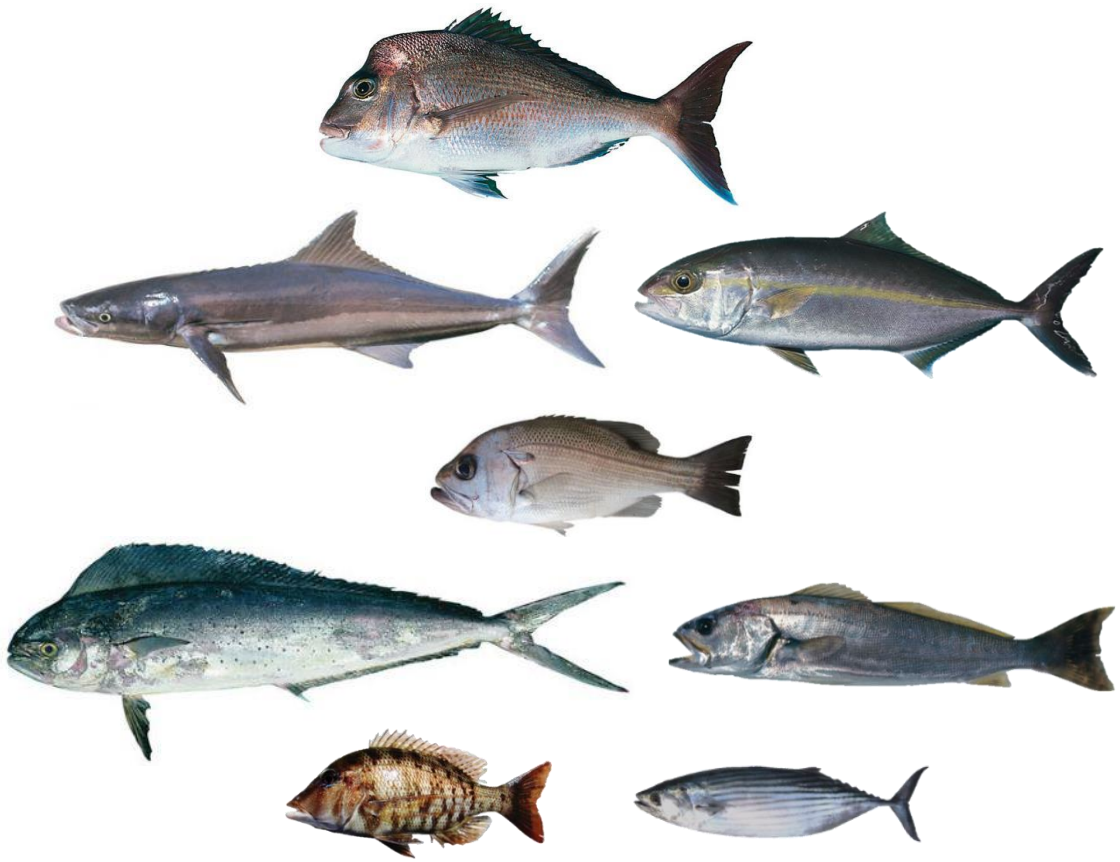
Sustainable Fisheries Strategy 2017–2027

Level 1 Ecological Risk Assessment

Rocky Reef Fin Fish Fishery



Queensland Government

Level 1 Ecological Risk Assessment
Rocky Reef Fin Fish Fishery

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Executive Summary

The Queensland Ecological Risk Assessment Guideline (the Guideline) was released in March 2018 as part of the *Queensland Sustainable Fisheries Strategy 2017–2027* (Department of Agriculture and Fisheries, 2017; 2018a). This Guideline provides an overview of strategy being employed to develop Ecological Risk Assessments (ERAs) for Queensland's fisheries. The Guideline describes a four-stage framework consisting of a Scoping Study; a Level 1, whole of fishery qualitative assessment; a Level 2, species-specific semi-quantitative or low-data quantitative assessment and; a Level 3 quantitative assessment (if applicable).

The aim of the Level 1 ERA is to produce a broad risk profile for each fishery using a qualitative ERA method described by Astles *et. al*. (2006). The method considers a range of factors including the current fishing environment (*e.g.* current catch, effort and licensing trends), limitations of the current management arrangements (*e.g.* the potential for additional effort to be transferred into areas already experiencing higher levels of fishing mortality, substantial increases in fishing mortality for key species, changing target species) and life-history constraints of the species being assessed. In the *Rocky Reef Fin Fish Fishery* (RRFFF) the Level 1 ERA assessed fishing related risks in 15 ecological components including target & byproduct species, bycatch, marine turtles, sea snakes, crocodiles, dugongs, cetaceans, protected teleosts, batoids, sharks, syngnathids, seabirds, terrestrial mammals, marine habitats and ecosystem processes.

To construct the risk profiles, seven fishing activities (*harvesting*, *discarding*, *contact without capture*, *loss of fishing gear*, *travel to/from fishing grounds, disturbance due to presence in the area, boat maintenance and emissions*) were assigned an indicative score (*e.g.* low, intermediate, high) representing the risk posed to each ecological component. Each ecological component was then assigned a preliminary risk rating based on the highest risk score within their profile. The preliminary risk ratings are precautionary and provided an initial evaluation of the low risk elements within each fishery. As this approach has the potential to overestimate the level of risk a secondary evaluation was conducted on ecological components with higher risk ratings. This evaluation examined the key drivers of risk within each profile, their relevance to the current fishing environment and the extent that a fishery contributes to this risk. The purpose of this secondary assessment was to examine the likelihood of the risk coming to fruition over the short to medium term and minimise the number of 'false positives'.

In the RRFFF, the preliminary ratings indicated that at least 14 of the ecological components were at negligible, low or intermediate risk of experiencing an undesirable event due to fishing activities. Of the ecological components assessed, only target & byproduct species were assessed as being at high risk. The key drivers of risk for this ecological component included the absence of an overarching control on catch, sustainability concerns for key species (*e.g.* snapper and pearl perch) and the potential for effort to expand or increase substantially for one or more of the target species.

After the likelihood of the risk coming to fruition was considered, the preliminary risk ratings of eight ecological components were reduced (Appendix 2). Most of these reductions involved low risk ecological components and species that are unlikely to interact with the fishery (*e.g.* crocodiles, syngnathids and dugongs). The most notable of the reductions were for marine turtles and sharks; both of which were reduced from intermediate to intermediate/low. For marine turtles, the preliminary risk rating was heavily influenced by *loss of gear* which is a risk factor that extends beyond the RRFFF

to all commercial and recreational line fishing operations. In comparison, the preliminary risk rating for sharks was influenced by the fishery's potential to interact with grey nurse sharks (GNS).

When the outcomes of the preliminary risk assessment and the secondary evaluation of likelihood (Table 3; Appendix 2) are taken into consideration, only the target & byproduct species ecological component was assigned a risk rating above intermediate. In accordance with the Guidelines, this ecological component will be progressed to a Level 2 assessment where the focus shifts from the whole of fishery level to individual species. In addition to the Level 2 assessment, the whole of fishery (Level 1) ERA identified key knowledge gaps in risk profiles of some ecological components. These information needs will be progressed to the *Fisheries Queensland Monitoring and Research Plan* for further consideration. Key information needs required to refine risk profiles in the RRFFF include:

- Increasing the level of information on short and medium term fishing trends including species most likely to experience increased rates of fishing mortality and the key drivers of change (*e.g.* changing fishing behaviours, improved marketability, biomass declines for key species, cumulative fishing pressures, changes to management).
- Improving the level of information on cumulative fishing pressures (commercial and recreational) for key rocky reef species and the potential implications for their long-term management and sustainability.
- Quantifying the extent of the risk posed by licence transfers by improving the level of information on line symbol transfers, pre-/post-transfer catch compositions and the number of L3 fishery symbols that are currently active in the each of the respective line fisheries *e.g.* the RRFFF, the East Coast Inshore Fin Fish Fishery and the Coral Reef Fin Fish Fishery.
- Validating species compositions and interaction rates (including release fates) for non-target teleosts (including SOCI) and elasmobranch (shark and ray) species.
- Validating the extent of GNS interactions with fishers (commercial and recreational) targeting rocky reef species in Queensland waters, release fates and the likelihood of an interaction resulting in a mortality.
- Obtaining greater information on gear loss rates and line-related injuries/mortalities for SOCI species including the origin of line debris *i.e.* commercial or recreational fishing line.

Summary of the outputs from the Level 1 (whole of fishery) Ecological Risk Assessment for the Rocky Reef Fin Fish Fishery (RRFFF).

Ecological Component	Level 1 Risk Rating	Progression
Target & Byproduct	High	Level 2 ERA Research & Monitoring Plan
Bycatch (non-SOCC)	Low	Not progressed further
Marine turtles	Low/Intermediate	Not progressed further
Sea snakes	Negligible	Not progressed further
Crocodiles	Negligible	Not progressed further
Dugongs	Negligible	Not progressed further

Ecological Component	Level 1 Risk Rating	Progression
Cetaceans	Low	Not progressed further
Teleosts (protected/SOCI only)	Intermediate	Research & Monitoring Plan
Batoids	Low	Not progressed further
Sharks	Low/Intermediate	Not progressed further
Syngnathids	Negligible	Not progressed further
Seabirds	Low	Not progressed further
Terrestrial mammal	Negligible	Not progressed further
Marine Habitats	Intermediate	Research & Monitoring Plan
Ecosystem Processes	Low/Intermediate	Not progressed further

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Definitions & Abbreviations

Active Licence	–	The definition of an active licence is the same as that used by DAF's data reporting system. An active licence is a licence that has reported catch and effort in the RRFFF through the logbook reporting system irrespective of the amount of catch and effort.
Bycatch	–	The portion of the catch that is discarded/returned to sea. For the purpose of this ERA, the definition of bycatch does not include unwanted target and byproduct species.
Byproduct	–	The portion of catch retained for commercial sale that was not intentionally targeted. For the purpose of this ERA, the definition of byproduct does not include any line caught product that was retained for sale in another fishery (*i.e.* the CRFFF or ECIFFF). In this risk assessment, this portion of the catch is classified as 'bycatch'.
CRFFF	–	Coral Reef Fin Fish Fishery
DAF	–	Queensland Department of Agriculture and Fisheries
ECIFFF	–	East Coast Inshore Fin Fish Fishery
Ecological Component	–	Broader assessment categories that include *Target & Byproduct* (harvested) species, *Bycatch*, *Species of Conservation Concern*, *Marine Habitats* and *Ecosystem Processes.*
Ecological Subcomponent	–	Species, species groupings, marine habitats and categories included within each Ecological Component.
EPBC Act	–	*Environment Protection and Biodiversity Conservation Act 1999*
ERA	–	Ecological Risk Assessment
False positive	–	The situation where a species at low risk is incorrectly assigned a higher risk rating due to the method being used, data limitation *etc.* In the context of an ERA, 'false positives' are preferred over 'false negatives'.
False negative		The situation where a species at high risk is assigned a lower risk rating. When compared, false negative results are considered to be of more concern as the impacts/consequences can be more significant.
Fishing Licence	–	Effectively a fishing platform. A Fishing Licence can have multiple symbols attached including a net (N) and line (L) fishing symbol. However, operators in the RRFFF are not permitted to line and net fish simultaneously (one or the other).
Fishery Symbol	–	The endorsement that permits a fisher to access a fishery and defines what gear can be used *i.e.* N = Net, L = line, T = trawl. The number of fishing symbols represents the maximum number of operators that could (theoretically) access the fishery at a single point in time.

FOP	–	Fisheries Observer Program. The FOP was operational in Queensland from 2006 to 2013 and collected independent data from a range of commercial fisheries.
GBR/GBRMP	–	Great Barrier Reef / Great Barrier Reef Marine Park
ITQ	–	Individual Transferable Quota
MEY	–	Maximum Economic Yield
MSY	–	Maximum Sustainable Yield
Offshore waters	–	Tidal waters that are at least 2m deep at low water.
QBFP	–	Queensland Boating and Fisheries Patrol
RRFFF	–	Rocky Reef Fin Fish Fishery
SAFS	–	Status of Australian Fish Stocks. National program coordinated by the Fisheries Research & Development Corporation to assess the status of key Australian fish stocks
Species of Conservation Concern (SOCC)	–	Broader risk assessment category used in the Level 1 assessments that incorporates marine turtles, sea snakes, crocodiles, dugongs, cetaceans, protected teleosts, batoids, sharks, seabirds, syngnathids and terrestrial mammals. These species may or may not be subject to mandatory reporting requirements.
Species of Conservation Interest (SOCI)	–	A limited number of species subject to mandatory reporting requirements as part of the Queensland logbook reporting system. Any reference to 'SOCI' refers specifically to the SOCI logbook or data compiled from the SOCI logbook.
TACC	–	Total Allowable Commercial Catch
Target	–	The primary species or species groups that have been selectively fished for and retained for commercial, recreational or Aboriginal peoples and Torres Strait Islander peoples purposes.
WTO	–	Wildlife Trade Operation

1 Overview

The *Rocky Reef Fin Fish Fishery* (RRFFF) is a line-only fishery that targets species and species complexes not regulated or retained in the *East Coast Inshore Fin Fish Fishery* (ECIFFF) or *Coral Reef Fin Fish Fishery* (CRFFF). While the fishery operates along the entire east coast, including within the Great Barrier Reef Marine Park (GBRMP), the central and southeast regions of Queensland record the highest amounts of effort (Department of Agriculture and Fisheries, 2019b). In addition to the commercial fishery, rocky reef species including snapper (*Chrysophrys auratus*) and pearl perch (*Glaucosoma scapulare*) receive significant levels of interest form the recreational and charter fishing sectors. The take of rocky reef fin fish species is managed through a mixture of input (*e.g.* gear restrictions, limited entry) and output controls (*e.g.* size restrictions, no-take species) (Department of Agriculture and Fisheries, 2019b).

While an ecological assessment for the RRFFF was completed in 2004 (Kingston & Ryan, 2004), it was largely focused on progress made against key reporting requirements. However, the findings of this report did incorporate the outcomes of a preliminary ecological risk assessment (ERA) that included a number of RRFFF species (McLeay *et al.*, 2002). Since the completion of these reports, the dynamics of the fishery has undergone substantial change and the outcomes of these assessments are likely to be outdated. The level of information on the stock structure of key species including pearl perch (Sumpton *et al.*, 2017) and snapper (Campbell *et al.*, 2009; Wortmann *et al.*, 2018) has also improved.

In March 2018, Queensland released the *Ecological Risk Assessment Guideline* (the Guideline) (Department of Agriculture and Fisheries, 2018a) as part of the *Queensland Sustainable Fisheries Strategy 2017–2027* (Department of Agriculture and Fisheries, 2017). This Guideline provides an overview of the strategy being used to develop ERAs for Queensland's fisheries and includes a four-stage framework consisting of 1) a Scoping Study, 2) a Level 1, whole of fishery qualitative assessment, 3) a Level 2, species-specific semi-quantitative or low-data quantitative assessment, and 4) a Level 3 quantitative assessment (if applicable).

The following provides a broad, qualitative (Level 1) assessment of the risk posed by the RRFFF on a number of key ecological components. The Level 1 assessment follows-on from the completion of a scoping study that provides information on the current fishing environment, licencing trends and broad catch and effort analyses (Department of Agriculture and Fisheries, 2019b).

2 Focus & Intent

The risk profiles for Queensland's commercial fisheries vary and are highly dependent on the apparatus used. For example, the risk posed by line fishing activities will be lower when compared to a net or trawl fishery. Similarly, single-species fisheries like Spanish mackerel will present a lower risk when compared to multi-species or multi-apparatus fisheries. Every fishery will have elements that present a higher risk for one or more of the ecological components *i.e.* species groupings, marine habitats and ecosystem process that interact with the fishery. These risk elements will still be present in smaller fisheries including those where there is greater capacity to target individual species.

In recognition of the above point, the primary objective of the Level 1 assessments were to identify a) the key sources of risk within a particular fishery and b) the ecosystem components that are most likely to be affected by this risk. Used in this context, Level 1 ERAs produce outputs or risk assessments that

are very fishery-specific. The inherent trade off with this approach is that risk ratings cannot be compared between fisheries as the scale, extent and impact of the risk are unlikely to be equal. They will however provide insight into the areas or fishing activities within the RRFFF that may contribute to an undesirable event for one or more of the ecological components.

By restricting the focus of the assessment, Level 1 ERAs can be used to examine the types of risk each ecological component will be exposed to within that fishery. In doing so, the outputs of the Level 1 assessment will determine what ecological components will progress to a finer scale assessment – otherwise referred to as a Level 2 ERA. These finer scale (Level 2 ERA) assessments will focus on the species, species groupings, marine habitats or ecosystem processes (if applicable) contained within each of the ecological subcomponents.

3 Methods

The Level 1 assessment is used to assess risk at the whole of fishery level with the primary objective being to establish a broader risk profile for each fishery. Level 1 assessments will focus on a wide range of ecological components and will include detailed assessments for *Target & Byproduct* (harvested) species, *Bycatch*, *Species of Conservation Concern*, *Marine Habitats* and *Ecosystem Processes*.

For the purposes of this ERA, the term '*Species of Conservation Concern'* (SOCC) was used instead of '*Species of Conservation Interes*t' as the scope of the assessment will be broader. In Queensland, the term '*Species of Conservation Interest*' or SOCI refers specifically to a limited number of non-targeted species that are subject to mandatory commercial reporting requirements. The expansion of this list allows for the inclusion of non-SOCI species including those that are afforded additional legislative protections *e.g.* the listing of hammerheads as '*Conservation Dependent*' under the EPBC Act. In the case of the SOCC, this ecological subgroup has been further divided into: marine turtles, sea snakes, crocodiles, dugongs, cetaceans, batoids, sharks, syngnathids, seabirds, protected teleosts and terrestrial mammals. The division of the SOCC ecological component recognises the variable life-history traits of this subgroup and the need to develop risk profiles for each complex.

Of the five ecological components, ecosystem processes represents the biggest challenge for management response as the viability of these processes will be influenced by factors outside of the control of fisheries management *e.g.* climate change, pollution, extractive use of the marine resources, and urban, port and agricultural development. From an ERA perspective, this makes it difficult to quantify the level of impact an individual fishery is having on these processes and by extension the accurate assignment of risk ratings. This problem is compounded by the fact that it is often difficult to identify measurable indicators of marine ecosystem processes (Pears *et al.*, 2012; Evans *et al.*, 2016). For example, what parameters need to be measured to determine if a) an ecosystem process is in decline, stable or improving and b) how much of this change can be attributed to fishing activities or lack thereof?

In order to refine the Level 1 ERA for ecosystem processes, a preliminary assessment was undertaken. The preliminary assessment examined the potential for a fishery to impact on 16 categories outlined in the *Great Barrier Reef Outlook Report 2014* (Great Barrier Reef Marine Park Authority, 2014). The specific processes examined in response to fisheries related impacts were *sedimentation*, *nutrient cycling / microbial processes*, *particle feeding*, *primary production*, *herbivory*, *predation*, *bioturbation*, *detritivory*, *scavenging*, *symbiosis*, *recruitment*, *reef building*, *competition*,

connectivity, *outbreaks of disease* and *species introductions*. Not all processes are applicable to every fishery, but all processes were considered before being eliminated. A full definition of each ecosystem process has been provided in Appendix 1.

The Level 1 ERA was modelled off of an assessment method established by Astles *et al.* (2006) and incorporates five distinct steps: *Risk Context*, *Risk Identification*, *Risk Characterisation, Likelihood* and *Issues Arising*. A brief overview of each step is provided below.

1. *Risk Context* – defines the broad parameters of the assessment including the risk that is to be analysed (*i.e.* the management objectives trying to be achieved or the nature of the undesirable events), the spatial extent of the analysis, the management regimes and the timeframes of the assessment.

2. *Risk Identification* – identifies the aspects of each fishery or the sources of risk with the potential to contribute to the occurrence of an undesirable event.

3. *Risk Characterisation* – provides an estimate (low, intermediate or high) of the likelihood that one or more of the identified sources of risk will make a substantial contribution to the occurrence of an undesirable event. Used as part of a Level 1 assessment, this stage will assign each fishing activity with an indicative risk rating representing the risk posed to each ecological component. These scores will then be use to assign each ecological component with a preliminary risk rating based on the highest risk score within the profile. In the Level 1 ERA, these preliminary risk scores will be used to identify the low-risk elements in each fishery.

4. *Likelihood* – a secondary evaluation of the key factors underpinning the preliminary risk assessments, their relevance to the current fishing environment and the potential for the fishery to contribute to this risk in the short to medium term. This step was included in recognition of the fact that preliminary scores (see *Risk Characterisation*) may overestimate the level of risk for some ecological components.

5. *Issues Arising* – examines the assigned risk levels and the issues or characteristics that contributed to the overall classifications.

The above framework differs slightly from Astles *et al.* (2006) in that it includes an additional step titled *Likelihood.* The inclusion of this additional step recognises the precautionary nature of qualitative assessments and the potential for risk levels to be overestimated in whole of fishery ERAs. This step in effect assesses the likelihood of the risk occurring in the current fishing environment and takes into consideration a) the key factors of influence and b) their relevance to the current fishing environment. In doing so, the *Likelihood* step helps to differentiate between **actual** and **potential** high risks. This aligns with the objectives of *Ecological Risk Assessment Guideline* (Department of Agriculture and Fisheries, 2018a) and helps limit the extent of ‘false positives’ or the misclassification of low risk elements as high risk.

While viewed as a higher-level assessment, the Level 1 ERA provides important information on activities driving risk in a fishery, the ecological components at risk and areas within the fisheries management system that contribute to the risk of an undesirable event occurring. Level 1 assessments will be undertaken for all ecological components including marine habitats and ecosystem processes which have the least amount of available data. These results will be used to

inform the Level 2 assessments and refine the scope of subsequent ERAs. Level 2 assessments will focus specifically on the ecological subcomponents including key species and species groupings.

Additional information on the four-staged qualitative assessment is provided in Astles *et al.* (2006) and Pears *et al.* (2012). A broad overview of the ERA strategy used in Queensland has been provided in the Queensland *Ecological Risk Assessment Guideline* (Department of Agriculture and Fisheries, 2018a).

4 Whole of Fishery Qualitative Assessments

4.1 Risk Context

As the Level 1 assessments are based at the whole of fishery level, the risk context has been purposely framed at a higher level. It also takes into consideration the main purpose of the *Fisheries Act 1994* which is to: "*…provide for the use, conservation and enhancement of the community's fisheries resources and fish habitats in a way that seeks to: apply and balance the principles of ecologically sustainable development; and promote ecologically sustainable development.*

In line with this objective, the risk context for the Level 1 assessment has been defined as:

> *The potential for significant changes in the structural elements of the fishery or the likelihood that fishing activities in the Rocky Reef Fin Fish Fishery will contribute to a change to the fishery resources, fish habitats, environment, biodiversity or heritage values that is inconsistent with the objectives of the Fisheries Act 1994.*

The inclusion of 'potential' in the risk definition recognises the need to take into consideration both current and historic trends and the likelihood that a fishery will deviate from these trends in the short to medium term. The reference to 'structural elements of a fishery' largely relates to the current fishing environment and the potential for it to change over the longer term *e.g.* the potential for effort to increase under the current management arrangements, effort displacements or the ability for effort to shift between regions.

In order to frame the scope of the assessment, a 20-year period was assigned to all Level 1 assessments. That is, the likelihood that the one or more of the ecological components will experience an undesirable and unacceptable change over the next 20 years due to fishing activities in the RRFFF. In order to do this, the Level 1 assessments assume that the management arrangements for the fishery will remain the same over this 20-year period. A 20-year timeframe has previously been used in ERAs involving the *East Coast Trawl Fishery* (Pears *et al.*, 2012; Jacobsen *et al.*, 2018) and is considered to be relatively precautionary.

At a whole of fishery level, the risk that commercial fishing activities will contribute or cause an undesirable event has reduced through time. This has been achieved through a range of management reform initiatives designed to reduce both the number of symbols able to access the fishery and the level of fishing effort (real and potential). This includes an 86% reduction in the number of L1 fishery symbols, a 21% reduction in the number of L2 fishery symbols and a 36% reduction in the number of L3 fishery symbols (Department of Agriculture and Fisheries, 2019b). Despite these reductions, the collective line fishery still has a notable percentage of underutilised or latent fishing symbols. This is most applicable to the L3 where around 40% of the fishing symbols are attached to licences used predominantly in non-line fisheries like trawl (*pers. comm.* S. Breen). The potential for underutilised

licences to contribute to an undesirable event will be dependent on a range of factors including the rate of re-activation, the amount of fishing effort and the species being targeted. In the RRFFF, this risk is considered to be more relevant as sustainability concerns surround a number of the key species (Sumpton *et al.*, 2017; Wortmann *et al.*, 2018).

Prior to 2004, licence holders with an east coast line fishing symbol (L1, L2, L3 and L8) could fish for and retain a wide range of species including those managed as part of the CRFFF. These arrangements changed in 2004 with the implementation of a coral trout, red throat emperor and 'other species' quota management unit. From a risk management perspective, this change would have reduced the number of species able to be targeted by operators and the (theoretical) footprint of the RRFFF. This inference is based on the assumption that fishing behaviour of non-quota holders will adjust through time to account for shortfalls in their annual catch. The trade-off being that some of the more prominent RRFFF species may experience an increase in annual rates of fishing mortality.

4.2 Risk Identification

Fishing activities are frequently subdivided into categories that identify the sources of risk or potential hazards (Astles *et al.*, 2009; Hobday *et al.*, 2011; Pears *et al.*, 2012). What constitutes a hazard can vary between ERAs and is often dependent on the specificity and scale of the assessment. For larger scale assessments, some of the more commonly used fishing activities include: harvesting, discarding, contact without capture, loss of fishing gear, travel to and from fishing grounds, disturbance due to presence in the area and boat maintenance and emissions (Table 1). The fishing activities outlined in Table 1 will provide the foundation of the risk profiles and will be used to assign preliminary risk ratings to each ecological component (see Risk Characterisation).

In Queensland, 'cumulative fishing pressures' has also been identified as key source of risk (Table 1). Used as part of a Level 1 assessment, the term 'cumulative fishing pressures' will examine the risk posed by Queensland's other commercial fisheries and sectors outside of the commercial fishing industry. This parameter was included in the Level 1 assessment in recognition of the fact that a number of Queensland's fisheries have multiple fishing sectors (*e.g.* commercial, recreational, and charter). This means that the risk posed to some species may be higher than what is observed in the commercial fishing sector *e.g.* species that attract a high level of interest from the recreational fishing sector.

In addition to the cumulative fishing pressures, this section will include a secondary examination of the cumulative risks that exist outside the control of fisheries management. These factors often have a wide range of contributors, are generally more complex and at times unavoidable. As a consequence, it can be difficult to assign an accurate rating to these factors or to quantify how much of a contribution (if any) a fishery will make to this risk. The primary purpose of including these factors in the Level 1 assessment is to provide the ERA with further context on how fisheries-specific risks relate to external factors, broader risk factors that a fishery will contribute to (*e.g.* boat strike) and factors that have the potential to negatively impact on a fishery (*e.g.* climate change, the potential for urban development to affect recruitment rates).

The inclusion of cumulative impacts in the Level 1 assessment provides further context on factors that may contribute to an undesirable event. In a fisheries-based ERA it can be difficult to account for these impacts in the final risk ratings. The main reason for this is that it can be difficult to define the extent of these impacts or quantify the level of contribution they make to an overall risk; particularly in

a whole of fishery assessment (*e.g.* the impact of recreational fishing/boating activities on SOCC subgroups). Given this, final risk ratings will concentrate on commercial fishing activities with cumulative impacts (when and where appropriate) identified as an additional source of risk *e.g.* for species targeted and retained by commercial, charter and recreational fishers. In the event that one or more of the ecological components are progressed to a Level 2 assessment than the cumulative impacts (*e.g.* from other fisheries) will be given additional considerations.

Unlike the fishing activities, ratings assigned to 'cumulative risks' will not be used in the determination of preliminary risk scores (see Risk Characterisation). The main reason for this is that the preliminary risk scores relate specifically to commercial fishing activities.

The following provides an overview of the key fishing activities/sources of risk in the RRFFF and for each of the respective ecological components. When and where appropriate the contributor of risk (*i.e.* the fishing activity) is also identified in the text.

Table 1*. Summary of the key fishing activities and their relation to risk. Table 1 is based on an extract from Pears et al. (2012). * Cumulative risk scores are not considered when assigning preliminary risk ratings as these values relate specifically to the commercial fishing sector.*

Sources of Risk
Harvesting*:* capture and retaining of marine resources for sale.
Discarding*:* returning unwanted catch to the sea. This component of the catch is landed on the deck of the boat or brought to the side of the vessel before its release and the reference is applied to all sectors *e.g.* commercial, recreational, charter.
Contact without capture: contact of any part of the fishing gear with ecological subcomponents (species, habitats *etc.*) whilst deployed but which do not result in the ecological components being captured and landed on deck.
Loss of fishing gear: partial or complete loss from the boat of gear including lines, ropes, floats etc.
Travel to/from fishing grounds: steaming of boat from port to fishing grounds and return.
Disturbance due to presence in the area: other influences of boat on organisms whilst fishing activities take place (*e.g.* underwater sound disturbances).
Boat maintenance and emissions: tasks that involve fuel, oil or other engine and boat-associated products that could be accidentally spilled or leaked into the sea or air.
Cumulative fishing pressure*:* Indirect external factors, including other fisheries or fishing sectors; and non-fisheries factors that apply across fishery sectors.*

4.2.1 Whole of Fishery

Harvesting and **discarding** are considered the greatest contributors of risk in the RRFFF fishery, with **loss of fishing gear** viewed as a secondary factor of influence. Given the size of the RRFFF, there is

a possibility that **travel to/from fishing grounds**, **disturbance due to presence in the area**, and **boat maintenance and emissions** will make a small contribution to the overall level of risk. **Contact without capture** is similarly viewed as a low risk activity that is largely restricted to vessel interactions and/or undocumented interactions with lost fishing gear.

As the majority effort is reported from southern and central Queensland, fishing activities in this region will be the biggest contributor of risk for this fishery. When compared to the prescribed fishing area, a high percentage of the fishing effort will occur under the L1 fishery symbol (Department of Agriculture and Fisheries, 2019b).

4.2.2 Ecological Subcomponents

Target & Byproduct (harvested)

Almost half of the catch reported from the RRFFF is snapper with the remainder mostly comprised of pearl perch, cobia, amberjack, grass emperor, teraglin, mahi mahi, bonito and yellowtail kingfish. While licence holders can retain other species of kingfish, frypan bream, samson fish and sea sweep, catch for these species (combined) tends to be less than 1t per year (Department of Agriculture and Fisheries, 2019b).

As the fishery does not operate under a quota system, operators can retain all RRFFF species that fall within the prescribed size limits. Similarly, operators can readily transfer effort from one species to another to account for changing availability or marketability. While this provides operators with a high degree of flexibility, there is a risk that one or more of the species will experience disproportionate levels of fishing mortality (**harvesting**). This may already be occurring in the fishery with the most recent snapper stock assessment indicating that total catch (commercial and recreational) is above maximum sustainable yield (MSY) estimates. In line with this assessment, the Australian east coast snapper stocks were considered to be overfished (Wortmann *et al.*, 2018). Similarly, a recent stock assessment for pearl perch classified this stock as transitional depleting, with the risk of recruitment overfishing uncertain (Sumpton et al., 2017). The situation surrounding the rest of the fishery is less defined and the majority of the species require further information on their stock structure and sustainability status. Given the above considerations, the **harvesting** of key RRFFF species poses a real risk to their long and short-term sustainability. This risk would heighten if catch and effort were to contract to a small number of species and or shift to a particular species due increased marked demand or species declines.

The potential for fishers to transfer effort to secondary target species is evident in the catch composition data (Department of Agriculture and Fisheries, 2019b). Catch and effort for snapper has steadily declined since 2006 with grass emperor, cobia and amberjack showing a corresponding increase. This shift in effort may be due to snapper biomass declines (Wortmann *et al.*, 2018) or increased market value for these secondary species. With advances in technology, there has also been an increase in fishing effort directed towards deeper water environments *i.e.* >200m (Sumpton *et al.*, 2013). These advancements have allowed operators to target previously inaccessible portions of the stock and therefore present an additional risk factor for this fishery. Similarly, an absence of spawning protections means that operators can (potentially) increase their catch through the targeting of aggregations, particularly for snapper (Allen et al., 2006). This type of fishing activity increases the risk of a disguised overfishing event due to catch hyperstability (Erisman *et al.*, 2011; Erisman *et al.*, 2017).

While the re-activation of underutilised licences will affect other line fisheries, the risk is considered to be higher in the RRFFF due to an absence of quota management and ongoing sustainability concerns surrounding key species. Improved species marketability also increases the likelihood of underutilised or latent line symbols being transferred for use in the RRFFF. While this risk has been reduced through latent effort removal processes, a high number of L3 fishery symbols remain in distribution (L3 = 936 symbols; L1 = 226 symbols; L2 = 190 symbols) (Department of Agriculture and Fisheries, 2019b). With no controls in place to restrict total effort in the RRFFF, management has few options to prevent L3 fishery symbols being transferred and used in the RRFFF. The risk will be partly mitigated by management regulations that restrict L3 operations to the use of just one tender; compared to four tenders for the L2 fishery symbol.

As the RRFFF does not export live-fish, the risk posed by high-grading will be lower when compared to the CRFFF.[1] There will however be other factors that contribute to cryptic mortality rates such as barotrauma and poor post-release survival rates. Many operators can now access fish in waters greater than 100m depth including snapper, pearl perch, yellowtail kingfish, amberjack and to a lesser degree teraglin and cobia (Sumpton *et al.,* 2013). At these depths, there is an elevated risk of unwanted (*i.e.* undersized) fish experiencing barotrauma, which in turn, will influence post-release survival rates (**discarding**). Depending on their resilience, this will increase the level of fishing mortality for some species.

Research suggests that some species may be more resilient to the effects of barotrauma and treatment (venting) can minimise predation by decreasing surface-times once a fish has been released (Mclennan *et al.*, 2014). Of the species targeted in the RRFFF, snapper (*Chrysophyrys [Pagrus] auratus*) are susceptible to these effects, with barotrauma evident in the majority of fish caught at depths >20m (Butcher *et al.*, 2012; Peregrin *et al.*, 2015). The release fate of these fish will be influenced by a range of factors including the extent of the barotrauma, the type of treatment employed, the extent of any hook damage, the presence of predators and handling proceedures (Butcher *et al.*, 2012; Sumpton *et al.*, 2013; Mclennan *et al.*, 2014).

Of the remaining species, pearl perch is mostly caught between 100–200m (Sumpton *et al.*, 2013) and the species is known to incur swim bladder ruptures due to barotrauma. This poses an immediate risk to the fish in terms of internal injuries and a (potentially) elevated risk of predation. Paradoxically, this injury will enable gas to escape from fish brought to the surface; therefore allowing the fish to return to deeper water to recover providing the injury is non-fatal (Campbell *et al.*, 2014; Mclennan *et al.*, 2014). In this context, released (**discarded**) animals would spend less time at the surface and therefore be less vulnerable to predation. Information on the remaining species is limited but the effects of barotrauma are expected to be similar to that observed in tropical snappers (Mclennan et al., 2014), snapper (Butcher *et al*., 2012; Sumpton *et al*., 2013) and fin fish species with similar morphologies/physiologies.

As with most fisheries, there is a degree of risk associated with illegal fishing, non-reporting of product (black markets), inaccurate reports of catch weights and or non-compliance with input or output controls, such as minimum legal size and in-possession limits (Department of Agriculture and Fisheries, 2019b). As it is, illegal and unreported fishing activities are frequently identified as some of the biggest risks to sustainable fisheries management (Mapstone *et al.*, 1997; Williamson *et al.*, 2015).

[1] *High-grading is considered to be more of a risk in the live coral trout fishery where there is more incentive for operators to replace poor-quality of moribund fish for healthier fish or a more marketable size of fish.*

Compliance issues in this fishery include violations of closures and zoning boundaries, falsifying logbook records, and possessing regulated fish. These types of (illegal) fishing activities have the potential to mask the true extent of the fishing mortality experienced by some species (**harvesting**). In Queensland, this risk is managed through the Queensland Boating and Fisheries Patrol (QBFP) who continue to enforce the current regulations across all fishing sectors. The introduction of *Vessel Tracking* in the RRFFF has also helped to minimise a number of the risks associated with non-compliance including fishing in regulated waters.

Of the remaining fishing activities (Table 1), **contact without capture** is mostly associated with foul-hooks, broken lines, and fish able to free themselves before landing. This increases the risk of biofouling, infection and predation may reduce post-interaction survival rates (Borucinska *et al.*, 2002; McLeay *et al.*, 2002). **Contact without capture** also applies to the predation of captured fish taken by larger predators, such as sharks, before they can be landed *i.e.* depredation. This is particularly relevant for line fisheries where injured and panicked fish draw predators, who take advantage of tethered prey. This presents a risk to both the fishery, as losses are not accounted for in total catch or species stock assessments, and for predators that may become hooked themselves or experience unreported fishing mortalities.

The direct impacts of **loss of fishing gear** will be smaller when compared to other fishing methods, for example ghost nets. However, discarded fishing line is still a dominant form of marine debris, particularly in complex reef habitats (Williamson *et al.*, 2015). Line ingestion and incidental catch of passing animals with abandoned hooks also represents a risk to the long-term survival of affected fish. DAF notes though that these risks will transcend the commercial fishing sector (see *section 4.3.1 Fisheries Related Impacts*).

Note—Some species target by operators in the RRFFF are retained in other fisheries. The **harvesting** of RRFFF species in other fisheries including fish taken by net is examined further in the section relating to *Cumulative Impacts* (refer section 4.3).

Bycatch (non-SOCC)

One of the challenges of undertaking a broad-scale ERA for bycatch in the RRFFF is trying to identify the scope and depth of the assessment. This issue largely relates to the multi-species nature of the fishery and the fact that some of the species are retained in very small quantities. This problem is compounded by the fact that the definition of 'bycatch' and 'byproduct' often varies between operators and fishing events. In other instances, an operator will retain non-target species that are permitted for sale in an alternate fishery; namely the ECIFFF.

Line fishing provides few avoidance strategies to reduce the incidental catch of unwanted species or size classes. As most discards are not reported in this fishery, there is little information on the extent of these interactions or on the fate of the released (**discarding**) animal. The majority of discarded catch in the RRFFF consists of low value species, species managed in alternate fisheries (*e.g.* quota managed CRFFF species) and poor quality or undersized target/byproduct species.[2] While information on RRFFF is limited, the discontinued Fisheries Observer Program (FOP) recorded a small number of sharks including gummy, sandbar whaler and silvertip (Department of Employment Economic

[2] *For the purpose of this ERA the discarding of target/byproduct species and the associated risks were considered as part of the harvest species ecological component.*

Development and Innovation, 2011). The impact of the fishery on bycatch species will vary and post-release survival rates will depend on a range of factors including the species, their anatomy, fishing depths and handling procedures.

In the RRFFF, the capture of non-target species will continue to occur in the fishery. These species will either be retained for sale in another line fishery or **discarded** as bycatch due to low marketability or regulations. At present, there is limited information on retention rates for non-target species or on the composition or quantity of discarded species. This portion of the catch though is expected to be comparatively low given the nature of the apparatus used and the species being targeted. Accordingly, the RRFFF will contribute to the overall level of risk for some species but is unlikely to be the main driver of risk.

Species of Conservation Concern

While the RRFFF has a large geographical distribution, the fishing apparatus limits the extent of interactions with the SOCC ecological component. As a high proportion of the SOCC subgroups (marine turtles, dugongs, cetaceans, protected teleosts *etc.*) cannot be retained for sale, **discarding** and **loss of fishing gear** poses the most risk to these species. In the RRFFF there is some potential for the animal to incur injuries during this interaction and for the fishery to contribute to the level of fishing mortality. These mortalities may be as a direct result of this interaction (*e.g.* barotrauma, hook-related injuries) or upon their release (*e.g.* increased risk of predation). In this fishery, the risk of an interaction resulting in serious injury or death will be dependent on the species and the type of interaction.

Quantifying SOCC interactions in the RRFFF can be difficult as line fishing symbols (L1, L2, and L3) can also be used in the ECIFFF and CRFFF. As the three line fisheries are defined by the species being retained, it is possible for a licence holder to simultaneously operate in more than one fishery. If for example an operator caught and retained a snapper and a shark species they would technically be fishing in both the RRFFF and the ECFFF. Due to this division, some of the line interactions with SOCC subgroups may be attributed to other fisheries. Regardless line fishing presents a similar risk to SOCC species across the CRFFF, RRFFF and ECIFFF. Finer scale species compositions may vary depending on the target species and the operating environment of the fishery (*e.g.* inshore or offshore; sandy substrates or rocky reefs or coral reefs).

Marine turtles

Since its inception in 2003, the Species of Conservation Interest (SOCI) logbooks have reported three interactions between marine turtles and commercial line fishing apparatus. All of these interactions were with loggerhead turtles; one was released alive and two sustained injuries (Department of Agriculture and Fisheries, 2019b).

Given the extent of line fishing operations in Queensland and the popularity of recreational fishing, the total number of marine turtle interactions may to be higher than what has been reported over this period. This inference is partly supported by data contained within the *Marine Wildlife Stranding and Mortality Database* which attributes (directly and indirectly) approximately 120 interactions to entanglement in fishing line or hook ingestions. This data does not differentiate between interactions in the commercial fishing sector and recreational fishing. Similarly, the data cannot determine if the interaction was with an ‘active’ fishing line or with discarded line. It is for these reasons the *Marine Wildlife Stranding and Mortality Database* cannot be used to verify SOCI logbook data, including the

potential for underreporting to occur in this fishery. This data though does provide further insights into the potential risks posed by line fishing operations (in general).

Within this fishery, the ingestion of hooks and entanglement in fishing line are risks to marine turtles, with research indicating that many sub-adult and adult turtles are affected each year in Queensland. While these risks are mostly attributed to the recreational fishing sector (United Nations Environment Program, 2014), gear similarities suggest that this risk would also apply to the commercial fishing sector. Loggerheads in particular, are a generalist species and have been known to take baited hooks. Swallowed hooks present as a high risk of mortality for discarded turtles, but risk will vary with the location of the hook (external, swallowed, mouth hooked). If a length of fishing line remains attached to a swallowed hook, this has the highest risk for post-release mortality (Parga, 2012; Parga *et al.*, 2015).

When compared to the impacts of hooking, entanglement in fishing line arguably represents a greater risk to marine turtles. Entanglements can occur in line not associated with a fishing event (*e.g.* line that has been lost, cut off, or discarded during a previous fishing event) or resulting from capture (*e.g.* line that is still attached to a hook embedded or swallowed by the animal) (**contact without capture**, **loss of fishing gear**). The negative consequences of line entanglement is often long-term and includes death due to asphyxiation, increased predation risk due to impairment or loss of an appendage (Meager & Limpus, 2012). In some instances, the impacts may be more immediate such as preventing the animal from reaching the surface *e.g.* if opposite end is attached to the substrate. While difficult to quantify, evidence suggests that discarded and lost fishing gear contributes to the number of marine turtles deaths recorded each year (Meager & Limpus, 2012). Marine turtles are also susceptible to boat strike while swimming or breathing air at the surface. However, this risk cannot be quantified as SOCI logbooks provide no distinction between the types of interactions.

Despite the above risks, line fishing has previously been identified as having a minimal impact on marine turtles (Smith & McCormack, 2007). This for the most part is due to low hooking rates and the short release time involved if a turtle is hooked. It is noted though that fishing line has been found in the gut of stranded marine turtles and in many cases has been identified as the primary cause of death (Meager & Limpus, 2012). Further, this subgroup will experience increased mortalities due to entanglement in lost or discarded fishing line. In addition to the commercial fishery, recreational and charter fishing make notable contribution to the level of lost or discarded fishing line.

Sea snakes

No interactions have been reported between sea snakes and line operators within the RRFFF, although data form the *Recreational Fishing Survey 2013-14* indicates that this type of interaction can occur (Webley *et al.*, 2015). While a sea snake could conceivably become hooked or entangled within a commercial fishing line (**discarding**, **contact without capture**), interactions are expected to be low in numbers and infrequent. The extent of these interactions are not expected to have a long-term or detrimental impact on regional sea snake populations. Interactions, while still comparatively low, are likely to be higher in the recreational fishing sector due to a higher number of participants.

Crocodiles

There are no known records of interactions with crocodiles in the RRFFF. Crocodiles mostly inhabit coastal waters and riverine habitats and interactions with the commercial, recreational or charter-

fishing sectors are unlikely. The vast majority of fishing effort reported in the RRFFF occurs outside of known crocodile distributions (Queensland Government, 2017).

Dugongs

The habitat distribution of dugongs does not spatially overlap with the target fishery (*i.e.* rocky reefs as opposed to seagrass meadows) and the likelihood of an interaction is low. In the event that the fishery did interact with this subgroup, it would most likely be with the vessel while **travelling to/from the fishing grounds**. While vessel or boat strike remains a significant issue for dugongs, the sources of risk are much wider than commercial fishing and will involve a wide range of stakeholders.

Cetaceans

Species distributions and seasonal movements are expected to influence impacts of the RRFFF on cetaceans. For example, baleen whales (*i.e.* humpbacks, minkes) migrate to tropical waters in the Great Barrier Reef (GBR) in winter every year to calve and mate (Acevedo *et al.*, 2013). As air-breathing mammals, cetaceans must spend a portion of their time at the surface. In the tropical waters of the GBR, Hervey bay and Moreton Bay this can also include resting behaviour or nursing mothes/calf pairs. Mothers with calves, in particular, prefer shallow waters (Ersts & Rosenbaum, 2003). These types of behaviours may make this subgroup more susceptible to non-fishing impacts such as boat strike.

Humpback whales are the only cetacean species with recorded interactions in the RRFFF (Department of Agriculture and Fisheries, 2019b). The data indicates that all animals were released alive although one did sustain injuries. At a whole of fishery level, cetacean interactions in line fisheries are more likely to be due to contact with the vessel rather than entanglements. This inference is supported by the *Marine Wildlife Stranding and Mortality Database* (2011–2015) which attribute a comparatively low number of interactions (n = 25) to capture by line fishers (commercial, recreational or charter), entanglement in line or the ingestion of line fishing gear.

As a whole, interactions between cetaceans and the RRFFF are low and infrequent. The immediate consequences of these interactions (excluding boat strike) are also expected to be low.

Protected teleosts

There are four species of teleost with SOCI reporting requirements. All are no-take species in Queensland, with the humphead Maori wrasse (*Cheilinus undulatus*) listed as endangered on the IUCN redlist; potato rockcod (*Epinephelus tukula*) listed as least concern; and the Queensland groper (*Epinephelus lanceolatus*) and barramundi cod (*Chromileptes altivelis*) both listed as vulnerable. The barramundi cod is the only teleost with an interaction recorded in the RRFFF, and it was released injured (Department of Agriculture and Fisheries, 2019b).

The discontinued fisheries observer program has limited data for SOCI interactions in this fishery[3], although line fishers caught a number of humphead Maori wrasse and barramundi cod in 2006 and 2007. All were released alive except for one humphead Maori wrasse (Department of Agriculture and Fisheries, 2019b). Prior to 2004, catch data for adjacent fisheries (*i.e.* the CRFFF) included a small number of potato rockcod, and a moderate catch of barramundi cod and humphead Maori wrasse.

[3] *There is much overlap between the three east coast line fisheries, CRFFF, RRFFF and ECIFFF, due the use of the L1, L2 and L3 symbols in all three fisheries. The Fisheries Observer Program did not distinguish between the line fisheries and thus all line observations are reported together.*

The post-release survival for these species are unknown. The Queensland groper and humphead Maori wrasse both grow to become extremely large fish, and are harder to handle without injury.

The distribution of the reported effort combined with the apparatus used increases the risk that protected teleosts will interact with the commercial RRFFF. The risk will vary for this subgroup and depend on a range of factors including the species, water depth, and handling procedures. This subgroup will also interact with recreational and charter fishers; and will therefore experience cumulative fishing pressures.

Batoids

The RRFFF has the potential to interact with a small number of batoids associated directly (*i.e.* preferred habitat) or indirectly (*i.e.* feeding grounds) with key fishing grounds. Barotrauma is not applicable to this sub-group of species and provided animals are handled correctly, post-release survival rates will be high. Of the batoids afforded additional protections under state and Commonwealth legislation, manta and devil rays (*Mobula* spp.) have the potential to interact with the RRFFF. These species are pelagic, spending a significant amount of time near the surface and, although migratory, are common on coral reefs (Last & Stevens, 2009; Last *et al.*, 2016). Line entanglements and foul hooking can be common for these species, particularly manta rays, despite their pelagic habitats (Deakos *et al.*, 2011; Couturier *et al.*, 2012). The frequency of these types of interactions in the RRFFF though are expected to be low and infrequent.

All five species of sawfish are listed in the IUCN redlist as Endangered or Critically Endangered. While many of the sawfish species have been recorded offshore, most populations inhabit shallow coastal waters, estuarine habitats, and mudflats (Department of Environment, 2015). Although, these species have the potential to interact with line fisheries, these are more likely to occur in the ECIFFF with inshore fishing activities. If handled correctly, line-caught sawfish have a good chance of post release survival. The correct procedure for line fishing is to cut the line as close to the hook as possible, only removing the hook if this can be done without damaging the sawfish (Kyne & Pillans, 2014).

Overall, the RRFFF will present a relatively low risk to batoids including the two protected subgroups—mobula rays and sawfish.

Sharks

Shark species, including small benthic or epibenthic species, will interact with line fishers and will readily take baited lines. In other instances, sharks will target line caught fish during the line retrieval stage (**contact without capture**) and may become hooked during this process. As sharks are not managed directly through the RRFFF, this portion of the catch will be discarded as bycatch or retained for sale as part of the ECIFFF. If handled correctly, post-release survival rates for **discarded** line-caught sharks will be high. However, mortalities may still occur in this fishery due to injuries incurred during the fishing event and/or due to poor handling techniques *e.g.* use of a gaff, deliberately injuring the shark to retrieve gear. The extent of these mortalities or injuries (frequent/infrequent) will be difficult to quantify without additional catch validation measures and further information on the fate of line caught sharks (*e.g.* number of sharks retained for harvest in the ECIFFF, discarded: line cut, discarded: injured). With the expansion of the shark reporting requirements, some of this information is already being collected from the RRFFF[4].

[4] *As on 1 January 2018, RRFFF operators must report shark discards as part of the logbook reporting system.*

The RRFFF may have infrequent interactions with shark species afforded additional protections under state and commonwealth legislature. Fishing effort in the RRFFF does occur in higher concentrations around Fraser Island where there is a degree of overlap between the fishery and the northern most aggregation site for grey nurse sharks (*Carcharias taurus*). Although fishing is prohibited in the Wolf Rock marine national park zone, grey nurse sharks are migratory and there is some potential for the RRFFF to interact with this species. Research on the Australian east coast grey nurse shark population confirmed a high incidence (52% of males and 29% of females) of retained fishing gear (*i.e.* fishing hooks, lines or ropes attached to free roaming sharks) and fishing related injuries (Bansemer & Bennett, 2010; Robbins *et al.*, 2013). These results were attributed to a range of fishing activities (both recreational and commercial) and highlights the potential of this species to interact with line fisheries (in general).

At a whole of fishery level, the number of interactions with grey nurse sharks may be underestimated. Under reporting of interactions with grey nurse shark may occur for several reasons including line breaks allowing the shark to escape before it can be identified, illegal fishing activities and misidentifications with other shark species. Given the overlap between the fished area and habitats preferred by target species, it is likely that grey nurse sharks also interact with the recreational fishing sector where the reporting of SOCI interactions is not required (refer to section on *Cumulative Impacts*).

More broadly, there is limited information on the extent of shark interactions in the RRFFF. The FOP identified gummy, sandbar whaler and silvertip sharks from the RRFFF bycatch along with two reports of a shortfin mako shark (*Isurus oxyrinchus*). The shortfin mako shark is not afforded full protection in Queensland but is classified as a 'no-take' species in the Great Barrier Reef Marine Park (GBRMP) due to its listing as a migratory species under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). While not taken and managed as part of the RRFFF, operators also have the potential to interact with grey (*Carcharhinus amblyrhynchos)* and white tip reef sharks (*Triaenodon obesus*); particularly in central Queensland where there is a higher concentration of effort. These species can be retained for sale in other fisheries, but are subject to stringent in-possession limits.

The RRFFF will contribute to the number of shark mortalities through a) their retention for sale in other fisheries and b) through injuries incurred during the fishing event (*e.g.* due to poor handling and release practices). When compared to other fisheries though, the RRFFF will present as a lower risk for the majority of shark species. This risk may be higher for species like grey nurse shark, where population declines have already affected the species. With that said, the RRFFF will make a smaller contribution to this overall risk and it is unlikely to be the main driver of risk for these species.

Syngnathids

This subgroup will have negligible interactions with the RRFFF due to the type of gear used in the fishery, the small size of the species and their general behaviour / life history traits.

Seabirds

There are only two logged interactions with seabirds in the RRFFF, both of which were with pelicans which were released alive (Department of Agriculture and Fisheries, 2019b). The RRFFF presents limited opportunities for seabird fatalities and injuries as the bait and weighted hooks sink quickly. Fishers are also on hand to attend to any seabirds that do interact with baited hooks. While there are

concerns that fishing activity (in general) can reduce the availability of seabird prey (Cury *et al.*, 2011), RRFFF species are not expected to make up a significant portion of regional seabird diets.

Within this fishery, entanglement in fishing line arguably presents a greater threat to seabirds. This risk will manifest as either a direct consequence of becoming hooked or indirect entanglement in line that has been lost during a fishing event or discarded. Entanglement in monofilament fishing line can lead to starvation, injury, limb amputation or death in seabirds (Yorio *et al.*, 2014). Seabird interactions with the recreational and charter sectors are likely to contribute significantly to line fishing interactions, particularly with discarded fishing gear. Seabirds attached to fishing line can also become entangled to vegetation, which can lead to injury as they try to free themselves or mortality if they are unable to free themselves (Martin, 2012; Yorio *et al.*, 2014).

Marine Habitats

The RRFFF has the potential to damage regional habitats through general boating activities, anchoring, fishing effects including the **loss of fishing gear** and pollutants. Fishing line is easily lost, particularly if it becomes snagged or tangled on benthic substrate. Discarded and lost fishing line is amongst the most common marine debris in many habitats, including rocky reefs (Chiappone *et al.*, 2005; Smith & Edgar, 2014; Figueroa-Pico *et al.*, 2016). The persistence of fishing line enables it to accumulate in habitats over time, thus even no-take areas can have significant burdens of discarded line. Illegal fishing is also a large contributor of lost line in no-take areas (Williamson *et al.*, 2015). Discarded or lost fishing line is damaging to sessile benthic organisms (*e.g.* sponges and corals), and injuries can increase the transmission of diseases in corals, as they provide entry wounds for pathogens (Yoshikawa & Asoh, 2004; Chiappone *et al.*, 2005; Lamb *et al.*, 2015).

Anchors can damage reefs and the substratum, particularly when setting and retrieving. Corals and benthic structures can be broken and overturned, further damage is caused as they drag and wrap around structures. There are significant relationships between areas of high boating activity and reef damage due to anchoring (Dinsdale & Harriott, 2004). However, this risk not only applies to fishing activities (both recreational and commercial) but all boating activities.

In all of the above, the risk will extend beyond the commercial fishery with other fishing sectors and uses of the marine environment making variable contributions.

Ecosystem Processes

When compared to other fisheries, the impact of line fishing on ecosystem processes is expected to be smaller. The possible exceptions to this are the removal of mid-level predators, or the increased frequency of disease/damage to sessile benthic organisms, such as corals and sponges (Yoshikawa & Asoh, 2004; Chiappone *et al.*, 2005; Lamb *et al.*, 2015). There is also anecdotal evidence that spawning aggregations of snapper are being targeted within the fishery. Spawning aggregations are productivity hotspots that support ecosystem health. Many particle feeding species utilise the temporary surplus of spawned eggs as a food source while predatory species can feed on the aggregating fish (Mourier *et al.*, 2016; Erisman *et al.*, 2017). The loss of spawning aggregations have previously resulted in declines of ecosystem health for many species (de Mitcheson, 2016).

While a higher proportion of fishing effort in the RRFFF occurs outside of the GBRMP, target species would derive some benefit from marine reserves including those used in the Moreton Bay and Great Sandy Marine Parks. No-take zones work as a connected network to replenish stocks across the

ecosystem. One of the primary aims of a no-take zone is to protect a portion of the breeding stock from the effects of fishing. When functioning effectively, these zones allow individuals to breed multiple times and therefore help facilitate recruitment back into fishing regions (Harrison *et al.*, 2012). However when reserves are highly fragmented or fisher noncompliance is more than minimal, their efficacy for replenishing the population through recruitment is markedly diminished (Little *et al.*, 2005). Similarly, the effectiveness of measures designed to maintain or improve recruitment rates may be undermined by the absence of measures to protect spawning aggregations for key species *e.g.* snapper (de Mitcheson, 2016; Erisman *et al.*, 2017)**.**

Juvenile snapper inhabit coastal inshore habitats and migrate offshore when they mature. Bycatch in the trawl fisheries is likely to cause increased mortality in this life stage (Sumpton & Jackson, 2005; Courtney *et al.*, 2007). Thus, trawling has some potential to impact on connective pathways for this species. Furthermore, the east coast population of snapper is considered as a single stock, ranging from Victoria to Queensland. The general connectivity of the east coast stock is maintained though the East Australian Current that allows larvae to disperse south, while adult snapper have a general northern migration/dispersion (Sumpton *et al.*, 2008). Targeting spawning aggregations and localised depletions, which can occur due to overfishing, have the potential to disrupt this movement through seascapes.

There is some evidence for top down predator-prey control of sea urchins by snapper on rocky reefs, but these are limited to the smaller size class of urchins, and other species (*e.g.* spiny lobsters) may be more dominant in controlling sea urchin populations and their associated grazing (Shears & Babcock, 2002).

4.3 Cumulative Impacts

A significant portion of fisheries-based ERAs are dedicated to understanding the potential impacts and risks posed by commercial fishing activities. There will however be a range of factors that contribute to an ecological component experiencing an undesirable event including the presence and size of other fishing sectors, broader environmental trends and operations that are not managed within the fisheries framework.

For the purpose of this assessment, the cumulative impacts section has been subdivided into '*Fisheries Related Impacts*' and *'External Risks'*. The inclusion of *Fisheries Related Impacts* as a cumulative fishing pressure reflects the fact that most of Queensland's fisheries have multiple sectors *e.g.* commercial, recreational, charter. These sectors, for the most part, are managed alongside the commercial fishery and are subject to management regimes managed by the Department of Agriculture and Fisheries. The inclusion of *Fisheries Related Impacts* in the *Risk Characterisation* process reflects DAF's ability to mitigate potential risks through the broader management structure.

The establishment of a secondary cumulative risks category, *External Risks*, recognises that there are factors outside the control of DAF that have the potential to contribute to an undesirable event occurring for one or more of the ecological components. These risks represent an accumulation of issues or activities that span across stakeholders, fisheries and often state and federal management bodies. Of those that are identified, fishing activities are considered to be a contributing factor but are unlikely to be the primary source of risk and/or cannot simply be resolved through a fisheries context *e.g.* climate change.

External Risks are addressed in Queensland through a wide variety of forums and by various departments. Given the wide-ranging nature of these risks, these risks will not be addressed directly within Queensland's ERA framework. They have however been included in the Level 1 assessment as they have the potential to either impact on fishery (*i.e.* pose a risk to the fishery) or are a factor that the fishery contributes to (*i.e.* risks posed by the fishery). When and where appropriate, the Queensland Government will contribute to these discussions including (among others) participating in the *Reef Plan 2050* process, broader management reform initiatives, national plans of action and recovery strategies. In these instances, DAF will continue to participate and represent the fishing interests of the State.

4.3.1 Fisheries Related Impacts

Other Fisheries

The RRFFF includes a number of species with high social significance and are actively targeted in the recreational fishing sector. While recreational fishers are subject to individual limits, catch reporting is not mandatory and the level of information for this sector is limited. In 2006, a routine monitoring program commenced collection of biological information (length, sex and age) from recreationally and commercially caught snapper and pearl perch. However, the majority of the available information on the recreational fishing sector comes from infrequent voluntary recreational fisher surveys (Webley *et al.*, 2015).

The 2013/14 recreational fishers' survey reported 203 000 line caught snapper, 73 000 grass emperor and 25 000 pearl perch across the State. Approximately 72% of the snapper catch was discarded, with both grass emperor and pearl perch registering discard rates of greater than 50%. Charter fishing also **harvested** 20t of snapper, and 10t of pearl perch catch in 2017, with another 7500 and 5500 individual fish discarded respectively (Department of Agriculture and Fisheries, 2019a). While high discard rates will reduce the number of direct fishing mortalities, risks associated with barotrauma and depredation still remain. Given the level of discarding, post-release mortality rates may be higher in these sectors. This risk is considered to be of particular relevance to species targeted in the RRFFF as evidence suggests fishers are accessing deeper water environments with more regularity (Sumpton *et al.*, 2013). The risk of barotrauma contributing to the number of post-release mortalities will vary depending on the species involved, handling procedures, and the experience of the fisher.

More broadly, the recreational and charter fishing sectors will have similar risk traits to the commercial sector in terms of their **disturbance due to presence in the area** and their potential to impact regional environments *e.g.* **loss of fishing gear**, damage due to anchoring, removal of predators *etc.* As the recreational fishing sector uses lighter gear and has varying levels of experience, this sector would arguably make a larger contribution with respect to lost and discarded fishing line.

Outside of the recreational and charter fishing sectors, smaller amounts of RRFFF species are retained for sale by net fishers operating on the Queensland east coast. This portion of the catch is incidental and is retained by fishers targeting species managed as part of the ECIFFF. As the take of rocky reef species is not regulated by gear type or quota, the retention of these species is permitted under the *Fisheries Regulations 2008.* The portion of the total RRFFF catch taken by nets is relatively low with the annual (net) catch of most species coming in at less than 1t (Department of Agriculture and Fisheries, 2019b). However, inter-seasonal trends are highly variable, with catches of 6–8t reported for some species in recent years (Department of Agriculture and Fisheries, 2019b). Similarly,

the increased fishing power of nets and the (potential) ability for them to be used to target aggregations (**harvesting**) does present a longer-term risk for this fishery. For species where there are ongoing sustainability concerns (*e.g.* pearl perch and snapper), this will present as a more immediate risk.

While not permitted to be retained for sale, juvenile snapper and pearl perch are caught as bycatch in the otter trawl fishery, particularly in Moreton Bay (Sumpton & Jackson, 2005; Courtney *et al.*, 2007). Despite the low catch in some areas, mortality rates for trawl caught snapper can be high with research showing that 15 minutes of air exposure can increase mortality by up to 85% (Sumpton & Jackson, 2005). As these fish have yet to recruit to the RRFFF and their removal from the system may have longer term implications and will be a contributing factor with respect to the overall level of risk these species are exposed to.

As mentioned above, snapper distributions are not restricted to Queensland governed waters, with the population stretching from Hinchinbrook Island, Queensland to Tasmania (Pecl *et al.*, 2011). Queensland and New South Wales share a common stock but management differs between the two states (Campbell *et al.*, 2009). The New South Wales Department of Primary Industries assessed snapper as *Growth Overfished*, whereas Queensland has assessed snapper as *Overfished*. Similarly, the *Status of Australian Fish Stocks* has classified the Queensland snapper stock as *depleted* due to current levels of fishing mortality hindering stock recovery (Fowler *et al.*, 2018).

Outside of **harvesting** and **discarding**, **loss of fishing gear** presents as one of the more notable risks emerging from the recreational fishing sector. This risk largely relates to the accessibility of recreational fishing and the sector having a high number of participants and varying levels of experience *i.e.* fishing gear is readily available, is cost effective and can be used by a wide range of people. The impacts of lost and discarded fishing line will be similar to those observed in the commercial fishery including for SOCC subgroups like marine turtles. However, the density of lost line may be higher in and around fishing locations that are more accessible. Given the above factors and the type of line used, the recreational sector will make a significant contribution to the amount of fishing line that is lost or discarded.

Risks relating to the harvest of RRFFF species by Aboriginal peoples and Torres Strait Islander peoples is more difficult to assess as there is less information on catch and effort rates. Gear restrictions for aspects of the fishery may be less stringent and take into account the importance of traditional fishing rights. Catch and effort rates for this sector have yet to be quantified and the level of overlap with key species is relatively unknown. At a whole of fishery level, catch and effort from Aboriginal peoples and Torres Strait Islander peoples will (most likely) present a lower risk for a number of the ecological components including harvest species, bycatch and marine habitats because of low numbers. This risk though will be highly dependent on the species and their significance to this sector.

4.3.2 External Impacts

Boat Strike

The effects of vessel use are generally similar regardless whether they are used for commercial or recreational fishing, or other forms of recreational use. Therefore, despite the direct impacts being relatively low for RRFFF, these impacts, when analysed in context of the all vessel activity throughout reef, may be a higher risk than initially perceived.

For most air-breathing species, the general probability of boats strikes is low, but become more likely depending on habitat use and vessel traffic. For turtles, interactions are more likely in internesting habitats and whilst travelling through shallow coastal foraging area to/from the fishery (United Nations Environment Program, 2014). Dugongs, too, are vulnerable in shallow coastal foraging areas. In the Queensland stranding database, stranded turtles with mortalities attributed to vessel strikes greatly outnumber fishing related mortalities. The greatest risk for Humpbacks occurs in offshore areas around major ports and the offshore area between the Whitsundays and Shoalwater Bay (Department of the Environment and Energy, 2017). Fishing activities (commercial and recreational) have the potential to contribute to this risk. With that said, the issue of boat strike mortalities is much larger than fisheries (commercial and recreational) with a wide range of recreational and commercial services contributing to this risk. It is for this reason that this risk will be difficult to assess and quantify in a fishing environment.

Marine Debris & Pollutants

Discarded and lost fishing line from both commercial and recreational fishing is abundant in the marine environment, and in the Great Barrier Reef (Loder *et al.*, 2012; Lamb *et al.*, 2015; Williamson *et al.*, 2015). Nylon fishing line is extremely persistent in the marine environment. Plastic marine debris is a significant problem for the health of the coral reefs, and indeed all marine ecosystems, through the degradation of habitats, ingestion by organism and entangling marine life. Discarding and loss of fishing related debris also occur in this fishery. This includes both deliberate and incidental release. Aside from lost fishing gear, the most significant sources of fishing related marine debris are bait bags, cigarette butts and food packaging (Byrnes *et al.*, 2016). In addition to fishing activities, plastic debris originates from tourism, both land and sea based, land based runoff and shipping (Bergmann *et al.*, 2015). Discarded fishing line, and other plastic debris, will degrade into microplastics, which are easily ingested by many species, including species harvested for human consumption. These microplastics are highly mobile and able to interact with species from all trophic levels (Bergmann *et al.*, 2015)**.**

Discharge of garbage from a marine vessel is illegal in all Australian waters. However, boating causes the discharge of a number of pollutants. The major pollution sources associated with recreational and small to medium fishing vessels is fuel and oil. Although, antifouling paints, exhaust fumes including greenhouse gases and Polycyclic Aromatic Hydrocarbons (PAHs), and heavy metals are also released into the marine environment through boating activities (Burgin & Hardiman, 2011). Many of these pollutants are bioaccumulative, *i.e.* they build up in the environment due to their persistence.

The RRFFF is likely to represent a comparatively small, but consistent, source of marine pollution. These risks are very difficult to quantify and due to the multifaceted sources of this risk and almost impossible to assign to a particular sector or activity. For example, marine pollutants can be sourced from land based runoff and boat emissions, from not only fishers but also recreational boat users and commercial shipping as well. Marine pollutants and emissions present a somewhat unique situation in that they are a risk to the fishery whilst risk is simultaneously increased by fishing activity.

Climate Change

Anthropogenic climate change is expected to have significant and lasting effects on the marine environment. These will likely impact fisheries operations, with some effects already perceptible in recent years. In Queensland, the severity of storms, tropical cyclones and extreme rainfall events are predicted to increase by the end of the century (Steffen *et al.*, 2017). In the past, these events have

led to population reductions in affected areas and reduced fish catchability for extended periods after these events (Holbrook & Johnson, 2014). Further to this, increased warming of the atmosphere also leads to increased sea surface temperatures. Temperatures have been steadily increasing around Australia, and globally. This increase in temperature has been responsible for several largescale mass bleaching and die-offs of coral, mangroves and seagrass (Hoegh-Guldberg *et al.*, 2007; Duke *et al.*, 2017; Arias-Ortiz *et al.*, 2018), which are critical spawning (*e.g.* coral trout (Russell, 2001)) and nursery grounds (*e.g.* prey (Manson *et al.*, 2005)) for many species.

Changes in temperature and oceanic chemistry have been seen to affect physiology, growth and reproduction of fisheries species as well as the primary production that many of these species depend on (Sumaila *et al.*, 2011). This can lead to widespread shifts in fish and ecosystem productivity and stock distributions. There is also evidence of increased ocean acidity. Increased carbon dioxide in the atmosphere decreases the pH of seawater, leading to ocean acidification and dissolution of calcium based reef-building corals, molluscs and crustaceans (Hoegh-Guldberg *et al.*, 2007). Within this context, sustainably managed fisheries will be in a better position to respond to the effects of climate change. Globally fisheries are already under significant stress due to, for example, overfishing, pollutants, and habitat degradation, may not have the resilience to deal with such a largescale threat (Sumaila *et al.*, 2011).

Within the GBR, this effect is already inducing large-scale coral bleaching events, with the most recent occurring in 2017. Sea level rise, increased frequency and severity of extreme weather events and changed oceanic currents also have the potential to degrade the quality and resilience of the GBR ecosystems (Great Barrier Reef Marine Park Authority, 2014).

4.4 Risk Characterisation

Used as part of the Level 1 assessment, the primary purpose of the *Risk Characterisation* stage is to assign a qualitative value to each fishing activity that represents the potential (low, Intermediate or high) for it to contribute to an undesirable event for each of the ecological components and SOCC subcomponents (Table 2). In doing so, the *Risk Characterisation* stage aims to identify the key sources of risk from each fishery in order to inform finer scale assessments. If, for example, an ecological subcomponent is identified as ‘high risk’ in the Level 2 Productivity, Susceptibility, Analysis (PSA) or a Sustainability Assessment for Fishing Effects (SAFE), the results of the Level 1 assessment will identify the activities within the fishery that are contributing to this risk.

The scores assigned to each ecological component (excluding Ecosystem Processes) and SOCC subcomponent are based on the issues raised during the *Risk Identification* process (refer section 4.3). To this extent, they take into consideration the current fishing trends (*e.g.* current catch, effort and licensing), limitations of the current management regime (*e.g.* the potential for additional effort to be transferred into areas already experiencing higher levels of fishing mortality, substantial increases in fishing mortality for key species, changing target species) and the consequences of the interaction. While the majority of SOCC are classified as bycatch they have been assessed as separate entities in recognition of their complex life histories. Risk scores assigned to ecosystem processes are based on the preliminary assessment (Appendix 1) and represent the maximum score assigned to that particular fishing activity.

Outputs of the *Risk Categorisation* stage, excluding *cumulative impacts*, were used to assign each ecological component with a preliminary risk rating based on the highest risk score in the profile (Table 2). If for example an ecological component received a ‘high risk’ for one or more of the fishing activities,

it would be reflected in the preliminary risk ratings (Table 2; Appendix 2). These preliminary risk ratings are conservative in nature and provide the first opportunity to remove low risk elements from the assessment process. Scores assigned to the cumulative risks were not considered as the preliminary risk scores are only applicable to the commercial fishery. The cumulative impacts scores though provide insight into the potential for ancillary risks to impact each of the respective ecological components.

In line with above approach, preliminary assessments for the RRFFF indicated that fishing activities presented a negligible, low or intermediate risk to 14 of the ecological components (Table 2). Of the ecological components assessed, only target and byproduct species were assigned a high risk rating. While not universal, key drivers of risk in this fishery include the absence of an overarching control on catch or effort, sustainability concerns for key species, data limitations and an inability to validate catch rates and discards (*e.g.* non-target species and SOCI).

Table 2*. Summary of preliminary risk scores for the Rocky Reef Fin Fish Fishery, including the impacts of the main fishing activities on key ecological components.*

Ecological Component	Line fishing – Main activities of the Fishery							Preliminary Risk Rating	Cumulative impacts Other fisheries***
	Harvesting	Discarding	Contact without capture	Loss of fishing gear*	Travel to/from grounds**	Disturbance due to presence in area	Boat maintenance & emissions		
Target & Byproduct	H	I	I	L	-	-	-	H	H
Bycatch species (non-SOCC)	-	L/I	L/I	L	-	-	-	L/I	L/I
SOCC									
Marine turtles	-	L/I	I	I	I	L	L	I	I
Sea snakes	-	L	L	L	L	L	L	L	L
Crocodiles	-	-	-	-	L	L	L	L	L
Dugongs	-	-	-	L	L	L	L	L	L
Cetaceans	-	-	L/I	L	L/I	L	L	L/I	L/I
Batoids	-	L	L	L	-	L	L	L	L/I
Protected teleosts	-	I	L/I	L	-	L	L	I	H
Sharks	-	L	I	I	L	L	L	I	I/H
Syngnathids	-	-	-	L	-	L	L	L	L
Seabirds	-	L	L	L	-	-	-	L	I/H[#]
Terr. mammals	-	-	-	-	-	-	-	-	-
Marine Habitats	-	-	-	I	-	I	L	I	H[#]
Ecosystem Processes	I	L	L	L	L	L	-	I	I

Includes recreational & charter sectors, ** includes boat strike en route, * Includes recreational, charter, CRFFF, ECIFFF, Trawl bycatch, and Net fisheries, # includes all recreational activities i.e. on water and off water activities; inshore and offshore.*

A full account of the preliminary risk ratings, the key considerations and risk factors have been provided in Appendix 2. However, the following provides a general overview of the key findings of the risk characterisation stage:

- Target and byproduct species received higher risk ratings due to a) the declining stocks of the two main target species, b) a corresponding increase in catch and effort for secondary species and c) the absence of an effective/overarching control on catch and effort *e.g.* quota.
- Secondary factors including contact without capture (*e.g.* depredation), the reactivation of underutilised line licences and cumulative fishing pressures are additional sources of risk for a number of the target and byproduct species.
- Data deficiencies and an inability to validate catch data were factors of influence for bycatch species and a number of the SOCC ecological components.
- When compared, the RRFFF posed a lower risk to sharks, protected teleosts and seabirds when compared to the cumulative impacts and fishing pressures.
- Depending on the species being retained, RRFFF interactions with protected species may be attributed to other line fisheries and as a consequence the risk rating may be an underestimate.
- Loss of fishing gear including discarded line contributed to a number of the ecological components receiving elevated risk scores including marine turtles and marine habitats.

4.5 Likelihood

The *Risk Characterisation* stage takes into consideration what is occurring in the fishery and what can occur under the current management regime. This provides a more holistic account of the risks posed by the fishery and provides the Level 1 ERA with greater capacity to address the (potential) long-term consequences of a risk. The inherent trade off with this approach is that some of the ecological components may be assigned more conservative risk ratings. Otherwise known as ‘false positives’, these values effectively overestimate the level of risk posed to an ecological component or subcomponent. In other words, preliminary risk ratings compiled in the *Risk Characterisation* stage may represent a potential risk—something that is discussed at length in the Ecological Risk Assessment Guidelines (Department of Agriculture and Fisheries, 2018a).

False positives should not be discounted as they point towards areas where further monitoring and assessment may be required. However, triggering management changes or progressing an ecological component to a Level 2 (species-specific) ERA based on a conservative whole of fishery (Level 1) assessment may be unwarranted. This places added importance on examining the preliminary risk ratings and determine if they represent a real or potential high risk (Department of Agriculture and Fisheries, 2018a).

In order to address the potential overestimation of risk for some ecological components, a secondary qualitative review of the preliminary risk ratings were undertaken. This review examined factors underpinning each assessment, their relevance to the current fishing environment and areas where this risk may be overestimated. The purpose of the secondary review is not to dismiss the preliminary findings of the *Risk Characterisation* stage. Rather, this secondary assessment aims to assess the likelihood of the risk coming to fruition over the short to medium term. This in itself will aid in the

identification of priority risk areas and help to inform broader discussions surrounding the development of risk management strategies for key species. Given the extent of fisheries reforms outlined in the *Queensland Sustainable Fisheries Strategy 2017–2027* (Department of Agriculture and Fisheries, 2017) and the available resources, this was considered to be an important and necessary step.

When mitigation measures and risk likelihood are given further consideration, the preliminary risk ratings of eight ecological components were reduced (Appendix 2). Most of these reductions involved low risk ecological components and species that are unlikely to interact with the fishery (*e.g.* crocodiles, syngnathids and dugongs). The most notable of the reductions were for marine turtles and sharks; both of which were reduced from intermediate to intermediate/low. For marine turtles, the preliminary risk rating was heavily influenced by **loss of gear** which is a risk factor that extends beyond the RRFFF to all commercial and recreational line fishing operations. In comparison, the preliminary risk rating for sharks was influenced by the fishery's potential to interact with grey nurse sharks (GNS). While GNS interactions are still a risk in this fishery, the preliminary rating was considered to be overestimate. Going forward, the risk rating for both marine turtles and sharks could be reduced further with additional information on interaction rates, gear loss events and release fates.

A summary of the key findings of the Level 1 ERA have been provided in Table 3. Additional information on the Level 1 risk ratings including key considerations of both the preliminary risks and mitigation measures has been provided in Appendix 2.

***Table 3**. Level 1 ratings for the ecological components and subcomponents interacting with the Rocky Reef Fin Fish Fishery taking into consideration the likelihood of the risk coming to fruition in the short to medium term.*

Ecological Component	Level 1 Risk Rating	Likelihood Considerations	Level 2 Required?
Target & Byproduct	High	• Multi-species fishery able to be accessed by any operator with an L1, L2 or L3 fishery symbol. • Absence of effective controls on catch and effort at a whole of fishery, regional and species level and high potential for effort to increase for one or more of the species (*e.g.* due to increased marked demand). • Research indicates that at least two of the key species are being fished above sustainability reference points. Information on the stock structure (*e.g.* biomass estimates, sustainability reference points) are less developed for most of the remaining species. • Some target species attract considerable attention from the commercial, recreational and charter fishing sectors. • A portion of the annual RRFFF catch is retained as byproduct by net fishers targeting ECIFFF species. Primary risks associated with these activities related to the increased fishing power of nets and the potential for	Yes

Ecological Component	Level 1 Risk Rating	Likelihood Considerations	Level 2 Required?
		operators to target species at vulnerable periods of their life history *e.g.* during aggregation events. • Risks associated with licence transfers and the reactivation of underutilised fishery symbols is considered to be higher for this species given a) sustainability concerns for some of the key species and b) the increased marketability of RRFFF species. • Management arrangements may not provide sufficient protection to species during key life-history events *e.g.* protections for seasonal aggregators. • While not retained for sale, smaller cohorts are caught as bycatch in trawl fisheries situated on the Queensland east coast. As these fish have yet to recruit to the fishery, their capture may impact on the ability of a stock to rebound after decline. • As a number of the species hold significant social interest, cumulative fishing pressures (*e.g.* commercial, recreational, charter) may be a key issue for this subgroup. • Information on non-commercial catch including from the recreational fishing sector is limited for some species and the extent of the risk from this subgroup is yet to be fully quantified. • The use of a *Vessel Tracking* system in this fishery helps minimise some of the risks posed by non-compliance. This information will also help refine subsequent ERAs including assessments of fine-scale effort patterns.	
Bycatch (non-SOCC)	Low	• While information on bycatch is limited, risk is expected to be low for this ecological component. • The amount of bycatch would be reduced by provisions that allow RRFFF to retain and sell species managed as part of the ECIFFF. • Future risk assessments (if applicable) would benefit from additional information on the species that are discarded and the amount of catch that is retained and sold in other fisheries.	No

Ecological Component	Level 1 Risk Rating	Likelihood Considerations	Level 2 Required?
Species of Conservation Concern (SOCC)			
Marine turtles	Low / Intermediate	• The fishery has low interaction rates and, outside of boat strike, is unlikely to result in the direct mortality of the animal. • Risk ratings for this subgroup were heavily influenced by impacts associated with lost and discarded fishing gear. This risk transcends the commercial fishery with recreational fishing making responsible for a notable proportion of the discarded fishing line. • In the event that an interaction does occur (*i.e.* the direct capture of the animal), there is a higher risk of the animal experiencing post-release injuries. However, fishers will be on hand to minimise this risk and facilitate a quick release of the animal. • Post-release injuries and the risk of mortalities increases if the hook has been ingested and cannot be retrieved. • Measures in place to minimise risk *i.e.* media encouraging best practice such as ensuring rubbish (fishing lines plastic bags are disposed of correctly), SOCI reporting and limitation on the number of lines and hooks used. • Cumulative risks including loss of fishing gear and boat strike will be a broader risk factor for this subgroup. • This subgroup may also experience longer-term complications; particularly in the hook has been ingested. The risk of mortality is expected to be higher for animals that have ingested the hook. • Given the above considerations, the preliminary risk rating was reduced from an intermediate to low/intermediate. Risk scores may be reduced further, if and when, the veracity of the SOCI data can be validated further.	No
Sea snakes	Negligible	• Low to negligible interactions / mitigation measures not considered necessary.	No

Ecological Component	Level 1 Risk Rating	Likelihood Considerations	Level 2 Required?
		• Interactions, while still comparatively low, are likely to be higher in the recreational fishing sector due to a higher number of participants.	
Crocodiles	Negligible	• Subgroup highly unlikely to interact with the RRFFF. • Any interaction (if applicable) unlikely to result in a mortality.	No
Dugongs	Negligible	• Risk rating downgraded from low to negligible due to the fishery having low overlap with habitats preferred by dugongs and the low probability of an interaction occurring in this fishery. • Impacts to this subgroup would largely relate to interactions with the vessel. This risk extends beyond the commercial fishery and encompasses a wide range of stakeholders / activities in the marine environment.	No
Cetaceans	Low	• Risks to this subgroup would largely relate to interactions with the vessel *e.g.* boat strike. • While there is potential for some species to interact with the line apparatus, the long-term consequences of this interactions are not considered to be significant. • Further management of risk not considered to be warranted.	No
Teleosts (protected / SOCI only)	Intermediate	• Elevated risk in the RRFFF due to fishing method and the area of operation. The impact of the RRFFF is anticipated to be lower than in the CRFFF as the majority of effort occurs in south east Queensland. • Available SOCI data has limited reliability and the veracity/accuracy of this data (including release rates) requires further clarification. Uncertainty in this data contributed to the ecological component receiving a higher risk rating. • Some mitigation measures in place *e.g.* gear restrictions, spatial closures, information about post release techniques (deflating swim bladders) and barotrauma on fisheries website.	No

Ecological Component	Level 1 Risk Rating	Likelihood Considerations	Level 2 Required?
		• Increased awareness of post-release handling procedures would aid in reducing post-release mortalities for some species. • Cumulative risks including the impact of recreational and charter fishing will be a broader risk factor for this subgroup. • The preliminary risk rating was heavily influenced by data deficiencies and uncertainty surrounding the catch data and interaction rates. The risk rating for this ecological component could (potentially) reduce with additional information on species compositions, interaction rates, locations and fisher intentions.	
Batoids	Low	• Low likelihood of interactions occurring in this fishery and post release survival rates expected to high providing best management and handling practice are followed. • Further management of risk not considered to be warranted.	No
Sharks	Low / Intermediate	• Low likelihood of interactions occurring in this fishery and post release survival rates will be high providing best management and handling practice are followed. • Interactions with this subgroup include those associated with depredation; although grey nurse shark (GNS) interactions were a factor of influence. • Poor handling practices may increase the number of mortalities for this subgroup including the deliberate injuring of the animal. • The potential for the fishery to interact with GNS contributed to this subgroup receiving a higher risk rating. This species has experienced historical population declines and is currently the subject of a detailed recovery plan. • The GNS recovery plan identifies mortalities related to the incidental (accidental and/or illegal) capture by commercial and recreational fisheries. • At present, there is limited information on the extent of GNS interactions with fishers (commercial and recreational) targeting rocky reef species.	No

Ecological Component	Level 1 Risk Rating	Likelihood Considerations	Level 2 Required?
		• Future risk assessments would benefit from additional information on depredation rates, GNS interaction rates, the outcomes of the interaction (all sharks), the extent of gear loss, multiple hooking events and interaction rates in the recreational and charter fishing sectors. • While not classified as high risk category, improved data validation techniques for both the commercial and recreational fishing sector would a) refine the risk profile for this subgroup and b) provide further insight into the need to progress GNS to a fisher scale Level 2 assessment.	
Syngnathids	Negligible	• Risk rating downgraded from low to negligible due to the low probability of an interaction occurring in this fishery.	No
Seabirds	Low	• Risk reduced in this fishery due to nature of fishery and capacity of fishers to sink baits down to a depth quickly. • In the event that a seabird becomes hooked or entangled in the line than operators at hand to rectify the situation. • Risk is further managed through restrictions on number of lines and hooks plus guides on best management and handling. • The collective risk associated with discarded line (*e.g.* commercial, recreational and charter fishing) considered to be more significant for this subgroup and may require further investigation *e.g.* outside the ERA framework.	No
Terrestrial mammal	Negligible	• Subgroup unlikely to interact with the RRFFF.	No
Marine Habitats	Intermediate	• Key risks to this ecological component relate to the loss of fishing gear and regional impacts associated with general boating activities *e.g.* anchoring. • Risks are expected to be more significant in high effort / high usage areas and areas frequented by both commercial and recreational fishers. • The fishery has increased potential to contribute to discarded line / loss of fishing gear that can persist in the environment for extended period.	No

Ecological Component	Level 1 Risk Rating	Likelihood Considerations	Level 2 Required?
		• While best practice methods of anchoring and mooring have been developed and promoted, these risks are difficult to monitor across sectors. • Direct impacts will be difficult to avoid; particularly with respect to anchoring and loss of fishing gear. • These risks extends beyond the commercial fishery and will be equally applicable to the recreational fishing sector.	
Ecosystem Processes	Low / Intermediate	• Overall risk posed to ecosystem process is anticipated to at the lower end of the spectrum. However the risk profile for this ecological component has a high degree of uncertainty as it is difficult to quantify the impacts of an individual fishery. • As risks to these impacts are largely linked to predation / removal of predators and recruitment, these risks will be indirectly addressed through the *Sustainable Fisheries Strategy 2017–2027* and the development of harvest strategies for key species. • There are however areas that contributed to the level of risk for this ecological component including the absence of an overarching control on effort, the potential impact of the fishery on species that aggregate, the targeting of key species by recreational fishers and regulations that permit the species to be retained in a net-dominated fishery *i.e.* the ECIFFF.	No

4.6 Issues Arising

Catch & Effort Controls / Ongoing Sustainability Concerns

The RRFFF targets 13 non-regulated species. These are not restricted by quota and can be targeted and retained by any fisher with an L1, L2 or L3 fishery symbol. Due to this management regime, there is significant potential for catch and effort to increase or switch between species as market demand or species abundance varies. This risk is present for all RRFFF species and may have broader implications given the lack of information on cumulative fishing pressures and post-release mortalities.

Fisheries data indicates that elements of the RRFFF are not being managed to key sustainability reference points; namely snapper and pearl perch. Declining biomass increases the risk that stocks will have a lower resilience to changing fishing environments or be unable to recover from potential declines. In the RRFFF, this risk may extend to secondary species as catch and effort levels increase

to compensate for declining snapper and pearl perch catch rates. Going into the future, management reforms may be required to address this risk and meet key objectives of the *Queensland Sustainable Fisheries Strategy 2017–2027*.

A number of initiatives being undertaken as part of the *Queensland Sustainable Fisheries Strategy 2017–2027* will greatly assist in the monitoring and mitigation of risk in this Fishery. A RRFFF Fisheries Working Group has been established as part of the *Queensland Sustainable Fisheries Strategy 2017–2027* and includes a range of stakeholders from the scientific community, management agencies, and the commercial and recreational fishing sectors. This working group will be responsible for discussing management reform initiatives for the fishery, evaluating the suitability and applicability of the current management regime and potential alternatives.

Increased effort on latent/underutilised licences

Management initiatives implemented on the Queensland east coast have greatly reduced the risk of latent licences becoming reactivated in this fishery. With that said, only 20% of the L fishery symbols are currently in use in the RRFFF. Given this, there is considerable potential for effort to increase in this fishery over time. For the L1 and L2 fishery symbols, this will mostly likely occur through a redirection of effort to RRFFF species. In this instance, total line effort (*i.e.* across the State) may stay the same but target species in the RRFFF will experience higher rates of fishing mortality.

The situation surrounding the L3 fishery symbol arguably presents the most risk for the RRFFF. At present, the risk of a mass re-activation of L3 fishery symbols is considered to be unlikely. There are however a large number of L3 symbols still in existence and around 40% of these are attached to licences used in non-line fisheries (*pers. comm.* S. Breen). As there is limited restrictions on the transfer of fishing symbols (permanent and temporary), there is considerable potential for the L3 symbols to be re-activated and for effort to increase in the RRFFF over time. While this risk is also present in the ECIFFF, it is arguably more relevant in the RRFFF where there is concerns about the long-term sustainability of some of the more marketable species.

Recreational fishing data

The historical data for the Queensland recreational fishing sector is poor with state wide surveys only commencing in 1997. This lack of historical catch, effort and distribution data contributes to significant difficulties in managing risk within the fishery, particularly as fishing effort is not directly regulated in the recreational sector. However, management measures do include in possession limits, gear restrictions, size limits and spatial closures.

The majority of information on the recreational take of RRFFF species is obtained through voluntary localised monitoring programs (*e.g.* the boat ramp survey program) and more expansive voluntary recreational fisher surveys (Webley *et al.*, 2015). Recreational harvest estimates are derived from the state wide recreational fishing surveys and are generally only useful at the stock level for common target species. The main reasons for this are that the surveys do not produce useable estimates for rare or infrequently caught species and a lack of sampling power can result in the data having poor species resolution (Webley *et al.*, 2015). Given these factors, the extent of fishing mortality resulting from the recreational fishing requires further investigation. This is considered to be of particular relevance to south east Queensland where there is a higher concentration of commercial effort.

Catch harvested by Aboriginal peoples and Torres Strait Islander peoples remains the least understood component of the collective RRFFF. This sector is likely to have lower levels of catch and effort; although the dynamics of the fishery are poorly understood. At a whole of fishery level, this fishing sector is unlikely to make a significant contribution to overall risk levels. This sector may have more of a role to play with respect to regional fishing pressures. Accordingly, further information on the distribution and extent of this fishery would be useful for future ecological risk assessments.

Use of non-line apparatus to take RRFFF species

The use of nets to take RRFFF species is permitted under the *Fisheries Regulations 2008*, provided operators have a current net licence symbol. Although catch in this sector is small compared to the traditional line fishery, there is very little information on this aspect of the fishery and the degree to which RRFFF are targeted by net operations. One of the greatest risks posed by net fishing relates to the increase in fishing power and the potential for fishers to target aggregations. With any targeted fishing of aggregations, hyperstability becomes a risk. The limited information regarding this sector of the fishery increases the overall risk at the whole of fishery level.

While the RRFFF cannot be retained for sale in the East Coast Trawl Fishery, a number are caught and subsequently discarded as bycatch. Information on this component on the trawl bycatch has improved though time (Sumpton & Jackson, 2005; Courtney *et al.*, 2007) and this fishery is likely to be a contributor of risk for these species. There is however a need to gain a better understanding of the cumulative risks posed to RRFFF by commercial fishing activities and its potential to impede stock recovery.

Under Reporting / Misidentification of SOCI Species

Species of Conservation Interest or SOCI is a group of species that are afforded additional protections in Queensland waters. Often no-take species, this group includes marine turtles, whales, dolphins, crocodiles, seabirds, sawfish plus a small number of sharks, rays, teleosts and syngnathids. This group formed the basis of the broader *Species of Conservation Concern* (SOCC) ecological component that was assessed as part of this Level 1 ERA. In Queensland, all commercial operators are required to report interactions with these species in a dedicated SOCI logbook.

In the RRFFF, the majority of SOCI interactions are with protected teleost species. SOCI information for this fishery though is fragmented and in some instances, interactions may be underreported. There are currently limited methods to validate the veracity of the SOCI data submitted by commercial fishers. There is also an absence of information on the level of interactions recreational fishers have with the SOCI. In terms of the Level 2 ERAs, this information is considered to be important, as will information on the propensity of these species to interact with each sector. Of significance, the validation of commercial fishing data including SOCI logbooks is being actively addressed as part of the *Queensland Sustainable Fisheries Strategy 2017–2027.*

5 Summary & Recommendations

When the outcomes of the preliminary risk assessment and the secondary evaluation of likelihood (Table 3; Appendix 2) are taken into consideration, only the target & byproduct species ecological component was assigned a risk rating above intermediate. In accordance with the Guidelines, this

ecological component will be progressed to a Level 2 assessment where the focus shifts from the whole of fishery level to individual species.

While the marine habitats ecological component was assigned an intermediate rating, the risk profile for this ecological component was influenced by factors with a broader scope *e.g.* anchoring, general boating operations and loss of fishing gear. Similarly, data deficiencies and uncertainties in the SOCI data contributed to protected species receiving a risk rating of intermediate. Given these factors, these two ecological components will be progressed through the *Fisheries Queensland Monitoring and Research Plan* (Department of Agriculture and Fisheries, 2018b).

Outside of these ecological components, the Level 1 ERA identified a number of information gaps which a) contributed to the level of uncertainty and b) produced more conservative/precautionary risk evaluations. To address these issues and help refine a number of the risk profiles, the following avenues should be progressed to *the Fisheries Queensland Monitoring and Research Plan* (Department of Agriculture and Fisheries, 2018b). Specifically:

- Increasing the level of information on short and medium term fishing trends including species most likely to experience increased rates of fishing mortality and the key drivers of change (*e.g.* changing fishing behaviours, improved marketability, biomass declines for key species, cumulative fishing pressures, changes to management);
- Improving the level of information on cumulative fishing pressures (commercial and recreational) for key rocky reef species and the potential implications for their long-term management and sustainability;
- Quantifying the extent of the risk posed by licence transfers by improving the level of information on line symbol transfers, pre-/post-transfer catch compositions and the number of L3 fishery symbols that are currently active in the RRFFF, ECIFFF and CRFFF;
- Validating species compositions and interaction rates (including release fates) for teleosts classified as *Species of Conservation Interest* (SOCI);
- Validating the extent of GNS interactions with fishers (commercial and recreational) targeting rocky reef species in Queensland waters, release fates and the likelihood of an interaction resulting in a mortality;
- Obtaining greater information on gear loss rates and line-related injuries/mortalities for SOCI species including the origin of line debris *i.e.* commercial or recreational fishing line.

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Appendix 1 – Ecological Processes Preliminary Assessment

A1 – Ecological Processes Categories

Categories taken into consideration as part of the Level 1 preliminary assessment for the Ecological Processes ecological component. Definitions adopted from the Great Barrier Reef Outlook Report (Great Barrier Reef Marine Park Authority, 2014) and Pears *et al.* (2012).

CATEGORY	DESCRIPTION
SEDIMENTATION	The inflow, dispersion, resuspension and consolidation of sediments
NUTRIENT CYCLING / MICROBIAL PROCESSES	The input, export and recycling of nutrients within the ecosystem. Removal of animals through harvesting is a direct loss of nutrients to the ecosystem
PARTICLE FEEDING	Feeding process targeted at particles suspended in the water column, or deposited on submerged surfaces
PRIMARY PRODUCTION	The conversion of the sun's energy into carbon compounds that are then available to other organisms
HERBIVORY	The consumption of plants
PREDATION	The removal of mid and top order predators from the marine environment and the potential for animals to be subject to increase predation
BIOTURBATION	The biological reworking of sediments during burrow construction and feeding and bioirrigation (mixing of solutes) leading to the mixing of oxygen-bearing waters into sediments
DETRITIVORY	Feeding on detritus (decomposing organic matter)
SCAVENGING	Predators eating already dead animals
SYMBIOSIS	The interdependence of different organisms for the benefit of one or both participants
RECRUITMENT	The impact of the fishery on the ability of a species replenishment populations
REEF BUILDING	The process of creating habitats composed of coral and algae and includes the creation of all biogenic (*i.e.* of living origin) habitats
COMPETITION	Interactions between species that favour or inhibit mutual growth and functioning of populations
CONNECTIVITY	Migration, movement and dispersal of propagules between habitats at a range of scales; and functional connectivity which represents ontogenetic cycles of habitat use
OUTBREAKS OF DISEASE	The spread or introduction of disease to organisms or ecosystems
SPECIES INTRODUCTIONS	The introduction of exotic species and their spread once established

A2 – Ecosystem Processes Preliminary Assessment

The following provides an overview of risk scores for each ecosystem processes category for RRFFF fishing operations, including an overall score for each of the fishing activity sub-components (Table 1). As with risk scores for the whole of fishery assessment, they are ranked Low (L), Intermediate (I), High (H), or negligible (-), and describe the likelihood that the fishing activity (*e.g.* **harvesting**, **discarding** *etc.*) will have an undesirable effect on the ecosystem process category (*e.g.* sedimentation, nutrient cycling *etc.*). Overall risk scores for each fishing activity are conservative, and are therefore based on the highest score ranking between the ecosystem processes categories.

	Line fishing – Main activities of the Fishery							**Cumulative Impacts**
Ecological Component	**Harvesting**	**Discarding**	**Contact without capture**	**Loss of fishing gear***	**Travel to/from grounds**	**Disturbance due to presence in area**	**Boat maintenance & emissions**	**Other fisheries***
Sedimentation	-	-	-	-	L	L	-	-
Nutrient cycling / Microbial processes	L	-	-	-	-	-	-	L
Particle feeding	L	-	-	-	-	-	-	L
Primary production	-	-	-	-	-	-	-	-
Herbivory	-	-	-	-	-	-	-	-
Predation	L	L	-	-	-	-	-	L
Bioturbation	-	-	-	-	-	-	-	-
Detritivory	-	-	-	-	-	-	-	-
Scavenging	-	L	L	-	-	-	-	L
Symbiosis	-	-	-	-	-	-	-	-
Recruitment	I	-	-	-	-	-	-	I
Reef building	-	-	-	L	-	-	-	-
Competition	L	-	-	-	-	-	-	L
Connectivity	L	-	-	-	-	-	-	L/I
Outbreaks of disease	-	-	-	L	-	-	-	-
Species introductions	-	-	-	-	-	-	-	-
ECOSYSTEM PROCESSES (overall)	I	L	L	L	L	L	-	I

*Includes recreational, & charter sector.

Appendix 2 – Risk Ratings and Outputs.

The primary objective of the Level 1 assessments were to a) identify the key sources of risk within a particular fishery and b) the ecosystem components that are most likely to be effected by this risk. Preliminary risk ratings developed as part of the *Risk Characterisation* stage take into consideration the current fishing environment (*e.g.* current catch, effort and licensing trends) and risk factors associated with the current management regime (*e.g.* the potential for additional effort to be transferred into areas already experiencing higher levels of fishing mortality, substantial increases in fishing mortality for key species, changing target species). Depending on the fishery, broader risk factors may also contribute to an ecological component receiving a more conservative risk rating. These preliminary rates are precautionary or more conservative in nature and provide a more holistic account of a) risks posed by the fishery and b) provide the Level 1 ERA with greater capacity to address the (potential) long-term consequences of a risk. The trade-off with this approach is that the preliminary risk may overestimate the level of risk posed to an ecological component or be a reflection of the 'potential risk'. Otherwise known as a 'false positive', these values effectively overestimate the risk posed to an ecological component or subcomponent.

The potential for large-scale qualitative ERAs to produce 'false positives' places added importance on examining the likelihood of the risk coming to fruition in the short to medium term. The following provides an overview of the preliminary risk ratings and an assessment of the likelihood of it occurring in the RRFFF. Depending on the species and the current fishing pressures, preliminary risk ratings may be amended to reflect the current fishing environment.

Ecological Component	Key Issues / Sources of Risk	Preliminary (Potential) Risk	Likelihood / Management Considerations	Residual risk assessment
Target & Byproduct	• Multi-species fishery able to be accessed by any operator with an L1, L2 or L3 fishery symbol. • Absence of effective controls on catch and effort at a whole of fishery, regional and species level.	High	*Likelihood* • Moderate to high depending on the species. Evidence indicates that a) at least two of the key species have sustainability concerns and b) that catch and effort has diversified to focus on other species. *Mitigation Measures & Considerations*	High

Ecological Component	Key Issues / Sources of Risk	Preliminary (Potential) Risk	Likelihood / Management Considerations	Residual risk assessment
	• Research indicates that at least two of the key species are being fished above sustainability reference points. • High potential for effort to transfer / increase for secondary species; many of which lack biomass estimates. • Some target species attract considerable attention from the commercial, recreational and charter fishing sectors. • A portion of the catch is retained by net fishers targeting ECIFFF species which has a) increased fishing power and b) higher potential to target spawning aggregations. • Management arrangements may not provide sufficient protection to species during key life-history events *e.g.* protections for seasonal aggregators.		• Some species have the potential to be caught using apparatus with greater fishing power; namely net fishers. Similarly, the fishery currently lacks protections that aggregate at key times of their lifecycle. • Protections largely revolve around legal size limits and spatial closures. The RRFFF does not currently use seasonal spatial closures such as those used in the RRFFF. • A number of the species are subject to indicative stock status assessments and the stock structure of snapper and pearl perch is well understood. These results though are not connected directly to the RRFFF management regime *i.e.* are not connected to TACC limits or ITQs. • A three tiered system of ITQs has been proposed with TACs, and catch triggers used to manage risk for some species. • DAF examining ways to increase the number of stock assessments to support tier 1 and 2 species as part of the	

Ecological Component	Key Issues / Sources of Risk	Preliminary (Potential) Risk	Likelihood / Management Considerations	Residual risk assessment
			Sustainable Fisheries Strategy 2017–2027. • Various initiatives being considered to improve catch reporting processes, including the introduction of electronic logbooks and electronic observation. • Improving data on recreational fishing.	
Bycatch (non-SOCC)	• Limited information on the discard quantities, species compositions and discard fates. • Bycatch in this fishery will include species that can be retained for sale in the ECIFFF or CRFFF. • It is difficult to determine what ratio of non-target ECIFFF species are retained and discarded. • As fishers do not nominate the fishery they are operating in it is difficult to determine what non-target species are retained as byproduct while a fisher is operating in the RRFFF *vs.* when they are actively targeting ECIFFF species. This information is of value as a) it	Low / Intermediate	*Likelihood* • Fishers will interact with a range of species not targeted for sale in the RRFFF. However, a high number of these species can be retained for sale in the ECIFFF. *Mitigation Measures & Considerations* • Key risks to this ecological subgroup will relate to the capture of target and byproduct species that cannot be retained for sale or are discarded. These risks will be addressed as part of the assessment for target & byproduct species.	Low

Ecological Component	Key Issues / Sources of Risk	Preliminary (Potential) Risk	Likelihood / Management Considerations	Residual risk assessment
	identifies the fisher intentions and b) provides a more accurate account being used in the fishery.			
Species of Conservation Concern (SOCC)				
Marine turtles	• Indirect impacts (contact without capture, lost fishing gear, boat strike) considered to be higher risk than direct impacts (discarding). • Post-release mortalities and injuries viewed as a considerable risk for line fisheries. • Subgroup will be afforded notable protections from spatial closures along the Queensland coastline; namely within the Great Barrier Reef Marine Park, Moreton Bay Marine Park and Great Sandy Marine Park. • High spatial overlap between key • Cumulative impacts of lost and discarded fishing line (*i.e.* commercial and recreational) will be a broader issue for this subgroup.	Intermediate	<u>*Likelihood*</u> • Low to medium. <u>*Mitigation Measures & Considerations*</u> • Media encouraging best practice such as ensuring rubbish (fishing lines plastic bags) are disposed of correctly. • SOCI reporting in place across commercial fisheries in Queensland. • Limited information on interaction rates between this subgroup and other sectors; namely the recreational fishing sector. • Limits on number of lines and hooks used.	Low / Intermediate

Ecological Component	Key Issues / Sources of Risk	Preliminary (Potential) Risk	Likelihood / Management Considerations	Residual risk assessment
Sea snakes	• Considerable spatial overlap between key fishing grounds and preferred habitats. • Recreational fishing data indicates that subgroup can and does interact with the line apparatus. • No reported SOCI reports from the RRFFF and interactions (if applicable) will be low in number of infrequent.	Low	*Likelihood* • Low as reports of snakes interacting with lines or targeting baited hooks are relatively low. *Mitigation Measures & Considerations* • SOCI reporting. Limits on number of lines and hooks used • Best management and handling practice in place. • Further management of risk not considered to be warranted. • Interactions, while still comparatively low, are likely to be higher in the recreational fishing sector due to a higher number of participants.	Negligible
Crocodiles	• Limited spatial overlap between key fishing grounds and preferred habitats (possibly in FNQ). • Interactions with this subgroup are highly unlikely and (if applicable) not expected to result in mortalities.	Low	*Likelihood* • Considered to be negligible. *Mitigation Measures & Considerations* • Risk largely relates to non-fishing related activities *e.g.* boat strike, contact without	Negligible

Ecological Component	Key Issues / Sources of Risk	Preliminary (Potential) Risk	Likelihood / Management Considerations	Residual risk assessment
			capture. Direct risks posed by line fishing considered to be negligible. • Further management of risk not considered to be warranted.	
Dugongs	• No reported interactions and are considered to be an unlikely occurrence in this fishery. • Limited spatial overlap between key fishing grounds and preferred habitats. • Interactions more likely to occur with the vessel *versus* direct entanglement in the fishing line.	Low	*Likelihood* • Considered to be negligible. *Mitigation Measures & Considerations* • Risk largely relates to non-fishing related activities *e.g.* boat strike, contact without capture. Direct risks posed by line fishing considered to be negligible. • Further management of risk not considered to be warranted.	Negligible

Ecological Component	Key Issues / Sources of Risk	Preliminary (Potential) Risk	Likelihood / Management Considerations	Residual risk assessment
Cetaceans	• Infrequent interactions with apparatus including line entanglements and boat strikes. • Line entanglements unlikely to result in mortalities but may result in longer term complications *i.e.* strangulation of appendages. • High spatial overlap between key fishing grounds and preferred habitats. • Indirect impacts (contact without capture, boat strike) are a higher risk than direct impacts (discarding, entanglement). • Risks will vary with species size and relate more to post-interaction injuries and (potential) mortalities. Both of which are difficult to assess. • Interactions and (if applicable) mortalities unlikely to have a long-term impact on regional populations.	Low / Intermediate	*Likelihood* • Considered to be low. *Mitigation Measures & Considerations* • Risk largely relates to non-fishing related activities *e.g.* boat strike, contact without capture. Direct risks posed by line fishing considered to be negligible. • SOCI reporting in place across commercial fisheries in Queensland. • Further management of risk not considered to be warranted. .	Low
Protected teleosts	• Some potential for interactions to occur in the RRFFF to fishing method and target species.	Intermediate	*Likelihood*	Intermediate

Ecological Component	Key Issues / Sources of Risk	Preliminary (Potential) Risk	Likelihood / Management Considerations	Residual risk assessment
	• Risk may be lower than in the CRFFF as majority of effort focused on central and southern Queensland. • Number of interactions may be higher than what is reported as monitoring systems may attribute this portion of the catch to other line fisheries. • Limited capacity to validate SOCI records across line fisheries and, by extension, interaction rates across line fisheries.		• Medium interactions with some protected species are inevitable due to the methods used. <u>*Mitigation Measures & Considerations*</u> • Information on the extent of interactions may be underestimated with SOCI reports attributed to other line fisheries. • Information about best practice post release techniques (deflating swim bladders) and barotrauma on web page. • SOCI reporting in place across commercial fisheries in Queensland. • Limits on number of lines and hooks used.	
Batoids	• Interaction rates (overall) anticipated to be low. • Potential for interactions to occur due to overlap between key fishing grounds and preferred habitats of some species.	Low	<u>*Likelihood*</u> • Low <u>*Mitigation Measures & Considerations*</u> • Interaction rates expected to be low and post-release survival rates for this ecological component will be high.	Low

Ecological Component	Key Issues / Sources of Risk	Preliminary (Potential) Risk	Likelihood / Management Considerations	Residual risk assessment
	• Interactions and (if applicable) mortalities unlikely to have a long-term impact on regional populations.		• SOCI reporting in place across commercial fisheries in Queensland. • Best management and handling practice in place.	
Sharks	• Interaction rates (*i.e.* direct capture and predation on caught fish) will be higher than batoids. • Species complex more likely to be retained as byproduct to be sold in the ECIFFF. • One of the few fisheries that has the potential to interact with GNS. This resulted in the ecological component receiving a higher risk rating. • GNS are a species that displays high site fidelity and these impacts may be amplified over time. • High post-interaction / release survival rate. Most interactions will not result in the animal being landed on deck.	Intermediate	<u>*Likelihood*</u> • Considered to be lower as the preliminary risk rating was heavily influenced by a) the location of key fishing grounds and b) the potential for fishers to interact with GNS. • While interactions with GNS may occur, there is a high probability that the animal will survive the initial event. • Other interactions with sharks are not expected to result in significant mortalities unless animal is retained for sale in the ECIFFF. • Marketability constraints will be a limiting factor with respect to the number of sharks that are retained by operators in the RRFFF. <u>*Mitigation Measures & Considerations*</u>	Low / Intermediate

Ecological Component	Key Issues / Sources of Risk	Preliminary (Potential) Risk	Likelihood / Management Considerations	Residual risk assessment
			• Best management and handling practice in place including for grey nurse sharks. • Further management of risk may not be warranted for this ecological component in this fishery.	
Syngnathids	• Subgroup highly unlikely to interact with line apparatus.	Low	<u>*Likelihood*</u> • Considered to be negligible. • Further management of risk not considered to be warranted.	Negligible
Seabirds	• Small number reported through SOCI logbooks and interaction rates anticipated to be low. • Direct interactions and (if applicable) mortalities unlikely to have a long-term impact on regional populations. • Higher risk associated with indirect impacts and cumulative fishing pressures *e.g.* discarded fishing line. • Risks likely to be more relevant to diving species.	Low	<u>*Likelihood*</u> • Low <u>*Mitigation Measures & Considerations*</u> • Best management and handling practice in place. • Further management of risk not considered to be warranted.	Low

Ecological Component	Key Issues / Sources of Risk	Preliminary (Potential) Risk	Likelihood / Management Considerations	Residual risk assessment
Terrestrial mammals	• Negligible interactions or spatial overlap.	Negligible	*Likelihood* • Considered to be negligible. *Mitigation Measures & Considerations* • Further management of risk not considered to be warranted.	Negligible
Marine Habitats	• Contact with marine habitat highly localised and impacts will be more significant in high use areas. • The two primary impacts and risks relate to general boating activities (*e.g.* anchoring) and lost fishing gear. • Cumulative impacts will also be a risk *i.e.* when lost and discarded fishing line from the recreational fishing sector are taken into consideration. • Secondary factors including rubbish and marine pollutants would contribute to environmental degradation. The extent of this impact though is difficult to quantify given the number of stakeholders and the potential sources.	Intermediate	*Likelihood* • Intermediate and potentially higher in high-use areas. *Mitigation Measures & Considerations* • Key impacts and risks (*e.g.* boating activities, lost fishing gear) extends beyond the commercial fishing sector. • Cumulative impacts are considered to be more with the RRFFF being a contributor of risk *vs.* the main driver of risk. • Best practice methods of anchoring and mooring in and around marine parks.	Intermediate

Ecological Component	Key Issues / Sources of Risk	Preliminary (Potential) Risk	Likelihood / Management Considerations	Residual risk assessment
			• Media campaigns and education programs encouraging best practice such as ensuring rubbish (fishing lines plastic bags) are disposed of correctly.	
Ecosystem Processes	• Fishery targets a range of species including mid-level predators. • The fishery also has the potential to impact/effect recruitment process. This inference is supported by research that shows some of the target species are being fished above sustainability reference points. • This is of particular relevance to snapper whose stocks extend across jurisdictional lines. • The potential of the RRFFF to affect or influence key ecosystem processes is limited.	Intermediate	*Likelihood* • Uncertain but likely to be lower than the preliminary assessment. *Mitigation Measures & Considerations* • A three tiered system of ITQs has been proposed with TACs, and catch triggers used to manage risk for some species. • DAF examining ways to increase the number of stock assessments to support tier 1 and 2 species as part of the *Sustainable Fisheries Strategy 2017–2027*. • Various initiatives being considered to improve catch reporting processes, including the introduction of electronic logbooks and electronic observation. • Improving data on recreational fishing.	Low / Intermediate