Department of Agriculture and Fisheries

Sustainable Fisheries Strategy 2017–2027

Level 1 Ecological Risk Assessment

Coral Reef Fin Fish Fishery

Queensland Government

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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 Coral Reef Fin Fish Fishery (CRFFF) the Level 1 ERA assessed fishing related risks in 17 ecological components including the three quota management units (coral trout, red-throat emperor and other 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 CRFFF, the preliminary ratings indicated that at least 15 of the ecological components were at negligible, low or intermediate risk of experiencing an undesirable event due to fishing activities including the coral trout (CT) and redthroat emperor (RTE) management unit. The two remaining ecological components, the other species (OS) management unit and protected teleosts, were assigned a high risk rating. The key drivers of risk for these ecological components related to the quality of the data for catch and effort levels, species compositions and interaction rates.

After the likelihood of the risk coming to fruition was considered, the preliminary risk ratings for six ecological components were downgraded. The most notable of these reductions were for the RTE management unit (downgraded from intermediate to low) and the OS management unit (downgraded from high to intermediate/high). These amendments were in response to harvest data that shows both management units are operating well below the prescribed Total Allowable Commercial Catch (TACC) limits. Loss of gear and the potential for animals to become entangled in discarded fishing line was an influential factor for marine turtles and ecosystem processes. As this issue or risk extends beyond the

CRFFF to other line fisheries and sectors, the risk rating for these ecological components was downgraded from intermediate to low-intermediate. The remaining amendments involved ecological components that were assigned low risk ratings and had minimal contact with the fishery.

Based on the revised risk ratings, two ecological components will be progressed to a Level 2 assessment—the OS quota management unit and protected teleosts. The Level 2 assessment will produce risk profiles for key species or species groupings and address issues relating to risk variability. 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 CRFFF include:

- Improving the level of understanding on compositions and release fates (including depredation) of target species, particularly in the other species (OS) management unit.
- Validating species compositions and interaction rates (including release fates) for teleosts classified as *Species of Conservation Interest* (SOCI).
- Obtaining greater information on gear loss rates and line-related injuries/mortalities for SOCI species including potential sources *i.e.* commercial or recreational fishing line.
- Further assessment of regional catch and effort levels in the recreational fishing sector for key species where cumulative fishing impacts present as a higher risk.

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

Ecological Component	Level 1 Risk Rating	Progression
Target & Byproduct	CT – Low	Not progressed further
	RTE – Low	Not progressed further
	OS – Intermediate/High	Level 2 ERA
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
Cetaceans	Low	Not progressed further
Teleosts (protected/SOCI only)	Intermediate/High	Level 2 ERA
Batoids	Low	Not progressed further
Sharks	Low	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

Table of contents

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 CRFFF through the logbook reporting system irrespective of the amount of catch and effort.
AIVR	–	Automated Interactive Voice Response (AIVR) system.
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 ECIFFF or RRFFF). In this risk assessment, this portion of the catch is classified as 'bycatch'.
CRFFF	–	Coral Reef Fin Fish Fishery.
CT	–	Coral Trout also referred to as the CT-RQ quota management unit.
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 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.
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'.
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 CRFFF 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. Refer to the *Fisheries Regulation 2008* for additional information on provisions governing the use of fishery symbols.
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.
OS	–	Other species also referred to as the OS-RQ quota management unit.
QBFP	–	Queensland Boating and Fisheries Patrol.
RRFFF	–	Rocky Reef Fin Fish Fishery.
RTE	–	Redthroat emperor also referred to as the RTE-RQ quota management unit.
SAFS	–	Status of 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 *Coral Reef Fin Fish Fishery* (CRFFF) is a line-only fishery that targets coral trout and a range of bottom-dwelling reef fish. The fishery mostly operates within the confines of the Great Barrier Reef Marine Park (GBRMP), although a small proportion of catch is reported from outside this area. The CRFFF has a large commercial fishery and it includes a range of species that attract a significant level of interest from recreational and charter fishers. At a whole of fishery level, the CRFFF is managed through a mixture of input and output controls that includes gear restrictions, limited entry provisions, individual transferable quotas (ITQs), in possession limits, size limits and no-take species (Department of Agriculture and Fisheries, 2019). While input controls, size limits and no-take species are applied across the fishery, output controls relating to quota are only applicable to the commercial fishery. The CRFFF uses ITQs to manage commercial catch with the total allowable commercial catch split unevenly between three quota management units: coral trout (CT), redthroat emperor (RTE) and other species (OS).

A partial Ecological Risk Assessment (ERA) was carried out for the CRFFF in 2007 and focused on the OS quota management unit. This ERA incorporated all regulated OS species and examined the direct impacts of the fishery on the most vulnerable species in this subgroup (Smith & McCormack, 2007). While coral trout and redthroat emperor were not included in the ERA, detailed stock assessments have been completed for both species (Leigh *et al.*, 2006; Leigh *et al.*, 2014). A number of species have also been provided with indicative sustainability assessments through the *National Status of Australian Fish Stocks* (SAFS) and Queensland stock status processes (Department of Agriculture and Fisheries, 2018b; Fisheries Research and Development Corporation, 2018; Department of Agriculture and Fisheries, 2019).

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 CRFFF 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, 2019).

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 CRFFF 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 broad 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 a) if 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 under the current management arrangements 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 Coral 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 CRFFF. 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.

While operators can access the CRFFF using a range of line symbols (L1, L2, L3, L8) they must hold an 'RQ' symbol and quota for the coral trout (CT), redthroat emperor (RTE) and/or other species (OS) management units. As the number of RQ symbols and quota are restricted in this fishery, these are the limiting factors with respect to accessing the CRFFF (Department of Agriculture and Fisheries, 2019). Prior to the introduction of quota in 2004, anyone with an east coast line-fishing symbol (L1, L2, L3 and L8) could fish for and retain regulated coral reef fin fish species. From an ERA perspective, this represented a far greater risk as the number of licences able to access the fishery was much higher (Department of Agriculture and Fisheries, 2019). Now, regardless of the number of L1, L2, L3 or L8 fishery symbols, participation rates will be limited by the available quota. Based on current licensing

data around 70% of the available RQ symbols are operating in the CRFFF in a given season (Department of Agriculture and Fisheries, 2019). However, participation rates will vary in this fishery depending on the amount of available quota.

In addition to the number of licences accessing the fishery, the introduction of quota resulted in a substantial decline in the amount of effort being used in the fishery (Department of Agriculture and Fisheries, 2019). This reduction in effort had a direct impact on the amount of catch retained in the fishery and by extension the amount of fishing related mortalities. While not universal, declines in effort and fishing mortalities frequently translate to lower levels of risk.

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 CRFFF 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 CRFFF, with **loss of fishing gear** and **contact without capture** viewed as secondary factors of influence. The fishery is restricted to the use of line fishing (*e.g.* handlines, pole and line or, specifically in the L8 fishery, multi-hook demersal longlines) and contact without capture is mostly associated with line breakages, predation and depredation. Given the size of the CRFFF, there is a possibility that **travel to/from**

fishing grounds, **disturbance due to presence in the area**, and **boat maintenance and emissions** will contribute to the risk levels of ecological components. Most of these impacts will be of a low to intermediate risk and highly regionalised.

Catch and effort in the CRFFF is dominated by the L2 and L3 symbols which covers waters north of 24°30´S (Department of Agriculture and Fisheries, 2019). Provisions governing the use of these symbols are similar and they allow the licence holders to line fish in the GBRMP, a key habitat for coral reef fin fish species. The main difference between these symbols is that only one tender can be used under an L3 fishery symbol *vs.* four tenders under the L2 fishery symbol. With the L2 and L3 fishery symbols operating in the confines of the GBRMP, the extent of these operations will be impacted on by the myriad of spatial closures used in the area (Great Barrier Reef Marine Park Authority, 2018). For this fishery, the representative areas programme presents one of the more significant risk mitigation measures in the region. DAF notes that that a portion of the retained catch is reported from waters south of 24°30´S by line operators fishing under an L1 fishery symbol. As such, the fished area for the CRFFF is larger than the marine park.

Line fishers have the potential to interact with a diverse range of species whose resilience to a fishing event can vary. For instance, species fished for and caught in deeper water environments will be more susceptible to the effects of barotrauma and may experience higher levels of fishing mortality (Sumpton *et al.*, 2010; Butcher *et al.*, 2012). In the CRFFF, this risk will be more pronounced in the smaller multi-hook fishery (L8) which, when in operation, fishes waters greater than 200m depth. This risk will also be present in L1, L2 and L3 operations that fish in deeper water environments (*e.g.* >25m) and may be more pronounced in key species *e.g.* saddletail snapper, tusk fish etc. (pers. comm. C. Lunow; Butcher *et al.*, 2012). However, the frequency of barotrauma events should reduce when fishers are using the L1, L2 or L3 symbol to target fin fish species in shallower water environments. It is noted though that fishing depths for the L1, L2 and L3 symbols are not restricted and improvements in fishing technology has seen some fishers advance into deeper water environments to target species from the OS management unit. This risk is also reflected in the recreational fishing sector (Sumpton *et al.*, 2013).

4.2.2 Ecological Subcomponents

Target & Byproduct (harvested)

Operators in the CRFFF interact with a wide range of species with catch data revealing that 88 (out of a possible 118 regulated coral reef fin fish) species or species complexes were retained for sale in the 2016/17 season (**harvesting**) (Department of Agriculture and Fisheries, 2019). While the CRFFF has one major target species, coral trout (CT), the RQ symbol allows for the take of all regulated coral reef fin fish that fall within the prescribed size limits (excluding no-take species). As the total catch is managed by quota units (CT, RTE, OS), the primary risks posed by CRFFF operations relate to fishing pressures exerted on key species or species groupings (**harvesting**). This risk will be most evident in the OS management unit, which covers a wide array of species and, to a lesser degree, the CT management unit that includes six species.

A stock assessment for coral trout indicated that the management unit was fished at less than the estimated maximum sustainable yield (Leigh *et al.*, 2014). An earlier stock assessment of redthroat emperor also indicated that the stocks of this species are sustainably fished (Leigh *et al.*, 2006). Providing the population dynamics have not changed substantially since the completion of these reports, these results indicate that the risks posed to the two primary management units (CT and RTE)

were being managed effectively. When compared, the situation surrounding the OS management unit is less certain as a) the complex is not managed under species-specific quotas and b) there is higher potential for effort to shift between species. In this management unit, there is a risk that a considerable proportion of the catch and effort will be directed towards a small number of species or shift to a particular OS species due increased marked demand (**harvesting**). If this were to occur, the risk of an undesirable event occurring for one or more species within this unit would increase.

The quota setting process for the CT management unit is the most advanced with the risk of over overfishing reduced through a five-year quota setting review process and a reliance on regular stock assessments. Stock assessments provide the most comprehensive assessment of the available data and consider the catch, effort and management history of the fishery. In the first year of the cycle, the CT quota is set on the results of the most recent stock assessment with the remaining four years based on commercial catch rates. Every five years, the stock assessment is updated and the cycle is repeated. In this way, quota for the CT management unit can be reviewed and declared every year. This allows for adjustments to the quota to reflect annual stock productivity changes and the impact of extreme weather events, such as cyclones.

When compared to CT, quota-setting mechanisms for RTE and OS are less developed and have less flexibility with respect to their ability to respond to a changing fishing environment. This risk is smaller for RTE as the original quota setting process was informed by a stock assessment (Leigh *et al.*, 2006). The risk is considered higher in the OS management unit where there is less capacity to restrict the effort targeted at a particular species or species grouping (**harvesting**). Depending on the species in question and their life-history constraints, this has the potential to affect population sizes by removing reproductively important large fish from the system. This would be of particular relevance to long-lived species that congregate in lower densities (*e.g.* cods and groupers) and change sex during their lifecycle (*e.g.* wrasses, parrotfish) (Smith & McCormack, 2007; Bray, 2017).

Extractive fishing of key species can affect the size and structure of regional populations. For example, research has shown that coral trout found in fished areas tend to be less abundant, smaller and younger (Mapstone *et al.*, 2004). In the CRFFF, the use of spatial closures in the GBRMP will help to limit the extent of these impacts at a regional level. At a whole of fishery level, this risk is managed through initiatives aimed at maintaining recruitment rates and insuring the long-term sustainability of the fishery. These measures include the introduction of two seasonal spawning closures, minimum and maximum legal size limits and mechanisms to assist in the validation of catch records *e.g.* the Automated Interactive Voice Response (AIVR) system, unload reports and catch disposal records (Department of Agriculture and Fisheries, 2019). Concerning spawning closures, these provide most benefit to CT and a number of the OS species. The effectiveness of these measures will vary between species and be highly dependent on their reproductive strategy. It is also important to note that commercial fishing in these areas does not stop completely as some charter fishing operations may be granted an exemption under the current management system.

Discarding and 'high grading' is a risk that applies disproportionally across all three quota-management units. This issue is most pertinent to CT where there are significant discrepancies between the price paid for live fish (export market) and that paid for dead CT (domestic market). In this highly valuable market, there is significant incentive for high grading to occur with damaged or dead fish discarded for 'healthy' live fish. Similarly, fishers may manipulate their catch in order to meet current market demands and maximise their returns *e.g.* replacing already caught product with more marketable size ranges or fish with a more appealing appearance. In these instances the fish will be

released alive but will be at an increased risk of predation. The challenge with high grading is that fishers are not required to report this component of the catch and therefore it is not included in the annual CT catch. Information on high grading and product loss (*e.g.* due to predation) is limited and it is difficult to ascertain what effects (none, low, intermediate or high) it would have on annual catch levels. In terms of this Level 1 assessment, high-grading is considered a potential risk as it could contribute to the removal of fish from the system, particularly during periods when the value for CT is low.

High grading is considered to be less of a concern for the RTE and OS quota categories as these species are not sold on the live market, are currently underutilised resulting in a low lease price, and are not the primary target for the majority of the fleet. In these management units, the **discarding** of retainable fish would mostly occur due to poor product quality *e.g.* when a fish incurs damage during the line retrieval process and or due to predation. As with coral trout, fishers are not required to report this component of the catch and is not accounted for in the ITQs. It is noted though that both RTE and OS are operating well under the prescribed quota and that discards are unlikely to impact the fishery significantly (Department of Agriculture and Fisheries, 2019). To this extent, discarding / high grading representing a lower sustainability risk for these management units.

The impact of barotrauma on post-release mortality rates (**discarding)** will be more restricted in the CRFFF as a wide range of reef species can be retained as part of the OS management unit. In the CRFFF, risks associated with barotrauma will be most applicable to a) no-take species, b) fish that are outside the prescribed size limits, c) sectors of the fishery operating in deeper waters and d) species at higher susceptibility. This includes the L8 portion of the fishery that, when operational, targets fish in deeper waters (>200m). For some species including Maori rockcod, blacktip rockcod, bommie cod and speckled-fin rockcod, risks relating to barotrauma are compounded by the use of highly conservative minimum legal size (MLS) limits. In these examples, the MLS has been set below or approximating the known maximum length for the species (Smith & McCormack, 2007). This in turn, results in a higher number of discarded animals and increases the potential for barotrauma to contribute (directly or indirectly) to the number of post-release mortalities.

Improvements in fishing gear and technology have increased the ability of fishers to target previously inaccessible fish stocks in deeper waters (Sumpton *et al.*, 2013). This includes commercial fishers operating under an L1, L2 and L3 fishery symbol and the charter and recreational fishing sectors. Mortality rates for species caught at depth are high and are often attributed to the effects of barotrauma. Bar rock cod for example comprise a large proportion of the deep water catch (Sumpton *et al.*, 2013) and are highly susceptible to barotrauma induced post-release mortalities. The extent and impact of barotrauma is very difficult to quantify as it relates specifically to post-release survival rates. Research has shown though that handling techniques including venting may reduce the effects of barotrauma for some species (Sumpton *et al.*, 2010)**.**

As with most quota based 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, 2019). 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). In the CRFFF, this risk is managed through a range of monitoring and reporting initiatives including a requirement for fishers to use a *Vessel Tracking* system, prior-reporting of catch through the AIVR system with information on the landing location, time of landing and

numbers of fish on board. These measures are complimented by 'Catch Disposal Records', which are completed by CRFFF fishers once they have landed. These combined with logbook records provides a system of crosschecks that can be used to validate catch against key reference points including ITQ holdings. While the catch validation measures do not address issues relating to non-compliance at sea (*i.e.* illegal catch, fishing during a closure or in no-take areas); they reduce the risk of non-compliance with the quota system through strict reporting practices.

Of the remaining fishing activities included in the Level 1 assessment, **contact without capture** is associated with foul-hooks, broken lines and fish able to free themselves before landing. In most of these instances, the immediate impacts will be relatively minor; although biofouling, infection and an increased risk of predation may reduce post-interaction survival rates (Borucinska *et al.*, 2002; McLeay *et al.*, 2002). **Contact without capture** also applies to captured fish that have been taken by larger predators (*e.g.* sharks) before they can be landed. This is particularly relevant for line fisheries where injured and panicked fish draw predators, who take advantage of tethered prey. For **harvested** species, this presents as a potential risk as losses are not accounted for in total catch and for predators as they may become hooked themselves. In Queensland, there is little information on the extent of depredation including on how it impacts on the sustainability and economic viability of a fishery.

While still a prevalent risk, **loss of fishing gear** in the commercial line fishery will have less of an impact when compared to the recreational fishing sector. Discarded fishing line is a dominant form of marine debris in the GBR due the frequency of loss, particularly in complex reef habitats (Williamson *et al.*, 2015). This impact will transcend the commercial fishing sector and will be most relevant in areas that attract a wider array of fishing interests. For example, the use of lighter line is expected to be more prevalent in the recreational fishing sector where there is a greater emphasis on sport fishing *i.e.* catch and release (**discarding**) (see section 4.3– cumulative impacts). Line ingestion and incidental catch of passing animals with abandoned hooks is also a threat to other ecological subcomponents.

Bycatch (non-SOCC)

One of the challenges of undertaking a broad-scale ERA for bycatch in the CRFFF is identifying the scope and depth of the assessment. This issue largely relates to the multi-species nature of the fishery and the fact that some byproduct species are retained in very small quantities. The distinction between bycatch and byproduct will also vary between operators and fishing events.

Line fishing provides few avoidance strategies to reduce the incidental catch of undersized or unwanted fish. In the CRFFF, discards are mostly composed of target species that do not satisfy legal size restrictions with recent reports indicating that this portion of the catch is dominated by coral trout, redthroat emperor, grassy sweetlip, stripey snapper, hussar, trevally species and blacktip rockcod (Department of the Environment and Energy, 2017b). For the purpose of this ERA, risks relating to the **discarding** to these fish are considered as part of the *Target and Byproduct* ecological component.

When undersized target and byproduct species are excluded (see above), the majority of the CRFFF bycatch will consist of low-value teleosts and species managed as part of the *Rocky Reef Fin Fish Fishery* (RRFFF) and the *East Coast Inshore Fin Fish Fishery* (ECIFFF). For species managed as part of the RRFFF and ECIFFF, operators have the option of discarding these fish or retaining them for sale providing they adhere to the regulatory requirements (Queensland Government, 2008; Department of Agriculture and Fisheries, 2019). This decision will depend on range of factors including

the setup of the operation, economics and time required to process this portion of the catch. If retained, this portion of the catch will be reported against one of the other line fisheries. With that said, it can be difficult to quantify retention rates for non-target species as fishers are not required to report discards and/or nominate the fishery they intend to operate in.

Species of Conservation Concern

The fishing apparatus used in the CRFFF will limit the diversity of interactions with the SOCC ecological component; something that is reflected by the domination of teleosts in the SOCI data (Department of Agriculture and Fisheries, 2019). As the majority of the SOCC cannot be retained for sale, **discarding**, **contact without capture** and **loss of fishing gear** poses the most risk to these species. While it is difficult to quantify, DAF anticipates that a proportion of these animals will die (*in-situ* or post-release) because of this interaction. In the CRFFF, the risk of an interaction resulting in serious injury or death will be highly dependent on the species and the type of interaction, *i.e.* vessel strike *vs.* entanglement, catching on fishing gear. This is considered to be of notable importance in the CRFFF as the SOCI logbook data does not distinguish between interactions with gear and collisions.

In Queensland, it is difficult to differentiate which line fishery a SOCI interaction occurred in. This is mainly because Queensland's principle line fisheries (CRFFF, RRFF and ECIFFFF) are defined by the species that are retained. If for example, a fisher that has retained a coral trout and a trevally they will be technically fishing in both the CRFFF and the ECIFFF. Line fishing presents similar risk to SOCI species across the CRFFF, RRFFF and ECIFFF. However, 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 SOCI logbooks have reported five interactions between marine turtles and commercial line fishing operators: four green turtles and one unidentified turtle (Department of Agriculture and Fisheries, 2019). Given the extent of line fishing operations in Queensland and the popularity of recreational fishing, it is anticipated that this data underestimates the total number of marine turtle interactions (*i.e.* direct capture plus contact without capture). This inference is partially supported by the *Marine Wildlife Stranding and Mortality Database* which connects over 100 marine turtle interactions to entanglement in fishing line or hook ingestions from 2001 to 2011 (Meager & Limpus, 2012).

With regards to the *Marine Wildlife Stranding and Mortality Database*, it is important to note that the majority of the reported interactions cannot be assigned to a particular fishery (CRFFF, RRFFF, and ECIFFF) or sector (commercial, charter, recreational). Further, it can be difficult to determine if a turtle interacted with an active line apparatus or if it became entangled in discarded fishing line. As a consequence, this *StrandNet* data cannot be used to validate or verify SOCI logbook data and/or attribute interactions to one particular fishery. In reality, these interactions will come from a variety of fisheries with **loss of fishing gear** considered to be a key factor of influence. While noting these caveats, data contained in the *Marine Wildlife Stranding and Mortality Database* provides further insight in to the potential and types of risk line fishing poses to this subgroup.

The ingestion of hooks or lines and entanglements are the most prominent risks to this subgroup with research indicating that sub-adult and adult turtles will both be affected. 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 a high risk of mortality for discarded turtles but will vary with the hook location (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 as a result of their capture (*e.g.* line that is still attached to a hook embedded or swallowed by the animal) or due to an interaction with line not associated with a fishing event (*e.g.* line that has been lost, cut off or discarded during a previous fishing event). The negative consequences of line entanglement is often long-term and can include death due to asphyxiation and an increased predation risk due to impairment or loss of an appendage (Meager & Limpus, 2012). In some instances, the impacts may be more immediate with the line preventing the animal from reaching the surface *e.g.* if opposite end is attached caught in the substrate. While not quantified, evidence suggests that discarded and lost fishing gear contributes to a number of marine turtles deaths recorded each year (Meager & Limpus, 2012).

As air-breathing marine animals, turtles are at risk of boat collisions, but as the SOCI logbook provides no distinction between the types of interaction, DAF cannot quantify this risk. However, fishers can voluntarily add comments to describe the interaction, thus DAF has identified at least one turtle interaction resulting from a boat strike.

While noting the above risks, the CRFFF has previously been identified as having minimal direct impact on marine turtles (Smith & McCormack, 2007). This for the most part is due to the relatively low rates of hooking turtles on line fishing gear and the short release time involved if a turtle is hooked. It is noted that fishing line has been found in the gut of stranded marine turtles and in many cases has been identified as the cause of death. The subgroup will also experience additional risks relating to discarded fishing line, which transects all line fishing sectors and fisheries.

Sea snakes

There are no records of sea snakes interacting with the CRFFF but the spatial distribution of operations targeting reef fish will overlap with their preferred habitats. Sea snakes will take baited lines and their capture has been recorded in the recreational fishing survey (Webley *et al.,* 2015). The number of interactions (overall) though are expected to be low and the CRFFF presents a very low risk to this ecological subcomponent. Interactions, while still comparatively low, are likely to be higher in the recreational fishery due to the sector having a higher number of participants.

Crocodiles

There are no known records of interactions with crocodiles in the CRFFF. Crocodiles mostly inhabit coastal waters and riverine habitats, and interactions with CRFFF operations including the recreational and charter-fishing sectors are considered unlikely.

Dugongs

The habitat distribution of dugongs does not spatially overlap with the target fishery (*i.e.* coral reefs as opposed to seagrass meadows). The likelihood of interaction is extremely low, with the possible exception of boat strikes while **travelling to/from the fishing grounds**.

Cetaceans

Cetacean interactions in the CRFFF are low with the SOCI logbooks reporting interactions with two humpback whales, six minke whales and offshore bottlenose dolphins (Department of Agriculture and Fisheries, 2019). The largest recorded interaction was a single report of 15 bottlenose dolphins that interacted with the fishing vessel. The SOCI data revealed that all cetaceans survived the interaction, although one humpback was recorded as injured.

Season and individual species distributions are one of the controlling factors for determining impacts on cetaceans in the CRFFF. For example, baleen whales (*i.e.* humpbacks, minkes) migrate to tropical waters in the GBR in winter every year to calve and mate (Acevedo *et al.*, 2013). In the tropical waters of the GBR this can also include resting behaviour or nursing mother/calf pairs who prefer shallower waters (Ersts & Rosenbaum, 2003). During this time, this subgroup may be more susceptible to boat strike (**contact without capture**).

SOCI reports and the *Marine Wildlife Stranding and Mortality Database* show that line entanglement is a low but present risk for this subgroup (*n* = 25 interactions between 2011–2015; Meager, 2016). Given the nature of the apparatus and the relative size of dolphins/whales, the immediate consequence of this type of interaction would be limited. If a dolphin or whale was released with line still attached, the animal may experience injuries analogous to that observed for marine turtles. The number of interactions reported from the CRFFF though, suggests that line entanglements pose a low risk to this subgroup.

Protected teleosts

There are four species of teleost with SOCI reporting requirements: the humphead Maori wrasse (*Cheilinus undulatus*), the potato rockcod (*Epinephelus tukula*), the Queensland groper (*Epinephelus lanceolatus*) and barramundi cod (*Chromileptes altivelis*). The humphead Maori wrasse, Queensland groper and barramundi cod have all been reported from the CRFFF through the SOCI logbooks. However, the majority of the reported SOCI interactions involve the humphead Maori wrasse and barramundi cod (Department of Agriculture and Fisheries, 2019). The discontinued fisheries observer program have limited data for SOCI interactions in this fishery[1]; although line fishers caught a number of humphead Maori wrasse and barramundi cod in 2006 and 2007. All but one of these fish, a humphead Maori wrasse, were released alive.

The CRFFF has a high number of reported interactions with protected teleosts (>1500 since 2016) but comparatively low levels of fishing mortality. For example, fisheries data indicates that annual mortality rates for both the humphead Maori wrasse and barramundi cod were less than 1% (since 2016). However, SOCI logbooks only provide an evaluation of the animal's health at the time of its release (**discarding**); therefore does not account for post-release mortalities. Factors that may increase post-release mortalities for protected species include injuries incurred during the fishing event and/or as part of the handling and release processes, increased stressors for larger animals, predation and barotrauma. While difficult to quantify, all of these factors have the potential to increase the total rate (*e.g.* direct and indirect) of fishing mortality for these species and therefore the risk to this complex.

[1] *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 CRFFF has considerable overlap with the preferred fishing grounds of protected teleosts and, as a line fishery, has a higher interaction potential. Data for this fishery though is inconsistent with SOCI reports increasing exponentially since 2016. While noting that a high proportion of the fish caught in the CRFFF are released alive, post release mortalities remain a largely unknown entity. These issues are compounded by the fact that in Queensland (at present) there is limited capacity to validate catch records and release fates for this fishery. Given these factors, the protected teleosts are expected to be at the higher end of the risk spectrum for this fishery.

Batoids

The CRFFF has the potential to interact with a small number of batoids associated directly (*i.e.* preferred habitat) or indirectly (*i.e.* feeding grounds) with coral reef systems. 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 devilrays (*Mobula* spp.) have the potential to interact with the CRFFF. 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 for *Mobula* spp., despite their pelagic habitats (Deakos *et al.*, 2011; Couturier *et al.*, 2012). The frequency of these types of interactions in the CRFFF though are expected to be low and infrequent.

Sawfish (*Family Pristidae*) are one of the few elasmobranch families that are afforded full protection in Queensland waters. All five species of sawfish are listed as Endangered or Critically Endangered and most populations inhabit shallow coastal waters, estuarine habitats, and mudflats (Department of Environment, 2015). Although, these species have the potential to interact with line fishers, this is more likely to occur in the ECIFFF. If handled correctly, sawfish caught on a line 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, fishing activities in the CRFFF are unlikely to contribute significantly or cause an undesirable event for this SOCC subgroup.

Sharks

Shark species including small benthic or epibenthic species will interact with line fishers and will readily take baited lines. Shark species will also target line caught fish during the line retrieval stage and may become hooked in the process. In most of these instances, the comparatively low value of shark will see CRFFF operators discard shark as bycatch. Excluding the potential for injury (*e.g.* use of a gaffe), post-release survival rates for these animals are expected to be high in line fisheries.

There is limited information on shark interaction rates in the CRFFF, as fishers were not required to report shark discards until recently[2]. Some information is available from the discontinued fisheries observer programme where two shortfin mako sharks interactions were reported in 2006. Both were

[2] *As on 1 January 2018, line operators must report shark discards as part of the logbook reporting system. This portion of the catch will be taken into consideration as part of the shark Total Allowable Commercial Catch (TACC) limit.*

retained dead and were likely recorded as catch under the ECIFFF. Mako sharks have also been recorded in the fisheries logbook as released, one in 2011 and eleven in 2013, all were released dead.

Of the sharks afforded additional protections under state and commonwealth legislature (Queensland Government, 2008; Department of the Environment and Energy, 2019), the CRFFF will have limited interactions with these species. The most notable will be with white tip reef sharks (*Triaenodon obesus*) which, while not fully protected, are subject to an in-possession limit of one and maximum size length restrictions. As the majority of sharks captured in the CRFFF will survive a line-fishing event, DAF anticipates that the fishery poses a low risk to these species. These species would also benefit from the myriad of spatial closures situated throughout the GBRMP.

While the CRFFF has some historical shark catch, this component of the fishery is now managed as part of the ECIFFF. In these instances, line fishers that do not hold a shark (S) fishery symbol are restricted by a combined in-possession limit of 4 sharks and rays. Catch in this sector is further restricted through the use of a maximum legal size limit.

Syngnathids

Due to the type of gear used in the line fishery and the small size of syngnathids, they are unlikely to be directly affected by fishing operations in the CRFFF.

Seabirds

The Great Barrier Reef region supports 20 species of nesting seabirds and an estimated 420 000 non-breeding birds which utilise the area. The most dominant species of seabird in the GBR are shearwaters, noddies, sooty terns and boobies, with albatrosses, giant petrels, frigatebirds and terns and the brown booby noted as the mostly likely species to take bait from CRFFF fishers (Smith & McCormack, 2007; Great Barrier Reef Marine Park Authority, 2014). Despite this, there is only one logged interaction with a seabird in the CRFFF.

The CRFFF is a demersal line fishery that presents limited opportunities for seabird fatalities and injuries. Weighted hooks used in the fishery sink quickly and operators are on hand to attend to any seabirds that interact with the gear. There are broader concerns that fishing activity can reduce the availability of seabird prey. Although, the main target species in the CRFFF, coral trout and redthroat emperor, are unlikely to form a significant proportion of seabird diets, and do not enhance seabird hunting by corralling schooling fish.

When compared to direct mortalities, discarded and lost fishing line presents a greater risk to this subgroup. This risk will be present in most of Queensland's line fisheries and is not restricted to the commercial fishing sector. In the case of discarded line, the risk posed by this sector is expected to be smaller than the recreational fishing sector. In the CRFFF, line entanglements are more likely to occur when a seabird escapes with a length of fishing line attached (*i.e.* the line breaks after a bird becomes hooked) or if operator cuts the bird free but a length of line remains attached to the bird. Entanglement in monofilament fishing line can lead to starvation, injury, limb amputation or death in seabirds (Yorio *et al.*, 2014). 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

Coral reefs contribute significantly to the cultural and economic values of the GBR region, are a significant sink for global carbon, and are a habitat for more than 1600 species of fish (Kinsey & Hopley, 1991; Great Barrier Reef Marine Park Authority, 2014). The GBR may be reasonably robust to individual coral decline events, however the resilience of the reef will reduce under chronic pressure and coral cover may decline progressively in response to anthropogenic habitat degradation. These impacts will be compounded by a range of other factors including risks associated with climate change, more frequent and intense bleaching events and crown of thorns outbreaks.

Fishing methods used in the CRFFF suggest that the impact of the fishery on marine habitats will be more localised. The fishery as a collective (*i.e.* commercial, recreational, charter) has the potential to damage regional habitats through general boating activities, anchoring (**disturbance due to presence in the area**), fishing effects including the **loss of fishing gear,** and pollutants. 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). Fishing line poses a risk of physical damage to sessile benthic organisms, such as coral. Fishing line entanglement and vessel strike injuries leave coral susceptible to infection, disease, tissue loss and ultimately reef degradation. Assuming high levels of compliance, protected areas may improve ecosystem resilience in terms of providing disease free refuges for outbreak mitigation (Lamb *et al.*, 2015).

Anchors can damage coral reefs and the substratum, particularly during the setting and retrieval process. Corals can be broken and overturned and further damage is caused if the anchor is dragged or wrapped around structures. There is a significant relationship between areas of high boating activity and coral damage due to anchoring (Dinsdale & Harriott, 2004). DAF notes though that this risk is not limited to the CRFFF or fishing activities in general (both recreational and commercial), rather it will apply to a range of boating activities. Dropping and dragging anchors is also a source of resuspended sediments.

Due to the highly valuable live fish trade, coral trout are stored in holding tanks on board fishing vessels in the CRFFF, sometimes for several days. To enhance the survivability of coral trout, the holding tanks are equipped with a seawater flow-through system where the entire volume of water in the tank is exchanged with the ambient seawater, replacing fouled water with fresh seawater. The water is also aerated in the process (Anderson *et al.*, 2003; Andersen *et al.*, 2005). While this system may act a source of increased nutrients, such as ammonia, the impacts will be highly localised and should dilute quickly due to tidal movement and currents. Due to these reasons, the discharge of water from CRFFF is not considered a significant risk for this fishery.

Ecosystem Processes

Coral trout are a common predatory species in the GBR and the top-down effects of removing mid-level predators on ecosystem assemblages is not well established in the GBR. Theoretically, the removal of predators can cause cascading alterations in species assemblages and research suggests that fished areas have a higher abundance of coral trout prey (Graham *et al.*, 2003), although, recruitment success is also likely to be a major diver for prey abundance. There is also evidence that competition is strong between different size and age cases of coral trout with the species displaying size based feeding hierarchies (Mapstone *et al.*, 2004). More broadly, the removal of fish (**harvesting**) can remove nutrients from the system but is not considered a major risk factor in this fishery. Similarly,

the effect of fishing activities in the CRFFF is unlikely to impact significantly on processes related to herbivory processes.

No-take zones work as a connected network to replenish stocks across the ecosystem. Retaining biologically significant adults, these zones allow coral trout to mate multiple times, which overall facilitates 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). This risk would be partly mitigated by management initiatives that limit fishing effort during key times of the year *e.g.* the two seasonal spawning closures and the use of a *Vessel Tracking* system.

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 CRFFF is Queensland's second most valuable fishery, with the vast majority of catch and effort focused on a single management unit: coral trout. While commercial pressures on the coral trout stock are well managed, the management regime has less capacity to address increased catch and effort in the recreational fishing sector or by Aboriginal peoples and Torres Strait Islander peoples. While the recreational fishers are subject to individual catch limits, this component of the catch does not count against the quota and/or reported with great regularity. This information along with the recreational catch of redthroat emperor, is taken into consideration as part of the stock assessments (Leigh *et al.*, 2006; Leigh *et al.*, 2014).

The majority of information for the recreational sector comes from infrequent voluntary fisher surveys. The 2013/14 survey estimated that the recreational catch of coral trout (all species) was 170 000 fish; with 38% of the catch being **discarded** (Webley *et al.*, 2015). In previous surveys, annual recreational catch of coral trout (all species) was estimated at 160t per annum, down from 500t in 2000 (Taylor *et al.*, 2012; Leigh *et al.*, 2014). While catch levels are higher in the commercial fishery, the recreational sector will make a notable contribution to the cumulative risks for this subgroup. This component of the total coral trout catch has been taken into consideration as part of previous coral trout stock assessments (Leigh *et al.*, 2014).

When compared to coral trout, smaller amounts of redthroat emperor were landed by recreational fishers (n = 78 000 fish, 52% discards). While a previous stock assessment for redthroat emperor estimated the recreational harvest to be 450t per year (Leigh *et al.*, 2006), this data is considered to be outdated and it is unclear if the recreational catch has undergone declines similar to that observed in coral trout (Taylor *et al.*, 2012; Leigh *et al.*, 2014). Recreational data for the remaining CRFFF species varies with the survey reporting total catches of 155 000 crimson & saddletail snapper (combined value), 74 000 red emperor, 73 000 stripey snapper and 21 000 golden snapper (Webley *et al.*, 2015). A lack of sampling power in the recreational fishing surveys can make it difficult to estimate total catch rates of infrequently caught CRFFF species and/or quantify the harvest-to-discard ratios with a high degree of confidence (Webley *et al.*, 2015).

The popularity of the two key species, coral trout and redthroat emperor, is reflected in data for the charter fishery. This sector recorded catch totals of 71t of coral trout and 80t of redthroat emperor in 2017. Discard and harvest rates for the sector are more difficult to quantify but around 7000 coral trout and 3500 redthroat emperor were discarded by charter fishers during the 2017 period (based on Qfish data, http://qfish.fisheries.qld.gov.au/). This sector will again be a contributor of risk for these species. Further information on the composition of the charter fishery catch including for species targeted in the CRFFF is available through Qfish (http://qfish.fisheries.qld.gov.au/).

Comparatively high discard rates from the recreational and charter fishing sectors, reflects a greater emphasis on catch and release. From a risk management perspective, catch and release practices will reduce the number of direct fishing mortalities. However, research indicates that recapture events have the potential to lower post-release survival rates (McLeay *et al.*, 2002). Similarly, recreationally caught fish may still experience barotrauma and will be at high risk of predation. As a consequence recreational and charter fishery will be contributing to the overall risk levels for these species through indirect mortalities.

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 CRFFF 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 CRFFF, 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 humpback whales occurs in offshore areas around major ports and the offshore area between the Whitsundays and Shoalwater Bay (Department of the Environment and Energy, 2017a). 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 gear from both commercial and recreational fishing is abundant in the marine environment. Nylon fishing mesh is extremely persistent in the marine environment. Plastic marine debris is a significant problem for the health of marine environments, through the degradation of habitats, ingestion by organisms and entangling marine life. 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 (Kroon *et al.*, 2018). 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. 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. 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).

The CRFFF Fishery is likely to represent a comparatively small, but consistent source of marine pollution. However, these risks are very difficult to quantify and almost impossible to assign to a particular sector or activity, due to the multifaceted sources of this risk. 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.

Urban Development & Changes in Land Use

Stemming from Queensland's increasing population highly concentrated along the coast, urban development remains a key issue for terrestrial and marine habitats that connect to fisheries. Impacts of urban development may include, but are not limited to, land/vegetation clearing, pollution/sediment run-off, and alteration of natural hydrogeological processes, pollutions originating from residential, industrial and agricultural sources. Key implications of these activities with respect to fisheries is the loss or damage to freshwater and marine habitats, including those that are critically important nursery habitats. Quantifying the full effect of urban development on Queensland's fisheries and their ecological components is inherently difficult. The extent of these impacts will arguably be more significant for fisheries that target species in inter-tidal waters or species that utilise these environments for nursery areas before recruiting to the fishery.

Farming, particularly sugarcane and grazing, and urban development in GBR catchment areas are the largest contributors to land based runoff. Excess nutrients, fine sediments and pesticides have substantially increased in the GBR since pre-development levels, and significantly reduce the overall water quality of the whole GBR region (Brodie *et al.*, 2017). Reduced water quality leads to loss of corals and seagrass cover, population declines in mega fauna *i.e.* dugongs, increased crown of thorns outbreaks, and overall degradation to the GBR (Brodie *et al.*, 2017). For the CRFFF, urban development and land is a potential ongoing and long-term risk that has the potential to impact on the fishery.

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 and frequency 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 (Hoegh-Guldberg *et al.*, 2007; Godbold & Calosi; Hoegh-Guldberg *et al.*, 2017). 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).

Laboratory experiments have shown common coral trout to be vulnerable to climate change induced effects and this may present a risk to the fishery. Overall, coral trout have limited ability to adapt to increased seawater temperature (Pratchett *et al.*, 2013). With increasing temperatures, larval coral trout have severely affected growth, development and survival. Increased temperatures also effect the metabolic demands of adult coral trout. Energetic costs are increased with increased temperature while foraging activity is decreased. Furthermore, coral trout are unable to survive physically exhausting activities at higher temperature, which includes fishing related stress (Clark *et al.*, 2017).

Adult coral trout are closely associated with live coral coverage. A reduction in coral coverage due to ocean acidification and wide scale bleaching events is predicted to reduce coral trout populations (Jones *et al.*, 2004; Pratchett *et al.*, 2011; Pratchett *et al.*, 2013). Previous bleaching and flooding events in the GBR have resulted in large decreases of adult coral trout induced by the reduction of live coral coverage (Williamson *et al.*, 2014). Ocean acidification may also alter the antipredator behaviour of larval coral trout with implications for population level survival of newly settled larvae and juveniles.

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 CRFFF indicated that fishing activates presented a negligible or low risk to at least ten of the ecological components or subcomponents (the coral trout (CT) management unit, bycatch (non-SOCC), sea snakes, crocodiles, dugongs, batoids, sharks, syngnathids, seabirds, terrestrial mammals). Cetaceans had a preliminary risk rating of low-intermediate with the redthroat emperor (RTE) quota management unit, marine turtles, ecosystem processes and marine habitats assessed as being at an intermediate risk. Only two of the ecological components had preliminary risk assessments greater than intermediate—the other species (OS) quota management unit (high) and protected teleosts (high) (Appendix 2).

A full account of the preliminary risk ratings, 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:

- Risk ratings for the three quota management units (CT, RTE, and OS) depend on the ability of the management regime to respond to changes in fishing pressure.
- The OS quota management unit received a higher risk rating due to it multispecies management unit with limited ability to regulate catch and effort among the species.
- Loss of fishing gear was considered a higher risk for marine habitats and some SOCC subgroups.
- Teleosts and turtles were determined to be the SOCC subgroups most at risk of from line fishing activities across a number of the fishing sectors.
- While not directly accounted for in the preliminary risk assessments, the cumulative fishing impacts were identified as notable issues for the following ecological components: target & byproduct species, protected teleosts and marine habitats.

***Table 2**. Summary of risk scores for the Coral Reef Fin Fish Fishery, including the impact 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	CT – L RTE – I OS – H	L L H	L	L	-	L	-	CT – L RTE – I OS – H	H
Bycatch species (non-SOCC)	-	L	L	L	-	L	-	L	L
SOCC									
Marine turtles	-	L/I	I	I	I	L	L	I	I
Sea snakes	-	L	L	L	L	L	L	L	L
Crocodiles	-	-	-	-	-	-	-	-	-
Dugongs	-	-	-	L	L	L	L	L	L
Cetaceans	-	-	L/I	L	L/I	L	L	L/I	I
Batoids	-	L	L	L	-	L	L	L	L
Protected teleosts	-	H	H	L	-	L	L	H	H
Sharks	-	L	L	L	-	L	L	L	L
Syngnathids	-	-	-	L	-	L	L	L	L
Seabirds	-	L	-	L	-	L	L	L	I/H[#]
Terr. mammals	-	-	-	-	-	-	-	-	-
Marine Habitats	-	-	-	I	L	L/I	L	I	H[#]
Ecosystem Processes	I	I	L	L/I	-	L	L	I	I

** Includes recreational, charter fishing sectors; [#] includes all recreational line fishing activities i.e. on water and off water activities; inshore and offshore.*

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 Guideline (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 in the CRFFF, the risk ratings of six ecological components were reduced. The most notable of these were the downgrading of the risk rating for the RTE management unit (intermediate to low), the OS quota management unit (high to an intermediate/high risk), marine turtles (intermediate to low/intermediate), protected teleosts (high to an intermediate/high risk), ecosystem processes (intermediate to low/intermediate) and dugongs (low to negligible) (Table 3; Appendix 2).

The downgrading of RTE was due to the species being fished well below the quota limit over an extended period of time, the likelihood of this trend continuing into the future and an absence of significant concerns surrounding their long-term sustainability. The risk rating for marine turtles was downgraded due to the fishery having (comparatively) low interaction rates and the influence of indirect actions. In terms of the fishing activities effecting marine turtles (*e.g.* **contact without capture, loss of fishing gear** and **travel to/from fishing grounds**), the CRFFF was not considered to be a primary driver of risk for these categories. The downgrading of protected teleosts from high to intermediate/high reflects improvement’s in post release handling strategies for teleosts. The downgrading of dugongs from low to negligible reflects the key drivers of risk for this subgroup and the limited capacity of the fishery to interact with this subgroup.

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 Coral Reef Fin Fish Fishery taking into consideration the likelihood of the risk coming to fruition in the short to medium term. *Represents quota management units for coral trout (CT), redthroat emperor (RTE) and other species (OS).*

<table>
<tr><th>Ecological Component</th><th>Level 1 Risk Rating</th><th>Likelihood Considerations</th><th>Level 2 Required?</th></tr>
<tr><td rowspan="3">Target & Byproduct*</td><td>CT
Low</td><td rowspan="3">Risk levels considered to be lower for redthroat emperor (RTE) than what is presented in the preliminary assessment. Total catch for this management unit has remained consistently below the TACC and there are no long-term sustainability concerns for this species. This inference is supported by indicative sustainability assessments like SAFS.
The risk posed to RTE may change into the future if, for example, catch and effort levels were to increase or the TACC limit was approached with more regularity.
Risk to other species (OS) management unit considered to be marginally lower than what is presented in the preliminary assessment due to current catch and effort levels. The OS management unit is still considered to be at a at higher risk due to a) the multi-species nature of the management unit and b) the targeting of specific species by both the commercial and recreational sectors across a range of depths. Fisheries Working Groups (FWG) currently developing a whole of fishery harvest strategy that will include OS species. FWG also actively examining mechanisms to improve quota-setting processes across management units and addressing concerns relating to OS species.
Similarly, catch data is being actively improved through boat ramp surveys (recreational) and further monitoring of key OS species (commercial). These measures will reduce the risk to the each of the subgroup overtime. However, a high number of these measures are still being developed and/or in their infancy.
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.</td><td>No</td></tr>
<tr><td>RTE
Low</td><td>No</td></tr>
<tr><td>OS
Intermediate/ High</td><td>Yes</td></tr>
</table>

Ecological Component	Level 1 Risk Rating	Likelihood Considerations	Level 2 Required?
		• 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.	
Bycatch (non-SOCC)	Low	• While information on bycatch is limited, risk is expected to be low. • Bycatch in the CRFFF may include species that can be retained for sale in the RRFFF or 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. • Some voluntary bycatch mitigation measures in place for this fishery *e.g.* use of viewing buckets by fishers targeting coral trout.	No
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 the potential impacts of discarded & lost fishing gear. This risk transcends the commercial fishery and the recreational fishing sector will make a notable contribution to the amount of lost and 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 or an elevated risk of death. However, fishers will be on hand to minimise this risk and facilitate a quick release of the animal. • Measures in place to minimise risk *i.e.* media encouraging best practice such as ensuring rubbish (fishing lines and plastic bags are disposed of correctly), SOCI reporting and limitation on the number of lines and hooks used.	No

Ecological Component	Level 1 Risk Rating	Likelihood Considerations	Level 2 Required?
		• Cumulative risks including loss of fishing gear and boat strike will be a broader risk factor for this subgroup. • 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. • While electronic observation being considered for some fisheries, the feasibility and applicability of this method is still being determined.	
Sea snakes	Negligible	• Low to negligible interactions / mitigation measures not considered necessary. • Interactions, while still lower, are anticipated to be higher in the recreational fishing sector due to a higher number of participants.	No
Crocodiles	Negligible	• N/A	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.	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.	No
Teleosts (protected / SOCI only)	Intermediate / High	• Elevated risk in the commercial fishery due to fishing method and the area of operation and the impact of cumulative fishing pressures. • SOCI data available but limited reliability and the veracity/accuracy of this data (including release rates) requires further clarification. Uncertainty in this data also contributed to the ecological component receiving a higher risk rating. • Some mitigation measures in place *e.g.* gear restrictions, marine park closures, information about post release techniques (deflating swim bladders) and barotrauma on fisheries website.	Yes

Ecological Component	Level 1 Risk Rating	Likelihood Considerations	Level 2 Required?
		• Increased awareness of post-capture 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. • This group (overall) is at the higher end of the risk spectrum. However, the preliminary risk rating was heavily influenced by data deficiencies and uncertainty surrounding the catch data and SOCI interaction rates. Given these considerations, the preliminary risk rating was reduced from a high to an intermediate/high. • This score is still considered to be precautionary in nature and the subgroup will still be progressed to a Level 2 ERA. Risk scores assigned to this group may decline further with improved SOCI data. • While electronic observation being considered for some fisheries, the feasibility and applicability of this method is still being determined.	
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. • While electronic observation being considered for some fisheries, the feasibility and applicability of this method is still being determined.	No
Sharks	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. • Interactions with this fishery include those associated with depredation. However, the broader management of this risk in the CRFFF is not required at this point in time. • While electronic observation being considered for some fisheries, the feasibility and applicability of this method is still being determined.	No

Ecological Component	Level 1 Risk Rating	Likelihood Considerations	Level 2 Required?
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	• N/A	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. • Risk ratings for this subgroup were influenced by the potential impacts of discarded & lost fishing gear. This risk transcends the commercial fishery and the recreational fishing sector will make a notable contribution to the amount of lost and discarded fishing line. • 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. • 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.	No

Ecological Component	Level 1 Risk Rating	Likelihood Considerations	Level 2 Required?
Ecosystem processes	Low / Intermediate	• Overall risk posed to ecosystem process is anticipated to be low. • Assessment has a high degree of uncertainty as impacts of an individual fishery are difficult. • The impacts on ecosystem processes such as predation and recruitment will be reduced through the use of quotas. Stocks of the two key species are also fished sustainably / within key sustainability reference points. • Effective management of the targeted stocks will help to minimise the risk posed to regional ecosystem processes. • Well established mitigation measures in places including spawning closures and quota would reduce the impact of the fishery on ecosystem processes like predation and recruitment. • There is a degree of uncertainty with respect to the OS management unit and how the fishery impacts ecosystem processes for these species / species groupings. This risk is considered to be lower due to current catch and effort levels but may change into the future.	No

4.6 Issues Arising

Increased catch and effort (OS Management Unit)

As management of the CRFFF is based on output controls, total catch for each of the three management units is capped. However, the cap for the OS management unit is considered to be less limiting and less effective when compared to CT and RTE. Current quota usage for the OS management unit, which includes more than 90 species, is less than 50% of the total allowable catch (Department of Agriculture and Fisheries, 2019). As all species within this unit fall under the same quota, there is capacity for fishing effort to switch between individual fish species and for effort to concentrate on a limited number of species. This inability to control finer-scale catch and effort trends in the OS management unit presents one of the more significant risks in this fishery. This was reflected in the higher risk rating scores assigned to the unit as part of the risk characterisation process (Table 2).

With the OS species continuing to be managed under a multi species quota, this risk will remain even if catch and effort remains the same. Within the management unit, this risk will (potentially) be higher for deeper water species as they tend to have slower growth, longer life spans and restricted distributions. The extent of this risk will be highly dependent on a range of factors including management's ability to track effort shifts within regions and validate catches in multi-species

fisheries. Both of these items are currently being addressed as part of the *Queensland Sustainable Fisheries Strategy 2017–2027* that will greatly assist in the monitoring and mitigation of this risk. This includes the expansion of the current *Vessel Tracking* system to include all commercial fishing boats by the end of 2020. This move alone will help improve the accuracy of Level 2 assessments and help to quantify the level of risk associated with the movement of effort within a fishery.

Information on additional (cumulative) fishing pressures

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 CRFFF 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 CRFFF. 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.

Validation and catch compositions (OS Management Unit)

There have been considerable improvements to the CRFFF monitoring program including the removal of the catch categories *'Mixed Reef A*' and *Mixed Reef B'* (Department of Agriculture and Fisheries, 2019). While a proportion of the catch in the OS category is still reported in generic categories *e.g.* 'cod unspecified' this component of the catch has declined (Department of Agriculture and Fisheries, 2019). There is however, limited capacity to validate catch in the OS management unit, evaluate the veracity of the logbook data and/or quantify bycatch compositions and discard rates. For a fishery that retains over 100 species, this may present a risk for one or more of these ecological subcomponents.

'*Improved Monitoring & Research'* was included in the *Queensland Sustainable Fisheries Strategy 2017–2027* as one of four foundation reforms (Department of Agriculture and Fisheries, 2017). The improvement of commercial fishing data is now being addressed through a dedicated *Fisheries Data Validation Plan* and through the *Monitoring and Research Plan* (Department of Agriculture and Fisheries, 2018c; d). These reforms along with the expansion of the vessel-tracking program and the introduction of changes to the catch disposal records (CDR) will improve the accuracy of Queensland's catch and effort data. These measures though will take time to develop and implement; therefore will take time to filter through to the ERA process.

Under reporting and misidentification of SOCI

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 CRFFF, 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. This issue is highlighted by the infrequent nature of the SOCI records for humphead Maori wrasse, Queensland groper and barramundi cod. Prior to 2016, fishers did not report interactions with these species due to misinformation on reporting requirements. Validation of commercial fishing data, including SOCI logbooks is a priority reform action under the *Queensland Sustainable Fisheries Strategy 2017–2027.*

Non-compliance

Queensland Boating and Fisheries Patrol (QBFP) and the quota-monitoring unit detect instances of non-compliance. These have identified a number of issues, which affect the enforceability, and effectiveness of the current management arrangements. Not all trips can be inspected; as a result, there is a level of self-compliance about the correct weighing and reporting their catch.

More broadly, the introduction of Vessel Tracking in the CRFFF has helped to minimise a number of the risks associated with non-compliance including fishing in regulated waters. Accordingly these risks may now be more relevant to the recreational fishing sector.

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 two of the ecological components were assigned a risk rating above intermediate—the OS management unit and protected teleosts. Both of these ecological components will be progressed to a Level 2 ERA. 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. As such this ecological component will not be progressed to a Level 2 assessment.

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, 2018d). Specifically:

- Improving the level of understanding on compositions and release fates (including depredation) of target species, particularly in the other species (OS) management unit.
- Validating species compositions and interaction rates (including release fates) for teleosts classified as *Species of Conservation Interest* (SOCI).

- Obtaining greater information on gear loss rates and line-related injuries/mortalities for SOCI species including potential sources *i.e.* commercial or recreational fishing line.

- Further assessment of regional catch and effort levels in the recreational fishing sector for key species where cumulative fishing impacts present as a higher risk.

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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 ACTIVITY	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

Due to the difficulty of assessing the impacts of a fishery on ecosystem processes, a precautionary approach was adopted for the Level 1 assessment. In line with this approach, an initial or preliminary assessment was undertaken for 16 ecosystem processes that may be influenced by fishing activities. As with risk scores for the whole of fishery assessment (Table 2) each category was assigned a risk rating of Low (L), Intermediate (I), High (H), or negligible (-). This risk score describes the potential for each fishing activity to impact negatively on the ecosystem process category.

For the Level 1 ERA, each fishing activity was assigned a final risk score that corresponded with the maximum risk rating assigned in the preliminary assessment. If for example 'Predation' received an 'H', than the final risk score for harvesting will be a H. To this extent, the final risk scores assigned to each fishing activity present the highest potential risk and therefore may not be applicable to all of the ecosystem processes categories. Used in this context, the Level 1 assessment for ecosystem processes should be considered as both precautionary and preliminary in nature. The following presents a summary of the preliminary risk scores assigned to the main fishing activities in the CRFFF.

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

*Includes recreational, charter sectors

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 CRFFF. 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	Risk Characterisation (Preliminary rating)	Considerations of Likelihood and Mitigation Measures	Level 1 Risk Rating
Target & Byproduct	• Quota setting procedures for coral trout (CT) are well developed and include review mechanisms. • Quota setting procedures for redthroat emperor (RTE) are less developed and poor for the other species (OS) catch category.	CT – Low	*Likelihood* • Low to moderate for CT. • Low for RTE. • Medium to high for OS. *Mitigation Measures & Considerations* • Currently developing a whole of fishery harvest strategy.	CT – Low
		RTE – Intermediate		RTE – Low
		OS – High		OS – Intermediate / High

Ecological Component	Key Issues / Sources of Risk	Risk Characterisation (Preliminary rating)	Considerations of Likelihood and Mitigation Measures	Level 1 Risk Rating
Target & Byproduct	• Increased potential for high-grading to occur (not accounted for in seasonal quota or stock assessments). • Increased potential for high amounts of effort to be targeted at a small number of species within the OS category. • Limited capacity to constrain effort in the OS category. • Fishery operates in areas where there are significant risk mitigation measures already in place *e.g.* the Great Barrier Reef Marine Park Representative Areas Programme.		• FWG actively examining mechanisms to improve quota setting processes across management units and addressing concerns relating to OS species. • Improving data on recreational fishing through boat ramp surveys. • Specific monitoring program started in 2017/18 of 5 key species in the OS quota category.	
Bycatch (non-SOCC)	• Interaction rates with non-target species will be relatively low due to use of the OS catch category. • Limited information on bycatch compositions for this sector. • Bycatch in this fishery may be retained as byproduct for another line fishery.	Low	*Likelihood* • Low. *Mitigation Measures & Considerations* • Fishers targeting coral trout use view buckets resulting in limited byproduct.	Low

Ecological Component	Key Issues / Sources of Risk	Risk Characterisation (Preliminary rating)	Considerations of Likelihood and Mitigation Measures	Level 1 Risk Rating
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. • High spatial overlap between key fishing grounds and preferred habitats (GBR). • Cumulative impacts of lost and discarded fishing line (*i.e.* commercial and recreational) will be a broader issue for this subgroup.	Intermediate	*Likelihood* • Low to medium. *Mitigation Measures & Considerations* • Media encouraging best practice such as ensuring rubbish (fishing lines, plastic bags) are disposed of correctly. • SOCI reporting. • Some fishers are part of the Great Barrier Reef Marine Park Reef Guardian program that encourages best practice operation in the marine park. • Limits on number of lines and hooks used.	Low / Intermediate
Sea snakes	• No reported interactions and (if applicable) fishery is unlikely to impact significantly on regional populations. • Considerable spatial overlap between key fishing grounds and preferred habitats.	Low	*Likelihood* • Low. *Mitigation Measures & Considerations* • SOCI reporting.	Negligible

Ecological Component	Key Issues / Sources of Risk	Risk Characterisation (Preliminary rating)	Considerations of Likelihood and Mitigation Measures	Level 1 Risk Rating
Sea snakes	• Recreational fishing data indicates that subgroup can and does interact with the line apparatus.		• 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 lower, are anticipated to be higher in the recreational fishing sector due to a higher number of participants.	
Crocodiles	• Limited spatial overlap between key fishing grounds and preferred habitats (possibly in FNQ). • Interactions with this subgroup are highly unlikely and (if applicable) very infrequent.	Negligible	N/A	Negligible
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.	Low	<u>*Likelihood*</u> • Low. <u>*Mitigation Measures & Considerations*</u> • 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.	Negligible

Ecological Component	Key Issues / Sources of Risk	Risk Characterisation (Preliminary rating)	Considerations of Likelihood and Mitigation Measures	Level 1 Risk Rating
Dugongs			• SOCI reporting. • Further management of risk not considered to be warranted.	
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.	Low / Intermediate	*Likelihood* • Low. *Mitigation Measures & Considerations* • SOCI reporting. • Limits on number of lines and hooks used. • Best management and handling practice in place.	Low

Ecological Component	Key Issues / Sources of Risk	Risk Characterisation (Preliminary rating)	Considerations of Likelihood and Mitigation Measures	Level 1 Risk Rating
Cetaceans	• Interactions and (if applicable) mortalities unlikely to have a long-term impact on regional populations.			
Teleosts (protected/SOCI only)	• High interactions and poor estimates of total mortality (*in-situ* and post-release). • Post-release mortality a considerable risk for this subgroup. • Survivability of released fish will depend on a range of factors including the species, water depth and handling procedures. • High spatial overlap between key fishing grounds and preferred habitats. • Increased potential for injuries/mortalities. • Number of interactions may be inflated for this species as it may include interactions with line fishers targeting species from the *Rocky Reef Fin Fish Fishery* and *East Coast Inshore Fin Fish Fishery.*	High	*Likelihood* • Medium to high. *Mitigation Measures & Considerations* • Information about best practice post release techniques (deflating swim bladders) and barotrauma on web page. • SOCI reporting. • Limits on number of lines and hooks used.	Intermediate / High
Batoids	• Interaction rates (overall) anticipated to be low.	Low	*Likelihood* • Low.	Low

Ecological Component	Key Issues / Sources of Risk	Risk Characterisation (Preliminary rating)	Considerations of Likelihood and Mitigation Measures	Level 1 Risk Rating
Batoids	• Potential for interactions to occur due to overlap between key fishing grounds and preferred habitats of reef species. • Interactions and (if applicable) mortalities unlikely to have a long-term impact on regional populations.		*Mitigation Measures & Considerations* • Best management and handling practice in place. • Further management of risk not considered to be warranted.	
Sharks	• Interaction rates (*i.e.* direct capture and predation on caught fish) will be higher than batoids. • High post interaction/release survival rate. Most interactions will not result in the animal being landed on deck. • High spatial overlap between key fishing grounds and preferred habitats of reef species. • Indirect interactions more likely with sharks targeting fish during the retrieval process.	Low	*Likelihood* • Low. *Mitigation Measures & Considerations* • Best management and handling practice in place. • Further management of risk not considered to be warranted.	Low

Ecological Component	Key Issues / Sources of Risk	Risk Characterisation (Preliminary rating)	Considerations of Likelihood and Mitigation Measures	Level 1 Risk Rating
Sharks	• Interactions and (if applicable) mortalities unlikely to have a long-term impact on regional populations.			
Syngnathids	• Subgroup highly unlikely to interact with the line apparatus.	Negligible	N/A	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	*Likelihood* • Low. *Mitigation Measures & Considerations* • SOCI reporting. • Limits on number of lines and hooks used. • Best management and handling practice in place.	Low
Terrestrial mammals	• Negligible interactions or spatial overlap.	Negligible	N/A	Negligible
Marine Habitats	• Contact with marine habitat highly localised (anchoring widely used).	Intermediate	*Likelihood* • Intermediate/High as many vessels use anchors as part of their operation.	Intermediate

Ecological Component	Key Issues / Sources of Risk	Risk Characterisation (Preliminary rating)	Considerations of Likelihood and Mitigation Measures	Level 1 Risk Rating
Marine Habitats	• Cumulative impacts will be a risk for areas (*e.g.* key reefs) that attract higher levels of effort. • Longer term impacts will be driven largely by the loss of fishing gear and the cumulative (commercial and recreational) impacts.		*Mitigation Measures & Considerations* • Best practice methods of anchoring and mooring in the marine park by GBRMPA. • Problem compounded by cumulative impacts *e.g.* recreational fishing. • Media encouraging best practice such as ensuring rubbish (fishing lines, plastic bags) are disposed of correctly. • Some fishers are part of the Great Barrier Reef Marine Park Reef Guardian program that encourages best practice operation in the marine park.	
Ecosystem Processes	• Fishery targets a range of species including mid-level predators. • The potential of the CRFFF to affect or influence key ecosystem processes is limited.	Intermediate	*Likelihood* • Uncertain. *Mitigation Measures & Considerations* • Have quotas that limit the amount of fish taken out of the system. • Evidence suggests that CT and RTE, the two species making the largest	Low / Intermediate

Ecological Component	Key Issues / Sources of Risk	Risk Characterisation (Preliminary rating)	Considerations of Likelihood and Mitigation Measures	Level 1 Risk Rating
Ecosystem Processes			contribution to the total catch, are fished sustainably. • Effective management of the targeted stocks will help to minimise the risk posed to regional ecosystem processes. • Well established mitigation measures in places including spawning closures.	