

Sustainable Fisheries Strategy

2017–2027

Gulf of Carpentaria Developmental Fin Fish Trawl Fishery Level 1 ERA—Whole of Fishery Assessment

Level 1 Ecological Risk Assessment
Gulf of Carpentaria Developmental Fin Fish Trawl Fishery

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Executive Summary

The Queensland Ecological Risk Assessment Guideline (the Guideline) was released in March 2018 as part of the *Queensland Sustainable Fisheries Strategy 2017–2027* (Department of Agriculture and Fisheries, 2017; 2018a). This Guideline provides an overview of the 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 Level 1 ERA produces 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, changing target species) and life-history constraints of the species being assessed. In the *Gulf of Carpentaria Developmental Fin Fish Trawl Fishery* (GOCDFFTF) the Level 1 ERA examined fishing related risks in 20 broader ecological components including the six quota management units, 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'.

The GOCDFFTF is a small fishery ($n = 3$ permits) that targets a range of teleost species. Effort in the fishery over the last five years has been low with permit holders operating infrequently in the fishery. No fishing effort has been reported in the fishery in 2016–17 or 2017–18 and permit holders have recorded less than 100 effort days in the GOCDFFTF since 2012–13. With this level of inactivity, the fishery does not currently present a risk to any of the ecological components. However, developmental permits for the fishery are still in effect; meaning fishing can recommence in the GOCDFFTF over the short to medium term. Given this, the Level 1 (whole of fishery) ERA was developed under the following assumptions: a) fishing will recommence in the GOCDFFTF and b) annual effort will not significantly exceed that previously recorded in the fishery.

Preliminary assessments for the GOCDFFTF indicated that all but three of the ecological components were at a low to intermediate risk of experiencing an undesirable event. At intermediate/high, bycatch species, marine habitats and ecosystem processes had the highest preliminary risk ratings. The six quota management units were all assigned a preliminary risk rating of intermediate and their risk profiles were influenced by both the direct (e.g. *harvesting, contact without capture*) and indirect (e.g.

disturbance due to presence in the area) impacts of trawl fishing. For the bycatch ecological component, batoids, sharks and protected teleosts, the direct and indirect impacts of trawl fishing were compounded by an absence of data on catch compositions and release fates.

When mitigation measures and risk likelihood are given further consideration, a number of the preliminary risk ratings were downgraded. Risk ratings assigned to all quota management units were downgraded with crimson snapper, saddleback snapper, golden snapper and red emperor all assessed as low risk. The mangrove jack and other species management units were marginally higher at low/intermediate and intermediate respectively. Risks posed to target and byproduct species are managed through permit conditions that include enforceable TACC limits and a requirement for operators to cease fishing if the proportion of undersized fish exceeds 10%. For ecological components like bycatch, batoids and sharks, the mandated use of a TED, BRD and larger mesh sizes will reduce the level of risk for these species. Data deficiencies identified in a number of the risk profiles are also being addressed through permit conditions that require an observer to be on board the vessel for the first two trips of the season and on every third trip thereafter.

With the GOCDFFTF reporting low levels of effort, the outcomes of the Level 1 ERA should be viewed as precautionary in nature and indicative of what may occur if fishing were to recommence in the fishery. Due to the current inactivity, the GOCDFFTF will not be progressed to a finer scale (Level 2) ERA. The need to subject the fishery to additional ERAs will depend on the level of effort in the fishery at that point in time.

Summary of the outputs from the Level 1 (whole of fishery) Ecological Risk Assessment for the Gulf Of Carpentaria Developmental Fin Fish Trawl Fishery (GOCDFFTF).

Ecological Component	Level 1 Risk Rating	Progression
Target & Byproduct	Crimson Snapper—Low	No
	Saddletail Snapper—Low	No
	Golden Snapper—Low	No
	Red Emperor—Low	No
	Mangrove Jack— Low/Intermediate	No
	Other Species (Gulf)— Intermediate	No, risks addressed through permit conditions.
Bycatch (non-SOCC)	Intermediate	No, risks addressed through permit conditions.
SOCC		
<i>Marine turtles</i>	Intermediate	No, risks addressed through permit conditions.
<i>Sea snakes</i>	Intermediate	No
<i>Crocodiles</i>	Negligible	No
<i>Dugongs</i>	Negligible	No
<i>Cetaceans</i>	Low / Intermediate	No
<i>Protected teleosts</i>	Low / Intermediate	No, risks addressed through permit conditions.
<i>Batoids</i>	Intermediate	No, risks addressed through permit conditions.
<i>Sharks</i>	Low	No
<i>Syngnathids</i>	Low	No
<i>Seabirds</i>	Negligible	No
<i>Terrestrial mammals</i>	Negligible	No
Marine Habitats	Intermediate	No
Ecosystem Processes	Precautionary Intermediate	Not progressed due to data deficiencies.

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Definitions & Abbreviations

Active Licence	– The definition of an active licence is the same as that used by DAF's data reporting system. An active licence is a licence that has reported catch and effort in the GOCDFTF through the logbook reporting system irrespective of the amount of catch and effort.
AIVR	– Automated Integrated Voice Response. AIVR is part of the quota reporting system used in Queensland.
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.
Competitive TAC	– A total allowable catch (TAC) under which participants are not allocated a portion of the total catch limit but the catches from all participants are summed to ensure that the sum of all catches does not exceed that TAC
DAF	– Queensland Department of Agriculture and Fisheries
Ecological Component	– Broader assessment categories that include <i>Target & Byproduct</i> (harvested) species, <i>Bycatch</i> , <i>Species of Conservation Concern</i> , <i>Marine Habitats</i> and <i>Ecosystem Processes</i>
Ecological Subcomponent	– Species, species groupings, marine habitats and categories included within each Ecological Component.
EPBC Act	– <i>Environment Protection and Biodiversity Conservation Act 1999</i> .
ERA	– Ecological Risk Assessment
FOP	– Fisheries Observer Program
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 <i>etc.</i> In the context of an ERA, 'false positives' are preferred over 'false negatives'.
False negative	The situation where a species at high risk is assigned a lower risk rating. When compared, false negative results are considered to be of more concern as the impacts/consequences can be more significant.
Fishery Symbol	– The endorsement that permits a fisher to access a fishery and defines what gear can be used <i>i.e.</i> 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.

Fishing Licence	– Effectively a fishing platform. A Fishing Licence can have multiple symbols attached including a net (N) and line (L) fishing symbol.
GOCDFTF	– Gulf of Carpentaria Developmental Fin Fish Trawl Fishery
MEY	– Maximum Economic Yield
MSY	– Maximum Sustainable Yield
Offshore waters	– Tidal waters that are at least 2m deep at low water.
OS (Gulf)	– One of six quota categories used in the GOCDFTF. The OS (Gulf) is a multi-species quota category covering fin fish species not included in the more specific quota categories.
QFJA	– Queensland Fisheries Joint Authority
SAFS	– Status of Australian Fish Stocks
Species of Conservation Concern (SOCC)	– Broder 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 Species	– 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.

1 Overview

The *Gulf of Carpentaria Developmental Fin Fish Trawl Fishery* (GOCDFFTF) is a developmental fishery managed under the *Queensland Fisheries Joint Authority* (QFJA). Operators are granted access to the fishery via commercial fishing permits, to determine if a potential new fishery is commercially viable, socially acceptable and ecologically sustainable.¹ The fishery has maintained developmental status since implementation in 1998 and, due to its developmental nature, is managed through permit conditions rather than provisions contained within subordinate legislation of.

Commercial operators in the GOCDFFTF target a range of tropical snappers and reef fish—some of which hold wider significance in the recreational and charter fishing sectors. The fishery is managed through a mixture of input (e.g. gear restrictions, limited entry) and output controls (e.g. Total Allowable Commercial Catch [TACC] limits, size limits, and no-take species) that are contained within the permit conditions. While input controls are applied at the whole of fishery level, six key groupings have been allocated a TACC limit: crimson snapper (*Lutjanus erythropterus*), saddletail snapper (*L. malabaricu*), red emperor (*L. sebae*), mangrove jack (*L. argentimaculatus*), golden snapper (*L. johnii*), and other species (Department of Agriculture and Fisheries, 2020).

The GOCDFFTF was included in a comprehensive ecological risk assessment (ERA) examining risk in all Queensland-managed fisheries operating in the Gulf of Carpentaria (Zeller & Snape, 2006). This report was based on the Fisheries-Ecological Sustainable Development Reporting Framework (Fletcher *et al.*, 2005) and provided relative risk levels for 47 retained species, 45 non-retained species and 44 general ecosystem components (Zeller & Snape, 2006). While this study found that the GOCDFFTF posed a low to moderate risk to range of target and byproduct species, the operating environment for the fishery has changed markedly since the completion of this ERA (Zeller & Snape, 2006). For example, the management of the fishery has become more prescriptive, has more conservative TACC limits and has an expanded list of teleosts classified as no-take species (Department of Agriculture and Fisheries, 2020). The fishery has also experienced a notable contraction with permit holders recording less than 100 effort days since 2012-13 and no effort in the last two fishing seasons.

In March 2018, Queensland released the *Ecological Risk Assessment Guidelines* (the Guidelines) as part of the broader *Queensland Sustainable Fisheries Strategy 2017–2027* (Department of Agriculture and Fisheries, 2017; 2018a). This Guideline provides an overview of the ERA strategy being employed by Queensland and includes a four-stage framework consisting of 1) a Scoping Study) 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 represents a broader qualitative (Level 1) assessment of the risks posed by fishing activities in the GOCDFFTF and their potential to influence 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 broader catch and effort analyses (Department of Agriculture and Fisheries, 2019a). It is recognised that permit holders are not active in the fishery and therefore the GOCDFFTF does not currently present a risk to any ecological component. However, developmental permits for the fishery are still in effect; meaning fishing can recommence in the GOCDFFTF over the short to medium term. Given this, the Level 1 (whole of fishery) ERA was developed under the following

¹ As defined in section 3 of the Fisheries Act 1994.

assumptions: a) fishing will recommence in the GOCDFFTF and b) annual effort will not significantly exceed that previously recorded in the fishery.

2 Focus & Intent

The risk profiles for Queensland's commercial fisheries will 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 processes 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 GOCDFFTF that may contribute to an undesirable event for one or more of the ecological components.

In focusing on the risk within the fishery, the Level 1 ERAs will provide further insight into the level of risk each ecological component may be exposed to. 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 assessments will focus on species, species groupings, marine habitats or ecosystem processes (if applicable) within each of the ecological subcomponents.

3 Methods

The Level 1 assessment will be 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 Interest' 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 *Environment Protection and Biodiversity Conservation Act 1999* (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, sea birds, 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 represent 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, particle feeding, primary production, herbivory, predation, bioturbation, detritivory, scavenging, symbiosis, recruitment, reef building, competition, connectivity, outbreaks of disease* and *introduced species*. 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 used to assign each ecological component with a preliminary risk rating based on the highest risk score within the profile. In the Level 1 ERA, these preliminary risk scores will be used to identify the low-risk elements in each fishery.
4. *Likelihood*—a secondary evaluation of the key factors underpinning the preliminary risk assessments, their relevance to the current fishing environment and the potential for the fishery to contribute to this risk in the short to medium term. This step was included in recognition of the fact that preliminary scores (see *Risk Characterisation*) may overestimate the level of risk for some ecological components.
5. *Issues Arising*—examines the assigned risk levels and the issues or characteristics that contributed to the overall classifications.

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

While viewed as a higher-level assessment, the Level 1 ERA provides important information on activities driving risk in a fishery, the ecological components at risk and areas within the fisheries management system that contribute to the risk of an undesirable event occurring. Level 1 assessments will be undertaken for all ecological components including marine habitats and ecosystem processes which have the least amount of available data. These results will be used to inform the Level 2 assessments and refine the scope of subsequent ERAs. Level 2 assessments will focus specifically on the ecological subcomponents including key species and species groupings.

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

4 Whole of Fishery Qualitative Assessments

4.1 Risk Context

The risk context for the whole of fishery assessments has been framed at a higher level and 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.”

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

The likelihood that fishing activities in the Gulf of Carpentaria Developmental Fin Fish Trawl Fishery will contribute to a change to fishery resources, fish habitats, environment, biodiversity or heritage values which is inconsistent with the objectives of the Fisheries Act 1994 including the potential for structural elements in the fishery to change significantly.

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 may 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

GOCDFFTF. 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* (ECTF) (Pears *et al.*, 2012; Jacobsen *et al.*, 2018) and is considered to be relatively precautionary.

When reviewing the context of the Level 1 assessment, it is important to take into consideration the structure of the current licensing provisions and the amount of effort being used in the fishery. As the GOCDFFTF is a developmental fishery; operators can only access the fishery if they hold one of three permits. These restrictions have had a direct impact on the scale of the fishery, with effort peaking in 2009/10 at 389 days fished. Since this peak, effort levels have declined substantially with the fishery recording less than 10 fishing days in four of the past five fishing seasons (2012/13, 2013/14, 2014/15 and 2016/17). In two of these years, 2013/14 and 2016/17 no effort was reported from the fishery (Department of Agriculture and Fisheries, 2020). This contrasts to the *Fin Fish (Stout Whiting) Trawl Fishery* on the Queensland east coast which has a comparable number licences (5 total and 2 active) and averaged 274 days fished over the equivalent period (Department of Agriculture and Fisheries, 2019b; 2020).

Due to the absence of effort and low (overall) fishing potential, the GOCDFFTF is more likely to be a contributor of risk for most ecological components. As no effort was recorded in the 2016/17 and 2017/18 seasons, the Level 1 ERA will only identify the potential risks posed by this fishery *verse* the actual risk. If and when fishing recommences, the results of the Level 1 ERA will assist by identifying the key drivers of risk in this fishery and the ecological components requiring additional attention.

4.2 Risk Identification

Fishing activities are frequently subdivided into categories that identify the sources of risk or potential hazards (Astles *et al.*, 2006; 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 GOCDFFTF 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 an ecological subcomponent (species, habitats etc.), 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, nets, ropes, floats etc.

Travel to/from 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

As the GOCDFFTF is a developmental fishery it is managed through permit conditions that, among other things, outline quota holdings for individual species. As the number of permits and quota are restricted in this fishery, these will be the limiting factors with respect to licence holders accessing the fishery (Department of Agriculture and Fisheries, 2020). Permit conditions used in the GOCDFFTF have evolved through time, becoming more prescriptive and less risk adverse. From an ERA perspective, this has resulted in a decrease in the overall level of risk this fishery poses to the ecological components. The extent of this risk decline will be highly dependent on the species, species complexes and marine habitats that interact with the fishery.

Logbook data for the fishery indicates that permit holders have operated infrequently in the GOCDFFTF over the last five years. This decline in participation rates has been attributed to a range of factors including the operational priorities of the permit holders and the (potential) impacts of management changes e.g. the introduction of more stringent bycatch reduction measures, the expansion of the no-take species list and amendments to the TACC for key species (Department of Agriculture and Fisheries, 2019b). This reduction in effort has had a direct and immediate impact on the amount of catch retained in the fishery and by extension the amount of fishing related mortalities. As no effort has been reported in the fishery for both the 2016/17 and 2017/18 season, the fishery currently presents no risk to the ecological components assessed in this Level 1 ERA. This situation would change if fishing were re-activated in the fishery. The extent of this change and therefore the level of risk will be dependent on the fishing environment.

When in operation, **harvesting** and **discarding** are considered the greatest contributors of risk in the GOCDFFTF, with **contact without capture, travel to/from fishing grounds** and **disturbance due to presence in the area** viewed as secondary factors of influence. Given the size of the GOCDFFTF and infrequent nature of the fishing activity, **boat maintenance and emissions** are not expected to be significant risk factors in this fishery. Similarly, **loss of fishing gear** is regarded as a low risk.

4.2.2 Ecological Subcomponents

Target & Byproduct (harvested)

Operators in the GOCDFFTF interact with a wide range of species with catch data revealing that 26 (out of a historical 56 retained species) species or species complexes were retained for sale in the 2015/16 fishing season (**harvesting**) (Department of Agriculture and Fisheries, 2020). While the GOCDFFTF has two major target species, crimson and saddletail snapper, commercial fishing permits allow for the take of all fin fish species excluding those classified as no-take (Department of Agriculture and Fisheries, 2020). For the most part these species will fall into the other species (OS (Gulf)) management unit. As this management unit covers a wide array of species with varying life-history constraints, the primary risks to the target & byproduct ecological component will relate to the fishing pressures exerted on this subgroup of species (**harvesting**).

From 2004 to 2014, the GOCDFFTF operated under a combined species TACC of 1250t—the majority of this TACC remained unfulfilled. This TACC was reduced in 2015/16 in response to a 2011 stock assessment which found that a) the red snapper complex was not overfished in the Gulf of Carpentaria but TACC limits were set higher than recommended sustainability reference points and b) Maximum Sustainable Yield (MSY) for this complex was closer to 450t (O'Neill *et al.*, 2011). In the

years following the TACC decrease, the quota setting process was further refined with the introduction of species-specific quota categories for crimson snapper (*Lutjanus erythropterus*), saddletail snapper (*L. malabaricu*), red emperor (*L. sebae*), mangrove jack (*L. argentimaculatus*), golden snapper (*L. johnii*), and other species (Leigh & O'Neill, 2016; Department of Agriculture and Fisheries, 2020).

The species-specific quota categories are based on a completed stock assessment and provide a solid framework for management to monitor the fishery against key reference points (O'Neill *et al.*, 2011; Leigh & O'Neill, 2016). The potential for the fishery to surpass these reference points is restricted by a decision rule that closes the entire fishery if it exceeds one or more of the TACC limits. To this extent, the risks posed to these management units (**harvesting**) are being managed effectively. The situation surrounding the OS (Gulf) management unit is less certain as this complex is not managed under species-specific quotas. Consequently, there is considerable potential for effort in this management unit to target a small number of species or for effort to shift to a particular OS (Gulf) species due increased marked demand (**harvesting**).

As operators target fin fish schools there is some capacity for the fishery to change target species based on marketability, availability and accessibility. As the OS (Gulf) category covers a multitude of species, this increases the risk that one or more species within the category will experience an undesirable event. For example, data for the fishery indicates that operators have directed effort towards the OS (Gulf) category with the reported catch of goldband snapper; redspot emperor and painted sweetlip often exceeding that of the species-specific quota categories (Department of Agriculture and Fisheries, 2020). This ability to target various species in the OS (Gulf) management unit is considered a key driver of risk within this ecological component.

Of the remaining target and byproduct species, mangrove jack is arguably one of the more prominent species retained by operators in the GOCDFTF. While the species has not been the subject of a formal stock assessment, the 2016 Queensland stock status processes classified the Gulf of Carpentaria stock as *overfished* (Department of Agriculture and Fisheries, 2018b). This assessment was heavily influenced by the GOCDFTF where catch levels regularly exceeded a recommended 30t MSY limit; resulting in a 60% decline in standardised catch rates (Department of Agriculture and Fisheries, 2020).² Mangrove jack stocks in the Gulf of Carpentaria have since been classified as *recovering* due to, in part, falling effort levels in the GOCDFTF and the introduction of new management arrangements (Department of Agriculture and Fisheries, 2018b; Langstreth *et al.*, 2018). The risk of the stock reverting to an overfished state has also been minimised by the formalisation/introduction of an enforceable 30t mangrove jack TACC limit (Department of Agriculture and Fisheries, 2020).

Prior to 2016, operators were permitted to discard target and byproduct species that did not meet the prescribed regulations or were in poor quality. As this proportion of the catch was not reported, it was not accounted for in the annual TACC limits. In 2017, new regulations were imposed on the fishery that required operators to retain and report all authorised/permitted species caught during the trawl event. These conditions were underpinned by a further requirement that the total catch must not contain more than 10% of undersized fish. If the 10% limit is breached the operator must declare this breach and take steps to reduce the catch of undersized fish (Department of Agriculture and Fisheries, 2020). While these measures will not prevent the capture of undersized fish, they help to minimise the

² This assessment pre-dates the introduction of the 30t TACC limit for mangrove jack.

risk that undersized target and byproduct species will experience a sustained level of high fishing mortality e.g. due to the continued fishing of schools of fish with smaller age groups.

The system of spatial closures used in the Gulf of Carpentaria is less expansive when compared to the Queensland east coast. The main reason for this is that the Queensland east coast has a more developed system of State and Commonwealth marine parks. An absence of spatial and temporal closures protecting spawning aggregations was identified as a potential source of risk in this fishery. An absence of spawning protections means that operators can increase their catch through the targeting of aggregations. This type of fishing activity increases the risk of an overfishing event being disguised due to catch hyperstability (Erisman *et al.*, 2011; Erisman *et al.*, 2017). This risk is relevant to the GOCDFFTF as fishers specifically target aggregations as part of their trawl operation. More broadly, the introduction of the *North Marine Parks Network* has expanded the number of spatial closures used in the Gulf of Carpentaria. The *North Marine Parks Network* came into effect through Commonwealth legislation and prohibited commercial net fishing in key sections of the Gulf of Carpentaria (Director of National Parks, 2018). These closures will be less effective in the GOCDFFTF as they largely exist outside the prescribed fishing area (Department of Agriculture and Fisheries, 2020).

As with most quota based fisheries, there will be 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 bycatch limits and no-take species. 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 GOCDFFTF, this risk is managed through a range of monitoring and reporting requirements (Department of Agriculture and Fisheries, 2018c). For example, fishers operating in a quota-based fishery are required to prior-report their catch through an Automated Integrated Voice Response (AIVR) system including 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 GOCDFFTF fishers once they have landed. These combined with logbook records provide a system of crosschecks that can be used to validate catch against key reference points including quota holdings. While the catch validation measures do not address issues relating to other non-compliance (e.g. fishing during a closure or in no-take areas); they reduce the risk of underreporting in a quota managed fishery.

More general compliance issues/risks in the GOCDFFTF will include the use of non-permitted gear, retaining regulated fish, failure to comply with *Vessel Tracking* obligations and failing to adhere to conditions relating to the retention of bycatch or byproduct. These types of illegal fishing activities have the potential to mask the true extent of the fishing mortality experienced by some species (**harvesting/discarding**). In other instances, the black marketing of high value no-take species like black jewfish could present as a sustainability risk and/or have wider implications for other fisheries operating in the Gulf of Carpentaria. In the GOCDFFTF, these risks are largely managed through a limit on the number of available permits and conditions imposed on individual trawl operations. These risks are further managed through the *Queensland Boating and Fisheries Patrol* (QBFP) who continue to enforce the current regulations across all fishing sectors.

Of the remaining fishing activities included in the Level 1 assessment, **contact without capture** is mostly associated with fish who are able to escape the trawl net before landing. In this fishery, mesh sizes are designed to allow the release of small fish, including undersize target species. The use of a turtle excluder device (TED) and bycatch reduction devices (BRD) would also aid in the removal of

non-target species and size classes. While escape mortality due to injuries and trawl stress is mostly unaccounted for, post-interaction survival rates for fish that have been expelled from the net would be higher when compared to landed bycatch (Broadhurst *et al.*, 2006).

According to a previous ERA, only one fisher has reported a lost trawl net (**loss of gear**) in the history of the fishery (Zeller & Snape, 2006). Loss of trawling nets is expensive for operators and usually occurs when they become snagged on an obstruction (Richardson *et al.*, 2018). While noting that lost gear and ghost nets is a significant issue (Edyvane & Penny, 2017), the loss of gear from trawl fisheries operating in northern Australia is a low occurrence (Ghost Nets Australia, 2018).

Bycatch (non-SOCC)

One of the challenges of undertaking a broad-scale ERA for bycatch in the GOCDFFTF 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 species are retained in small quantities. The bulk of the bycatch will consist of no-take species which, as of 2017, includes barramundi; sharks; tuna and tuna-like fish (namely yellowfin, southern bluefin tuna, bigeye tuna, longtail tuna, albacore tuna, northern bluefin tuna and skipjack tuna); pomfrets (Family *Bramidae*); billfish, black jewfish (*Protonibea diacanthus*); queenfish (*Scomberoides* spp.); king salmon (*Polydactylus sheridani*); blue salmon (*Eleutheronema tetradactylum*); grey mackerel (*Scomberomorus semifasiatus*); Spanish mackerel (*Scomberomorus commerson*); and squid (*Photololigo* spp.) (Department of Agriculture and Fisheries, 2020). The remainder of the bycatch will consist of low value species or poor quality target and byproduct species.

Fishery logbooks used in the GOCDFFTF from the 2003/04 season onwards requires all operators to report total weights for the discarded portion of the catch. This data shows that an average of 14% of the total annual catch is discarded in the fishery with discards peaking in 2008/09 at 28% (275t in the 2008/09 season) (Department of Agriculture and Fisheries, 2020). This data is now considered outdated, as it does not take into account recent management changes e.g. the requirement to use a BRD or 2017 revisions to the no-take species list. It does however provide further insight into the level of bycatch (**discarding**) when the fishery is reporting higher levels of effort.

Bycatch reduction devices and TEDs are mandatory on all trawling apparatus in the GOCDFFTF. These are used to reduce the incidental catch of undersized or unwanted fish and larger marine megafauna. Previous ERAs on the GOCDFFTF reported bycatch as undersize fin fish and non-marketable species like benthic invertebrates (e.g. corals and gorgonians, sponges, and echinoderms) (Roelofs & Stapley, 2004; Department of Sustainability Environment Water Population and Communities, 2010). Examples of the type of bycatch reported from the fishery include: trevally, scad, surgeon fish, catfish, triggerfish, grinner, fusilier, kingfish, moray eels, snappers, ponyfish, emperors, tuskfish, jelly blubber, jacks, coralfish, razorfish, herring, batfish, burrfish, flutemouth, sweetlip, javelin fish, seabream, goatfish, leatherjacket, flounder, flathead, bream, turretfish, boxfish, jewfish, halibut, bigeye, mackerel, barracuda, toadfish, stonefish, spinefoot, cods, sea cucumber, bugs, lobster, octopus, crabs, cuttlefish, squid and others (Roelofs & Stapley, 2004).

At the whole of fishery level, the discarding of non-target species would be at the higher end of the risk spectrum for the GOCDFFTF. The extent of this risk is difficult to quantify without additional information on the bycatch compositions (excluding target and byproduct species) and fates. The introduction of measures to protect undersized target and byproduct species would assist in reducing this risk; in particular rules that prevent fishing if the proportion of undersized fish exceeds 10%. These measures though are reactionary and do not prevent undersized fish being caught, nor do they apply

to species not managed under quota. It is for this reason the discarding of non-target bycatch, primarily teleosts, presents as a higher risk for this fishery.

Species of Conservation Concern

As the fishery operates in offshore waters, the GOCDFFTF has the potential to interact with a number of components in the expanded *Species of Conservation Concern* (SOCC) ecological component.³ As most of these species cannot be retained for sale, **discarding** is considered the largest risk factor for this ecological component. Secondary factors including **contact without capture** and **disturbance due to presence in the area** will also contribute to the overall level of risk. These risks mostly relate to the robustness of the gear, the active nature of the fishing method and the potential for interactions to go unobserved. This includes animals that are excluded from the net through the BRD or TED and non-landed animals that have interacted with the net (**contact without capture**).

No interactions with SOCI³ have been reported from the GOCDFFTF since the introduction of a SOCI specific logbook in 2003. Prior to the introduction of this logbook, permit holders reported interactions with three groups that are now classified as SOCI—sea snakes, caught and discarded on five separate occasions; unspecified sawfish, caught and discarded on six separate occasions; and unspecified marine turtles, caught and discarded on two separate occasions (Department of Agriculture and Fisheries, 2020). A discontinued fishery observer program and industry consultation also identified olive ridley turtles, flatback turtles, elegant sea snakes, pipefish, narrow sawfish, Queensland gropers, barramundi cods, scalloped hammerheads, great hammerheads, and leopard sharks as species that interact infrequently with this fishery (Roelofs & Stapley, 2004; Zeller & Snape, 2006; Department of Employment Economic Development and Innovation, 2011). As this information pre-dates the use of TEDs and BRDs, DAF anticipates that a number of these species will now be excluded from the catch with more regularity (Brewer *et al.*, 2006; Griffiths *et al.*, 2006).

Despite there being no official SOCI interactions recorded in GOCDFFTF, neighbouring fisheries using similar trawl apparatus and targeting similar fin fish have recorded a number of interactions with SOCC species. For example, reports in the Pilbara Fish Trawl Fishery found around 48% of trawls contained marine megafauna (Wakefield *et al.*, 2014). A number of interactions with SOCC have also been reported from the east coast *Fin Fish (Stout Whiting) Trawl Fishery* (Roswell & Davies, 2011). While difficult to quantify, this suggests that the fishery will interact with SOCC when in operation.

Marine Turtles

Two unspecified marine turtles appear in the catch logbooks for this fishery in 1998 with one dying as a result of the interaction and the other being released alive. An independent survey and fishery observer records also reported a non-fatal interaction with a flatback turtle in 2010 (Department of Employment Economic Development and Innovation, 2011) and the capture of olive ridley turtles. Based on these records, a previous ERA suggested that up to 10 turtles per vessel per year may be caught in the fishery (Zeller & Snape, 2006). It is noted though that all of these catch records occurred before the use of a TED became mandatory for this fishery.

Turtle excluder devices have proven to be highly effective at excluding marine turtles from trawl catches (Robins, 1995; Robins & Mayer, 1998; Brewer *et al.*, 2006; Pears *et al.*, 2012) and their use in

³ SOCI or the Species of Conservation Interest refers to a specific subset of no-take species that are subject to mandatory reporting requirements through the SOCI logbook. These species form the basis of the Species of Conservation Concern (SOCC) ecological component. The SOCC ecological component has an expanded species list and includes species that are not included in the SOCI reporting requirements.

the GOCDFFTF will help to reduce the level of risk for this subgroup. At 150mm, the spacing of the TED bars used in the GOCDFFTF is larger than that used in the *East Coast Otter Trawl Fishery* (120mm) and the *Northern Prawn Fishery* (120mm). The extended bar spacing reflects the need to account for differences in the type of species being targeted (teleosts vs. prawns) and the size classes of the retained product (large vs. small). The trade-off with this modification is that it increases the risk that smaller turtles will pass through the bars of the TED and into the codend of the net. For turtles that are not excluded from the nets, mortality rates are linked with shot times and will be dependent on the stress levels experienced by an individual (Robins & Courtney, 1998; Broadhurst *et al.*, 2006). Shot times in this fishery are often longer than 1 hour, which could lead to mortalities for turtles that remain in the net for the majority of the tow duration.

While noting the above concerns, the use of TEDs in the GOCDFFTF will increase the number of turtles that are excluded from the net. As a successful exclusion means the animal is not landed on the deck of the vessel, **contact without capture** will be a risk factor for these species. Potential risks associated with **contact without capture** include injuries resulting from an interaction with the TED or during the exclusion process *i.e.* as it passes out of the escape hatch and under the net. While difficult to quantify, the risk of this type of interaction resulting in a mortality is expected to be low and post-interaction survival rates will be higher when compared to an animal that is retained in the net. In the event that a turtle is retained in the net, operators are required to follow best practice for the handling and release of captured turtles. This includes having the animal spend a significant amount of time on deck to recover from the stress and effects of prolonged submersion / reduced oxygen levels. These measures are designed to reduce post-release mortalities and minimise risk to the animals after their removal from the net. As always, there is a risk that the animal has incurred internal injuries during the trawl event, which can impede the recovery process and make it more susceptible to predation. As internal injuries cannot be detected on deck, this risk will persist even if handling best practice is followed.

When the GOCDFFTF is in operation, it is likely that the fishery will interact with this subgroup. There is a risk that some of the animals will die as a direct result of their capture, because of an undocumented interaction with the apparatus (**contact without capture**) or upon their release (**discarding**). While these factors present as a higher risk for this fishery, the structure of the GOCDFFTF reduces the risk that the fishery will have a significant long-term impact on regional marine turtle populations. This assessment may need to be revised when effort levels increase in the fishery and or if the management regime changes.

Sea Snakes

While no sea snakes have been reported in the SOCI logbooks, the Fisheries Observer Program (FOP) reported six interactions in 2002; including five mortalities (**discarding**). The elegant sea snake is the only species previously identified in reports but 30 species of sea snake are known to inhabit the Gulf of Carpentaria and have the potential to interact with GOCDFFTF (Zeller & Snape, 2006).

Sea snakes are a common bycatch component in many trawl fisheries operating on the Queensland east coast and in northern Australia, including in the adjacent *Northern Prawn Fishery* (Courtney *et al.*, 2010). Sea snakes were also identified as common bycatch species in the Pilbara Fish Trawl Fishery, although many escape through the net mesh, and of those landed, many were released alive (Wakefield *et al.*, 2014). More broadly, research indicates that post-interaction survival rates for trawl-

caught sea snakes is poor; although BRD designs like the fish-eye BRD can improve escapement rates (Courtney *et al.*, 2010).

Effort levels over the last five years indicate that the GOCDFFTF poses a low risk to this species complex at present. If effort were to increase, the fishery will contribute to the overall level of risk for this subgroup in the Gulf of Carpentaria. While this risk is being managed through the operational constraints of the fishery and bycatch mitigation measures, further information on the effectiveness of this strategy may be required if and when effort increases.

Crocodiles

The GOCDFFTF operates in offshore waters and fin fish trawling is not permitted within 25 nautical miles of the shoreline or in waterways. These provisions minimise trawl fishing activities in areas where crocodiles are more prevalent; therefore reducing the likelihood of an interaction occurring in this fishery. In the unlikely event that a crocodile were to interact with a fin fish trawl, the use of a TED would help the animal escape before it enters the cod-end (**contact without capture**).

Dugongs

The risk profile for dugongs will be similar to that observed for crocodiles. No dugong interactions have been reported from the fishery and trawled areas do not overlap with their preferred habitats (seagrass meadows). While the species occurs in the Gulf of Carpentaria, dugong hotspots are located outside the prescribed area of the GOCDFFTF (Department of Environment and Heritage Protection, 2018; Department of Agriculture and Fisheries, 2020). This subgroup is susceptible to boat strikes and increased vessel movements will have a direct (e.g. injuries, mortalities) and indirect (e.g. disrupting natural behaviours, **disturbance due to presence in the area, travel to and from fishing grounds**) impact on regional dugong populations (Marsh *et al.*, 2002; Haynes *et al.*, 2005). These risks are not considered to be significant in the GOCDFFTF as the fishery has a maximum operating potential of three vessels.

Cetaceans

Species distributions are one of the controlling factors for determining impacts on cetaceans in the GOCDFFTF. Baleen whales (*i.e.* humpbacks, minke) are seldom observed in the Gulf of Carpentaria, but in rare instances may be present in winter months during their migration. However several species of toothed whales (*i.e.* dolphins) are known to frequent these waters, including the Australian snubfin dolphin (*Orcaella heinsohni*), Australian humpback dolphin (*Sousa sahulensis*), Common bottlenose dolphin (*Tursiops truncatus*), Indo-Pacific bottlenose dolphin (*Tursiops aduncus*) and false killer whale (*Pseudorca crassidens*) (Atlas of Living Australia, 2018) and interactions with these species may be more likely. Previous ERAs identified a number of other potential cetacean species that may interact with GOCDFFTF based on habitat distributions (Roelofs & Stapley, 2004). As air breathing mammals, cetaceans must spend a portion of their time at the surface where they may come into contact with vessels. Vessel speed is considered a key determinant to the risk of collision and likelihood of mortality (Martinez & Stockin, 2013). Faster moving small cetaceans may be less susceptible to this risk whilst trawling is underway due to the slow trawl speeds, but still may be impacted while the vessel is **travelling to/from fishing grounds**.

Dolphins, in particular, are known to associate with trawlers, scavenging on discards and feeding directly on catch from within the nets (Jaiteh *et al.*, 2013; Allen *et al.*, 2014). On the Queensland east coast, interactions with trawlers form part of the discrete social structure of some dolphin populations

(Ansmann *et al.*, 2012). As these interactions do not involve the direct capture of the animal, they will often go unnoticed and undocumented (**contact without capture**). For example, underwater video footage from the Pilbara fin fish trawl fishery showed that a high number of dolphins enter and escape the trawl net before landing. The underwater video footage also showed that dolphin mortalities may go undetected as the animal can fall out of the net during the retrieval process (Allen & Loneragan, 2010). In the Pilbara Trawl Fishery, 90% of trawls surveyed ($n = 36$) recorded some form of interaction with a dolphin. In 80% of the trawls surveyed the dolphin actively entered the net during the fishing event (Jaiteh *et al.*, 2013).

While information on dolphin interactions is limited, comparisons can be made between the GOCDFFTF and the Pilbara Trawl Fishery (Jaiteh *et al.*, 2013). In the majority of instances, the interaction will be more passive, initiated by the dolphin and is unlikely to result in the capture of the animal. To this extent, the vast majority of interactions in this fishery will not have a long-term impact on the health of the animal or on regional populations. The level of risk will increase when a dolphin enters the net as entanglements can easily result in injuries and mortalities (Jaiteh *et al.*, 2013). This risk though is intimately linked with the natural foraging behaviour of the animal and therefore is very difficult to address through the prism of fisheries management.

Even when taking into consideration the potential for boat strikes and undocumented interactions, the risk of fishing activities in the GOCDFFTF causing an undesirable event for one or more of these species is unlikely. With a maximum operating potential of three vessels, the number of (potential) boat strikes in this fishery is expected to be low. The risk of an interaction resulting in the capture of these animals has also been reduced with the introduction of TEDs. Noting however that the permit holders use bottom opening TEDs and these may not be as effective as top opening TEDs for air breathing animals. Species like dolphins will continue to interact with trawl vessels; targeting fish that have been caught in the net, have escape through the BRD or are discarded. The extent of these interactions though are not expected to have a long-term detrimental impact on regional populations.

Protected Teleosts

There are four species of teleost with SOCI reporting requirements: the humphead Maori wrasse (*Cheilinus undulates*), the potato rockcod (*Epinephelus tukula*), the Queensland groper (*Epinephelus lanceolatus*) and barramundi cod (*Chromiletes altivelis*). The distribution of all four species largely centre on the Queensland east coast with only limited accounts of the Queensland Groper and barramundi cod occurring in waters of the Gulf of Carpentaria (Australian Museum, 2013; 2016a; b; c).

The Queensland groper was identified in observer reports in 2009, and an estimated 20 per year are caught in the GOCDFFTF. Barramundi cod are also infrequently caught in this fishery (Zeller & Snape, 2006). Queensland groper grow to become extremely large, can be harder to handle without injury, and are at risk of experiencing the effects of barotrauma. A fishery observer in 2009 noted that a trawled Queensland groper was suffering from barotrauma. Operators in this fishery do vent the swim bladder of Queensland gropers, which may reduce this risk (Zeller & Snape, 2006). Large gropers may be expelled though escape hatches or BRD's but smaller individuals are likely to be retained in the cod end.

While difficult to quantify, post-release mortality rates for trawl caught Queensland groper and barramundi cod may be higher. This risk though is countenanced by the fact that interactions with this fishery (when in operation) will be comparatively low.

Batoids

While batoids can be retained for sale in the GOCDFFTF, catch composition data indicates that the majority of these species are discarded as bycatch. There is little information on batoid catch compositions in this fishery; although a previous ERA indicated that the blue spotted mask ray, painted mask ray, Jenkins, brown, and leopard whipsrays, Australian butterfly ray, banded eagle ray, narrow sawfish, and whitespotted wedgfish were some of the more prominent species (Roelofs & Stapley, 2004). For batoids, research has shown that TEDs are effective at preventing larger rays from entering the cod-end (Stobutzki *et al.*, 2001; Stobutzki *et al.*, 2002; Brewer *et al.*, 2006); although smaller individuals can still slip through a TED (Stobutzki *et al.*, 2001; Brewer *et al.*, 2006; Kyne *et al.*, 2007). This problem is compounded by the fact that smaller batoids are more likely to experience higher rates of mortality (Stobutzki *et al.*, 2002; Ellis *et al.*, 2016).

Of the batoids afforded additional protections under state and Commonwealth legislation, manta and devil rays (*Mobula* spp.) may interact infrequently with this fishery. Based on the distribution of the species, the preferred fishing habitats and effort levels, interactions with these species will be low and present a negligible risk to their long-term conservation. This inference is supported by catch data from the much larger *East Coast Otter Trawl Fishery* where interactions for both mantas and devilrays are low and infrequent. The distribution of the estuary stingray (*Hemirhynchus fluviorum*), which is protected under *Nature Conservation (Wildlife) Regulations 2006* (Qld legislation), does not overlap with the GOCDFFTF.

All five species of sawfish are listed as Endangered or Critically Endangered and the complex has been reported as bycatch in previous reports, by fisheries observers and in historical catch records. These reports include one narrow sawfish in 2009, four freshwater sawfish in 2010 and eight unspecified sawfish in 2002 (Roelofs & Stapley, 2004; Zeller & Snape, 2006; Department of Employment Economic Development and Innovation, 2011). While sawfish are largely associated with inshore waters, the largetooth sawfish (*Pristis pristis*) and the green sawfish (*Pristis zijsron*) are found in offshore waters (Peverell, 2005; 2010; Last *et al.*, 2016). As sawfish are highly susceptible to entanglement in trawl gear, they would be more susceptible to fishing activities in the GOCDFFTF.

Due to the shape of rostrum, sawfish are less likely to be expelled from a trawl net through the TED or a BRD. More often, they are entangled in the mesh of the nets or in the BRD itself (Wakefield *et al.*, 2017). This type of interaction can lead to injuries and mortalities; therefore increasing the likelihood of the subgroup experiencing an undesirable event. In the GOCDFFTF, this risk is currently offset by the low levels of interaction and, to a smaller degree, an absence of fishing pressures in shallow water environments. The fishery though does have the potential to contribute to the cumulative fishing pressures exerted on this subgroup which are also caught in adjacent gill net fisheries (Department of Agriculture and Fisheries, 2019a) and in the *Northern Prawn Fishery*.

If fishing were to recommence in the GOCDFFTF to the point where an additional risk assessments were required, subsequent ERAs would benefit from additional information on batoid interaction rates, catch compositions and release fates; particularly for sawfish. This absence of information makes it difficult to assess the risk posed to individual species and evaluate the long-term impacts of the fishery on regional batoid populations. In the context of this fishery, this uncertainty increases the risk that fishing activities in the GOCDFFTF will contribute to an undesirable event for one or more of these species

Sharks

As permit holders in the GOCDFFTF cannot retain sharks or shark product (Department of Agriculture and Fisheries, 2020)⁴, **discarding** and **contact without capture** are considered the biggest drivers of risk in this subgroup.

The majority of information on shark compositions comes from a previous FOP. This program reports on a range of species that were caught as trawl bycatch in the GOCDFFTF including pigeye sharks, spinner sharks, whitecheek sharks, spot-tail sharks, Australian blacktip sharks, lemon sharks, Australian sharpnose sharks, weasel sharks, scalloped hammerhead sharks, great hammerhead sharks and leopard sharks (Roelofs & Stapley, 2004). As this information was collected before the introduction of TEDs, this information is now considered to be outdated.

The benefits of using TEDs in this fishery will be similar to that observed for larger batoids (Stobutzki *et al.*, 2001; Stobutzki *et al.*, 2002; Brewer *et al.*, 2006). The vast majority of larger sharks should be excluded from the catch, although smaller species and individuals may be retained within the cod-end (**contact without capture, discarding**). As effort levels have declined substantially over the last five years, the effectiveness of TEDs at excluding sharks from the fin fish trawl catch cannot be evaluated at this point in time. However, reports from the Pilbara Trawl Fishery show that 80% of benthic sharks, 66% of skates and rays, 31% of shark like rays and 30% of benthopelagic sharks escaped through the TED or BRD (Wakefield *et al.*, 2017). Survival of shark bycatch may vary by size, with smaller sharks less likely to survive a fishing event (Department of Fisheries, 2010).

Previous bycatch mitigation trials in the GOCDFFTF demonstrated that the use of both a square mesh cod-end BRD and a TED were effective in reducing the capture of large sharks (**contact without capture**). While the trials were limited, estimates from the study revealed that sharks made up around 3% of the total catch weight (Department of Sustainability Environment Water Population and Communities, 2010). The use of a BRD (along with a TED) is now compulsory in the GOCDFFTF and these measures will assist in reducing the risk for this subgroup. Quantifying the extent of these benefits though will require additional information on the type of BRDs being used and the species being caught/discarded in the fishery. This in itself will be dependent on the amount of effort being utilised in the fishery.

Syngnathids

Bycatch records indicate that the fishery interacts infrequently with syngnathids. Given the morphology of the species and their overall size, syngnathids will derive significant benefit from the combined use of a TED, BRDs and a larger minimum mesh size (110mm). These factors indicate that the risk to this subgroup is relatively low with **contact without capture** identified as the most likely outcome.

Seabirds

No seabird interactions have been recorded in previous GOCDFFTF fishery reports, from the FOP or in catch data from analogous fisheries e.g. the Pilbara Trawl Fishery, east coast Fin Fish (Stout Whiting) Trawl Fishery. As the GOCDFFTF utilises a demersal trawl apparatus, the weighted gear

⁴ Prior to 2004, operators were permitted to retain shark product. Historical data for the fishery indicates that this portion of the catch was dominated by Australian blacktip sharks and Unspecified shark (refer to GOCDFFTF Scoping Study).

sinks quickly and presents limited opportunities for seabird fatalities and injuries. Accordingly, this subgroup is considered to be at the lower end of the risk spectrum.

Marine Habitats

The Wendy and Champion cutaway wing trawl nets used in the GOCDFFTF were developed cooperatively by industry and Government and a description is provided in the *GOCDFFTF Scoping Study* (Department of Agriculture and Fisheries, 2020). Previous studies on this type of trawl gear have identified limited effects on macrobenthic organisms (*i.e.* sponges, corals *etc.*) when used as designed (Moran & Stephenson, 2000) and previous annual reports on the fishery report little to no benthos bycatch (Department of Employment Economic Development and Innovation, 2011).

In principle, trawl nets used in the GOCDFFTF will be kept above the sea floor by wheels, which roll along the structure as the net is towed. This method may reduce some disturbance to benthic habitats but is still likely to damage corals, sponges and other sessile organisms that occur in the trawl track (***disturbance due to presence in the area***). This increases the risk for this subcomponent. Fishery Observers and in-water camera observation are likely to be required to clarify this risk should effort in the fishery escalate. When the trawl net is deployed high above the benthos, the catch efficiency of target species is reduced (Moran & Stephenson, 2000). In light of this, operators are likely to deploy the nets close to the benthos to maximise catch. There is considerable uncertainty in this fishery regarding how the trawl operators deploy their gear due to the lack of fishing under the most recent permits conditions. These conditions require observers to be on board the vessel for the first two trips of each fishing year and on every third trip thereafter, and unless otherwise required.

Lost trawl nets have significant potential to impact on marine habitats (***loss of fishing gear***). The nets are weighted so they may sink to the benthos where they can damage benthic habitats and organisms, particular corals, through smothering, abrasion and scouring of the substrate (Kiessling, 2003). While loss of fishing gear is a risk in trawl fisheries (*e.g.* due to hook-ups), this risk will be lower when compared to larger trawl fisheries.

Ecosystem Processes

Red snappers are top-mid level generalist predators in the Gulf of Carpentaria (Bustamante *et al.*, 2011). Theoretically, the removal of predators can cause cascading alterations in species assemblages. However, a study of trophic flows in the Gulf of Carpentaria, which assessed possible keystone species, found red snappers were not among the top 10 functional groups of the marine trophic web (Bustamante *et al.*, 2011). Removal of fish through fishing activities (***harvesting***) can remove nutrients from the system but is not considered a major risk factor in this fishery, due to lack of fishing effort and low catches in recent years. Similarly, the effect of fishing activities in the GOCDFFTF is unlikely to impact significantly on processes related to herbivory. Trawl nets used in GOCDFFTF do not impact seagrass beds, the risk to green turtles has been reduced through the use of a TED, and catch data indicate that there is nil catch of herbivorous reef fish.

There is a higher probability of trawl-caught discards sustaining injuries, experiencing elevated levels of stress or dying (either immediately or after a period of time) as a result of the interaction (Lindeboom & de Groot, 1998; Broadhurst *et al.*, 2006). This inference is supported by a previous GOCDFFTF ERA that suggested up to 70% of discarded bycatch was returned in a dead or moribund state (Zeller & Snape, 2006). The full extent of this impact on discarded individuals is unclear, but semi-demersal trawl fishing is likely to influence the process of scavenging. In neighbouring fisheries,

dolphins and sharks are known to associate with trawls, feeding on the discarded fish (Ansmann *et al.*, 2012). Seabirds too have known associations with trawl discards (Blaber *et al.*, 1995; Hill & Wassenberg, 2000; Tasker *et al.*, 2000).

In comparison with other trawling activities, GOCDFFTF presents a lower risk to benthic ecosystem processes, including sedimentation, reef building, bioturbation, and primary production. Although previous studies have identified some benthos bycatch (corals, sponges and gorgonians), they comprised a small percent of the total catch. This fishery does target reef fish but the nets are trawled above the benthos, thus due to the infrequency of contact and low effort in the fishery, the impacts should be low (Appendix 1). Conversely, due to the active nature of the trawling, ***disturbance due to presence in the area*** poses a greater risk to elements of the marine ecosystem. For example international studies on fish trawling found haddock displayed strong avoidance behaviours to trawling vessels, this was particularly evident in shallow water (Ona & Godø, 1990). Alterations in predator/scavenger behaviours are also likely.

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 (DAF). 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

Crimson snapper, saddletail snapper, goldband snapper, golden snapper, mangrove jack and red emperor all have biological stocks that extend beyond Queensland managed fisheries. The Gulf of Carpentaria is split between the Northern Territory and Queensland and the stocks of many species extend into adjacent fisheries or into international waters. Crimson snapper, saddletail snapper, and goldband snapper are retained in the Northern Territory managed Demersal Fishery, Coastal Line Fishery, and Timor Reef Fishery, and in the Queensland-managed Gulf of Carpentaria Line Fishery. Stock status assessments undertaken as part of the *Status of Australian Fish Stocks* (SAFS) process indicate that the biological stocks of all three are being fished sustainably (Martin *et al.*, 2018; Saunders *et al.*, 2018a; Saunders *et al.*, 2018b).

Of the remaining species, golden snapper taken in the Gulf of Carpentaria by Queensland fisheries is considered sustainable but catch taken by the Northern Territory Demersal, Coastal Line and Timor Reef fisheries is considered to be *Depleted* (Penny *et al.*, 2018). Red emperor and mangrove jack are also taken in the Demersal Fishery, Coastal Line Fishery, and Timor Reef Fishery; although the stock status for this species remains undefined (Langstreth *et al.*, 2018; Newman *et al.*, 2018)

When compared to the Queensland east coast, the impacts of the recreational fishing sector on shared fish stocks will be lower and more species-specific. This is primarily due to the area having a smaller population size and the logistical constraints of operating in the region e.g. reduced accessibility, lower levels of fishing tourism. The little information available for the recreational sector comes from infrequent voluntary recreational fisher surveys. Of the species targeted in the GOCDFFTF, the sector caught an estimated 4000 each of golden and Moses snapper in the Gulf of Carpentaria region (Webley *et al.*, 2015). Mangrove jack, golden snapper, crimson snapper and saddletail snapper will also be harvested in the Gulf of Carpentaria charter fishery to varying degrees. The sector has recorded around a half a ton of golden snapper from the Gulf of Carpentaria annually since 2015. **Discarding** within this sector varies between 125–290 individual fish per year.

Harvest levels for Aboriginal peoples and Torres Strait Islander peoples are expected to be below that reported for the recreational fishing sector. The National Recreational and Indigenous Fishing survey reported that Aboriginal peoples from Queensland harvested several key species of fin fish including mullet (68 573), catfish (21 738), sea perch/snappers (38 200), garfish (26 169), bream (44 205) and trevally (21 494) in northern Australia (Fisheries Research and Development Corporation, 2003). Although these estimates are outdated, the current harvest is unlikely to be a significant factor for the overall risk of the fishery. It is recognised though that additional information is required on the harvest rates of GOCDFFTF species by Aboriginal peoples and Torres Strait Islander peoples.

4.3.2 External Impacts

Boat Strike

The effects of vessel use are similar regardless of whether they are used for commercial or recreational fishing, or some other form of recreational use. Therefore, despite the direct impacts being relatively low for GOCDFFTF, these impacts, when analysed in context of the all vessel activity, 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. Turtle interactions are more likely in interesting habitats and whilst travelling through shallow coastal foraging areas *i.e.* traveling to or from the fishing grounds (United Nations Environment Program, 2014). Dugongs are also vulnerable in shallow coastal foraging areas. Boat strikes are considered a major risk to turtles; particularly in areas with higher populations. 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 Environment and Energy, 2015).

The risk associated with boat strike mortalities is significant as it will be much larger than fisheries as it will involve a wide range of recreational and commercial services. It is for this reason that boat strike mortalities will present a higher risk than commercial fishing in some areas. The risk will also be much larger on the Queensland east coast; particularly in areas with higher population densities *e.g.* south-east Queensland. To provide some context, the *Marine Wildlife Stranding and Mortality Database* attributes between 60 and 116 turtle mortalities or carapace fractures per year to boat strike (2000–2011 data) across the State (Meager & Limpus, 2012). This is compared to the estimated 19 turtle deaths per year to netting activities/on deck damage and one to 53 mortalities attributed to ghost nets (based on 2000–2011 data) (Meager & Limpus, 2012).

Marine Debris & Pollutants

Discarded and lost fishing gear from both commercial and recreational fishing is abundant in the marine environment. Nylon and other synthetic materials are extremely persistent in the marine environment. Plastic marine debris is a significant problem for the health of all marine ecosystems, through the degradation of habitats, ingestion by organism 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. These microplastics are highly mobile and able to interact with species from all trophic levels (Bergmann *et al.*, 2015).

Discharge of garbage from a marine vessel is illegal in all Australian waters. However, boating causes the discharge of a number of pollutants. The major pollution sources associated with recreational and small to medium fishing vessels is fuel and oil. Although, antifouling paints, exhaust fumes including greenhouse gases and Polycyclic Aromatic Hydrocarbons (PAHs), and heavy metals are also released into the marine environment through boating activities (Burgin & Hardiman, 2011). Many of these pollutants are bioaccumulative, *i.e.* they build up in the environment due to their persistence. 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 and cigarette butts, and food packaging (Byrnes *et al.*, 2016).

Farming, particularly sugarcane and grazing, and urban development are the largest contributors to land based runoff. Excess nutrients, fine sediments and pesticides have substantially increased in the pre-development levels, and significantly reduce the overall water quality (Waterhouse *et al.*, 2017). Reduced water quality leads to loss of corals and seagrass cover, population declines in mega fauna and the overall degradation of the marine environment (Brodie *et al.*, 2017). These impacts may not be

as prevalent in the GOCDFFTF largely due to the lower level of agricultural development within the Gulf of Carpentaria outside of the main ports and population centres such as Karumba and Weipa.

Climate Change

Anthropogenic climate change is expected to have significant and lasting effects on the marine environment. These will likely impact fisheries operations, with some effects already perceptible in recent years. In Queensland, the severity of storms, tropical cyclones and extreme rainfall events are predicted to increase by the end of the century (Climate Council, 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 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 and nursery grounds for many species. This is perhaps best exemplified by a relatively recent environmental event that resulted in the mass die-off of mangroves in the Gulf of Carpentaria (Duke *et al.*, 2017).

Changes in temperature and oceanic chemistry have been seen to affect physiology, growth and reproduction of fisheries species as well as the primary production that many of these species depend on (Sumaila *et al.*, 2011). This can lead to widespread shifts in fish and ecosystem productivity and stock distributions. There is also evidence of increased ocean acidity. Increased carbon dioxide in the atmosphere, decreases the pH of seawater (*i.e.* increased acidity), 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. Fisheries 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).

While DAF is currently unable to manage for the effects of climate change, due to the largely unquantifiable nature of largescale climatic effects on the GOCDFFTF, these issues are important to consider when identifying risks and future management decisions for the fishery. The Queensland Government will continue to address these issues through a range of forums.

Ghost Nets

Ghost nets are an issue that expands across ecological components and has the potential to significantly impact target and non-target species, as well as regional habitats. This issue though is much larger than the GOCDFFTF and extends beyond the Australian exclusive economic zone. Research indicates that only 10% of the collected ghost nets originate from Australian managed fisheries. A high proportion of the remainder comes from the Arafura Sea where a number of Indonesian fisheries operate (Ghost Nets Australia, 2018). Of the nets that are collected, over 60% comes from trawl fisheries (mostly Indonesian), 14% from gill nets and the remainder (~25%) from indeterminate sources.

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 4.2). 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.

Preliminary assessments for the GOCDFFTF indicated that all but three of the ecological components were at a low to intermediate risk of experiencing an undesirable event (Table 2). Risk ratings assigned to all quota management units (excluding OS) were elevated to intermediate due to two key fishing activities: contact without capture and disturbance due to presence in the area. The preliminary risk assigned to OS (Gulf) management unit was due the multi-species nature of the category and an increased ability for effort to be transferred or directed towards individual species. Discarding was not considered to be a factor for the target & byproduct species ecological component as permit conditions require operators to retain all species within these management units. While not universal, data deficiencies, the potential for trawl fishing to interact with a variety of non-target species, an inability to validate catch compositions and variability in the effectiveness of bycatch reduction devices were also identified as risk factors in this fishery.

Table 2. Summary of preliminary risk scores for fishing within Gulf of Carpentaria Developmental Fin Fish Trawl Fishery, including the impact of the main fishing activities on key ecological components. *Represents quota management units for crimson snapper (CS), saddletail snapper (SS); golden snapper (GS), red emperor (RE), mangrove jack (MJ) and other species (OS).

Ecological Component	Trawl Fishing Activities							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*	CS - L SS - L GS - L RE - L MJ - I OS - I	-	I	L	-	I	L	CS - I SS - I GS - I RE - I MJ - I OS - I	L
Bycatch (non-SOCC)	-	I/H	L	L	-	I	L	I/H	L
SOCC									
- Marine turtles	-	I	I	L	L	I	L	I	L
- Sea snakes	-	L/I	L/I	L	-	L	L	L/I	L
- Crocodiles	-	-	-	-	-	-	-	-	L
- Dugongs	-	-	-	-	L	L	L	L	L
- Cetaceans	-	I	I	L	L	I	L	I	L
- Batoids	L	I	I	L	-	I	L	I	L
- Protected teleosts	-	I	L	-	-	L	L	I	L
- Sharks	-	L	L	L	-	L	L	L	I
- Syngnathids	-	L	L	L	-	L	L	L	L
- Seabirds	-	L	L	L	-	L	L	L	L
- Terrestrial mammals	-	-	-	-	-	-	-	-	-
Marine Habitats	I	-	L	I	-	I/H	L	I/H	L
Ecosystem Processes	I/H	L	L	L	-	I	-	I/H	L

While a full account of the preliminary risk ratings, key considerations and risk factors have been provided in Appendix 2, the following provides a general overview of the key findings of the *Risk Characterisation* stage:

- The fishery is more likely to be a contributor of risk versus the main driver of risk for one or more of the ecological components.
- Risk ratings for the quota management units (CS, SS, GS, RE, MJ, OS (Gulf)) will depend on the ability of the management regime to respond to changes in the fishing pressure exerted on individual species.

- The OS (Gulf) management unit has an elevated risk rating due to a) a lower capacity to manage catch and effort for individual species and b) the risk that fishing mortality can increase rapidly for one or more of the species included in the management unit.
- The elevated risk rating for mangrove jack reflects the status of regional stocks and the potential for the fishery to affect the stock rebuilding process.
- Subsequent risk assessments for bycatch species and the SOCC would benefit from additional information on catch rates, species compositions and discard fates.
- Disturbance due to presence in the area was considered a significant risk for a number of the ecological components including target & byproduct, bycatch, marine habitats and ecosystem processes.

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, the risk ratings of all the target and byproduct species were downgraded (Table 3, Appendix 2). The preliminary risk ratings for this ecological component were heavily influenced by the scores assigned to ***disturbance due to presence in the area***. While this fishing activity can contribute to the overall level of risk, harvesting and discarding were considered to be more influential for this subgroup. These risks (***harvesting,***

discarding) are currently being managed through permit conditions that include enforceable TACC limits and a requirement for operators to cease fishing if the proportion of undersized fish exceeds 10% (Department of Agriculture and Fisheries, 2020). Despite the above restrictions, two of the management units were assigned a higher risk rating (Table 3). The OS (Gulf) management unit was assigned an intermediate risk rating as there is less capacity to manage effort at the species level. The mangrove jack management unit was assigned a low/intermediate risk rating as regional stocks are still recovering after an extended period of overfishing (Table 3, Appendix 2).

The majority of the remaining amendments involved low-risk ecological components or non-target species with data deficiencies. For ecological components like bycatch (non-SOCC), batoids and sharks, an absence of catch composition data produced more conservative preliminary risk ratings. The risk posed to these subgroups was considered to be lower given the size of the fishery and the mandated use of a TED, BRD and larger mesh sizes. Going forward, there will be increased opportunity to further refine these assessments as permit conditions now require operators to have an observer on board the vessel for a first two trips of each fishing year and on every third trip thereafter.

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 risk ratings for the ecological components and subcomponents interacting with the Gulf of Carpentaria Developmental Fin Fish Fishery. *Represents quota management units for crimson snapper (CS), saddletail snapper (SS); golden snapper (GS), red emperor (RE), mangrove jack (MJ) and other species (OS).

Ecological Component	Level 1 Risk Rating	Considerations of Likelihood and Mitigation Measures	Level 2 Required?
Target & Byproduct*	CS—Low	<ul style="list-style-type: none"> Fishery interacts and retains a comparatively high number of target and byproduct species. However, preliminary risk ratings were heavily influenced by scores assigned to disturbance due to presence in the area. 	No
	SS—Low	<ul style="list-style-type: none"> Quota used to control retention of key target and byproduct species. Quota is based on the outputs of stock assessment for tropical snapper. Operators are required to retain all quota managed species including undersized fish from the six management units. These measures, when the 	No

Ecological Component	Level 1 Risk Rating	Considerations of Likelihood and Mitigation Measures	Level 2 Required?
	GS—Low	<p>fishery is in operation, will provided a high degree of insight into the total catch.</p> <ul style="list-style-type: none"> Little information on the amount of product that is excluded through TEDs and BRDs or their post-interaction fate. 	No
	RE—Low	<ul style="list-style-type: none"> Risks (overall) are well managed through stringent permit conditions. These conditions are largely aimed at reducing the impact of the fishery on smaller cohorts and ensuring the long-term sustainability of regional stocks. Risks will be higher for the multi-species quota management unit (OS Gulf) and mangrove jack which has been historically overfished in this region. 	No
	MJ—Low / Intermediate	<ul style="list-style-type: none"> Risks may also be higher for species that are targeted during key points in their life-history e.g. during spawning aggregations. Risk ratings assigned to the MJ and OS management unit may be conservative. Further refinement of this group may be possible if or when fishing recommences. 	No
	OS GOC—Intermediate	<ul style="list-style-type: none"> The small size of the fishery is viewed as one of the key measures minimising risk in this fishery. If the scope of the fishery were to expand, some species or species groupings may be at higher risk of experiencing an undesirable event. 	No; Risks & deficiencies addressed through permit conditions.
Bycatch (non-SOCC)	Intermediate	<ul style="list-style-type: none"> This fishery will interact with a range of non-target species and there is a high probability that non-target species will be landed on the vessel. The amount of teleost bycatch will be reduced due to use of an OS (Gulf) quota management unit. While operators are required to retain all target and byproduct species (legal and undersized), there is limited information on the compositions of the remaining bycatch species. Bycatch mitigation measures including the use of a TED, BRDs and larger mesh sizes (>110mm) will 	No; Risks & deficiencies addressed through permit conditions.

Ecological Component	Level 1 Risk Rating	Considerations of Likelihood and Mitigation Measures	Level 2 Required?
		<p>assist in reducing the risk for this ecological component. The effectiveness of these measures will be dependent on the species, the size of the animal and the overall morphology.</p> <ul style="list-style-type: none"> The risk rating was influenced by data deficiencies and may still be precautionary in nature. Data issues are being actively addressed through permit conditions that require observers to be on board the vessel for the first two trips of each fishing year and on every third trip thereafter, and unless otherwise required. The suitability and applicability of the risk rating will need to be reviewed if and when fishing recommences in the fishery. 	
Species of Conservation Concern (SOCC)			
<i>Marine turtles</i>	Intermediate	<ul style="list-style-type: none"> Small number of interactions reported from the fishery. Interactions may be higher when contact without capture (e.g. exclusion due to TED) is taken into consideration. The fishery does overlap with a number of marine turtle species and the subgroup is known to interact with the trawl apparatus. Bar spacing of the TED larger than what is permitted in prawn trawls. This increases the risk for smaller turtles who may pass through or become trapped in the TED. Risk rating recognises the life-history constraints and the species and the increased risk of the interaction resulting from a mortality if, for example, they cannot escape through the TED. Risk rating may be precautionary as there is limited information on how this subgroup interacts with the fishery and/or post interaction survival rates. Data limitations are being actively addressed through permit conditions that require observers to be on board the vessel for the first two trips of each fishing 	No; Risks & deficiencies addressed through permit conditions.

Ecological Component	Level 1 Risk Rating	Considerations of Likelihood and Mitigation Measures	Level 2 Required?
		<p>year and on every third trip thereafter, and unless otherwise required.</p> <ul style="list-style-type: none"> Suitability and applicability of the risk rating will need to be reviewed if and when fishing recommences in the fishery. The fishery is will be a contributor of risk <i>verses</i> the main driver of risk for this ecological component. 	
Sea snakes	Intermediate	<ul style="list-style-type: none"> No direct reports from the SOCI logbooks, although subgroup has been reported through the previous FOP. Sea snakes are susceptible to capture in trawl fisheries and, depending on the fishing event, can have elevated rates of mortality. Sea snakes are a prominent component of bycatch in adjacent fisheries <i>e.g.</i> the NPF suggesting they will be encountered in the GOCDFTF. TED will be less effective for this subgroup and some BRDs are less effective at excluding sea snakes from the trawl catch. Risk rating may be precautionary as there is limited information on how this subgroup interacts with the fishery and/or post interaction survival rates. Data limitations are being actively addressed through permit conditions that require observers to be on board the vessel for the first two trips of each fishing year and on every third trip thereafter, and unless otherwise required. Given the extent of fishing operations in adjacent jurisdictions, the GOCDFTF will (at most) be a contributor of risk for this subgroup <i>verse</i> the main driver of risk. 	No
Crocodiles	Negligible	<ul style="list-style-type: none"> Interactions with this subgroup are unlikely. In the unlikely event that a crocodile interacts with the trawl net a) its manoeuvrability would help it avoid being caught and b) its size would increase the likelihood that it would be excluded from the net via the TED. 	No

Ecological Component	Level 1 Risk Rating	Considerations of Likelihood and Mitigation Measures	Level 2 Required?
<i>Dugongs</i>	Negligible	<ul style="list-style-type: none"> • No reports of dugongs interacting with the trawl apparatus and future interactions considered to be unlikely. • Limited spatial overlap between key fishing grounds and preferred habitats. • Higher risk associated with indirect impacts and cumulative fishing pressures e.g. boat strike, customary fishing practices. 	No
<i>Cetaceans</i>	Low / Intermediate	<ul style="list-style-type: none"> • High spatial overlap between key fishing grounds and preferred habitats; although interactions more likely to be with dolphin species. • Limited information on cetacean interactions with the GOCDFFTF. However research from adjacent fin fish trawl fisheries (<i>i.e.</i> Pilbara Trawl Fishery) shows that dolphins regularly interact with the net. • Interactions are often instigated by the animal who are entering the net to feed verse being caught in the sweep of the trawl. • Indirect impacts (<i>e.g.</i> contact without capture, boat strike) are also a potential factor for this subgroup higher risk than direct impacts (<i>e.g.</i> capture, discarding, entanglement). • Use of a TED will prevent a dolphin from entering the cod-end of the net. There is however a risk that the animal will become directly entangled in the net or as a result of their interaction with the TED. 	No
<i>Protected teleosts</i>	Low / Intermediate	<ul style="list-style-type: none"> • Limited information on interactions with protected teleosts or release fates; although both Queensland goproper and barramundi cod have been observed in the trawl catch. • Survivability of released fish will depend on a range of factors including the species, water depth and handling procedures. • Interactions with this subgroup expected to be infrequent due to the nature of the fishery event. 	No; Risks & deficiencies addressed through permit conditions.

Ecological Component	Level 1 Risk Rating	Considerations of Likelihood and Mitigation Measures	Level 2 Required?
		<p>However, the extent of these interactions cannot be validated at this point in time.</p> <ul style="list-style-type: none"> • TEDs will help to exclude larger specimens from the catch. • Limited capacity to validate interaction rates with this subgroup and/or assess the extent (if applicable) of underreporting. • Suitability and applicability of the risk rating will need to be reviewed if and when fishing recommences in the fishery. • Similarly, an evaluation of the appropriateness of the current risk mitigation measures will need to be undertaken once the extent of the effort increase is known. 	
<i>Batoids</i>	Intermediate	<ul style="list-style-type: none"> • When in operation the fishery will interact with a range of non-target species including batoids and batoid species that inhabit deeper waters. • Bycatch mitigation measures are more advanced in this fishery with the use of a TED and BRD mandated through permit conditions. • The effectiveness of these measures will be dependent on the species, the size of the animal and the overall morphology. • Smaller rays are more likely to pass through the bars of the TED. Larger batoids and sawfish may find it more difficult to escape through a TED due to entanglements. • The risk rating were partly influenced by data deficiencies. This issue is being actively addressed through permit conditions that require observers to be on board the vessel for the first two trips of each fishing year and on every third trip thereafter, and unless otherwise required. • Suitability and applicability of the risk rating will need to be reviewed if and when fishing recommences in the fishery. 	No; Risks & deficiencies addressed through permit conditions.

Ecological Component	Level 1 Risk Rating	Considerations of Likelihood and Mitigation Measures	Level 2 Required?
<i>Sharks</i>	Low	<ul style="list-style-type: none"> When in operation the fishery will interact with some species of shark. Bycatch mitigation measures including the use of a TED will be effective for this subgroup. Smaller individuals or species may pass through the bars of the TED and into the cod-end. Information on post-release survival rates of landed sharks is limited and further information is required on catch compositions The risk rating were partly influenced by data deficiencies. This deficiencies are being actively addressed through permit conditions that require observers to be on board the vessel for the first two trips of each fishing year and on every third trip thereafter, and unless otherwise required. 	No
<i>Syngnathids</i>	Low	<ul style="list-style-type: none"> Bycatch records indicate that the fishery interacts infrequently with syngnathids. Given the morphology of the species and their overall size, syngnathids will derive significant benefit from the combined use of a TED, BRDs and a larger minimum mesh size (110mm). 	No
<i>Seabirds</i>	Negligible	<ul style="list-style-type: none"> Fishery presents a negligible risk to this subgroup even with an increase in effort usage. 	No
<i>Terrestrial mammal</i>	Negligible	<ul style="list-style-type: none"> Fishery presents a negligible risk to this subgroup even with an increase in effort usage. 	No
Marine Habitats	Intermediate	<ul style="list-style-type: none"> Trawl fishing likely to result in regional disturbance and alter the long term structure of fished areas. Impacts will be environment specific and will depend on the extent of trawl history. Disturbance will be less in areas with a long history of trawl fishing as environment would have, more than likely, already experienced considerable change. Further information is required on the distribution of effort in this fishery and how it compares to previous trawl effort. However, overall impact on marine habitat 	No

Ecological Component	Level 1 Risk Rating	Considerations of Likelihood and Mitigation Measures	Level 2 Required?
		will be lower than in other fisheries due to a limited licensing policy.	
Ecosystem Processes	Precautionary Intermediate; data deficient	<ul style="list-style-type: none"> The broader impacts of trawling on ecosystem processes are complex. Will depend on a range of factors including the area of operation and the composition of the trawl catch. Ecosystem processes most likely to be affected includes scavenging, sedimentation, primary production and predation. Assessment of the key risks and potential consequences is difficult due to data deficiencies. While recognising that ecosystem processes has been assigned a higher risk rating, the ecological component will not be progressed to a Level 2 assessment without a significant increase in the amount of available information. 	Not progressed due to data deficiencies

4.6 Issues Arising

Uncertainties in fishing strategies and gear configurations

The fishing environment for the GOCDFFTF has undergone considerable change in recent years. Catch and effort in the fishery is now subject to more stringent management arrangements and operators must use a TED and BRD whilst fishing. With low to negligible levels of effort being reported from the fishery, there has been little opportunity to evaluate the effectiveness of these changes or obtain information on how the new management arrangements have affected gear types, gear configurations and fishing strategies.

With operators now required to have observers on board for the first two trips of the fishing season and on every third trip, it will be easier to gather information on the types of gear being used in the fishery. This information will be of value in future ERAs as fishing strategies and gear configurations will have a bearing on the risk profile of some ecological components, including marine habitats, ecosystem processes, marine turtles and cetaceans.

Validating SOCI interactions

In Queensland, all commercial operators are required to report interactions with SOCI in a dedicated logbook. In the GOCDFFTF, the majority of SOCI interactions are expected to be with sea snakes, protected teleosts and marine turtles. While no SOCI interactions have been recorded in the logbooks, reports from neighbouring and similar fisheries, historical catch data and observer data all indicates that the fishery will interact with these species. The requirement for observers to be present on the first

two trips of each fishery year and on every third trip thereafter (unless otherwise required) will improve the level of information on SOCI interactions in the GOCDFFTF. Validation of commercial fishing data, including SOCI logbooks is also a priority reform action under the *Queensland Sustainable Fisheries Strategy 2017–2027*.

Increased effort / underutilised quota

There is currently no fishing effort in the GOCDFFTF. Although the current ERA for this fishery has considered the risk of all ecological components under the assumption that all three permits are active. This process contains uncertainties due to the lack of baseline effort under the most recent permit conditions. These include compulsory use of TEDs and BRD's, no discards of permitted species and reduced quota. These conditions have never before been assessed in this fishery. Therefore, the risks assigned to each component may need to be reconsidered when effort increases in the GOCDFFTF.

5 Summary & Recommendations

With the fishery reporting low levels of effort, the risk of the GOCDFFTF contributing to or causing an undesirable event for one or more of the ecological components is negligible. In line with this assessment, risks ratings assigned in the Level 1 ERA should be viewed as a) precautionary in nature and b) indicative of what may occur if fishing were to recommence in the GOCDFFTF.

If fishing effort were to increase in the fishery, the extent of (any) risk increase will be managed through the limited licensing policy and permit conditions. Changes to the management regime over the last five years including the introduction of new bycatch reduction measures and additional reporting requirements are designed to reduce the risk to both target and non-target species. The effectiveness of these measures though have yet to be tested in a season with elevated catch and effort levels.

Given the above considerations, progressing the GOCDFFTF to a finer scale, species-specific ERA (Level 2 ERA) is not warranted. Going forward, the need to subject the fishery to additional ERAs will depend on the level of fishing effort in the fishery.

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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 ERA 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 ACTION	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	Includes 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 the 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', then 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 GOCDFTF.

Ecological Component	Trawl fishing—Main activities of the Fishery							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	
Sedimentation	-	-	-	L	-	I	-	-
Nutrient cycling / Microbial processes	L	-	-	-	-	-	-	L
Particle feeding	-	-	-	-	-	L	-	-
Primary production	-	-	-	-	-	L	-	-
Herbivory	-	-	-	-	-	-	-	-
Predation	L	L	L	-	-	-	-	L
Bioturbation	-	-	-	-	-	L	-	-
Detritivory	-	L	-	-	-	L	-	L
Scavenging	L	L	L	-	-	L	-	L
Symbiosis	-	-	-	-	-	-	-	-
Recruitment	H	-	-	-	-	-	-	-
Reef building	-	-	-	L	-	L	-	-
Competition	L	-	-	-	-	-	-	-
Connectivity	L	-	-	-	-	-	-	-
Outbreaks of disease	-	-	-	-	-	-	-	-
Species introductions	-	-	-	-	-	-	-	-
ECOSYSTEM PROCESSES (overall)	H	L	L	L	-	I	-	L

* Includes line caught species from the recreational and 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. As no effort has been reported from the GOCDFFTF in the last two years, the fishery does not currently present a risk to any of the ecological components. However, developmental permits for the fishery are still in effect; meaning fishing can recommence in the GOCDFFTF over the short to medium term. Given this, the Level 1 (whole of fishery) ERA was developed under the following assumptions: a) fishing will recommence in the GOCDFFTF and b) annual effort will not significantly exceed that previously recorded in the fishery. The following provides an overview of the preliminary risk ratings for the GOCDFFTF, the key considerations and other factors of relevance relating to the broader risks. 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	<ul style="list-style-type: none"> Fishery interact and retains a comparatively high number of target and byproduct species. 	CS—Intermediate	<p><u>Likelihood</u></p> <ul style="list-style-type: none"> Low to moderate depending on the species 	CS—Low

Ecological Component	Key Issues / Sources of Risk	Risk Characterisation (Preliminary rating)	Considerations of Likelihood and Mitigation Measures	Level 1 Risk Rating
	<ul style="list-style-type: none"> Quota used to control retention of key target and byproduct species. Quota is based on the outputs of stock assessment for tropical snapper. Operators are required to retain all quota managed species including undersized fish from the six management units. Little information on the amount of product that is removed through TEDs and BRDs or their post-interaction fate. Risks (overall) are well managed through stringent permit conditions. These conditions are largely aimed at reducing the impact of the fishery on smaller cohorts and ensuring the long-term sustainability of regional stocks. Risks will be higher for the multi-species quota management unit (OS Gulf) and mangrove jack which has been historically overfished in this region. As a trawl fishery, there is considerable potential for a high number of on-target sizes to be caught at once. However, permit conditions are in place to manage this risk. 	SS—Intermediate	<p><u>Mitigation Measures & Considerations</u></p> <ul style="list-style-type: none"> Preliminary risk ratings heavily influenced by ratings assigned to disturbance due to presence in the area. Risks rating assigned disturbance due to presence in the area were intimately linked with the use of a trawl apparatus and resulted in most of these management units being assigned an overestimated preliminary risk score. Risks (overall) are well managed through stringent permit conditions. These conditions are largely aimed at reducing the impact of the fishery on smaller cohorts and ensuring the long-term sustainability of regional stocks. Risks still considered to be higher for the OS (Gulf) due to the multi-species nature of this management unit. Mangrove jack received an elevated risk rating as regional stocks are currently recovering from an extended period of overfishing. The small size of the fishery is viewed as one of the key measures minimising risk in this 	SS—Low
		GS—Intermediate		GS—Low
		RE—Intermediate		RE—Low
		MJ—Intermediate		MJ—Low/Intermediate
		OS Gulf—Intermediate/High		OS GOC—Intermediate

Ecological Component	Key Issues / Sources of Risk	Risk Characterisation (Preliminary rating)	Considerations of Likelihood and Mitigation Measures	Level 1 Risk Rating
			fishery. If the scope of the fishery were to expand, some species or species groupings may be at higher risk of experiencing an undesirable event.	
Bycatch (non-SOCC)	<ul style="list-style-type: none"> Interaction rates with non-target teleosts will be lower due to the use of the OS (Gulf) quota management unit. While operators are required to retain all target and byproduct species (legal and undersized), there is limited information on the compositions of the remaining bycatch species. Bycatch mitigation measures including the use of a TED, BRDs and larger mesh sizes (>110mm) will assist in reducing the risk for this ecological component. The subgroup though will include a range of species with varying life-history constraints. Some of these species may be less resilient. Non-target species will experience <i>in-situ</i> mortalities, post-release mortalities (including predation) and cryptic mortalities. 	Intermediate/High	<p><u>Likelihood</u></p> <ul style="list-style-type: none"> Likely as the fishery, when in operation, will interact a range of non-target species. <p><u>Mitigation Measures & Considerations</u></p> <ul style="list-style-type: none"> As a trawl fishery, there is high likelihood of an operator catching and landing non-target species. Bycatch mitigation measures are more advanced in this fishery with the use of a TED, BRD and larger mesh sizes (>110mm) all mandated through permit conditions. The effectiveness of these measures will be dependent on the species, the size of the animal and the overall morphology. The risk rating was influenced by data deficiencies and may still be precautionary in nature. This issue is being actively addressed 	Intermediate

Ecological Component	Key Issues / Sources of Risk	Risk Characterisation (Preliminary rating)	Considerations of Likelihood and Mitigation Measures	Level 1 Risk Rating
			<p>through permit conditions that require observers to be on board the vessel for the first two trips of each fishing year and on every third trip thereafter, and unless otherwise required.</p> <ul style="list-style-type: none"> Suitability and applicability of the risk rating will need to be reviewed if and when fishing recommences in the fishery. 	
Species of Conservation Concern (SOCC)				
<i>Marine turtles</i>	<ul style="list-style-type: none"> Small number of interactions reported from the fishery. Interactions may be higher when contact without capture (e.g. exclusion due to TED) are taken into consideration. Risk is managed through the use of a TED, limited licensing policy and best practice and handling procedures. Bar spacing of the TED larger than what is permitted in prawn trawls. This increases the risk for smaller turtles who may pass through or become trapped in the TED. 	Intermediate	<p><u>Likelihood</u></p> <ul style="list-style-type: none"> Low to intermediate due to nature of the trawl fishery and overlap with species distributions. <p><u>Mitigation Measures & Considerations</u></p> <ul style="list-style-type: none"> Subgroup assigned an elevated risk rating in recognition of the fact that marine turtles may be caught in the apparatus and/or interact with the gear without detection. Risk rating recognises the life-history constraints and the species and the increased 	Intermediate

Ecological Component	Key Issues / Sources of Risk	Risk Characterisation (Preliminary rating)	Considerations of Likelihood and Mitigation Measures	Level 1 Risk Rating
	<ul style="list-style-type: none"> Limited information on how turtles interact with this fishery and/or the species compositions. Limited capacity to validate interaction rates with this subgroup and/or assess the extent (if applicable) of underreporting. 		<p>risk of the interaction resulting from a mortality if, for example, they cannot escape through the TED.</p> <ul style="list-style-type: none"> Risk rating may be precautionary as there is limited information on how this subgroup interacts with the fishery and/or post interaction survival rates. Data limitations are being actively addressed through permit conditions that require observers to be on board the vessel for the first two trips of each fishing year and on every third trip thereafter, and unless otherwise required. Suitability and applicability of the risk rating will need to be reviewed if and when fishing recommences in the fishery. SOCI reporting. 	
Sea snakes	<ul style="list-style-type: none"> No direct reports from the SOCI logbooks, although subgroup has been reported through the previous FOP. 	Intermediate	<p><u>Likelihood</u></p> <ul style="list-style-type: none"> Moderate potential due to size of species and areas being trawled. <p><u>Mitigation Measures & Considerations</u></p>	Intermediate

Ecological Component	Key Issues / Sources of Risk	Risk Characterisation (Preliminary rating)	Considerations of Likelihood and Mitigation Measures	Level 1 Risk Rating
	<ul style="list-style-type: none"> • Sea snakes are a prominent component of the bycatch in adjacent fisheries e.g. the NPF suggesting they will be encountered. • TED will be less effective for this subgroup and some BRDs are less effective at excluding sea snakes from the trawl catch. • Risk to this subgroup would be reduced by the limited licensing policy and the (maximum) effort levels which are much smaller than in the NPF. • Limited capacity to validate interaction rates with this subgroup and/or assess the extent (if applicable) of underreporting. • Populations for most of these species would be healthier than marine turtles and subgroup has greater potential to rebound after potential decline. 		<ul style="list-style-type: none"> • Sea snakes are susceptible to capture in trawl fisheries and, depending on the fishing event, can have elevated rates of mortality. • TED will be less effective for this subgroup and some BRDs are less effective at excluding sea snakes from the trawl catch. • Risk rating may be precautionary as there is limited information on how this subgroup interacts with the fishery and/or post-interaction survival rates. • Data limitations are being actively addressed through permit conditions that require observers to be on board the vessel for the first two trips of each fishing year and on every third trip thereafter, and unless otherwise required. • Given the extent of fishing operations in adjacent jurisdictions, the GOCDFFTF will (at most) be a contributor of risk for this subgroup <i>verse</i> the main driver of risk. • SOCI reporting. 	

Ecological Component	Key Issues / Sources of Risk	Risk Characterisation (Preliminary rating)	Considerations of Likelihood and Mitigation Measures	Level 1 Risk Rating
<i>Crocodiles</i>	<ul style="list-style-type: none"> Interactions with this subgroup are unlikely. In the unlikely event that a crocodile interacts with the trawl net a) its manoeuvrability would help it avoid being caught and b) its size would increase the likelihood that it would be excluded from the net through the TED. 	Negligible	<p><u>Likelihood</u></p> <ul style="list-style-type: none"> Low even with a substantial increase in effort <p><u>Mitigation Measures & Considerations</u></p> <ul style="list-style-type: none"> N/A as interaction rates (if applicable) are unlikely to have long term implications for regional populations. 	Negligible
<i>Dugongs</i>	<ul style="list-style-type: none"> No reports of dugongs interacting with the trawl apparatus and future interactions considered to be unlikely. Limited spatial overlap between key fishing grounds and preferred habitats. Limited capacity to validate interaction rates with this subgroup and/or assess the extent (if applicable) of underreporting. 	Low	<p><u>Likelihood</u></p> <ul style="list-style-type: none"> Low even with a substantial increase in effort <p><u>Mitigation Measures & Considerations</u></p> <ul style="list-style-type: none"> N/A as interaction rates (if applicable) are unlikely to have long term implications for regional populations. Higher risk associated with indirect impacts and cumulative fishing pressures e.g. boat strike, customary fishing. SOCI reporting. 	Negligible
<i>Cetaceans</i>	<ul style="list-style-type: none"> High spatial overlap between key fishing grounds and preferred habitats. 	Intermediate	<p><u>Likelihood</u></p>	Low/Intermediate

Ecological Component	Key Issues / Sources of Risk	Risk Characterisation (Preliminary rating)	Considerations of Likelihood and Mitigation Measures	Level 1 Risk Rating
	<ul style="list-style-type: none"> Limited information on cetacean interactions with the GOCDFFTF. However research from adjacent fin fish trawl fisheries (<i>i.e.</i> Pilbara Trawl Fishery) shows that dolphins regularly interact with the net. These interactions are often instigated by the animal who are entering the net to feed <i>verse</i> being caught in the sweep of the trawl. Indirect impacts (<i>e.g.</i> contact without capture, boat strike) are also a potential factor for this subgroup higher risk than direct impacts (<i>e.g.</i> capture, discarding, entanglement). Use of a TED will prevent a dolphin from entering the cod-end of the net. There is however a risk that the animal will become directly entangled in the net or as a result of their interaction with the TED. Risks will vary with species size and will be more applicable to dolphins. 		<ul style="list-style-type: none"> Interactions likely with this subgroup with the majority being instigated by the animal. <p><u>Mitigation Measures & Considerations</u></p> <ul style="list-style-type: none"> Limited information on how this subgroup interacts with the GOCDFFTF. However, interactions are more likely to be with dolphin species. Risk rating may be precautionary as there is limited information on how this subgroup interacts with the fishery and/or post interaction survival rates. Data limitations are being actively addressed through permit conditions that require observers to be on board the vessel for the first two trips of each fishing year and on every third trip thereafter, and unless otherwise required. Suitability and applicability of the risk rating will need to be reviewed if and when fishing recommences in the fishery. SOCI reporting. 	

Ecological Component	Key Issues / Sources of Risk	Risk Characterisation (Preliminary rating)	Considerations of Likelihood and Mitigation Measures	Level 1 Risk Rating
<i>Protected teleosts</i>	<ul style="list-style-type: none"> Limited information on interactions with protected teleosts or release fates. Queensland groper and barramundi cod have been observed in the trawl catch. Survivability of released fish will depend on a range of factors including the species, water depth and handling procedures. Post-interaction survival rates for trawl-caught fish are expected to be lower when compared to line caught fish. TEDs will help to exclude larger specimens from the catch. Limited capacity to validate interaction rates with this subgroup and/or assess the extent (if applicable) of underreporting. 	Intermediate	<p><u>Likelihood</u></p> <ul style="list-style-type: none"> Low to intermediate due to the species being targeted. <p><u>Mitigation Measures & Considerations</u></p> <ul style="list-style-type: none"> Some potential for the fishery to interact with the Queensland groper and barramundi cod. Interactions with this subgroup expected to be infrequent due to the nature of the fishery event. However, the extent of these interactions cannot be validated at this point in time. Suitability and applicability of the risk rating will need to be reviewed if and when fishing recommences in the fishery. Similarly, an evaluation of the appropriateness of the current risk mitigation measures will need to be undertaken once the extent of the effort increase is known. SOCI reporting. 	Low/Intermediate

Ecological Component	Key Issues / Sources of Risk	Risk Characterisation (Preliminary rating)	Considerations of Likelihood and Mitigation Measures	Level 1 Risk Rating
<p><i>Batoids</i></p>	<ul style="list-style-type: none"> • Batoids can be retained for sale in the GOCDFFTF but most are discarded. • High potential for the fishery to interact with a range of species including SOCI. • Little information on catch compositions, discard rates and discard fates including for SOCI. • While TEDs used in the fishery, they will be less effective for smaller species—particularly with larger bar spacing. • Limited capacity to validate interaction rates with this subgroup and/or assess the extent (if applicable) of underreporting. 	<p>Intermediate</p>	<p><u>Likelihood</u></p> <ul style="list-style-type: none"> • Likely as fishery, when in operation, will interact a range of non-target species including batoids. <p><u>Mitigation Measures & Considerations</u></p> <ul style="list-style-type: none"> • As s trawl fishery, there is high likelihood of an operator catching and landing non-target species including batoids. • Bycatch mitigation measures are more advanced in this fishery with the use of a TED and BRD mandated through permit conditions. • The effectiveness of these measures will be dependent on the species, the size of the animal and the overall morphology. • The fishery may also interact with sawfish species that spend periods of time out in deeper water. There is however a high degree of uncertainty surrounding the potential of this fishery to interact with sawfish species. 	<p>Intermediate</p>

Ecological Component	Key Issues / Sources of Risk	Risk Characterisation (Preliminary rating)	Considerations of Likelihood and Mitigation Measures	Level 1 Risk Rating
			<ul style="list-style-type: none"> • Smaller rays may also experience higher rates of within-trawl mortalities. • Larger batoids and sawfish may find it more difficult to escape through a TED due to entanglements. • The risk rating were partly influenced by data deficiencies. This issue is being actively addressed through permit conditions that require observers to be on board the vessel for the first two trips of each fishing year and on every third trip thereafter, and unless otherwise required. • Suitability and applicability of the risk rating will need to be reviewed if and when fishing recommences in the fishery. • SOCI reporting. 	
Sharks	<ul style="list-style-type: none"> • Subgroup not permitted to be retained for sale in the GOCDFTF. • Research has shown TEDs are effective at discarding larger sharks from trawl catch. 	Low / Intermediate	<p><u>Likelihood</u></p> <ul style="list-style-type: none"> • Interactions likely when in operation, as fishery will interact a range of non-target species including sharks. <p><u>Mitigation Measures & Considerations</u></p>	Low

Ecological Component	Key Issues / Sources of Risk	Risk Characterisation (Preliminary rating)	Considerations of Likelihood and Mitigation Measures	Level 1 Risk Rating
	<ul style="list-style-type: none"> While smaller individuals and species may pass through the TED, <i>in-situ</i> mortalities likely to be lower than batoids. Highest risks will be associated with post interaction injuries <i>i.e.</i> when they pass through the TED. High post-interaction/release survival rate. Most interactions will not result in the animal being landed on deck. Little information on catch compositions, discard rates and discard fates including for SOCI. Limited capacity to validate interaction rates with this subgroup and/or assess the extent (if applicable) of underreporting. 		<ul style="list-style-type: none"> While the fishery will interact with shark species, bycatch mitigation measures including the use of a TED will be effective for this subgroup. Smaller individuals or species may pass through the bars of the TED and into the cod-end. Information on post-release survival rates of landed sharks is limited and further information is required on catch compositions. The risk rating were partly influenced by data deficiencies. This issue is being actively addressed through permit conditions that require observers to be on board the vessel for the first two trips of each fishing year and on every third trip thereafter, and unless otherwise required. SOCI reporting. 	
<i>Syngnathids</i>	<ul style="list-style-type: none"> Bycatch records indicate that the fishery interacts infrequently with <i>Syngnathids</i>. Given the morphology of the species and their overall size, <i>syngnathids</i> will derive significant 	Low	<p><u>Likelihood</u></p> <ul style="list-style-type: none"> Negligible even with a substantial increase in effort 	Low

Ecological Component	Key Issues / Sources of Risk	Risk Characterisation (Preliminary rating)	Considerations of Likelihood and Mitigation Measures	Level 1 Risk Rating
	benefit from the combined use of a TED, BRDs and a larger minimum mesh size (110mm).		<p><u>Mitigation Measures & Considerations</u></p> <ul style="list-style-type: none"> N/A as interaction rates (if applicable) are unlikely to have long term implications for regional populations. Mandatory SOCI reporting is in place for this subgroup. Observers are required to be on board the vessel for the first two trips of each fishing year and on every third trip thereafter, and unless otherwise required. 	
Seabirds	<ul style="list-style-type: none"> Interactions with this subgroup are unlikely. 	Low	<p><u>Likelihood</u></p> <ul style="list-style-type: none"> Negligible even with a substantial increase in effort <p><u>Mitigation Measures & Considerations</u></p> <ul style="list-style-type: none"> N/A as interaction rates (if applicable) are unlikely to have long term implications for regional populations. Mandatory SOCI reporting is in place for this subgroup. 	Negligible

Ecological Component	Key Issues / Sources of Risk	Risk Characterisation (Preliminary rating)	Considerations of Likelihood and Mitigation Measures	Level 1 Risk Rating
			<ul style="list-style-type: none"> Observers are required to be on board the vessel for the first two trips of each fishing year and on every third trip thereafter, and unless otherwise required. 	
<i>Terrestrial Mammal</i>	<ul style="list-style-type: none"> Negligible interactions or spatial overlap. 	Negligible	<p><u>Likelihood</u></p> <ul style="list-style-type: none"> Negligible even with a substantial increase in effort <p><u>Mitigation Measures & Considerations</u></p> <ul style="list-style-type: none"> N/A as interaction rates (if applicable) are unlikely to have long term implications for regional populations. 	Negligible
Marine Habitats	<ul style="list-style-type: none"> High degree of contact with marine habitats over a sustained period. Higher potential for direct and indirect disturbance. Impacts will be environment specific and will depend on the extent of trawl history. 	Intermediate/High	<p><u>Likelihood</u></p> <ul style="list-style-type: none"> Likely disturbance due to the nature of trawl fishing. <p><u>Mitigation Measures & Considerations</u></p> <ul style="list-style-type: none"> Trawl fishing likely to result in regional disturbance and alter the long term structure of fished areas. Disturbance will be less in areas with a long history of trawl fishing as environment would 	Intermediate

Ecological Component	Key Issues / Sources of Risk	Risk Characterisation (Preliminary rating)	Considerations of Likelihood and Mitigation Measures	Level 1 Risk Rating
			<p>have, more than likely, already experienced considerable change.</p> <ul style="list-style-type: none"> Further information is required on the distribution of effort in this fishery and how it compares to previous trawl effort, Overall impact on marine habitat will be lower than in other fisheries due to a limited licensing policy. 	
Ecosystem processes	<ul style="list-style-type: none"> Interacts with diverse range of species and trophic levels. Has the potential to influence a range of ecosystem processes. Longevity of the impact will vary as will the extent of the impact. 	Intermediate/High	<p><u>Likelihood</u></p> <ul style="list-style-type: none"> Likely disturbance due to the nature of trawl fishing. <p><u>Mitigation Measures & Considerations</u></p> <ul style="list-style-type: none"> The broader impacts of trawling on ecosystem processes are complex. Will depend on a range of factors including the area of operation and the composition of the trawl catch. Ecosystem processes most likely to be affected includes scavenging, sedimentation, primary production and predation. 	Precautionary Intermediate; data deficient

Ecological Component	Key Issues / Sources of Risk	Risk Characterisation (Preliminary rating)	Considerations of Likelihood and Mitigation Measures	Level 1 Risk Rating
			<ul style="list-style-type: none"> • Assessment of the key risks and potential consequences is difficult due to data deficiencies. • While recognising that ecosystem processes has been assigned a higher risk rating, the ecological component will not be progressed to a Level 2 assessment without a significant increase in the amount of available information. 	