessment to the current fishing environment. More specifically, the LCA was used to assist in the allocation of precautionary risk ratings which are assigned to species with more conservative risk profiles. The benefit of completing a fully qualitative assessment following a more data-intensive, semi-quantitative assessment is the reduction of noise in the form of false positives. This was considered to be of particular importance when identifying priority risks for this fishery.

As the LCA is qualitative and lacks the detail of the PSA, the outputs should not be viewed as an alternate or competing risk assessment. To avoid confusion, the results of the PSA/RRA will take precedence over the LCA. The LCA was only used to evaluate the potential of the risk coming to fruition over the short to medium term.

2. Methods

The LCA was constructed using a simplified version of the *National ESD Reporting Framework for Australian Fisheries* (Fletcher, 2014; Fletcher *et al.*, 2002; Fletcher *et al.*, 2005) and focused specifically on the *Risk Analysis* component. The *National ESD Reporting Framework* incorporates additional steps including ones that establish the context of the assessment and identify key risks. As these steps were fulfilled with the completion of a *Scoping Study* (Department of Agriculture and Fisheries, 2019g) and whole-of-fishery (Level 1) assessment (Jacobsen *et al.*, 2019b), they were not replicated for the Level 2 ERA. For a more comprehensive overview of the *National ESD Reporting Framework for Australian Fisheries* consult Fletcher (2014); Fletcher *et al.* (2002).

Risk Analysis considers a) the potential consequences of an issue, activity, or event (Table E1), and b) the likelihood of a particularly adverse consequence occurring due to these activities or events (Table E2). Central to this is the establishment of a *Likelihood x Consequence* matrix that estimates the risk based on scores assigned to each component (Table E3).

Table E1. *Criteria used to assign scores to the Consequence component of the analysis.*

Level	Score	Definition
Negligible	0	Almost zero harvest/mortalities with impact unlikely to be detectable at the scale of the stock/regional population.
Minor	1	Assessed as low risk through the PSA, and/or fishing activities will have minimal impact on regional stocks or populations.
Moderate	2	Assessed as a medium risk through the PSA/harvest levels or mortalities at, near or approaching maximum yields (or equivalent).
Severe	3	Species assessed as high risk through the PSA/harvest or mortalities at levels that are impacting stocks and/or has high vulnerability and low resilience to harvest.
Major	4	Species assessed as high risk through the PSA/harvest levels or mortalities has the potential to cause serious impacts with a long recovery period required to return the stock/population to an acceptable level.

Table E2. *Criteria used to assign indicative scores of the likelihood that fishing activities in the East Coast Inshore Fishery (ECIF) will result in or make a significant contribution to a severe or major consequence.*

Level	Score	Definition
Likely	5	Expected to occur under the current fishing environment / management regime.
Occasional	4	Will probably occur or has a higher potential to occur under the current fishing environment / management regime.
Possible	3	Evidence to suggest it may occur under the current fishing environment / management regime.
Rare	2	May occur in exceptional circumstances.
Remote	1	Has never occurred but is not impossible.

Table E3. *Likelihood & Consequence Analysis risk matrix used to assign indicative risk ratings to each species: blue = negligible risk, green = low risk, orange = medium risk, and red = high risk.*

		Consequence				
Likelihood		**Negligible**	**Minor**	**Moderate**	**Severe**	**Major**
		0	1	2	3	4
Remote	1	0	1	2	3	4
Rare	2	0	2	4	6	8
Possible	3	0	3	6	9	12
Occasional	4	0	4	8	12	16
Likely	5	0	5	10	15	20

For the consequence analysis (Table E2), criteria used to assign scores (0–4) were primarily based on the outputs of the semi-quantitative assessment (PSA/RRA results outlined in Section 4, Table 7). In the likelihood assessment (Table E1), scores reflect the likelihood of the fishery causing or making a significant contribution to the occurrence of the most hazardous consequence (Fletcher *et al.*, 2002). Once scores are assigned to each aspect of the LCA, they are used to calculate an overall risk value (*Risk = Likelihood x Consequence*) for each species (Table E3).

As the Level 2 ERA uses the LCA as a supplementary assessment, risk scores and ratings were not linked to any operational objective as per the *National ESD Reporting Framework* (Fletcher, 2014; Fletcher et al., 2005). Instead, these issues are addressed directly as part of the Level 2 ERA through fisheries-specific recommendations. Criteria used to assign scores for likelihood and consequence are outlined in Table E1 and E2 respectively. The *Likelihood x Consequence* matrix used to assign risk ratings is provided as Table E3.

3. Results & Considerations

When compared to the PSA/RRA, the LCA produced lower risk estimates for species included in the Level 2 ERA. This was to be expected as the LCA gives greater consideration and equal weighting to the probability (likelihood) of a fishery contributing to or causing a severe or major event under the current conditions (catch, effort and interaction trends). In a number of instances, the outputs of the Level 2 ERA supported the assignment of precautionary risk ratings.

Teleosts

Over half of the teleosts assessed were assigned a low-risk rating as part of the LCA. For most of these species, a low-risk rating aligns well with the outcomes of the PSA/RRA. Species with stock assessments recorded the lowest overall LCA score (*e.g.* sea mullet, yellowfin bream, sand whiting, school mackerel); the notable exception being yellowtail scad which does not have a sustainability assessment (Table E4). The remaining teleosts were assessed as a medium risk and had ratings that either aligned with PSA/RRA, or were marginally lower. A review of the results of the PSA/RRA and LCA along with the key drivers of risk supported the assignment of precautionary risk ratings for a number of teleosts. These precautionary ratings have been identified in Section 4 of the Level 2 ERA.

Sharks

While a stock assessment indicates that a number of the sharks are being fished below sustainability reference points (Leigh, 2015), some species (*e.g. C. tilstoni, S. mokarran,* and *S. lewini*) have higher historical catches. There is also room within the current management regime for catch to increase for one or more of these species. These factors were taken into consideration as part of the LCA and contributed to the complex receiving higher risk ratings (Table E4). This risk is not expected to be uniform as the majority of the catch will consist of blacktip sharks (*C. tilstoni, C. limbatus, and C. amblyrhynchoides*). If catch and effort were to increase in the fishery, these species would arguably receive a higher proportion of this increase.

LCA risk estimates for three of the 15 shark species were lower (*low*) than what was reported in the PSA/RRA (*moderate*) (Table E4). For three species (hardnose shark, milk shark and Australian sharpnose shark), the results supported the assignment of a precautionary risk rating. The remainder of the shark species were all assessed as a medium risk in the LCA—one category below that recorded through the PSA. When these results were compared to the status of the species in the ECIF and their place as a target or secondary species, nine were assigned precautionary risk ratings. The notable exceptions being the two key blacktip shark species and three of the hammerhead shark species.

***Table E4**. Results of the Likelihood & Consequence Analysis for species assessed as part of the Large Mesh Net Target & Byproduct Species Level 2 ERA.*

Common name	Species name	Likelihood	Consequence	Matrix score	Risk category
Teleosts					
Sea mullet	*Mugil cephalus*	2	1	2	**Low**
Bluespot mullet	*Valamugil seheli*	2	1	2	**Low**
Fantail mullet	*Paramugil georgii*	2	1	2	**Low**
Diamondscale mullet	*Liza vaigiensis*	2	1	2	**Low**
Dusky flathead	*Platycephalus fuscus*	3	2	6	**Moderate**
Bartail flathead	*Platycephalus australis*	2	3	6	**Moderate**
Northern sand flathead	*Platycephalus endrachtensis*	2	2	4	**Low**
Yellowtail flathead	*Platycephalus westraliae*	2	2	4	**Low**
Trumpeter whiting	*Sillago maculata*	3	3	9	**Moderate**
Sand whiting	*Sillago ciliata*	2	1	2	**Low**
Yellowfin bream	*Acanthopagrus australis*	2	1	2	**Low**
Tarwhine	*Rhabdosargus sarba*	3	2	6	**Moderate**
Snubnose garfish	*Arrhamphus sclerolepis*	2	2	4	**Low**
Three-by-two garfish	*Hemiramphus robustus*	2	2	4	**Low**
Turrum (gold spot)	*Carangoides fulvoguttatus*	3	3	9	**Moderate**
Bigeye trevally	*Caranx sexfasciatus*	3	3	9	**Moderate**
Giant trevally	*Caranx ignobilis*	3	3	9	**Moderate**
Golden trevally	*Gnathanodon speciosus*	3	3	9	**Moderate**
Snubnosed dart	*Trachinotus blochii*	2	2	4	**Low**
Swallowtail dart	*Trachinotus coppingeri*	2	2	4	**Low**
Yellowtail scad	*Trachurus novaezelandiae*	1	2	2	**Low**
Barred javelin	*Pomadasys kaakan*	3	3	9	**Moderate**
Silver javelin	*Pomadasys argenteus*	2	2	4	**Low**
Giant queenfish	*Scomberoides commersonnianus*	2	3	6	**Moderate**

Common name	Species name	Likelihood	Consequence	Matrix score	Risk category
King threadfin	*Polydactylus macrochir*	3	3	9	**Moderate**
Blue threadfin	*Eleutheronema tetradactylum*	3	2	6	**Moderate**
Mulloway	*Argyrosomus japonicus*	3	3	9	**Moderate**
Silver jewfish	*Nibea soldado*	3	3	9	**Moderate**
Black jewfish	*Protonibea diacanthus*	3	2	6	**Moderate**
Grey mackerel	*Scomberomorus semifasciatus*	2	2	4	**Low**
Spotted mackerel	*Scomberomorus munroi*	2	2	4	**Low**
School mackerel	*Scomberomorus queenslandicus*	1	2	2	**Low**
Barramundi	*Lates calcarifer*	3	2	6	**Moderate**
Golden snapper	*Lutjanus johnii*	3	3	9	**Moderate**
Scribbled rabbitfish	*Siganus spinus*	1	2	2	**Low**
Sharks					
Australian blacktip shark	*Carcharhinus tilstoni*	3	3	9	**Moderate**
Common blacktip shark	*Carcharhinus limbatus*	3	3	9	**Moderate**
Graceful shark	*Carcharhinus amblyrhynchoides*	3	3	9	**Moderate**
Spot-tail shark	*Carcharhinus sorrah*	2	3	6	**Moderate**
Pigeye shark	*Carcharhinus amboinensis*	2	3	6	**Moderate**
Bull shark	*Carcharhinus leucas*	2	3	6	**Moderate**
Spinner shark	*Carcharhinus brevipinna*	2	3	6	**Moderate**
Blacktip reef shark	*Carcharhinus melanopterus*	2	3	6	**Moderate**
Hardnose shark	*Carcharhinus macloti*	2	2	4	**Low**
Milk shark	*Rhizoprionodon acutus*	1	3	3	**Low**
Australian sharpnose shark	*Rhizoprionodon taylori*	1	3	3	**Low**
Great hammerhead	*Sphyrna mokarran*	3	3	9	**Moderate**
Scalloped hammerhead	*Sphyrna lewini*	3	3	9	**Moderate**

Common name	Species name	Likelihood	Consequence	Matrix score	Risk category
Smooth hammerhead	*Sphyrna zygaena*	2	3	6	**Moderate**
Winghead shark	*Eusphyra blochii*	2	3	6	**Moderate**