Department of Agriculture and Fisheries

Sustainable Fisheries Strategy 2017–2027

Reef Line Fishery
Level 2 Ecological Risk Assessment

2021 Update

Queensland Government

Level 2 Ecological Risk Assessment
Reef Line Fishery

2021 Update

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Executive Summary

A Level 2 Ecological Risk Assessment (ERA) was undertaken for the Reef Line Fishery (RLF) during the 2019/20 fishing season (Walton *et al.*, 2021). This assessment evaluated the risk posed to a select group of teleosts from the Other Species (OS) quota management unit and a subset of protected fin fish. Since this assessment was completed, there have been significant changes to the management regime for the RLF, including implementation of the *Reef Line Fishery Harvest Strategy 2020–2025* (Department of Agriculture and Fisheries, 2020a). The following report provides an update of the RLF Level 2 ERA, which considers the content of the harvest strategy, updated fisheries data (catch, effort), and improvements in the available data for key species.

The 2021 RLF Level 2 ERA employed the same methodology (Walton *et al.*, 2021) with risk evaluated using a *Productivity & Susceptibility Analysis* (PSA). The PSA provides an indicative evaluation (low, medium or high) of the level of risk and considers the biological traits (productivity) of each species, and their interaction potential with the fishery (susceptibility). For consistency, the list of species, assessment criteria, and scoring provisions were aligned with the original assessment (Walton *et al.*, 2021). However, a review of updated catch and effort data supported the inclusion of three additional species: redspot emperor (*Lethrinus lentjan*), yellowtail emperor (*L. atkinsoni*), and eastern red scorpionfish (*Scorpaena jacksoniensis*). These inclusions extended the assessment to 38 target & byproduct species and four protected teleosts. To avoid replication, risk profiles of all previously assessed species (Walton *et al.*, 2021) were used as the baseline of the 2021 RLF Level 2 ERA.

When the outputs of the 2021 update were considered, most target & byproduct species (*n* = 32, 84%) were assigned risk scores within the medium-risk category. This is a marked improvement on the 2019/20 assessment where 14 species (40%) registered scores within the high-risk category (Walton *et al.*, 2021). As there was little change in available biological data or management arrangements for the protected teleosts subgroup, risk scores remained the same for species in this category. Thirty-six of the 42 species were assigned '*precautionary*' risk ratings as they are more representative of the potential risk. Management of the risk posed to these species, beyond what is already being undertaken as part of the *Queensland Sustainable Fisheries Strategy 2017–2027*, is not considered an immediate priority. Ratings for the red emperor (*Lutjanus sebae*), saddletail snapper (*L. malabaricus*), crimson snapper (*L. erythropterus*), goldband snapper (*Pristipomoides multidens*), stripey snapper (*L. carponotatus*) and spangled emperor (*Lethrinus nebulosus*) are viewed as more representative of the risk posed to these species within the current fishing environment. The efficacy of risk management strategies for these species may warrant further investigation.

Across the study, the introduction of a harvest strategy was given significant weighting in assessments involving the target & byproduct species ecological component. The RLF harvest strategy reduces the overexploitation risk for primary targets and establishes safeguards for secondary species when catch exceeds reference points in the commercial, recreational and/or charter fishing sectors (Department of Agriculture and Fisheries, 2020a). However, stock status uncertainty, recreational data deficiencies, and a limited capacity to independently validate catch compositions or total rates of fishing mortality (retained catch plus discard mortalities) were identified as the key drivers of risk. These deficiencies were largely reflected in the *susceptibility* component of the PSA. With improved information, scores assigned to key attributes (*e.g. management strategy* and *sustainability assessments*) could be refined and risk ratings further reduced. It is acknowledged that a high percentage of OS category species are viewed as lower priorities for stock assessments due to their current rates of harvest across sectors and the low level of concern surrounding their long-term sustainability.

Recommendations

Varying progress was made against recommendations made as part of the 2019/20 RLF Level 2 ERA (Walton *et al.*, 2021). This variation was expected as there was a need to prioritise more significant reforms and/or address key recommendations through broader reform strategies *e.g.* introducing a fisheries-specific harvest strategy, establishing a cost-effective mechanism to validate species compositions, improving catch data across a diverse range of fisheries, and mandating the use of *vessel tracking*. As a number of these reforms are ongoing, they provided incremental improvements to the RLF Level 2 ERA. With the continued implementation of the *Queensland Sustainable Fisheries Strategy 2017–2027* objectives, expectations are that these programs will improve the accuracy of future Level 2 ERAs and facilitate greater differentiation in terms of the level of risk posed to each species. The outputs of the 2021 RLF Level 2 ERA support the continued advancement of recommendations made by Walton *et al.* (2021). There are however several additional fisheries-specific recommendations that should be considered as part of this update.

1. *Update the risk assessment for red emperor to account for a) the outputs of the stock assessment (once completed) and b) any subsequent (if applicable) changes to management.*

2. *Review the suitability and applicability of management arrangements for red emperor, saddletail snapper and the four species at medium risk, including the efficacy of these measures at minimising fishing-related risks.*

3. *Explore avenues to improve the level of biological and fisheries-specific data for species with precautionary risk ratings, prioritising species with higher commercial harvest rates and/or species that experience increased cumulative fishing pressures i.e. species harvested in higher quantities across multiple fishing sectors.*

4. *Continue to explore avenues to improve information on total interaction rates (e.g. retained plus discards) and mechanisms to validate/verify catch data provided by industry; noting that issues relating to data validation and monitoring of catch are being addressed as part of a broader Queensland Sustainable Fisheries Strategy Data Validation Program.*

Summary of the outputs from the Reef Line Fishery Level 2 ERA 2021 Update.

Common name	Species name	Productivity	Susceptibility	Risk rating
Target & Byproduct species (Other Species quota category)				
Red emperor	*Lutjanus sebae*	2.00	2.71	**High**
Saddletail snapper	*Lutjanus malabaricus*	2.00	2.71	**High**
Goldband snapper	*Pristipomoides multidens*	1.86	2.57	**Medium**
Crimson snapper	*Lutjanus erythropterus*	1.71	2.57	**Medium**
Stripey snapper	*Lutjanus carponotatus*	1.43	2.43	**Medium**
Spangled emperor	*Lethrinus nebulosus*	1.43	2.43	**Medium**
Banded rockcod	*Hyporthodus ergastularius*	2.00	2.57	**Precautionary high**
Purple rockcod	*Epinephelus cyanopodus*	2.00	2.57	**Precautionary high**
Robinson's seabream	*Gymnocranius grandoculis*	2.00	2.57	**Precautionary high**
Collar seabream	*Gymnocranius audleyi*	2.00	2.57	**Precautionary high**
Rosy snapper	*Pristipomoides filamentosus*	1.86	2.57	**Precautionary medium**
Maori rockcod	*Epinephelus undulatostriatus*	1.86	2.57	**Precautionary medium**

Common name	Species name	Productivity	Susceptibility	Risk rating
Flame snapper	*Etelis coruscans*	2.00	2.43	**Precautionary medium**
Painted sweetlip	*Diagramma pictum*	1.71	2.57	**Precautionary medium**
Green jobfish	*Aprion virescens*	1.71	2.57	**Precautionary medium**
Maori snapper	*Lutjanus rivulatus*	1.71	2.57	**Precautionary medium**
Birdwire rockcod	*Epinephelus merra*	1.71	2.57	**Precautionary medium**
Blue spotted rockcod	*Cephalopholis cyanostigma*	1.71	2.57	**Precautionary medium**
Greasy rockcod	*Epinephelus tauvina*	1.57	2.57	**Precautionary medium**
Yellowtail emperor	*Lethrinus atkinsoni*	1.57	2.57	**Precautionary medium**
Specklefin grouper	*Epinephelus ongus*	1.57	2.57	**Precautionary medium**
Longnose emperor	*Lethrinus olivaceus*	1.57	2.57	**Precautionary medium**
Blackspot tuskfish	*Choerodon schoenleinii*	1.57	2.57	**Precautionary medium**
Eastern red scorpionfish	*Scorpaena jacksoniensis*	1.57	2.57	**Precautionary medium**
Blacktip rockcod	*Epinephelus fasciatus*	1.57	2.57	**Precautionary medium**
Moses perch	*Lutjanus russellii*	1.57	2.57	**Precautionary medium**
Ruby snapper	*Etelis carbunculus*	1.86	2.29	**Precautionary medium**
Longfin rockcod	*Epinephelus quoyanus*	1.43	2.57	**Precautionary medium**
Sharptooth snapper	*Pristipomoides typus*	1.43	2.57	**Precautionary medium**
Spotcheek emperor	*Lethrinus rubrioperculatus*	1.43	2.57	**Precautionary medium**
Highfin grouper	*Epinephelus maculatus*	1.43	2.57	**Precautionary medium**
Yellow spotted rockcod	*Epinephelus areolatus*	1.43	2.57	**Precautionary medium**
Purple tuskfish	*Choerodon cephalotes*	1.43	2.57	**Precautionary medium**
Blue tuskfish	*Choerodon cyanodus*	1.43	2.57	**Precautionary medium**
Redspot emperor	*Lethrinus lentjan*	1.43	2.57	**Precautionary medium**
Venus tuskfish	*Choerodon venustus*	1.43	2.57	**Precautionary medium**
Hussar	*Lutjanus adetii*	1.43	2.43	**Precautionary medium**
Brownstripe snapper	*Lutjanus vitta*	1.43	2.43	**Precautionary medium**
Protected teleosts				
Humphead Maori wrasse	*Cheilinus undulatus*	2.00	2.50	**Precautionary high**
Queensland groper	*Epinephelus lanceolatus*	2.00	2.50	**Precautionary high**
Potato rockcod	*Epinephelus tukula*	2.00	2.50	**Precautionary high**
Barramundi cod	*Cromileptes altivelis*	1.43	2.50	**Precautionary medium**

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Table 3. *Updated Level 2 ERA results. Attribute scores shaded* ■ *represent those that were amended as part of the update process. Scores shaded* ■ *indicate precautionary high scores due to missing information. * Denotes new species that did not form part of the original assessment.* *6*

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Definitions & Abbreviations

2021 Update	–	Refers to the enclosed assessment, which is an updated version of the Level 2 Ecological Risk Assessment for the Reef Line Fishery that was completed during the 2019/20 fishing season (available at: https://era.daf.qld.gov.au/id/eprint/8206/).
CAAB	–	*Codes for Australian Aquatic Biota.*
CT, RQ–CT	–	Coral Trout Quota Management Unit.
EM	–	Electronic Monitoring.
EPBC Act	–	*Environment Protection and Biodiversity Conservation Act 1999.*
ERA	–	Ecological Risk Assessment.
ERAEF	–	*Ecological Risk Assessment for the Effects of Fishing.*
FMP	–	*Fishery Monitoring Program.*
OS, RQ–OS	–	Other Species Quota Management Unit.
PSA	–	*Productivity & Susceptibility Analysis.* One of the two ERA methodologies that can be used as part of the Level 2 assessments.
RLF	–	*Reef Line Fishery*. Previously referred to as the Coral Reef Fin Fish Fishery or CRFFF.
RRA	–	Residual Risk Analysis.
RTE, RQ–RTE	–	Redthroat Emperor Quota Management Unit.
SAFE	–	*Sustainability Assessment for Fishing Effects*. One of the two ERA methodologies that can be used as part of the Level 2 assessments. This method can be separated into a base SAFE (bSAFE) and enhanced SAFE (eSAFE). The data requirements for eSAFE is 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.
TACC	–	Total Allowable Commercial Catch.

1 Introduction

A Level 2 Ecological Risk Assessment (ERA) for the Reef Line Fishery (RLF) was completed in accordance with the *Ecological Risk Assessment Guidelines* and as part of the *Queensland Sustainable Fisheries Strategy 2017–2027* (Walton et al., 2021). This ERA was finalised during the 2019/20 fishing season and assessed the risk posed to a select group of teleosts from the Other Species (OS) quota management unit and a subset of protected fin fish. As part of this process, the Level 2 ERA made a number of recommendations on where risk could be further understood, managed, or potentially mitigated in the RLF (Walton *et al.*, 2021)

Since this assessment was completed, there have been significant changes to the management regime for the RLF, including implementation of a *Reef Line Fishery Harvest Strategy 2020–2025* (Department of Agriculture and Fisheries, 2020a). These changes have reduced the long-term sustainability risk for key species and progressed recommendations made as part of the 2019/20 RLF Level 2 ERA (Appendix A).

The following report provides an update of the 2019/20 RLF Level 2 ERA and takes into consideration the content of the harvest strategy, updated fisheries data (catch, effort), and improvements in the available data for key species. This update, here on in, will be referred to as the 2021 RLF Level 2 ERA.

2 Methods

While the fishery now operates under a harvest strategy, the prescribed fishing area, primary access symbols (L1, L2, L3), and quota management units (*e.g.* coral trout [RQ–CT]; redthroat emperor [RQ–RTE]; and other species [RQ–OS]) have not changed since the last assessment (Walton *et al.*, 2021). There will however be inter-seasonal variability in terms of the number of fishers accessing the RLF and catch/effort totals for key species. Accordingly, key aspects of the original Scoping Study were updated to provide a better indicator of the current fishing environment. The Scoping Study update has been provided in Appendix B and includes information on changes in participation rates, catch trends, and effort levels since the introduction of quota in 2004. A more comprehensive overview of historical trends in catch, effort, and participation rate data is provided in the original RLF Scoping Study (Department of Agriculture and Fisheries, 2019).

In establishing the scope of the assessment, consideration was given to the outputs of the previous whole-of-fishery (Level 1) ERA and the 2019/20 Level 2 assessment (Jacobsen *et al.*, 2019; Walton *et al.*, 2021). For two of the three quota management units, coral trout and redthroat emperor, the risk potential has reduced with the introduction of the *Reef Line Fishery Harvest Strategy 2020–2025* (Department of Agriculture and Fisheries, 2020a). These developments combined with the publication of positive sustainability assessments indicate that the risk posed to these species is being effectively managed (Campbell *et al.*, 2019; Northrop & Campbell, 2020; Roelofs & Fairclogh, 2020; Saunders *et al.*, 2020a). This evidence supports the continued omission of coral trout (*Plectropomus leopardus*) and redthroat emperor (*Lethrinus miniatus*) from the Level 2 ERA.

For the OS Quota Management Unit, a preliminary species list was developed using updated fisheries data (Appendix B: Table B3). Catch totals were summed across the 2018–2020 (inclusive) period and cumulative catch contributions used to identify the species / species complexes that made up 95% of the total OS catch. Species that fell below this threshold were viewed as lower assessment priorities

and were excluded from the assessment. Refer to Walton *et al.* (2021) for a full account of the species rationalisation process.

Outside of the target & byproduct species, fisheries data indicates that the RLF fishery interacts with a number of non-target species. Most of the reported interactions were with protected teleosts and support their continued assessment (Appendix B: Table B4).

2.1 ERA Methodology

Under the ERA Guidelines (Department of Agriculture and Fisheries, 2018a), Level 2 ERAs can be developed using a *Productivity & Susceptibility Analysis* (PSA) or the quantitative *Sustainability Assessment for Fishing Effects* (SAFE; Department of Agriculture and Fisheries, 2018a; Hobday *et al.*, 2007; Zhou & Griffiths, 2008). As information levels do not support the development of a SAFE-based Level 2 ERA (Zhou & Griffiths, 2008; Zhou *et al.*, 2016; Zhou *et al.*, 2011), the PSA was retained as the assessment method for the 2021 RLF Level 2 ERA.

The *productivity* component of the PSA examines the life-history constraints of a species and the potential for biological attributes to contribute to the overall level of risk. These attributes include the *size and age at sexual maturity*, *maximum size and age*, *fecundity*, *reproductive strategy,* and *trophic level* (Table 1). *Productivity* attributes used in the Level 2 assessment were aligned with the *Ecological Risk Assessment for the Effects of Fishing* (ERAEF) approach (Hobday *et al.*, 2011) and were applied across all ecological components subject to a PSA. Criteria used to assign each attribute a score of low (1), medium (2), or high (3) risk are outlined in Table 1.

Table 1. *Scoring criteria and cut-off scores for the productivity component of the PSA undertaken as part of the Level 2 ERA. Attributes and the corresponding 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 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 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

**Fecundity for broadcast spawners was assumed to be >20,000 eggs per year (Miller & Kendall, 2009).*

For the *susceptibility* component of the PSA, up to seven attributes were used to examine risk: *availability*, *encounterability*, *selectivity, post-capture mortality, management strategy, sustainability assessments* and *recreational desirability / other fisheries* (Hobday *et al.*, 2011; Walton *et al.*, 2021). Of these, *management strategy, sustainability assessments* and *recreational desirability / other fisheries* were only applied to assessments involving the target & byproduct species ecological component. A brief description of each *susceptibility* attribute and the selection criteria are provided

Table 2. *Scoring criteria and cut-off scores for the susceptibility component of the PSA. Attributes and the corresponding scores/criteria are largely aligned with national (ERAEF) approach (Hobday et al., 2011).*

Attribute	Assessment description	Assessment Options	Low susceptibility (low risk, score = 1)	Medium susceptibility (medium risk, score = 2)	High susceptibility (high risk, score = 3)
Availability†	Overlap between fishing effort and the portion of the species range within the prescribed fishing area.	a) Overlap of species range with fishery.	<10% overlap.	10–30% overlap.	>30% overlap.
		b) Global distribution & stock proxies.	Globally distributed.	Restricted to same hemisphere / ocean basin.	Restricted to same country as fishery.
Encounterability†	Likelihood that a species will encounter the fishing gear when it is deployed within the known geographical range	a) Habitat type	Low overlap.	Medium overlap.	High overlap.
		b) Depth check	Low overlap.	Medium overlap.	High overlap.
Selectivity	The likelihood that a species will get caught by the apparatus.		Low selectivity.	Moderate selectivity.	High selectivity.
Post-capture mortality	The probability of the species surviving the fishing event.		Evidence of post-capture release and survival.	Released alive with uncertain survivability.	Retained species, or if released, interaction likely to result in death or life-threatening injuries.
Management strategy*	Management suitability 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 *etc*.		Management regime able to address emerging issues within the current framework, species-specific management of catch or effort, supported by biomass estimates or biomass reference points.	Limited capacity to address emerging risks without legislative reforms. Catch/effort restricted in some capacity, restrictions based on arbitrary or outdated biomass estimates or biomass reference points.	Harvested stocks do not have catch limits or robust input & output controls. Management regime based at the whole-of-fishery level.
Sustainability assessments*	Confirmation (or lack thereof) of sustainability through indicative evaluations, stock assessments *etc*.		Sustainability confirmed through stock assessments / biomass estimates.	Sustainability confirmed through indicative sustainability assessments & weight of evidence approach *e.g.* SAFS.	Not assessed, biomass depleted, declining, or not conducive to meeting Strategy targets.
Recreational desirability / other fisheries*	The risk posed by other sectors or fisheries.		<33% retention.	33–66% retention.	>66% retention.

†*The Availability and Encounterability attributes have two assessment options to account for data deficiencies and ancillary considerations. Availability option 'a' is applied when the distribution of a species can be mapped directly against the effort footprint of a fishery, otherwise the assessment defaults to assessment option 'b'.*

* *Attributes only applied to retainable product i.e. the target & byproduct species ecological component.*

in Table 2. Refer to Walton *et al.* (2021) for a more comprehensive overview of the *susceptibility* attributes.

2.2 PSA Scoring & Likelihood

The PSA assigns each attribute with a score of 1 (low risk), 2 (medium risk), or 3 (high risk) based on the criteria outlined in Table 1 and Table 2 (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).

Risk ratings (R) for each species are based on a two-dimensional graphical representation of the average *productivity* (*x*-axis) and *susceptibility* (*y*-axis) scores (Fig. 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 Fig. 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). 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; Hobday *et al.*, 2007; Zhou *et al.*, 2016).

Risk profiles for previously-assessed species (Walton *et al.*, 2021) were used as baseline for the 2021 RLF Level 2 ERA. This avoided replication and minimised the need to undertake a Residual Risk Analysis (section 2.4.4 of Walton *et al.*, 2021). All baseline attribute scores were then reviewed to determine their relevance to the current fishing environment. When and where appropriate, these baseline scores were updated to account for additional information and further analytical considerations. All changes made as part of this process were documented and justifications supporting the amendments provided in Appendix D. Species that did not have a previous assessment were assigned preliminary scores based on criteria outlined in Table 1 and 2.

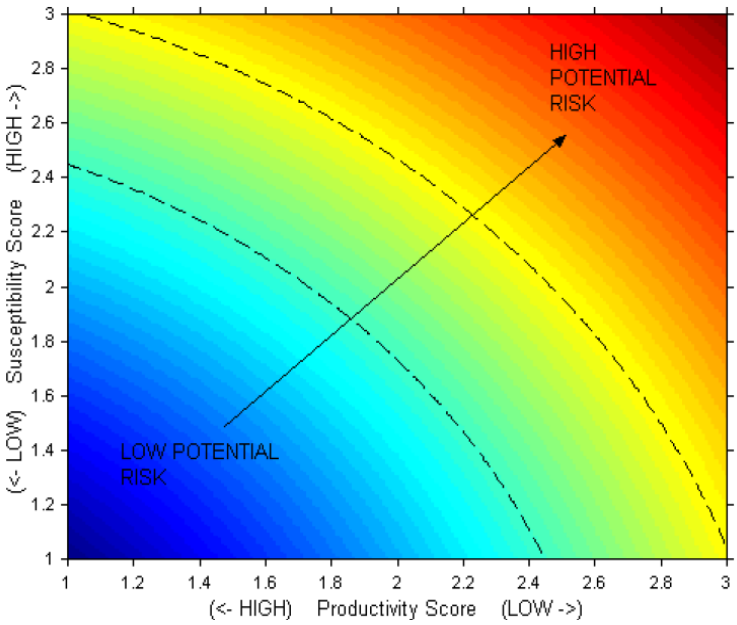

***Figure 1**. PSA plot demonstrating the two-dimensional space which species units are plotted. PSA scores for species units represent the Euclidean distance or the distance between the origin and the productivity (x axis), susceptibility (y axis) intercept (excerpt from Hobday. et al., 2007).*

While information levels have improved since the last assessment, several species still had data deficiencies or required the use of proxy values. These deficiencies introduce a degree of uncertainty into the assessment and contribute to the production of more conservative risk ratings. In the 2021 RLF Level 2 ERA, these uncertainties were explored further though a) an *ad-hoc*

Likelihood, Consequence Analysis (LCA) and b) the assignment of precautionary risk ratings (Appendix E; Walton *et al.*, 2021).

Precautionary risk ratings, in essence, help identify areas where the risk is best addressed through additional monitoring and research. This might include the development of more detailed stock assessments, undertaking sustainability evaluations and data collection through initiatives instigated under the *Queensland Sustainable Fisheries Strategy 2017–2027* (Department of Agriculture and Fisheries, 2017a; 2018b; c). For clarity, precautionary risk ratings are assigned to species that have a rating more reflective of the potential risk *verses* a real or actual risk.

3 Results

3.1 Target & Byproduct species

Logbook data for the 2018–2020 period (inclusive) produced an assessment list of 38 target & byproduct species. These species represent around 95% of the OS catch and the majority were included in the 2019/20 RLF Level 2 ERA (Walton *et al.*, 2021). Based on updated fisheries data (Appendix B: Table B3), three new species were included in the assessment: the redspot emperor (*Lethrinus lentjan*), yellowtail emperor (*Lethrinus atkinsoni*), and eastern red scorpionfish (*Scorpaena jacksoniensis*). As these species did not form part of the original assessment, new risk profiles were compiled for all three using criteria outlined in Table 1 and 2.

Productivity attributes assessed as part of the PSA produced scores between 1.43 and 2.00 (Table 3). Of the species assessed, 10 had their *productivity* assessments updated to take into consideration additional information and data (Table 3; Appendix D). These updates primarily involved the *maximum age* and *size at maturity* attributes (Table 3). Data for the redspot emperor, yellowtail emperor, and eastern red scorpionfish were sufficient to construct a *productivity* profile without the use of proxies. Across the study, the average *productivity* score for OS species (*average* = 1.65) was marginally higher than that reported in the 2019/20 assessment (*average* = 1.64; *range* = 1.43–2.00).[1]

In the *susceptibility* component, OS species registered scores between 2.29 to 2.71 (*average* = 2.55). The majority of the *susceptibility* attribute updates involved the *management strategy* attribute and were intimately linked with the establishment of a fisheries-specific harvest strategy (Table 3; Department of Agriculture and Fisheries, 2020a). As with the *productivity* component, data sets for the redspot emperor, yellowtail emperor and eastern red scorpionfish allowed for an informed assessment of most *susceptibility* attributes (Table 3). However, information gaps resulted in most species receiving more precautionary scores for the *sustainability assessments* attribute and contributed to the production of more conservative risk profiles. Even so, the updated Level 2 ERA produced notably lower scores for the *susceptibility* component when compared to the 2019/20 assessment (*average* = 2.71; *range* = 2.43–2.86).[2]

When the *productivity* and *susceptibility* scores were considered, target & byproduct species registered risk scores from 2.82 to 3.37 (*average* = 3.05). Based on the prescribed assessment criteria, risk scores assigned to species within the OS Quota Management Unit fell within medium (*n* = 32, 84%) and high (*n* = 6, 16%) risk categories (Table 3). For comparative purposes, risk scores from

[1] *Average and range values based off the final risk ratings. Details contained in Table 7 of Walton et al. (2021)*
[2] *Average and range values based off the final risk ratings. Details contained in Table 7 of Walton et al. (2021)*

Table 3. *Updated Level 2 ERA results. Attribute scores shaded ■ represent those that were amended as part of the update process. Scores shaded ■ indicate precautionary high scores due to missing information. * Denotes new species that did not form part of the original assessment.*

Common name	Species name	Age at maturity	Maximum age	Fecundity	Maximum size	Size at maturity	Reproductive strategy	Trophic level	Productivity	Availability	Encounterability	Selectivity	Post-capture mortality	Management strategy	Sustainability assessments	Rec. desirability / other fisheries	Susceptibility	*PSA score*
Target & Byproduct																		
Saddletail snapper	*L. malabaricus*	2	3	1	2	2	1	3	2.00	3	3	3	3	1	3	3	2.71	**3.37**
Spangled emperor	*L. nebulosus*	1	2	1	1	1	1	3	1.43	3	3	3	3	1	2	2	2.43	**2.82**
Goldband snapper	*P. multidens*	2	3	1	1	2	1	3	1.86	3	3	3	3	2	3	1	2.57	**3.17**
Red emperor	*L. sebae*	2	3	1	2	2	1	3	2.00	3	3	3	3	1	3	3	2.71	**3.37**
Stripey snapper	*L. carponotatus*	1	2	1	1	1	1	3	1.43	3	3	3	3	1	3	1	2.43	**2.82**
Banded rockcod	*H. ergastularius*	2	3	1	2	2	1	3	2.00	3	3	3	3	2	3	1	2.57	**3.26**
Crimson snapper	*L. erythropterus*	2	3	1	1	1	1	3	1.71	3	3	3	3	1	3	2	2.57	**3.09**
Hussar	*L. adetii*	1	2	1	1	1	1	3	1.43	3	3	3	3	2	2	1	2.43	**2.82**
Brownstripe snapper	*L. vitta*	1	2	1	1	1	1	3	1.43	3	3	3	3	2	2	1	2.43	**2.82**
Venus tuskfish	*C. venustus*	1	2	1	1	1	1	3	1.43	3	3	3	3	2	3	1	2.57	**2.94**
Green jobfish	*A. virescens*	1	2	1	2	2	1	3	1.71	3	3	3	3	2	3	1	2.57	**3.09**
Highfin grouper	*E. maculatus*	1	2	1	1	1	1	3	1.43	3	3	3	3	2	3	1	2.57	**2.94**
Birdwire rockcod	*E. merra*	2	3	1	1	1	1	3	1.71	3	3	3	3	2	3	1	2.57	**3.09**
Blue spotted rockcod	*C. cyanostigma*	2	3	1	1	1	1	3	1.71	3	3	3	3	2	3	1	2.57	**3.09**
Purple rockcod	*E. cyanopodus*	2	3	1	2	2	1	3	2.00	3	3	3	3	2	3	1	2.57	**3.26**
Blacktip rockcod	*E. fasciatus*	2	2	1	1	1	1	3	1.57	3	3	3	3	2	3	1	2.57	**3.01**
Greasy rockcod	*E. tauvina*	2	2	1	1	1	1	3	1.57	3	3	3	3	2	3	1	2.57	**3.01**
Longfin rockcod	*E. quoyanus*	1	2	1	1	1	1	3	1.43	3	3	3	3	2	3	1	2.57	**2.94**
Specklefin grouper	*E. ongus*	1	3	1	1	1	1	3	1.57	3	3	3	3	2	3	1	2.57	**3.01**
Yellow spotted rockcod	*E. areolatus*	1	2	1	1	1	1	3	1.43	3	3	3	3	2	3	1	2.57	**2.94**
Painted sweetlip	*D. pictum*	1	3	1	2	1	1	3	1.71	3	3	3	3	2	3	1	2.57	**3.09**

Common name	Species name	Age at maturity	Maximum age	Fecundity	Maximum size	Size at maturity	Reproductive strategy	Trophic level	Productivity	Availability	Encounterability	Selectivity	Post-capture mortality	Management strategy	Sustainability assessments	Rec. desirability / other fisheries	Susceptibility	*PSA score*
Flame snapper	*E. coruscans*	2	3	1	2	2	1	3	2.00	2	3	3	3	2	3	1	2.43	3.15
Moses perch	*L. russellii*	1	2	1	1	2	1	3	1.57	3	3	3	3	2	3	1	2.57	3.01
Maori rockcod	*E. undulatostriatus*	2	3	1	1	2	1	3	1.86	3	3	3	3	2	3	1	2.57	3.17
Rosy snapper	*P. filamentosus*	1	3	1	2	2	1	3	1.86	3	3	3	3	2	3	1	2.57	3.17
Sharptooth snapper	*P. typus*	1	2	1	1	1	1	3	1.43	3	3	3	3	2	3	1	2.57	2.94
Longnose emperor	*L. olivaceus*	1	2	1	2	1	1	3	1.57	3	3	3	3	2	3	1	2.57	3.01
Ruby snapper	*E. carbunculus*	2	3	1	2	1	1	3	1.86	1	3	3	3	2	3	1	2.29	2.95
Redspot emperor*	*L. lentjan*	1	2	1	1	1	1	3	1.43	3	3	3	3	2	3	1	2.57	2.94
Spotcheek emperor	*L. rubrioperculatus*	1	2	1	1	1	1	3	1.43	3	3	3	3	2	3	1	2.57	2.94
Yellowtail emperor*	*L. atkinsoni*	1	3	1	1	1	1	3	1.57	3	3	3	3	2	3	1	2.57	3.01
Collar seabream	*G. audleyi*	3	2	1	1	3	1	3	2.00	3	3	3	3	2	3	1	2.57	3.26
Robinson's seabream	*G. grandoculis*	3	2	1	1	3	1	3	2.00	3	3	3	3	2	3	1	2.57	3.26
Purple tuskfish	*C. cephalotes*	1	2	1	1	1	1	3	1.43	3	3	3	3	2	3	1	2.57	2.94
Blue tuskfish	*C. cyanodus*	1	2	1	1	1	1	3	1.43	3	3	3	3	2	3	1	2.57	2.94
Blackspot tuskfish	*C. schoenleinii*	1	2	1	2	1	1	3	1.57	3	3	3	3	2	3	1	2.57	3.01
Eastern red scorpionfish*	*S. jacksoniensis*	1	3	1	1	1	1	3	1.57	3	3	3	3	2	3	1	2.57	3.01
Maori snapper	*L. rivulatus*	1	3	1	1	2	1	3	1.71	3	3	3	3	2	3	1	2.57	3.09
Protected teleosts																		
Humphead Maori wrasse	*C. undulatus*	2	3	1	2	2	1	3	2.00	3	3	3	1	n/a	n/a	n/a	2.50	3.20
Queensland groper	*E. lanceolatus*	2	3	1	2	2	1	3	2.00	3	3	3	1	n/a	n/a	n/a	2.50	3.20
Barramundi cod	*C. altivelis*	1	2	1	1	1	1	3	1.43	3	3	3	1	n/a	n/a	n/a	2.50	2.88
Potato rockcod	*E. tukula*	2	3	1	2	2	1	3	2.00	3	3	3	1	n/a	n/a	n/a	2.50	3.20

the 2019/20 assessment range from 2.94 to 3.41 (*average* = 3.17) with 21 (60%) and 14 (40%) species classified as medium and high risk respectively (Table 7 & 8: Walton *et al.*, 2021).

3.2 Protected teleosts

Protected teleosts, including humphead Maori wrasse (*Cheilinus undulatus*), Queensland groper (*Epinephelus lanceolatus*), barramundi cod (*Cromileptes altivelis*), and potato rockcod (*Epinephelus tukula*), were assessed in the original Level 2 ERA. For completeness, all four were included in the 2021 RLF Level 2 ERA and reassessed to determine if risk ratings have changed between assessment periods.

There have been limited improvements in the available biological data for all four protected teleosts. Similarly, updated fisheries data indicates that the subgroup experiences similar fishing pressures to that observed in 2019/20. Consequently, all four species registered scores that were identical to the 2019/20 assessment: *productivity: average* = 1.86, *range* = 1.43–2.00; *susceptibility: average* = 2.50, *range* = 2.50–2.50; *risk rating* = medium–high (Table 3; Walton *et al.*, 2021).

4 Risk Evaluation

4.1 Target & Byproduct species (OS Quota Management Unit)

Risk ratings for reef line species have shown a general decline since the last assessment (Table 4; Walton *et al.*, 2021). This decline has been driven by management reforms implemented as part of the *Queensland Sustainable Fisheries Strategy 2017*–2027, improvements in the level of information for key species, and the introduction of the *Reef Line Fishery Harvest Strategy 2020–2025* (Department of Agriculture and Fisheries, 2020a). Most of the OS species (*n* = 32, 84%) were classified as a medium risk and the outcomes of the 2021 RLF Level 2 ERA are a marked improvement on the previous assessment. For example, just six of the assessed OS species (15%) were classified as a high risk; compared to 14 species (40%) in the 2019/20 RLF Level 2 ERA (Walton *et al.*, 2021).

For six of the 38 OS species, the final risk ratings are considered more representative of a real or actual risk. Red emperor (*L. sebae*) and saddletail snapper (*L. malabaricus*) were classified as high risk, whereas goldband snapper (*P. multidens*), crimson snapper (*L. erythropterus*), spangled emperor (*L. nebulosus*) and stripey snapper (*L. carponotatus*) were assessed as medium risk (Table 4). These species have annual commercial harvests ranging from 11 to 85t (2018–2020 data inclusive) and they are considered primary targets in the recreational and charter fishing sectors (Department of Agriculture and Fisheries, 2020c; 2021b). For at least two of these species, red emperor and saddletail snapper, there is a more pressing need to collect additional information on stock sustainability (*sustainability assessments*), examine cumulative fishing pressures (*recreational desirability / other fisheries*), and review the suitability/applicability of the current management arrangements (Table 3).

The remaining risk profiles involved species with comparatively low but consistent catch rates (Department of Agriculture and Fisheries, 2019). This included many of the cods, groupers, emperors, tropical snappers, sea perch, and tuskfish (*n* = 32; Table 4). These species registered a combined annual catch of around 85t in the last fishing season (Appendix B: Table B3). For context and reference, annual catch levels for the main target species, coral trout (*Plectropomus* & *Variola* spp.),

Table 4. *Summary of the target & byproduct species (OS Quota Management Unit) risk ratings including those that are considered to be more precautionary.*

Common name	Species name	PSA score	Final risk rating
Priority assessments			
Red emperor	*Lutjanus sebae*	**3.37**	**High**
Saddletail snapper	*Lutjanus malabaricus*	**3.37**	**High**
Goldband snapper	*Pristipomoides multidens*	**3.17**	**Medium**
Crimson snapper	*Lutjanus erythropterus*	**3.09**	**Medium**
Stripey snapper	*Lutjanus carponotatus*	**2.82**	**Medium**
Spangled emperor	*Lethrinus nebulosus*	**2.82**	**Medium**
Precautionary assessments			
Banded rockcod	*Hyporthodus ergastularius*	**3.26**	**Precautionary high**
Purple rockcod	*Epinephelus cyanopodus*	**3.26**	**Precautionary high**
Robinson's seabream	*Gymnocranius grandoculis*	**3.26**	**Precautionary high**
Collar seabream	*Gymnocranius audleyi*	**3.26**	**Precautionary high**
Rosy snapper	*Pristipomoides filamentosus*	**3.17**	**Precautionary medium**
Maori rockcod	*Epinephelus undulatostriatus*	**3.17**	**Precautionary medium**
Flame snapper	*Etelis coruscans*	**3.15**	**Precautionary medium**
Painted sweetlip	*Diagramma pictum*	**3.09**	**Precautionary medium**
Green jobfish	*Aprion virescens*	**3.09**	**Precautionary medium**
Maori snapper	*Lutjanus rivulatus*	**3.09**	**Precautionary medium**
Birdwire rockcod	*Epinephelus merra*	**3.09**	**Precautionary medium**
Blue spotted rockcod	*Cephalopholis cyanostigma*	**3.09**	**Precautionary medium**
Greasy rockcod	*Epinephelus tauvina*	**3.01**	**Precautionary medium**
Yellowtail emperor	*Lethrinus atkinsoni*	**3.01**	**Precautionary medium**
Specklefin grouper	*Epinephelus ongus*	**3.01**	**Precautionary medium**
Longnose emperor	*Lethrinus olivaceus*	**3.01**	**Precautionary medium**
Blackspot tuskfish	*Choerodon schoenleinii*	**3.01**	**Precautionary medium**
Eastern red scorpionfish	*Scorpaena jacksoniensis*	**3.01**	**Precautionary medium**
Blacktip rockcod	*Epinephelus fasciatus*	**3.01**	**Precautionary medium**
Moses perch	*Lutjanus russellii*	**3.01**	**Precautionary medium**
Ruby snapper	*Etelis carbunculus*	**2.95**	**Precautionary medium**
Longfin rockcod	*Epinephelus quoyanus*	**2.94**	**Precautionary medium**
Sharptooth snapper	*Pristipomoides typus*	**2.94**	**Precautionary medium**
Spotcheek emperor	*Lethrinus rubrioperculatus*	**2.94**	**Precautionary medium**
Highfin grouper	*Epinephelus maculatus*	**2.94**	**Precautionary medium**
Yellow spotted rockcod	*Epinephelus areolatus*	**2.94**	**Precautionary medium**
Purple tuskfish	*Choerodon cephalotes*	**2.94**	**Precautionary medium**
Blue tuskfish	*Choerodon cyanodus*	**2.94**	**Precautionary medium**
Redspot emperor	*Lethrinus lentjan*	**2.94**	**Precautionary medium**
Venus tuskfish	*Choerodon venustus*	**2.94**	**Precautionary medium**
Hussar	*Lutjanus adetii*	**2.82**	**Precautionary medium**
Brownstripe snapper	*Lutjanus vitta*	**2.82**	**Precautionary medium**

exceed 700t and 220t in the commercial and recreational fishing sectors respectively (Campbell *et al.*, 2019; Saunders *et al.*, 2020a). Similarly, commercial fishers retain around 150t of redthroat emperor (*L miniatus*) with recreational fishers harvesting an additional 119t (Northrop & Campbell, 2020; Roelofs & Fairclogh, 2020).[3]

Harvest rate data for the RLF (Appendix B) suggests that the Level 2 ERA over-estimated the risk posed to a number of the secondary targets. It is important to acknowledge that there is limited capacity within the current management regime to independently monitor/validate catch compositions or quantify discard rates for regulated size classes and low-value species.[4] This is of some importance as total rates of fishing mortality (retained plus post-release mortalities) will be higher than what is reported through the logbook system (*e.g.* due to injuries, barotrauma, depredation *etc*). These deficiencies contributed to most species being assigned a medium (2) risk score for the *management strategy* attribute (Table 3). This in turn made a direct contribution to the production of more conservative risk profiles.

While noting the above limitations, there is an increased probability that the 2021 RLF Level 2 ERA includes a number of false positives or risk overestimates. Accordingly, several species were assigned *precautionary* risk ratings (Table 4). The decision to classify these assessments as precautionary was supported by an ad-hoc *Likelihood & Consequence Analysis* (Appendix E).[5] **Precautionary risk ratings are viewed as a lower priority in terms of management intervention and/or are best addressed through additional monitoring, catch validation, and research**. For this subgroup, improving the level of information on size-regulated discards and the discarding of low-value / less marketable species would better inform management decisions and discussions surrounding the suitability of decision rules applied through the harvest strategy (Department of Agriculture and Fisheries, 2020a). Likewise, increasing the level of information on cryptic mortalities (*e.g.* post-capture mortalities, depredation) would provide further insight into the total rate of fishing mortality, post-interaction survivability, and (if applicable) the economic impacts of product loss.

From an ERA perspective, increasing the level of information on interaction rates and locations may facilitate further refinements and (potential) risk-score recalibrations. This is considered of particular relevance to secondary (low harvest) species where risk profiles were heavily influenced by the *availability, encounterability* and *selectivity* attributes (Table 3). These species have distributions that overlap with the effort footprint, have high selectivity[6] in reef-based line fisheries, and were all

[3] *Coral trout and redthroat emperor are not classified as OS species and have their own quota management units. The risk posed to these two quota management units is lower and they were not assessed.*

[4] *Information on catch compositions and discard rates has been previously collected through irregular surveys including an assessment of the Effects of Fishing in the GBR (Mapstone et al., 2004), through a previous Fisheries Observer Program and Fisheries Monitoring Research Surveys. The fishery though, at present, does not operate with a mechanism to independently validate/verify catch compositions and interaction rates on a regular basis i.e. within and between fishing seasons.*

[5] *The LCA is a fully qualitative assessment and was used to provide an indicative assessment of how conservative a risk rating 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 updated PSA will take precedence over the LC*A.

[6] *While hook & line apparatus are highly selective for reef teleosts, it is noted that the majority of operators in the RLF will target coral trout by using various techniques (e.g. viewing buckets, aiming for specific depths etc., pers. comm. C. Lunow, 2021). It is recognised that the use of these apparatus will improve the selectivity of individual operations (i.e. for the coral trout fishery). These measures though are difficult to account for in the PSA without additional information on fishery intentions, targeting effectiveness etc.*

assigned high (3) risk ratings for these three attributes (Table 3; Appendix F). These scores are consistent with the assessment criteria (Table 2) but may overestimate the interaction potential of some species. With improved information on fine-scale effort movements, these scores could be further refined and may facilitate the removal of low-risk species. Of significance, this work has already commenced as part of the *Queensland Sustainable Fisheries Strategy 2017–2027* with the time-scale of *vessel tracking* now extending into a fourth season (Department of Agriculture and Fisheries, 2017a; 2018d). This information will inform other projects undertaken as part of the *data validation plan* including those that are designed to map effort signatures within each fishery (Department of Agriculture and Fisheries, 2018c).

While noting the continued need for *precautionary* risk ratings, several refinements were made as part of the 2021 assessment. In the *productivity* component, the risk profiles of several species were updated to include new or additional information on their biology and life-history. For example, the *maximum age* attribute for Maori snapper (*L. rivulatus*) was increased from medium to high in response to new records showing that it lives to 50+ years in Australian waters (Wakefield *et al.*, 2020).[7] In other instances, scores were amended to account for additional feedback and further consideration of the available data. For example, several age/growth studies are available for red emperor (*L. sebae*) and a review of the literature placed the maximum age of this species at 30+ years (Newman & Dunk, 2002; Newman *et al.*, 2010).[8] The maximum age attribute score for red emperor was subsequently updated to reflect this (Table 3; Appendix D).

In the *susceptibility* component, up-to-date *Status of Australian Fish Stocks* (SAFS) reports, recreational fishing surveys, and new/revised stock assessments were all considered as part of the review process (Campbell *et al.*, 2021; Department of Agriculture and Fisheries, 2017a; 2020e; 2021b; Fisheries Research and Development Corporation, 2021; Teixeira *et al.*, 2021) (Appendix G). Information contained in these reports improved the accuracy of the data underpinning certain risk profiles but did not substantially alter scores assigned to the *sustainability assessments*, *recreational desirability / other fisheries* or *post-capture mortality* attributes (Table 3; Walton *et al.*, 2021). This contrasts with the *management strategy* attribute where all of the species assessed had their scores downgraded in response to the introduction of a fisheries-specific harvest strategy (Department of Agriculture and Fisheries, 2020a).

The *Reef Line Fishery Harvest Strategy 2020–2025* came into effect in April 2020 and includes a range of performance indicators, decision rules, and trigger limits (Department of Agriculture and Fisheries, 2020a). These provisions provide certainty surrounding the TACC setting process, safeguards against potential increases in the non-commercial catch, and establishes a strong foundation for the long-term management of reef fish stocks on the Queensland east coast. For OS species, some of the most effective measures include decision rules that instigate a stock assessment and/or establish an interim species-specific competitive TACC limit once harvest exceeds a historical reference point. The sustainability risk is further reduced through decision rules that are

[7] *At the time of the original assessment (Walton et al., 2021), the maximum age for the Maori snapper was reported as 10.5 years (Russell et al., 2016a). Based on the prescribed criteria, the species was assigned a medium (2) risk score for this attribute.*

[8] *Species was assigned a medium-risk rating in the original assessment based on a study from the Great Barrier Reef Marine Park (Newman et al., 2000; Walton et al., 2021).*

applied directly to the recreational and charter fishing sectors (Department of Agriculture and Fisheries, 2020a).

This ability to manage potential increases in catch across sectors and trigger sustainability assessments was given significant weighting in the 2021 RLF Level 2 ERA. In terms of the PSA, this was reflected in the downgrading of scores assigned to the *management strategy* attribute (Table 3; Walton *et al.*, 2021). The extent of the score downgrades were limited by the absence of an effective measure to independently monitor catch compositions and validate fisheries data. With time and a greater understanding of the effectiveness of the harvest strategy (*e.g.* at controlling harvest rates and improving information on the status of key stocks), further refinements could be made to scores assigned to this attribute. These refinements would likely include all four species assigned a precautionary high-risk rating and would result in a downgrading of their final risk-score (Table 4).

Recommendations—Other Species (OS) Quota Management Unit

The 2019/20 RLF Level 2 ERA included a number of recommendations where fishing-related risks could be better understood, managed or mitigated (Walton *et al.*, 2021). **These recommendations are non-binding and their priority status will be influenced by the broader reform agenda and RLF Working Group discussions** (Department of Agriculture and Fisheries, 2017a; b; c; 2018c; 2020b; 2021a).

Varying progress was made against recommendations outlined in 2019/20 RLF Level 2 ERA (Walton *et al.*, 2021). This is primarily due to the need to prioritise more significant reforms and the need to address some recommendations through a broader strategy *e.g.* introducing a fisheries-specific harvest strategy, establishing a cost-effective mechanism to validate species compositions and improve catch data across a diverse range of fisheries, mandating the use of *vessel tracking*. A number of these reforms are ongoing and provided incremental improvements to the 2021 RLF Level 2 ERA. With the continued implementation of the *Queensland Sustainable Fisheries Strategy 2017–2027*, expectations are that these programs will improve the accuracy of future RLF Level 2 ERAs and facilitate greater differentiation in terms of the level of risk posed to each species. The outputs of the 2021 RLF Level 2 ERA support the continued advancement of recommendations made by Walton *et al.* (2021). There are however several additional fisheries-specific recommendations that should be considered as part of this update.

1. *Update the risk assessment for red emperor to account for a) the outputs of the stock assessment (once completed) and b) any subsequent (if applicable) changes to management.*

2. *Review the suitability and applicability of management arrangements for red emperor, saddletail snapper and the four species at medium risk, including the efficacy of these measures at minimising fishing-related risks.*

3. *Explore avenues to improve the level of biological and fisheries-specific data for species with precautionary risk ratings, prioritising species with higher commercial harvest rates and/or species that experience increased cumulative fishing pressures i.e. species harvested in higher quantities across multiple fishing sectors.*

4. *Continue to explore avenues to improve information on total interaction rates (e.g. retained plus discards) and mechanisms to validate/verify catch data provided by industry; noting that issues relating to data validation and monitoring of catch are being addressed as part of a broader Queensland Sustainable Fisheries Strategy Data Validation Program.*

4.2 Protected teleosts

Seven teleost species have long-standing no-take restrictions in Queensland waters: the humphead Maori wrasse (*C. undulatus*), Queensland groper (*E. lanceolatus*), potato rockcod (*E. tukula*), barramundi cod (*C. altivelis*), paddletail (*L. gibbus*), red bass (*L. bohar*), and chinaman fish (*S. nematophorus*). For the paddletail, red bass and chinaman fish, their classification as no-take species stems from the fact that they may not be suitable for human consumption (Museum of Tropical Queensland, 2021; Queensland Government, 2018b). As this classification is not due to sustainability concerns, they were not included in either of the RLF Level 2 ERAs (Walton *et al.*, 2021).

The remaining four species have been classified as no-take due to their vulnerability to exploitation and their status as iconic species in the Great Barrier Reef (classification from the now superseded *Fisheries (Coral Reef Fin Fish) Management Plan 2003*). Up until 2021, the catch of humphead Maori wrasse, Queensland groper, potato rockcod and barramundi cod was also monitored through the *Species of Conservation Interest* (SOCI) logbook. This was the catalyst for their inclusion in the original assessment (Walton *et al.*, 2021).

Fisheries Queensland have recently conducted a review of the SOCI program and its ability to meet the core objective of reporting interactions with species listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). In response to this review, reporting requirements were refined and the SOCI logbook replaced with the *Threatened, Endangered and Protected (TEP) Animals Logbook.* The TEP logbook tracks interactions with EPBC Act listed species and assists the fishery in meeting key reporting requirements, namely under Part 13 of the Act (Department of Agriculture Water and the Environment, 2021).[9] As the humphead Maori wrasse, Queensland groper, potato rockcod and barramundi cod are not listed under the EPBC Act (but are protected under the Great Barrier Reef Marine Park Regulations 1983), they were not included in the new logbook. Consequently, mandatory reporting requirements for threatened, endangered, and protected species are not applied to this subgroup (Appendix B: Table B4).

Table 5. *Overview of risk ratings for protected teleosts assessed as part of the Level 2 ERA 2021 Update. All are considered to be precautionary.*

Common name	Species name	PSA score	Final risk rating
Humphead Maori wrasse	*Cheilinus undulatus*	**3.20**	**Precautionary high**
Queensland groper	*Epinephelus lanceolatus*	**3.20**	**Precautionary high**
Potato rockcod	*Epinephelus tukula*	**3.20**	**Precautionary high**
Barramundi cod	*Cromileptes altivelis*	**2.88**	**Precautionary medium**

[9] *The Threatened, Endangered and Protected Animals Logbook also includes species listed under the Queensland Nature Conservation Act 1992. The Nature Conservation Act 1992 (plus subordinate legislation) regulates the conservation and harvesting of particular species or groups of protected wildlife and provides the framework for the creation and management of protected areas (Queensland Government, 2020). To this extent, it shares some similarities with the federal-based EPBC Act.*

While the humphead Maori wrasse, Queensland groper, potato rockcod, and barramundi cod are not subject to mandatory reporting requirements, they were retained in the 2021 RLF Level 2 ERA. Their retention provides greater continuity in terms of assessing risk across this fishery and provides an additional opportunity to explore the key drivers of risk, their interaction potential, and the reasons behind their classification as protected teleosts.

All four protected teleosts have distributions that extend outside of Australian waters where they are likely to experience additional fishing pressures. For at least one of the species, the humphead Maori wrasse, the exploitation threat was sufficient to classify it as *Endangered* under the IUCN redlist classification system (Fennessy *et al.*, 2018; Pollard *et al.*, 2018; Russell, 2004; Sadovy *et al.*, 2018). Of the remaining species, the potato rockcod is classified as *Least Concern* and both the Queensland groper and barramundi cod are classified as *Data Deficient* with negative population trends (Fennessy *et al.*, 2018; Pollard *et al.*, 2018; Sadovy *et al.*, 2018).

Of significance, all four redlist assessments examine status on a global scale and include jurisdictions that have less developed fisheries management regimes (*i.e.* Indonesia and south-east Asia). As they are based at the global scale, the IUCN ratings may not provide an accurate reflection of what is occurring at a regional level. For example, some of the key threats for these species include localised depletion due to overexploitation, high market demand (particularly within Asia), and unregulated/unreported fishing activities. These activities are viewed as a lower risk in Queensland where all four species are afforded considerable protection from fishing activities including through a well-established system of state and national marine parks (Department of Environment and Science, 2020a; b; Great Barrier Reef Marine Park Authority, 2020).

While three of the protected teleosts were classified as high risk, these results likely represent a false positive or a risk overestimate. This is because the risk profiles of all four species were heavily influenced by the *availability, encounterability* and *selectivity* attributes (Table 3). Scores assigned to these attributes (3) may be precautionary but could not be refined as part of the 2021 RLF Level 2 ERA. With improved information on interaction rates and catch locations, one or more of these attributes could (potentially) be refined and reduced. If this were to occur, then all four protected teleosts would be classified as a medium risk (Fig. 1). The omission of these species from the TEP logbook limits the extent of attribute score refinements. There may however be further avenues to include these species in future projects or programs focused on improving catch composition data in the RLF. With that said, there remains a need to balance reporting requirements with the level of concern surrounding the long-term sustainability of these species.

Of the four, data suggests that the interaction potential will be lower for the Queensland groper and the potato cod. The maximum size for these two species is larger than reef line target species and the use of lighter lines (<90lbs) and smaller baits will limit their capture potential (pers. comm. C. Lunow; Bray, 2021a; b; Lieske & Myers, 1995). This is supported by information collected as part of the SOCI logbook program which shows that these two species have low and infrequent interactions with the RLF (Appendix B; Table B4). The extent and frequency of reported interactions suggest that the RLF poses a lower long-term sustainability risk for these species. Conversely, the SOCI data indicates that interactions with the humphead Maori wrasse and the barramundi cod have increased significantly over the 2016–2020 period (Appendix B: Table B4). Data collected from the RLF provides limited insight into the reasons behind this increase and/or explanation as to why these species are not recorded with more regularity across the SOCI logbook timescale (Appendix B: Table B4).

While the SOCI data indicates that most humphead Maori wrasse and the barramundi cod are released alive (Appendix B: Table B4), there has been limited research on post-capture mortality rates for these species. Similarly, it will be difficult to verify the veracity of the SOCI data or future interaction rates without additional monitoring or research on catch discards. It is reasonable to assume that a percentage of the released fish will die as a result of their interaction with the RLF *e.g.* due to injuries, stress, or predation. Consequently, the RLF will be a contributor of risk in terms of the overall rate of fishing mortality. It is noted though that cumulative fishing risks will be lower for these species as no-take provisions are applied across fisheries and sectors. While humphead Maori wrasse, potato cod, and barramundi cod are retained in the aquarium fishery, this can only be done under a permit and less than 100 collective individuals have been harvested in this fishery over the last decade (DAF, unpublished data).

Long-term protections have reduced the risk posed to all four species and there are fewer concerns surrounding their long-term sustainability in Queensland waters. This inference is supported by the absence of threatened species listings (*e.g.* under the EPBC Act, *Nature Conservation Act 1992*) and the fact that their protection status in Queensland is partly based on their status as iconic species. For these reasons, the decision to assess humphead Maori wrasse, Queensland groper, potato rockcod and barramundi cod could be viewed as precautionary. Given the outputs of the Level 2 assessment, subsequent ERAs will need to determine if this subgroup requires further evaluation. These deliberations would benefit from additional data on interaction rates, release fates and the encounterability potential of each species. Initiatives instigated as part of the *data validation plan* and *fishery monitoring program* may assist in this process.

5 Summary

The updated RLF Level 2 ERA indicates that the fishery poses a moderate or high risk to species within the OS Quota Management Unit and a select group of protected species. For most species, the final risk ratings are viewed as precautionary, and management of these risks beyond what is already being undertaken as part of the *Queensland Sustainable Fisheries Strategy 2017–2027* is viewed as less of a priority. For at least two of the species, red emperor and saddletail snapper, there is a more pressing need to review the suitability and applicability of the current management arrangements and/or increase the level of information on the health of regional stocks. There has however been a marked decrease in the number of RLF species being assigned high-risk ratings. This decline can be attributed to reforms instigated under the *Queensland Sustainable Fisheries Strategy 2017–2027* including the introduction of a fisheries-specific harvest strategy. Future updates of the RLF Level 2 ERA would benefit from more information on the biology of key species, stock status, and fine-scale movements of effort.

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7 Appendices

Appendix A – Progress against recommendations.

Appendix B – *Scoping Study* update.

Appendix C – Species rationalisation process: justifications and considerations.

Appendix D – Score change justifications.

Appendix E – *Likelihood & Consequence Analysis*.

Appendix F – *Availability* overlap percentages.

Appendix G – *Sustainability assessment* history.

Appendix A—Progress against recommendations.

Recommendations are a key part of the ERA process as they identify areas where there is greater potential for risk to be better understood, managed, or mitigated. These recommendations are non-binding and are principally considered through Fisheries Working Groups established under the *Queensland Sustainable Fisheries Strategy 2017–2027* (Department of Agriculture and Fisheries, 2017a). While the ERA recommendations can be fisheries-specific, some will be more significant, have longer time frames, and/or will need to be addressed across multiple assessment periods. The priority status of each recommendation will also vary as larger and more complex reforms will be prioritised as part of the Strategy (Department of Agriculture and Fisheries, 2017a). Similarly, some recommendations and risk mitigation measures will be addressed as part of broader reform programs as they impact multiple fisheries *e.g.* mandating the use of *vessel tracking* and the *data validation plan.* At a species-specific level, the priority status of a recommendation will be influenced by a range of factors including the level of risk posed to a species or species complex, assessment uncertainty (*i.e.* actual risk verse potential risk), and cumulative fishing pressures. The above factors are of some importance as they will influence the level of progress made against each recommendation. Below presents an update on the progress made against recommendations made as part of the 2019/20 RLF Level 2 ERA assessment, with context provided on departmental priorities and timeframes.

2019/20 Level 2 ERA recommendation	***Progress in 2021/2022***
General recommendations	
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.	***Completed*****—**The RLF now operates under a fisheries-specific harvest strategy that includes a range of performance indicators, decision rules, and trigger limits that are applied to the commercial, recreational, and/or charter fishing sectors. These measures provide a strong framework to manage the long-term overexploitation and cumulative fishing risks for key target & byproduct species. In the 2021 RLF Level 2 ERA, this was reflected in scores assigned to the *management strategy* attribute in risk profiles involving target & byproduct species.
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.	***Ongoing***—Issues relating to data validation and monitoring of catch are being addressed as part of a broader *Queensland Sustainable Fisheries Strategy Data Validation Program* (Department of Agriculture and Fisheries, 2018b). This program continues to evolve, with *vessel tracking* now being required on all primary and tender boats used in the RLF. The RLF does not currently operate under a system that closely monitors bycatch making it difficult to quantify total interaction rates and total rates of fishing mortality (*i.e.* retained plus post-release mortalities).

2019/20 Level 2 ERA recommendation	***Progress in 2021/2022***
	Notwithstanding, the fishery operates under a more complex catch reporting / quota monitoring system that includes Automated Interactive Voice Response (AIVR), unload reports, and catch disposal records. These measures provide a level of oversight and cross-checks that are only applied to quota-based fisheries. Issues relating to the monitoring of catch, bycatch, and protected species interactions, are not restricted to the RLF. Further, there are inherent challenges of implementing a catch monitoring program that is efficient, cost-effective, and provides adequate coverage across a diverse range of fisheries. There has been some progress with this aspect of the *data validation plan* with an Electronic Monitoring (EM) field trial being proposed to investigate the practicalities and costs of at-sea monitoring. The trial will focus on the trawl and large mesh net fisheries which have been identified as key EM priorities. While this trial will not directly involve the RLF, it will inform discussions surrounding the suitability, applicability, and limitations of EM for all fisheries.
Improve the level of information on the biology, stock structure, and status of priority species (sustainability assessments).	***Completed / Ongoing*****—**The monitoring program for reef species now includes coral trout, redthroat emperor and a range of species managed under the OS category *i.e.* saddletail snapper (*L. malabaricus*), spangled emperor (*L. nebulosus*), crimson snapper (*L. erythropterus*), red emperor (*L. sebae*) and stripey snapper (*L. carponotatus*). When and where appropriate, this information will support stock assessments and stock status evaluations for these species. In the RLF, stock assessments have now been completed for coral trout (*P. leopardus*), redthroat emperor (*L. miniatus*) and saddletail snapper (Campbell *et al.*, 2021; Campbell *et al.*, 2019; Department of Agriculture and Fisheries, 2020e; Northrop & Campbell, 2020). A stock assessment for red emperor is also scheduled for release in 2022 (Department of Agriculture and Fisheries, 2020e). As the *fishery monitoring program* now includes the two species at high risk, red emperor and saddletail snapper, further progress on this recommendation may not be required unless there is a significant change in the current fishing environment and/or a species reaches or exceeds catch

2019/20 Level 2 ERA recommendation	***Progress in 2021/2022***
	trigger limits established under the *Reef Line Fishery Harvest Strategy 2020–2025* (Department of Agriculture and Fisheries, 2020a).
Review the suitability and applicability of current legal size limits for OS category species and (when and where appropriate) update; taking into account available information on their biology (management strategy).	***Ongoing*****—**The RLF working group has commenced discussions surrounding the suitability and applicability of size limits for key species. These discussions are ongoing and the outcomes of any review have yet to be finalised or (if applicable) consulted on.
Review the suitability, applicability, and value of data submitted through the logbook program on the dynamics of the fishery. 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.	***Progressed / Ongoing*****—**New commercial fishing logbooks released in 2021 have been expanded to include recording of fishing symbol. New reporting requirements came with these changes and will also support the improvement of data submitted through the logbook program. The *data validation plan* is in its initial phases and will eventually support the improvement of logbook data quality.
Utilise fine-scale effort information to better assess true fishing overlap with the distribution of species included in the OS Quota Management Unit and the protected species ecological sub-component.	***Not Progressed / Ongoing*****—***Vessel tracking* on commercial vessels is well-established, with the RLF entering its fourth fishing season. These data sets are now being used to inform aspects of the *data validation plan* including avenues that can be used to provide a more accurate account of the RLF effort signature. The structure and scope of this research is still in development and could not be considered as part of the 2021 RLF Level 2 ERA. When and where appropriate, outputs/results from this research will be taken into consideration as part of future ERAs.
Quantify the cumulative fishing pressures exerted on key OS category species and, when and where appropriate, identify areas to improve catch monitoring across the recreational and charter fishing sectors (recreational desirability / other fisheries).	***Progressed / Ongoing*****—**A new *Statewide Recreational Fishing Survey 2019/20* has been released and data can be accessed via an interactive dashboard (Department of Agriculture and Fisheries, 2021b; Teixeira *et al.*, 2021). Species resolution within this survey has also improved, with key recreational species such as crimson (*L. erythropterus*) and saddletail (*L. malabaricus*) snapper now independently represented. Alongside the updated survey, data collected from the *fishery monitoring program* has meant that a weight multiplier can now be applied to data collected

2019/20 Level 2 ERA recommendation	***Progress in 2021/2022***
	from the recreational fishing sector. This means that the department can better quantify cumulative fishing pressure for key species *i.e.* the fishing pressure exerted on a species across sectors.
Implement strategies that encourage best handling practices for releasing OS category species and protected teleosts proven to help post-release survival rates (post-release mortalities).	***Not progressed*****—**Limited progress made against this recommendation as it is viewed as a lower priority; particularly when considered in context of the broader reform agenda (*e.g.* implementing a fisheries-specific harvest strategy, developing data validation strategies). Given the breadth of the reform agenda that has been / is being implemented in the RLF, a lack of progress on this recommendation is not viewed as a significant impediment for the fishery. *Note–while this recommendation has not been actioned for the RLF, DAF has released additional information on best-practice fishing release methods for snapper (Chrysophrys auratus*) *and pearl perch (Glaucosoma scapulare). Methods described for these species would apply equally to coral reef species.*
Establish a measure to estimate the gear-affected area and, when available and appropriate, reassess the risk posed to key species using a more quantitative ERA method like base Sustainability Assessment for Fishing Effects (bSAFE).	***Not progressed / Ongoing***—Information on effort distributions is not sufficient to provide an adequate representation of the gear-affected area. This was the catalyst for the 2021 RLF Level 2 ERA adopting the PSA as the assessment method. The bSAFE is known to produce fewer false positives and there are inherent benefits of moving the RLF to this type of assessment (Zhou *et al.*, 2016). In contrast, there are limited consequences of not progressing the fishery to bSAFE *i.e.* the assessment can still progress using the PSA. Research has shown though that a) the PSA tends to be more conservative and b) a move to SAFE would be beneficial in terms of minimising the number of false positives (Zhou *et al.*, 2016). The primary consequence of not moving to bSAFE is that the Level 2 ERA will need to determine if the outputs represent a real or potential risk.
Obtain better information on catch rates and release fates of protected teleosts across sectors (commercial, charter and recreational fishing).	***Not progressed*****—**In 2020, DAF conducted a review of the *Species of Conservation Interest* (SOCI) logbook reporting requirements. The review examined the scope of the SOCI logbook and its suitability in meeting mandatory reporting requirements under the Commonwealth *Environment Protection and Biodiversity Act 1999* (EPBC Act). As a result of this review, species-reporting

2019/20 Level 2 ERA recommendation	***Progress in 2021/2022***
	requirements were refined and the SOCI logbook replaced with the *Threatened, Endangered and Protected Animals Logbook.* The primary purpose of the *Threatened, Endangered and Protected Animals Logbook* is to report interactions with species listed under the EPBC Act to meet key reporting requirements *e.g.* for Wildlife Trade Operation (WTO) approvals. As the humphead Maori wrasse (*C. undulatus*), Queensland groper (*E. lanceolatus*), potato rockcod (*E. tukula*), and barramundi cod (*C. altivelis*) are not listed protected species under the EPBC Act (but are species protected under the Great Barrier Reef Marine Park Regulations 1983), they do not form part of the new reporting regime. Going forward, an effective course of action to collect an appropriate level of information on protected teleosts, without imposing an unbalanced data requirement on the fishery, might be through direct validation of species compositions and interaction rates *i.e.* through the *data validation plan*.

Appendix B—Updated Scoping Study.

The foundation for all assessments developed under the ERA Guidelines is the Scoping Study (Department of Agriculture and Fisheries, 2018a). A detailed Scoping Study was completed for the RLF in 2019 and included information on the structure and management of the fishery *e.g.* historic changes in participation rates, symbol numbers, management changes, and catch/effort (Department of Agriculture and Fisheries, 2019).

The following is an update of the 2019 Scoping Study and establishes a new baseline of information for use in the 2021 RLF Level 2 ERA. Information contained within this Scoping Study includes additional fisheries data and information on shifts within the broader management framework. Further information on historical fishing trends is provided in the original Scoping Study (available at: https://era.daf.qld.gov.au/id/eprint/6970/).

Management summary

Species targeted	Coral trout, redthroat emperor, saddletail snapper, spangled emperor, red emperor, crimson snapper, goldband snapper and other coral reef fin fish.
Fishery symbols	L1, L2, & L3 (line fishing), L8 (multi-hook) & RQ (quota)
Legislation	*Fisheries Act 1994* and subordinate legislation.
Working group	Reef Line Fishery Working group.
Harvest strategy	Reef Line Fishery Harvest Strategy 2020–2025
Gear	Hook and line apparatus. Recreational fishers may use hook and line, rods and reels, and spearfishing gear (*exc.* Hookah/SCUBA). *A full description of the types of apparatus prescribed for each fishery symbol is in the Fisheries (Commercial Fisheries) Regulation 2019.*
Main management methods	*All fishers* • Harvest strategy • Seasonal and spatial closures. • Minimum and maximum size limits. • No-take species. • Gear restrictions. *Commercial only* • Individual Transferable Quotas (ITQ) for coral trout & redthroat emperor. • Combined ITQ for Other Species (OS). • Vessel & tender restrictions including *vessel tracking*. *Recreational only* • Possession limits.
Licences & fishing symbols (2020)	Active licences—252; L1—223; L2—190; L3—903; RQ—346
Quota (assessed annually)	Coral trout (CT) – 1,163t (2020/21). Redthroat emperor (RTE) – 611t (2020/21). Other species (OS) – 956t (2020/21).
Fishing season	1 July to 30 June. Two annual five-day spawning closures apply in October and November coinciding with moon phase.
Accreditation under the *EPBC Act*	Part 13: Accredited. Part 13A: Accredited (expires 18 Jan 2024).

Catch, effort, and licencing data

The following provides and overview of catch, effort, and licencing data in the RLF from the introduction of quota in July 2004 through to the 2020/21 fishing season. A full account of the number of symbols available for use in the fishery, the number of active licences, and catch/effort trends during this period has been provided in (Table B1). Fisheries data prior to the 2004/05 fishing season is provided in the original RLF Scoping Study (Department of Agriculture and Fisheries, 2019; 2020d).

There has been a marginal decrease in the number of fishing symbols that can access the fishery since the completion of the last Scoping Study (Table B1). While marginal, this reflects a broader trend that has seen the total number of L1, L2, L3 and RQ fishery symbols reduce since the introduction of quota. The most notable change has been in the number of L1 fishery symbols. This symbol was subject to a latent effort review which resulted in around 1000 symbols being removed from the system between the 2007/08 and 2008/09 fishing seasons (Table B1).

When compared, the number of active licences (*i.e.* the number of licences recording catch and effort from the fishery) showed more variability. Over the 2018/19 to 2020/21 period, between 231 and 252 operators accessed the RLF and reported catch from one of the three quota management units (Table B1). These fluctuations are consistent with data collected from the fishery over the last 10 years, and there is little evidence that the fishing environment has changed significantly in terms of participation rates.

Catch and effort trends for the RLF mirrored those reported in the last Scoping Study with both showing a general decline over the 2018/19 to 2020/21 period. During this time, the fishery registered an average of 26,640 dory days and a combined average catch of 1191t. This compares to 42,402 dory days and 1500t in the first quota season (2004/05) and a 10-year average (2011/12–2020/21) of 35,701 dory days and 1326t (Table B1). As sustainability has been confirmed for the two key quota management units, coral trout and redthroat emperor (Campbell *et al.*, 2019; Northrop & Campbell, 2020; Roelofs & Fairclogh, 2020; Saunders *et al.*, 2020a), these downward trends are (likely) due to management/quota reforms.

At a quota-management level, coral trout (CT) continues to make the greatest contribution to the annual catch (59–64% of the total harvest). This compares to 9–12% for redthroat emperor (RTE) and 27–29% for all fin fish included in the Other Species (OS) quota management unit. Quota usage across the three management units is not uniform, with redthroat emperor and other species using less than half of their respective catch limits. Conversely, the CT quota management unit regularly exceeds two-thirds of the TACC (Table B2).

Species compositions—Harvested species

While reef line fishers can retain over 100 species, the bulk of the catch is made up of a smaller sub-set of fin fish. The coral trout complex dominates the annual RLF catch (Table B1; Fig. B1) and includes the common coral trout (*Plectropomus leopardus*), barcheek coral trout (*P. maculatus*), bluespotted coral trout (*P. laevis*), passionfruit coral trout (*P. areolatus*), yellow-edge coronation trout (*Variola louti*) and white-edge coronation trout (*V. albimarginata*). Of these, the common coral trout is the primary target for live export and is harvested in greater quantities. The sustainability of this species has been confirmed through a stock assessments and indicative sustainability evaluations (Campbell *et al.*, 2019; Saunders *et al.*, 2020a).

Table B1. *Number of fishing symbols, active licences[10], effort (dory days), and catch (tonnes) in the Reef Line Fishery since the introduction of quota in 2004.*

Year	Fishing symbols[11]				CT			RTE			OS			Total[12]		
	L1	L2	L3	RQ	Active licences	Dory days	Catch (t)	Active licences	Dory days	Catch (t)	Active licences	Dory days	Catch (t)	Active licences	Dory days	Catch (t)
2004/05	1514	233	1302	411	215	40,688	973	199	31,579	228	270	32,023	300	286	42,402	1,500
2005/06	1440	216	1228	376	191	38,259	1,025	181	30,489	213	255	33,364	307	265	39,866	1,545
2006/07	1399	210	1201	373	182	38,996	977	170	31,833	225	251	34,341	312	253	40,610	1,514
2007/08	1376	209	1200	373	189	39,190	1,070	177	30,648	269	255	36,198	385	256	41,086	1,723
2008/09	374	204	1109	370	193	42,897	1,105	178	31,754	247	271	40,456	506	274	45,394	1,858
2009/10	241	204	1102	370	203	45,640	940	194	32,487	271	266	44,184	496	269	47,899	1,707
2010/11	243	204	1100	370	189	41,128	801	170	30,440	248	242	39,503	427	246	43,094	1,476
2011/12	241	204	1088	370	174	38,960	725	151	27,588	226	247	37,085	357	252	40,656	1,308
2012/13	238	202	1057	367	181	37,488	751	163	25,831	218	239	35,124	373	244	39,038	1,342
201314	238	202	1043	365	186	36,553	840	161	25,857	219	239	34,796	407	239	38,214	1,466
2014/15	232	195	994	356	190	39,707	753	162	26,610	202	239	37,970	414	240	41,420	1,369
2015/16	231	192	969	350	201	39,413	817	170	25,347	164	251	37,512	436	253	41,527	1,417
2016/17	226	190	936	347	188	29,034	850	158	17,994	137	249	27,427	398	250	31,234	1,385
2017/18	225	190	931	346	184	28,716	829	164	18,954	167	240	26,519	403	242	30,674	1,399
2018/19	223	190	921	346	177	27,364	734	146	16,332	151	226	25,060	333	231	29,191	1,219
2019/20	223	190	903	346	187	25,255	684	154	16,342	140	234	23,883	330	240	27,106	1,153
2020/21	221	190	880	346	202	22,013	767	171	13,925	113	247	20,634	320	252	23,622	1,200

[10] The number of active licences represent the number of licences that reported catch in each of the respective quota management units.

[11] Operators must hold an Line (L) fishing symbol to access this fishery plus an RQ symbol with quota attached. The 'L' fishing symbol governs the fishing area and the RQ signifies that the licence has quota attached. For this reason, the RQ symbol (and quota) is the limiting factor with respect to the number of licences accessing the fishery.

[12] Total active licences and effort are not cumulative (i.e. cannot be summed) as operators can report catch in more than category during a single fishing event.

Redthroat emperor (*Lethrinus miniatus*) is the second largest single-species catch component; accounting for 9–12% of the reported catch (Table B1; Fig. B1). In the years following the original Scoping Study, harvest rates for redthroat emperor have remained relatively stable. Stock sustainability for this species has also been confirmed through a quantitative stock assessment and indicative sustainability evaluations (Northrop & Campbell, 2020; Roelofs & Fairclogh, 2020).

Data for the OS Quota Management Unit was more varied with a higher number of species reporting smaller catch quantities. All of these quantities were lower than that reported for coral trout and redthroat emperor (Table B1; Fig. B1). Across the 2018/19–2020/21 period over half of the OS catch (50.1%) was made up of saddletail snapper (*L. malabaricus*), spangled emperor (*L. nebulosus*), and goldband snapper (*P. multidens*). Over 80% of the catch for this period consisted of just eight species: the above three, red emperor (*L. sebae*), stripey snapper (*L. carponotatus*), banded rockcod (*H. ergastularius*), crimson snapper (*L. erythropterus*), and hussar (*L. adetii*). These catch compositions align well with the 2019 Scoping Study which shows that these species have a consistent history of comparatively high catches in the RLF (Table B3).

Table B2. *Annual catch quota and proportion utilised for each quota grouping, including coral trout (CT); redthroat emperor (RTE); and other species (OS) quota management units.*

Year	CT		RTE		OS	
	Quota (t)	Utilised	Quota (t)	Utilised	Quota (t)	Utilised
2016–17	~917	96%	~611	21%	~956	44%
2017–18	~963	92%	~611	24%	~956	46%
2018–19	~1,163	69%	~611	21%	~956	38%
2019–20	~1,163	66%	~611	22%	~956	38%
2020–21	~1,163	75%	~611	18%	~956	38%

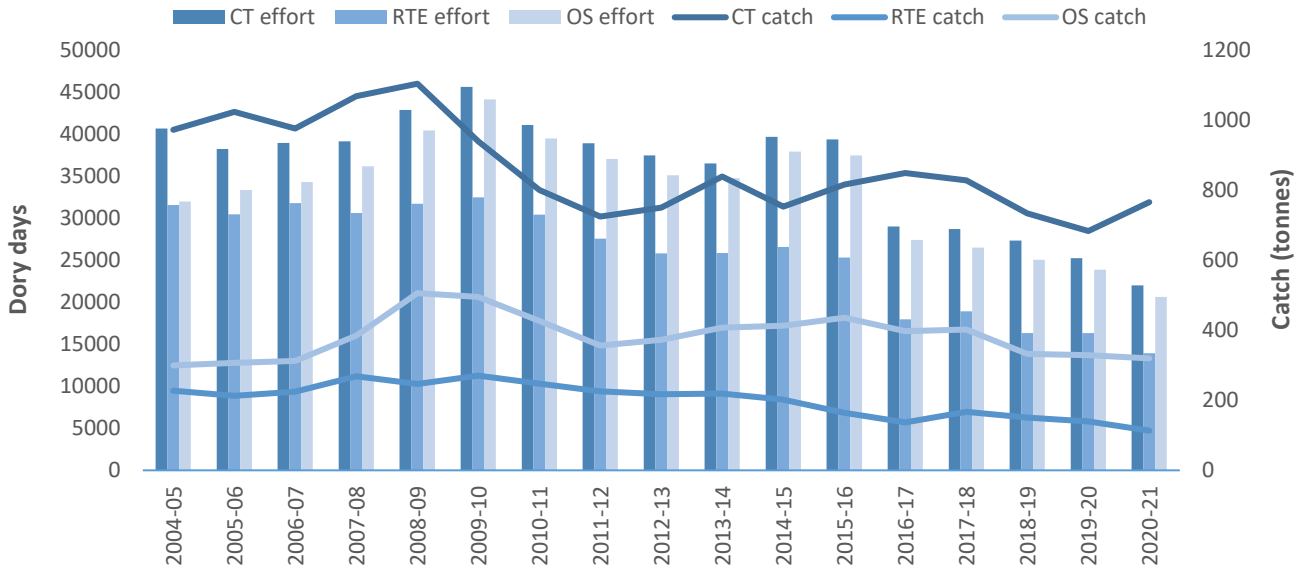

Figure B1. *Catch and effort for the three quota categories in the Reef Line Fishery: coral trout (CT); redthroat emperor (RTE); and other species (OS).*

Table B3. *The yearly total catch (t) for RQ quota restricted species in the Reef Line Fishery since the introduction of quota in 2004. Due to the large number of species in the OS Quota Management Unit, only species representing 99% of the total OS catch are listed here. The fishery season runs from 1 July to 30 June.*

Note—Rows shaded in blue represent the eight species / species complexes that made up over 80% of the reported OS catch during the 2018/19 to 2020/21 period. For reference: large mouth nannygai = saddletail snapper; bar cod (cod—bar) = banded rockcod; small mouth nannygai = crimson snapper; hussar = brownstripe snapper and hussar; gold banded jobfish = goldband snapper.

Species	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21
Coral trout	**973**	**1025**	**977**	**1069**	**1105**	**940**	**801**	**725**	**751**	**839**	**753**	**816**	**850**	**829**	**734**	**684**	**766**
Emperor—redthroat	**228**	**213**	**225**	**269**	**247**	**271**	**248**	**226**	**218**	**219**	**202**	**164**	**137**	**167**	**151**	**140**	**113**
Other Species (OS)																	
Nannygai—large mouth	8	14	9	27	65	52	54	38	47	54	64	79	77	99	70	63	70
Emperor—spangled	12	12	11	30	57	67	54	49	53	60	59	55	51	52	57	59	51
Jobfish—gold banded	31	28	37	44	47	52	39	36	33	43	51	54	62	47	38	48	37
Emperor—red	27	28	27	42	59	61	59	42	44	46	44	40	36	41	35	32	31
Stripey—spanish flag	21	24	23	53	45	66	51	54	48	40	43	40	29	24	29	25	21
Cod—unspecified	23	28	21	23	39	22	18	21	22	26	21	30	20	21	4	5	3
Fish—mixed reef	56	45	54	26	25	20	17	12	13	16	22	15	9	8	0	0	0
Hussar—unspecified	17	14	19	23	27	25	21	20	21	17	15	17	16	16	10	11	12
Cod—bar	1	4	1	26	38	17	23	16	6	13	8	11	14	14	19	17	18
Nannygai—small mouth	1	1	1	10	20	21	15	12	19	19	15	13	12	12	12	11	13
Emperor—unspecified	23	25	24	13	8	13	11	8	10	8	8	11	9	7	2	1	1
Tusk fish—unspecified	14	12	12	14	14	22	18	11	10	10	8	9	9	7	2	1	<1
Jobfish—unspecified	23	35	28	11	5	7	3	3	8	9	11	9	6	4	<1	<1	<1
Jobfish—rosy	2	6	5	7	16	5	3	2	3	9	9	10	14	10	2	2	10
Jobfish—green	1	1	<1	3	5	6	6	5	4	7	8	6	5	7	7	6	5
Snapper—unspecified tropical	3	1	2	5	5	6	4	5	9	11	7	9	8	4	<1	<1	<1

Species	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21
Nannygai—unspecified	14	15	18	3	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Painted sweetlip	2	<1	1	2	5	5	4	2	3	1	1	2	2	3	5	5	6
Tusk fish—venus	1	2	3	1	1	2	2	1	1	1	2	2	2	3	8	7	7
Perch—moses	1	1	1	2	3	3	2	2	2	2	2	2	2	3	5	5	4
Cod—maori	1	2	2	2	4	2	1	1	1	1	1	1	1	2	6	4	2
Seabream—collar	2	2	3	2	4	4	4	2	2	1	1	1	1	1	1	2	2
Snapper—flame tail	6	2	1	4	1	<1	<1	<1	<1	1	2	4	3	1	2	3	2
Emperor—long nose	1	<1	<1	1	1	2	1	1	2	2	1	1	2	2	3	3	4
Fish—mixed reef a	1	<1	1	1	<1	1	4	3	2	2	2	2	1	1	0	0	0
Grouper—comet	1	1	1	2	1	1	1	1	1	1	1	1	2	1	1	1	1
Emperor—yellow tailed	<1	<1	<1	<1	<1	1	1	1	1	1	2	1	1	2	2	2	2
Snapper—ruby	2	<1	<1	<1	1	1	<1	1	<1	<1	1	1	1	1	1	1	2
Fish—mixed reef b	1	1	3	1	1	1	1	<1	1	2	<1	<1	<1	<1	0	0	0
Cod—greasy	<1	<1	<1	<1	1	<1	<1	<1	<1	1	2	2	1	2	1	1	1
Bream—maori	<1	<1	<1	<1	<1	1	<1	<1	<1	<1	<1	1	<1	1	1	1	1
Cod—flowery	1	1	1	1	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1	<1
Bass groper	0	0	0	<1	1	1	2	<1	<1	<1	1	1	1	0	<1	<1	1
Cod—red rock	<1	<1	<1	<1	1	1	1	<1	<1	<1	<1	<1	<1	<1	1	2	<1
Cod—blue maori	<1	<1	<1	<1	<1	1	<1	<1	<1	<1	<1	<1	<1	<1	1	1	1
All other species	2	2	3	3	4	8	6	4	4	5	4	6	4	6	8	10	13
Total—OS only	**300**	**307**	**312**	**385**	**507**	**496**	**428**	**357**	**373**	**408**	**414**	**436**	**398**	**403**	**334**	**330**	**321**
Grand total	**1500**	**1545**	**1514**	**1723**	**1858**	**1707**	**1476**	**1308**	**1342**	**1466**	**1369**	**1417**	**1385**	**1399**	**1219**	**1153**	**1200**

Non-harvested species

In this fishery, bycatch is mostly target species that do not satisfy legal size restrictions, low-value permitted species, and species that do not fall within the remit of the RLF management regime. At present, there is little information on the extent of discards in the RLF; particularly for low-value OS species. To this extent, it is difficult to determine how prevalent the discarding of (potentially) retainable product is in this fishery and/or the number of regulated (*e.g.* undersized) fish that are discarded within a given fishing season.

With regards to non-RLF species, the L1, L2, and L3 fishery symbols also permit access to the *East Coast Inshore Fishery* (ECIF) and the *Rocky Reef Fishery* (RRF). Accordingly, operators can legally retain non-RLF species when targeting coral trout, redthroat emperor, or OS species providing a) it is permitted under the relevant 'L' fishery symbol and b) it meets the prescribed requirements *e.g.* minimum legal size limits. In these instances, the non-RLF portion of the catch will be recorded against the fishery that the species is managed under.

Of the non-target species, the fishery will interact with several teleosts that are afforded additional protections under the Queensland-based *Fisheries Declaration 2019*. Namely, the humphead Maori wrasse (*C. undulatus*), Queensland groper (*E. lanceolatus*), potato rockcod (*E. tukula*), and barramundi cod (*C. altivelis*). These species are not listed under the federal EPBC Act and their protection status is partly linked to their cultural significance *i.e.* they are viewed as iconic species.

Interactions with the humphead Maori wrasse, Queensland groper, potato rockcod, and barramundi cod have historically been monitored through the *Species of Conservation Interest* (SOCI) logbook (see note below). Data collected through the SOCI logbook show that interactions with the humphead Maori wrasse and the barramundi cod have increased significantly over the 2016–2020 period (Table B4). The reasons behind this increase remain unclear and the accuracy of this data will be difficult to validate without improved catch monitoring. However, data submitted through a previous SOCI logbook indicates that most of the fish survive the initial interaction (Table B4). When compared to the humphead Maori wrasse and the barramundi cod, there are minimal reports of the Queensland groper and potato rockcod interacting with reef line operations (Table B4).

Outside of protected teleosts, there have been limited interactions with groups classified as Threatened, Protected and Endangered (TEP) *i.e.* cetaceans, marine turtles, and seabirds (Table B4). Interactions with these subgroups tend to be low in number, infrequent and/or involve the vessel *vs.* the apparatus (*i.e.* a pod of dolphins interacting with the vessel, passing humpback whales and boat strikes). An overview of interactions reported through the former SOCI logbook including species compositions and release fates has been provided in Table B4.

Note—Interactions with Threatened, Endangered and Protected species were previously reported through the SOCI logbook. The SOCI logbook was reviewed in 2021 and replaced with the Threatened, Protected and Endangered Animals logbook (Queensland Government, 2018a). Reporting requirements for the Threatened, Protected and Endangered Animals logbook are specifically targeted at species listed under the EBPC Act; and therefore does not include the four teleosts protected under the Fisheries Declaration 2019 (QLD). As a result of this change, mandatory reporting requirements no longer apply to the humphead Maori wrasse, Queensland groper, potato rockcod, and barramundi cod.

***Table B4**. Interactions reported in the Species of Conservation Interest (SOCI) logbook by fishers operating in the Reef Line Fishery. Data includes all reports and encompasses dropline (demersal longline), handline, and line fishing operations.*

Species	2006				2007				2008				2009				2010–14
	Total	Alive	Dead	Injured	Total	Alive	Dead	Injured	Total	Alive	Dead	Injured	Total	Alive	Dead	Injured	No interactions
Threatened, Protected and Endangered Animals (EPBC Act)																	
Whales																	
Humpback					2	1		1				1					
Minke	4	4											2	2			
Dolphin																	
Offshore bottlenose					15	15											
Marine turtles																	
Unspecified	1			1													
Green																	
Loggerhead									1	1							
Sharks																	
Great white shark													1	1			
Seabirds																	
Terns																	
Pelicans									2	2							
Protected teleosts (iconic species, QLD legislation)																	
Humphead Maori wrasse																	
Queensland groper																	
Barramundi cod																	
Potato rockcod																	

Table B4 cont.

Species	2015				2016				2017				2018				2019				2020			
	Total	Alive	Dead	Injured	Total	Alive	Dead	Injured	Total	Alive	Dead	Injured	Total	Alive	Dead	Injured	Total	Alive	Dead	Injured	Total	Alive	Dead	Injured
Threatened, Protected and Endangered Animals (EPBC Act)																								
Whales																								
Humpback									2	2			3	3							14	14		
Minke																								
Dolphin																								
Offshore bottlenose																								
Marine turtles																								
Unspecified																								
Green					4	4							1	1										
Loggerhead													3	1		2								
Sharks																								
Great white shark																								
Seabirds																								
Terns									1	1														
Pelicans																								
Protected teleosts (iconic species, Qld legislation)																								
Humphead Maori wrasse					388	384	4		296	289	7		268	243		25	810	809	1		550	550		
Queensland groper					1		1																	
Barramundi cod	1			1	430	424	6		357	331	26		398	382		16	472	471	1		345	344	1	
Potato rockcod																								

Appendix C—Species prioritisation: justifications and considerations.

The species list contained in Walton *et al.* (2021) was used as the foundation for the 2021 RLF Level 2 ERA. A review of the catch data supported the inclusion of all previously assessed species and the list was carried over to the updated ERA without any omissions (Walton *et al.*, 2021). However, catch data compiled for the RLF did support the inclusion of two additional emperor species and a single scorpionfish.

The following provides details of the three additional species that were included in the 2021 RLF Level 2 ERA. These three species have not been the subject of a previous risk assessment compiled under the ERA Guidelines (Australian Fisheries Management Authority, 2018; Walton *et al.*, 2021). For a detailed explanation of the species rationalisation process, and a full list of target & byproduct species justifications, see **Appendix A** and **Appendix B** of the original assessment (Walton *et al.*, 2021).

Common name	Species name	CAAB	Level 2 ERA	Justifications & Comments
Redspot emperor	*Lethrinus lentjan*	37351007	Assessed	• Included based on catch records (*Emperor—unspecified*). • FWG recommended spotcheek emperor (*L. rubrioperculatus*) be included in the original Level 2 ERA, however, redspot emperor (*L. lentjan*) is harvested in greater quantities (0.5–1.3t verse 0.1–0.4t per annum 2018–2020 inclusive). Due to identification or naming discrepancies, both emperors were included in the 2021 RLF Level 2 ERA.
Yellowtail emperor	*Lethrinus atkinsoni*	37351013	Assessed	• Included based on catch records (*Emperor—yellow tailed*).
Eastern red scorpionfish	*Scorpaena jacksoniensis*	37287066	Assessed	• Included based on catch records (*Cod—red rock*).

Appendix D—Score change justifications.

The following provides an overview of the key score changes undertaken as part of the 2021 RLF Level 2 ERA. These amendments reflect improvements in the available data and/or considerations made as part of the preliminary review of the baseline scores from Walton *et al.* (2021). For the most part, refinements made as part of the original Residual Risk Analysis (RRA) were retained in this assessment or adopted with minor amendments (see below). For details of the attribute scores and changes made as part of the original RRA, refer to **Appendix D** of the previous assessment (Walton *et al.*, 2021).

Species	Attribute	Original assessment	2021 Update	Score change justifications
Brownstripe snapper (*L. vitta*)	*Age at maturity (Productivity)*	2	1	In the original assessment, the best available information indicated that the brownstripe snapper (*L. vitta*) reached maturity at 5–15 years of age. Accordingly, the species was assigned a medium-risk (2) rating. Research now indicates that the *age at maturity* for brownstripe snapper is <5 years of age (Palla & Sotto, 2021). Based on this information, the score assigned to *age at maturity* was reduced from medium (2) to low (1).
Flame snapper (*E. coruscans*) Ruby snapper (*E. carbunculus*)	*Age at maturity (Productivity)*	1	2	New information on the *age at maturity* for flame snapper (*E. coruscans*) is now available. This information indicates that the species reaches sexual maturity at between 5 and 15 years of age (Andrews *et al.*, 2020). This contrasts with data used in the original Level 2 ERA which suggested the *age at maturity* was <5 years (Russell *et al.*, 2016b; Walton *et al.*, 2021). Given the conservative nature of the PSA methodology and the new information, the score assigned to *age at maturity* was increased from low (1) to medium (2). *Age at maturity* data were not available for use in the initial ruby snapper (*E. carbunculus*) Level 2 ERA, and the assessment was completed using estimates for the flame snapper (Walton *et al.*, 2021). The level of information on ruby snapper reproductive development has not improved since the initial assessment and the use of a proxy is still required. In line with the previous Level 2 ERA, flame snapper data was used to complete the assessment and the *age at maturity* score increased from low (1) to medium (2).

Species	Attribute	Original assessment	2021 Update	Score change justifications
Saddletail snapper (*L. malabaricus*) Flame snapper (*E. coruscans*) Painted sweetlip (*D. pictum*) Red emperor (*L. sebae*)	*Maximum age (Productivity)*	2	3	New literature is available for the *maximum age* of flame snapper (*E. coruscans*) and it is now understood to reach ages greater than 25 years (Andrews *et al.*, 2020). This differs from the previous Level 2 ERA which provided a maximum age estimate of at least 18 years (Bray, 2017). There are several estimates of *maximum age* for saddletail snapper (*L. malabaricus*), painted sweetlips (*D. pictum*) and red emperor (*L. sebae*). In the original assessment, these species were assigned medium-risk (2) scores based on the available data and the PSA criteria (Grandcourt *et al.*, 2006; Grandcourt *et al.*, 2011; Newman *et al.*, 2000). A review of the literature was undertaken as part of the ERA update and a broader range of age estimates collated (Campbell *et al.*, 2021; Loubens, 1980; Newman & Dunk, 2002; Newman *et al.*, 2010). As some of these estimates exceeded the high-risk rating threshold, *maximum age* attribute scores for saddletail snapper, painted sweetlip and red emperor were adjusted. On the provision of new information, *maximum age* scores were increased from medium (2) to high (3) risk for all four species.
Greasy rockcod (*E. tauvin*a)	*Maximum age (Productivity)*	1	2	New *maximum age* estimates are available for the greasy rockcod (*E. tauvina*), and it is now understood to reach 10–25 years of age (Ohta *et al.*, 2017). This revised estimate supported increasing the score assigned to the *maximum age* attribute from low (1) to medium (2).
Maori snapper (L. rivulatus)	*Maximum age (Productivity)*	2	3	New literature on the *maximum age* of the Maori snapper (*L. rivulatus*) is available and evidence suggests that this species reaches ages greater than 25 years (Wakefield *et al.*, 2020). This revised estimate supported increasing the score assigned to the *maximum age* attribute from medium (2) to high (3).
Highfin grouper (*E. maculatus*)	*Size at maturity (Productivity)*	2	1	New estimates of *size at maturity* were obtained for the highfin grouper (*E. maculatus*), greasy rockcod (*E. tauvina*), and sharptooth snapper (*P. typus*). All three species are now understood to reach maturity at sizes <40cm (Martinez-Andrade, 2003; Ohta *et al.*, 2017; Rhodes *et al.*,

Species	Attribute	Original assessment	2021 Update	Score change justifications
Greasy rockcod (*E. tauvina*) Sharptooth snapper (*P. typus*)				2016). As this is below the threshold of a medium-risk rating, scores assigned to the *size at maturity* attribute were revised downwards from medium (2) to low (1).
Saddletail snapper (*L. malabaricus*) Rosy snapper (*P. filamentosus*)	*Size at maturity (Productivity)*	1	2	Several *size at maturity* estimates are available for the saddletail (*L. malabaricus*) and rosy (*P. filamentosus*) snapper. In the original assessment, both species were assigned low-risk (1) scores as *size at maturity* was estimated to be <40cm (Fry *et al.*, 2009; Martinez-Andrade, 2003; Mees, 1993). In the 2021 RLF Level 2 ERA, literature on these species was reviewed and further consideration was given to the suitability of the original scores. This review revealed a degree of variability in *size at maturity* estimates (Luers *et al.*, 2017; McPherson *et al.*, 1992). For this update, measurements at the higher end of the spectrum were used as the baseline of the *size at maturity* assessment. This resulted in the scores being increased from low (1) to medium (2). It is recognised that a medium rating may represent a risk overestimate for these species. This decision is consistent with the conservative nature of the PSA methodology.
Flame snapper (*E. coruscans*)	*Availability (Susceptibility)*	3	2	Overlap percentages between reef line fishing effort and the distribution of flame snapper has decreased since the last assessment. This decrease translated to a reduction in the score assigned to the *availability* attribute (see Appendix F).
Saddletail snapper (*L. malabaricus*) Red emperor (*L. sebae*)	*Management strategy (Susceptibility)*	3	1	Scores assigned to the *management strategy* attribute in the previous Level 2 ERA was based on the framework in place at the time of assessment *i.e.* it did not consider the content of the *Reef Line Fishery Harvest Strategy 2020–2025* (Department of Agriculture and Fisheries, 2020a). One of the key drivers of risk for this attribute was the fact that effort could increase substantially for one or more species in the multi-species OS Quota Management Unit. Under the old system

Species	Attribute	Original assessment	2021 Update	Score change justifications
Crimson snapper (*L. erythropterus*) Spangled emperor (*L. nebulosus)* Stripey snapper (*L. carponotatus*)				this could be done without the fishery reaching or exceeding the Total Allowable Commercial Catch Limit (TACC). The RLF now operates under a fishery-specific harvest strategy which includes a range of measures that minimise the long-term risk of stock overexploitation and safeguard the fishery from increasing effort across the commercial, recreational and charter fishing sectors (Department of Agriculture and Fisheries, 2020a). This strategy greatly improves management's ability to manage the inter-specific transfer of catch or effort and provides a strong foundation to manage some of the key risks in this fishery. While catch can still increase or be targeted at a smaller number of OS species, the framework includes species-specific triggers which (among other things) establishes an interim competitive TACC limit and instigates additional research and assessment. The primary objective of the harvest strategy is to promote a fishing environment that is more conducive to stock expansion/rebuilding (Department of Agriculture and Fisheries, 2020a). The shift from a multi-species TACC and input controls to species-specific decision rules has reduced the level of risk posed to this management unit (see the *Reef Line Fishery Harvest Strategy* for more detail) (Department of Agriculture and Fisheries, 2020a). For these five species, this risk is further reduced by their inclusion in the *fishery monitoring program*. The FMP collects critical information on the biology and structure of their take in Queensland and, when and where appropriate, will facilitate more rapid development of stock assessments or indicative sustainability evaluations. This differs from the remaining OS species where this process will not commence until catch triggers are reached and exceeded. Based on the above considerations, *management strategy* attribute scores for these five species were reduced from high (3) to low (1).

Species	Attribute	Original assessment	2021 Update	Score change justifications
				Note—it is recognised that deficiencies still remain in the broader RLF management framework e.g. catch validation, monitoring, and reporting of discards. These measures are principally considered as part of assessments involving the sustainability assessments, post-capture mortality, and recreational desirability / other fisheries attributes.
All assessed OS species aside from the five listed above	*Management strategy* *(Susceptibility)*	3	2	The implementation of the harvest strategy was a significant step forward for reducing risk to OS category species. Key benefits include the shift to species-specific management, consideration of both commercial and non-commercial catch and effort, and the use of reactive harvest control rules when triggers are reached. For most of the OS category species, aside from the five with extra monitoring arrangements, there is a deficiency in the quality of data that underpins the Harvest Strategy. Trigger points for all OS category species are based on catch records reported by operators which, at this point in time, cannot be independently validated or verified. This is important as decision rules require accurate accounts of catch/species compositions including discard mortalities. It is recognised though that the risk of misreporting or underreporting of catch for individual species may be lower in this fishery. This is because the RLF already operates with additional catch reporting requirements *e.g.* AIVR, catch disposal records etc. In addition to catch validation, sustainability reference points remain unknown for most of the species included in this management unit. This means that trigger points contained in the harvest strategy could (theoretically) be set above sustainability reference points for one or more of the OS species. While this again could be viewed as a low risk, the extent of this risk cannot be quantified for most of the OS species. It is recognised that a medium-risk score may be an overestimate of risk, particularly for species harvested in lesser amounts (<2t per year). With improved information on interaction rates, total fishing mortality, and better validation of data, there is potential for these

Species	Attribute	Original assessment	2021 Update	Score change justifications
				risk scores to be reduced further *i.e.* from medium (2) to low (1). It may also facilitate the removal of low-harvest species from future ERAs.
Saddletail snapper (*L. malabaricus*)	*Sustainability assessments* *(Susceptibility)*	3	3	Since the previous assessment, a quantitative stock assessment has been completed for the saddletail snapper (*L. malabaricus*) (Campbell *et al.*, 2021). While this assessment improves understanding of the stock status, the model suggested harvest rates may exceed that required to maintain and rebuild regional biomass. Further, current biomass estimates for the species suggest that the stock sits at or around 23% virgin biomass levels. This value is well below targets outlined in the *Queensland Sustainable Fisheries Strategy 2017–2027* (Department of Agriculture and Fisheries, 2017a). The original assessment assigned the species a high-risk score for *sustainability assessments* due to an 'undefined' SAFS stock status (Saunders *et al.*, 2018). While a stock assessment has now been completed for the species, these outputs suggest there is a high risk that the east coast stock is being fished beyond sustainability reference points. This issue is (potentially) compounded by a lack of information on cryptic mortalities, discards / post-release mortalities and cumulative fishing pressures. Due to these deficiencies and the observed stock assessment trends, a high-risk rating was retained for this attribute. *Note—While the base-case model scenario suggested biomass was at or around 23% of unfished levels, the authors recognise that there is significant uncertainty surrounding these conclusions (Campbell et al., 2021). Accordingly, a high-risk (3) rating may represent an overestimate for this species and could be refined with improved data / stock assessment inputs. In the risk assessment context, uncertainty is treated more precautionary and the PSA supports the assignment of a more precautionary risk rating (Hobday et al., 2011; Hobday et al., 2007).*

<table>
<tr><th>Species</th><th>Attribute</th><th>Original assessment</th><th>2021 Update</th><th>Score change justifications</th></tr>
<tr><td>Saddletail snapper (L. malabaricus)
Red emperor (L. sebae)</td><td>Recreational desirability / other fisheries (Susceptibility)</td><td>2</td><td>3</td><td>Saddletail snapper (L. malabaricus) and red emperor (L. sebae) are popular targets in the recreational and charter fishing sectors. At the time of the original Level 2 assessment, best available information supported the assignment medium-risk (2) score for these two species.

However, recreational harvest for saddletail snapper and red emperor exceeds the commercial harvest (by 86t for saddletail snapper and 63t for red emperor) and evidence suggests harvest rates have increased since the 2013/14 recreational fishing survey (Department of Agriculture and Fisheries, 2021b; Newman et al., 2020; Newman et al., 2018; Saunders et al., 2018; Saunders et al., 2020b).

<table><tr><th></th><th colspan="2">Survey</th><th rowspan="2">Increase</th></tr><tr><th></th><th>2013/14</th><th>2019/20</th></tr><tr><td>Saddletail snapper</td><td>120t</td><td>162t</td><td>35%</td></tr><tr><td>Red emperor</td><td>83t</td><td>95t</td><td>14%</td></tr></table>
Based on the above considerations, recreational fishing was viewed as a significant and important source of fishing mortality for both species. In line with this assessment, the recreational desirability / other fisheries attribute scores for the saddletail snapper and the red emperor were increased from medium (2) to high (3).</td></tr>
</table>

Appendix E—Likelihood & Consequence Analysis.

In the Level 2 ERA, a simplified version of the Likelihood & Consequence Analysis (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 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.

As the LCA methodology did not change between assessment periods, it will not be replicated in the 2021 RLF Level 2 ERA. However, a comprehensive explanation of the LCA methodology can be found in **Appendix E** of the original Level 2 ERA (Walton *et al.*, 2021) and accessed at https://www.daf.qld.gov.au/business-priorities/fisheries/monitoring-research/data/ecological-risk-assessments.

Results

The LCA for 2021 RLF Level 2 ERA produced risk ratings from low to high. Saddletail snapper (*Lutjanus malabaricus*) and red emperor (*Lutjanus sebae*) received the highest risk ratings. All remaining OS category species and the four protected teleosts were assigned low-risk ratings (Table E4).

Table E1*. Results of the Likelihood & Consequence Analysis for species assessed as part of the RLF Level 2 ERA 2021 Update.*

Species name	Common name	Likelihood	Consequence	Matrix score	Risk category
Lutjanus malabaricus	Saddletail snapper	4	3	12	**High**
Lutjanus sebae	Red emperor	2	3	6	**Moderate**
Pristipomoides multidens	Goldband snapper	1	2	3	**Low**
Lutjanus erythropterus	Crimson snapper	2	2	4	**Low**
Lutjanus carponotatus	Stripey snapper	1	2	3	**Low**
Lethrinus nebulosus	Spangled emperor	2	2	4	**Low**
Hyporthodus ergastularius	Banded rockcod	1	3	3	**Low**
Epinephelus cyanopodus	Purple rockcod	1	3	3	**Low**
Gymnocranius grandoculis	Robinson's sea bream	1	3	3	**Low**
Gymnocranius audleyi	Collar sea bream	1	3	3	**Low**
Pristipomoides filamentosus	Rosy snapper	1	2	2	**Low**
Epinephelus undulatostriatus	Maori rockcod	1	2	2	**Low**
Etelis coruscans	Flame snapper	1	2	2	**Low**

Species name	Common name	Likelihood	Consequence	Matrix score	Risk category
Diagramma pictum	Painted sweetlip	1	2	2	**Low**
Aprion virescens	Green jobfish	1	2	2	**Low**
Lutjanus rivulatus	Maori snapper	1	2	2	**Low**
Epinephelus merra	Birdwire rockcod	1	2	2	**Low**
Cephalopholis cyanostigma	Blue spotted rockcod	1	2	2	**Low**
Epinephelus tauvina	Greasy rockcod	1	2	2	**Low**
Lethrinus atkinsoni	Yellowtail emperor	1	2	2	**Low**
Epinephelus ongus	Specklefin grouper	1	2	2	**Low**
Lethrinus olivaceus	Longnose emperor	1	2	2	**Low**
Choerodon schoenleinii	Blackspot tuskfish	1	2	2	**Low**
Scorpaena jacksoniensis	Eastern red scorpionfish	1	2	2	**Low**
Epinephelus fasciatus	Blacktip rockcod	1	2	2	**Low**
Lutjanus russellii	Moses perch	1	2	2	**Low**
Etelis carbunculus	Ruby snapper	1	2	2	**Low**
Epinephelus quoyanus	Longfin rockcod	1	2	2	**Low**
Pristipomoides typus	Sharptooth Snapper	1	2	2	**Low**
Lethrinus rubrioperculatus	Spotcheek emperor	1	2	2	**Low**
Epinephelus maculatus	Highfin grouper	1	2	2	**Low**
Epinephelus areolatus	Yellow spotted rockcod	1	2	2	**Low**
Choerodon cephalotes	Purple tuskfish	1	2	2	**Low**
Choerodon cyanodus	Blue tuskfish	1	2	2	**Low**
Lethrinus lentjan	Redspot emperor	1	2	2	**Low**
Choerodon venustus	Venus tuskfish	1	2	2	**Low**
Lutjanus adetii	Hussar	1	2	2	**Low**
Lutjanus vitta	Brownstripe snapper	1	2	2	**Low**
Cheilinus undulatus	Humphead Maori wrasse	1	3	3	**Low**
Epinephelus lanceolatus	Queensland groper	1	3	3	**Low**
Epinephelus tukula	Potato rock cod	1	3	3	**Low**
Cromileptes altivelis	Barramundi cod	1	2	2	**Low**

Considerations

The outputs of the LCA represent lower risk ratings than the PSA for most of the species assessed. The LCA maintains the support of higher risk ratings assigned to both red emperor and saddletail snapper. These species are heavily influenced by cumulative fishing pressures, and for red emperor at least, there is a great deal of uncertainty surrounding their stock status. In the case of saddletail snapper, current estimates place the stock at 23% of the unfished biomass; noting that a level of uncertainty exists around this estimate (Campbell *et al.*, 2021). In the context of the broader Level 2 ERA, these results provide further weight to the notion that the outputs of the PSA (Table 4) are more representative of a real or actual risk *verse* the potential risk.

The remaining species (*n* = 40) were assigned low-risk scores in the LCA, indicating that the likelihood of the risk coming to fruition over the short to medium term is lower than what was presented by the PSA (Table 4). Scores for spangled emperor and crimson snapper were marginally higher (4 *verse* 3; Table E1) as they are more susceptible to cumulative fishing pressures. In the original assessment, all species assigned LCA scores of 4 or higher were assigned non-conservative risk ratings in the PSA (*i.e.* the assessments were not viewed as precautionary). Since the introduction of the harvest strategy however, likelihood scores for several of the more commercially important species have been reduced in the current assessment. The LCA results support the assignment of precautionary risk ratings for the majority of assessed species given their lower potential to be at risk from fishing pressures in the RLF (Table 4; Table 5).

Appendix F—*Availability* overlap percentages.

Common name	Species name	% overlap			Highest overlap %	Availability score
		2018	2019	2020		
Target & Byproduct species (OS Quota Management Unit)						
Saddletail snapper	*Lutjanus malabaricus*	45.2	45.2	45.4	45.4	**3**
Spangled emperor	*Lethrinus nebulosus*	42.4	42.8	43.5	43.5	**3**
Goldband snapper	*Pristipomoides multidens*	50.3	48.3	47.7	50.3	**3**
Red emperor	*Lutjanus sebae*	43.4	43.7	43.9	43.9	**3**
Stripey snapper	*Lutjanus carponotatus*	42.4	42.9	43.8	43.8	**3**
Banded rockcod	*Hyporthodus ergastularius*	38.0	37.6	38.5	38.5	**3**
Crimson snapper	*Lutjanus erythropterus*	44.0	43.7	44.0	44.0	**3**
Hussar	*Lutjanus adetii*	31.0	33.3	34.8	34.8	**3**
Brownstripe snapper	*Lutjanus vitta*	44.6	43.9	44.2	44.6	**3**
Venus tuskfish	*Choerodon venustus*	43.3	43.0	44.4	44.4	**3**
Green jobfish	*Aprion virescens*	43.2	43.5	43.9	43.9	**3**
Highfin grouper	*Epinephelus maculatus*	35.4	35.6	36.1	36.1	**3**
Birdwire rockcod	*Epinephelus merra*	35.4	35.6	36.1	36.1	**3**
Blue spotted rockcod	*Cephalopholis cyanostigma*	35.8	35.5	36.2	36.2	**3**
Purple rockcod	*Epinephelus cyanopodus*	35.0	35.2	35.8	35.8	**3**
Blacktip rockcod	*Epinephelus fasciatus*	35.4	35.6	36.1	36.1	**3**
Greasy rockcod	*Epinephelus tauvina*	35.4	35.6	36.1	36.1	**3**
Longfin rockcod	*Epinephelus quoyanus*	35.4	35.6	36.1	36.1	**3**
Specklefin grouper	*Epinephelus ongus*	35.8	35.4	35.3	35.8	**3**
Yellow spotted rockcod	*Epinephelus areolatus*	32.4	34.0	36.3	36.3	**3**
Painted sweetlip	*Diagramma pictum*	42.6	42.9	43.6	43.6	**3**
Flame snapper	*Etelis coruscans*	15.4	15.3	14.9	15.4	**2**
Moses perch	*Lutjanus russellii*	42.8	43.5	44.1	44.1	**3**
Maori rockcod	*Epinephelus undulatostriatus*	38.2	37.5	37.3	38.2	**3**
Rosy snapper	*Pristipomoides filamentosus*	36.2	36.3	34.2	36.3	**3**
Sharptooth snapper	*Pristipomoides typus*	48.0	43.2	54.1	54.1	**3**
Longnose emperor	*Lethrinus olivaceus*	42.4	44.6	42.6	44.6	**3**
Ruby snapper	*Etelis carbunculus*	8.6	7.8	8.4	8.6	**1**
Redspot emperor	*Lethrinus lentjan*	42.9	43.5	43.9	43.9	**3**
Spotcheek emperor	*Lethrinus rubrioperculatus*	44.8	45.0	45.1	45.1	**3**
Yellowtail emperor	*Lethrinus atkinsoni*	34.9	36.8	37.7	37.7	**3**
Collar seabream	*Gymnocranius audleyi*	40.0	38.4	42.3	42.3	**3**
Robinson's seabream	*Gymnocranius grandoculis*	40.6	43.2	42.0	43.2	**3**
Purple tuskfish	*Choerodon cephalotes*	39.5	41.5	42.7	42.7	**3**
Blue tuskfish	*Choerodon cyanodus*	33.9	36.3	38.2	38.2	**3**
Blackspot tuskfish	*Choerodon schoenleinii*	42.8	43.5	44.1	44.1	**3**
Eastern red scorpionfish	*Scorpaena jacksoniensis*	46.6	52.5	49.9	52.5	**3**
Maori snapper	*Lutjanus rivulatus*	43.2	43.0	43.6	43.6	**3**
Protected teleosts						
Humphead Maori wrasse	*Cheilinus undulatus*	43.1	43.8	44.7	44.7	**3**
Queensland groper	*Epinephelus lanceolatus*	35.4	35.6	36.1	36.1	**3**
Barramundi cod	*Cromileptes altivelis*	35.8	35.6	36.3	36.3	**3**
Potato rockcod	*Epinephelus tukula*	33.4	35.3	37.5	37.5	**3**

Appendix G—Sustainability assessment history.

Additional information can be found on the DAF stock assessment website (https://www.daf.qld.gov.au/business-priorities/fisheries/monitoring-research/data-reporting/stock-assessment-program) and the SAFS website (http://fish.gov.au/).

Species	2016 SAFS status	2018 SAFS status	2020 SAFS status	Stock assessment
Coral trout (*Plectropomus and Variola* spp.)	Sustainable	Sustainable	Sustainable	Campbell, A., Leigh, G., Bessell-Browne, P. and Lovett, R. (2019) Stock assessment of the Queensland east coast common coral trout (*Plectropomus leopardus*) fishery. https://era.daf.qld.gov.au/id/eprint/7009/
Redthroat emperor (*Lethrinus miniatus*)	Sustainable	Sustainable	Sustainable	Northrop, A. and Campbell, A. B. (2020) Stock assessment of the Queensland east coast redthroat emperor (*Lethrinus miniatus*). https://era.daf.qld.gov.au/id/eprint/7492/
Saddletail snapper (*Lutjanus malabaricus*)	Undefined	Undefined	Undefined	Campbell, A. B., Fox, A.R., Hillcoat, K.B. and Sumpter, L. (2021) Stock assessment of Queensland east coast saddletail snapper (Lutjanus malabaricus), Australia. https://era.daf.qld.gov.au/id/eprint/8225/
Crimson snapper (*Lutjanus erythropterus*)	Undefined	Undefined	Undefined	Scheduled for 2021
Goldband snapper (*Pristipomoides multidens*)	Undefined	Undefined	Undefined	Scheduled for 2023
Red emperor (*Lutjanus sebae*)	Undefined	Undefined	Undefined	Scheduled for 2022
Brownstripe snapper (*Lutjanus vitta & L. adetii*)	Not assessed	Not assessed	Undefined	Not scheduled
Stripey snapper (*Lutjanus carponotatus*)	Not assessed	Not assessed	Sustainable	Scheduled for 2023
Spangled emperor (*Lethrinus nebulosus*)	Not assessed	Undefined	Sustainable	Scheduled for 2022
Ruby snapper (*Etelis* spp.)	Not assessed	Not assessed	Undefined	Not scheduled