

Sustainable Fisheries Strategy

2017–2027

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

**Level 1 Ecological Risk Assessment
Gulf of Carpentaria Inshore Fin Fish Fishery**

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Executive Summary

The Queensland Ecological Risk Assessment Guideline (the Guideline) was released in March 2018 as part of the *Queensland Sustainable Fisheries Strategy 2017–2027* (Department of Agriculture and Fisheries, 2017; 2018a). This Guideline provides an overview of 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 aim of the Level 1 ERA is to produce a broad risk profile for each fishery using a qualitative ERA method described by Astles *et al.* (2006). The method considers a range of factors including the current fishing environment (*e.g.* current catch, effort and licensing trends), limitations of the current management arrangements (*e.g.* the potential for additional effort to be transferred into areas already experiencing higher levels of fishing mortality, changing target species) and life-history constraints of the species being assessed. In the *Gulf of Carpentaria Inshore Fin Fish Fishery* (GOCIFFF) the Level 1 ERA examined fishing related risks in 16 broader ecological components including target & byproduct species, bycatch, marine turtles, sea snakes, crocodiles, dugongs, whales, dolphins, 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'.

Preliminary assessments for the GOCIFFF indicated that at least eight of the ecological components were at low to intermediate risk of experiencing an undesirable event. The most notable risks related to target & byproduct species, bycatch, marine turtles, dugongs, dolphins, batoids, sharks and ecosystem processes, which were all assigned higher risk ratings. While not universal, the key drivers of risk in this fishery included a limited capacity to control catch and effort (target & byproduct) at a whole of fishery and regional level, data limitations (bycatch, species of conservation interest), and an inability to validate catch data (species with conservation concerns). The structure of the Gulf of Carpentaria net attendance provisions, currently set at 5nm (~9km) in rivers and creeks and 6nm (~11km) in nearshore waters, was also a factor of influence in a number of the risk profiles.

After the likelihood of the risk coming to fruition was considered, the preliminary risk ratings of four ecological components were reduced. The risk rating for crocodiles was reduced from intermediate to low/intermediate based on the number of interactions and the health of the population across northern Australia. Risk ratings for whales and marine habitats were reduced from intermediate to low due to a) the influence of ghost nets on the preliminary risk ratings and b) research showing that the majority of

ghost nets come from fisheries outside of Australia. Lastly, the risk rating for syngnathids was reduced from low to negligible to reflect the likelihood of an interaction occurring and a low capture potential.

Based on the revised risk ratings, seven ecological components will be progressed to a Level 2 assessment: target & byproduct species, bycatch, marine turtles, dugongs, dolphins, batoids and sharks. While ecosystem processes were assigned a precautionary high risk rating, it was not progressed to a Level 2 ERA due to data limitations. The Level 1 ERA also identified key knowledge gaps in a number of the risk profiles and areas where the scope of the Level 2 ERA can be further refined. These information needs will be largely progressed through the *Fisheries Queensland Monitoring and Research Plan* for further consideration. Key information needs to refine risk profiles of ecological components that interact with the GOCIFFF include:

- Providing greater differentiation between target, byproduct and bycatch species including an examination of regional variability in catch compositions and emerging market trends e.g. secondary target species that may experience increased fishing mortality over the short to medium term or where international demand is increasing.
- Increasing the level of information on discard rates and fates for low value target/byproduct species and non-target species including those identified as threatened, endangered and protected.
- Validating species compositions, interaction rates and catch dynamics (e.g. size structures, sex ratios) for the SOCC ecological component.
- Improving the level of information on the efficiency of the current net attendance provisions and how they are utilised by net fishers in the Gulf of Carpentaria.
- Further assessment of regional catch and effort levels in the recreational fishing sector for key species where cumulative fishing impacts present as a higher risk.

Summary of the outputs from the Level 1 (whole of fishery) Ecological Risk Assessment for the Gulf of Carpentaria Inshore Fin Fish Fishery (GOCIFFF).

Ecological Component	Level 1 Risk Rating	Level 2 Required?
Target & Byproduct	High	Level 2 ERA
Bycatch (non-SOCC)	Intermediate/High	Level 2 ERA
Species of Conservation Concern (SOCC)		
Marine turtles	High	Level 2 ERA
Sea snakes	Low	Not progressed further.
Crocodiles	Low/Intermediate	Not progressed further.
Dugongs	Intermediate/High	Level 2 ERA
Whales	Low	Not progressed further.
Dolphins	High	Level 2 ERA
Protected teleosts	Low	Not progressed further.
Batoids	High	Level 2 ERA
Sharks	High	Level 2 ERA
Syngnathids	Negligible	Not progressed further.

Ecological Component	Level 1 Risk Rating	Level 2 Required?
Seabirds	Low	Not progressed further.
Terrestrial mammal	Negligible	Not progressed further.
Marine Habitats	Low/Intermediate	Not progressed further.
Ecosystem Processes	Precautionary high; data deficient	Not progressed due to data limitations.

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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 GOCIFFF through the logbook reporting system irrespective of the amount of catch and effort.
Bycatch	– The portion of the catch that is discarded/returned to sea. For the purpose of this ERA, the definition of bycatch does not include unwanted target and byproduct species.
Byproduct	– The portion of catch retained for commercial sale that was not intentionally targeted. For the purpose of this ERA, the definition of byproduct does not include any line caught product that was retained for sale in another fishery (<i>i.e.</i> the CRFFF or RRFFF). In this risk assessment, this portion of the catch is classified as ‘bycatch’.
DAF	– Queensland Department of Agriculture and Fisheries.
ECIFFF	– East Coast Inshore Fin Fish Fishery.
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.
False positive	– The situation where a species at low risk is incorrectly assigned a higher risk rating due to the method being used, data limitation etc. In the context of an ERA, ‘false positives’ are preferred over ‘false negatives’.
False negative	The situation where a species at high risk is assigned a lower risk rating. When compared, false negative results are considered to be of more concern as the impacts/consequences can be more significant.
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. However, operators in the GOCIFFF are not permitted to line and net fish simultaneously (one or the other).
FOP	– Fisheries Observer Program. The FOP was operational in Queensland from 2006 to 2013 and collected independent data from a range of commercial fisheries.
GBR/GBRMP	– Great Barrier Reef / Great Barrier Reef Marine Park.
MEY	– Maximum Economic Yield.
MSY	– Maximum Sustainable Yield.
Offshore waters	– Tidal waters that are at least 2m deep at low water.
QBFP	– Queensland Boating and Fisheries Patrol.
SAFS	– National 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, 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.
Target	– The primary species or species groups that have been selectively fished for and retained for commercial, recreational and Aboriginal peoples and Torres Strait Islander peoples.
TACC	– Total Allowable Commercial Catch.
WTO	– Wildlife Trade Operation.

1 Overview

The *Gulf of Carpentaria Inshore Fin Fish Fishery* (GOCIFFF) extends from Slade Point near the tip of Cape York Peninsula westward to the Queensland – Northern Territory border and operates in all tidal waters. A net only fishery, GOCIFFF operators target a wide range of species with the retained catch dominated by barramundi, grey mackerel, king threadfin, blue threadfin and tropical sharks (Department of Agriculture and Fisheries, 2019a). The fishery also interacts with a range of non-target species including a number that have ongoing concerns regarding their long-term sustainability.

The GOCIFFF 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). The results of this risk assessment have subsequently been built upon by programs like the national *Status of Australian Fish Stocks* (SAFS) and Queensland stock status process. However, a secondary risk assessment for the GOCIFFF has not been undertaken since the original review (Zeller & Snape, 2006).

The fishing environment for the GOCIFFF has undergone considerable change since the completion of the previous ERA. The GOCIFFF was originally managed through the *Fisheries (Gulf of Carpentaria Inshore Fin Fish) Management Plan 1999*. However, this Management Plan was repealed in November 2011, and management arrangements were placed under the broader *Fisheries Regulation 2008*. As part of this process, the GOCIFFF underwent a considerable management reform and rationalisation process which included the introduction of new fishery symbols. Strategies used to monitor catch and effort in the fishery have also evolved and the level of information has continued to improve through time. Today, the GOCIFFF is managed under the *Fisheries Act 1994* and its subordinate legislation including *Fisheries (Commercial Fisheries) Regulation 2019*, *Fisheries (General) Regulation 2019*, and *Fisheries Declaration 2019*.

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 GOCIFFF 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).

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 GOCIFFF 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 SOCC, this ecological subgroup has been further divided into: marine turtles, sea snakes, crocodiles, dugongs, cetaceans, batoids, sharks, syngnathids, seabirds, protected teleosts and terrestrial mammals. The division of the SOCC ecological component recognises the variable life-history traits of this subgroup and the need to develop risk profiles for each complex.

Of the five ecological components, ecosystem processes 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 / microbial processes, particle feeding, primary production, herbivory, predation, bioturbation, detritivory, scavenging, symbiosis, recruitment, reef building, competition, connectivity, outbreaks of disease* and *species introductions*. Not all processes are applicable to every fishery, but all processes were considered before being eliminated. A full definition of each ecosystem process has been provided in Appendix 1.

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

1. *Risk Context*—defines the broad parameters of the assessment including the risk that is to be analysed (*i.e.* the management objectives trying to be achieved or the nature of the undesirable events), the spatial extent of the analysis, the management regimes and the timeframes of the assessment.
2. *Risk Identification*—identifies the aspects of each fishery or the sources of risk with the potential to contribute to the occurrence of an undesirable event.
3. *Risk Characterisation*—provides an estimate (low, intermediate or high) of the likelihood that one or more of the identified sources of risk will make a substantial contribution to the occurrence of an undesirable event. Used as part of a Level 1 assessment, this stage will assign each fishing activity with an indicative risk rating representing the risk posed to each ecological component. These scores will then be 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 Level 1 Qualitative Assessment

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 Inshore Fin Fish 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 GOCIFFF. 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 both the complexity of the GOCIFFF and the management regime history. Due to the similarities in fishing methods and target species, the GOCIFFF is frequently compared to the *East Coast Inshore Fin Fish Fishery* (ECIFFF). However, the operating framework for the GOCIFFF is much simpler; consisting of a single sector (net) and four fishery symbols (Department of Agriculture and Fisheries, 2019a). This contrasts with the ECIFFF which has a well-established net and line fishing sector and 17 different fishery symbols (Department of Agriculture and Fisheries, 2019b). This is reflected in the licencing data which shows that the GOCIFFF has a maximum operating potential of 89 large mesh net symbols compared to 243 in the ECIFFF. Similarly, the GOCIFFF has a smaller number of active licences

(GOCIFFF = 79, ECIFFF = 273) and registers lower levels of effort (GOCIFFF = 8252 net fishing days; ECIFFF = 16,597 net fishing days) (Department of Agriculture and Fisheries, 2019b; a).

At a whole of fishery level, the risk of the GOCIFFF contributing or causing an undesirable event has declined over the last 20 years. This is due to a range of management reforms designed to reduce both real and potential effort. These reforms have seen the number of large mesh net symbols (*i.e.* N3, N12 and N13) and the number of licences active in the fishery decline by around 20% in the post-2000 period (Department of Agriculture and Fisheries, 2019a). While not universal, one of the benefits of reducing the number of fishing symbols and active licences is that there is a direct correlation with the amount of effort (potential and real) utilised in the fishery. A decrease in the number of active licences would be accompanied by a reduction in effort and a corresponding but not necessarily equal reduction in total fishing mortality. The extent of this benefit would depend on a range of factors including the species being targeted, improvements in fishing efficiency and any fishing power increases.

More broadly, licensing data for the GOCIFFF indicates that a high proportion of the N3 and N12 fishery symbols are active in the fishery. In the context of this ERA, this data suggests that a) the activation of latent licences presents as a lower risk in this fishery; and b) that a management reform package is more likely to have an impact on real effort.

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 GOCIFFF 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 boat influences 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 GOCIFFF targets multiple species in a wide range of environments, most of the activities defined in Table 1 will apply to the fishery. **Harvesting** and **discarding** are considered to be the greatest contributors of risk, with **contact without capture** and **loss of fishing gear** viewed as secondary but significant factors of influence. Risks associated with harvesting and discarding relate to net fishing having a lower degree of selectivity and the increased potential for operators to interact with a range of target and non-target species. Contact without capture and loss of fishing gear were identified as sources of risk due, in part, to the structure of some of the net attendance provisions.

The primary purpose of the 'net-attendance provisions' is to minimise harm to marine megafauna such as those included in the SOCC ecological component. While net attendance provisions apply to all GOCIFFF operations (refer to *Schedule 4 Fisheries (Commercial Fishing) Regulation 2019*), those used in the N3 fishery are less stringent. When fishing under an N3 fishery symbol, operators must be no more than 5 nautical miles (nm) from any net that is being used. In nearshore waters, this distance extends to no more than 6nm from any net being used (Department of Agriculture and Fisheries, 2019a). This means that fishers operating under an N3 fishery symbol can be within (approximately) nine kilometres of a net set in a river or creek or within 11km of a net set in nearshore waters and still be compliant with the *Fisheries (Commercial Fisheries) Regulations 2019*. The above contrasts with net attendance provisions used in offshore waters (*i.e.* the N12 & N13 fishery symbols) and in the ECIFFF where operators are required to be between within 100 or 200 metres of the net depending on the area fished and the symbol used.¹

The structure of the current net attendance provisions increases the risk of a **contact without capture** event occurring in this fishery *i.e.* entangled animals freeing themselves after a period of time with or without equipment still attached. Likely consequences of this type of interaction include increased stress on the animal, increased risk of injury and an increased risk of post-interaction mortalities. The extent of these consequences will be highly dependent on the length of the interaction and the health of the animal once it has been able to free itself. For marine megafauna, a 9km (river and creek) or 11km (nearshore) attendance provision offers little opportunity for fishers to meet their obligations and release trapped animals or minimise capture related injuries.

More broadly, the structure of the net attendance provisions for rivers, creeks and nearshore waters, elevates the risk that regional ecosystems will be impacted through uncontrolled or unpredictable fishing pressures. Examples of where this risk may be applicable include when the gear:

- is subjected to extended soak times resulting in potentially avoidable *in-situ* mortalities *i.e.* due to poor weather;
- becomes lost during a fishing event *i.e.* is irretrievable, left abandoned or derelict; persisting in the environment as an unattended "ghost" net; or
- becomes entangled among habitat structures and degrades or fragments overtime; presenting a potential risk to the health of biota if ingested.

With regards to ghost nets, research has shown that only 10% of the collected ghost nets originate from Australian managed fisheries with the majority coming from Indonesian vessels operating in the Arafura Sea (Ghost Nets Australia, 2018). Of the nets that are collected, over 60% comes from trawl fisheries

¹ The attendance provision for offshore set nets in the GOCIFFF N12 and N13 symbol areas is similar to those that apply to equivalent netting operations in the ECIFFF.

(mostly Indonesian), 14% from gill nets and the remainder (~25%) from indeterminate sources. Based on these figures, the GOCIFFF is not expected to make a significant contribution to the number of ghost nets found in the Gulf of Carpentaria. However, **loss of fishing gear** will remain a potential risk factor for this fishery given the structure of the net attendance provisions within creeks, rivers and nearshore waters.

Given the size and remoteness of the fishery, there is a possibility that **travel to/from fishing grounds** and **disturbance due to presence in the area** will contribute to risk posed to one or more of the ecological components. These impacts are likely to be localised, of short duration and primarily associated with the setting and retrieval of nets. This is because the net sector uses a relatively passive fishing technique reliant on animals swimming into and becoming entangled in the net.

4.2.2 Ecological Components.

Target & Byproduct species (harvested)

A heavy reliance on input controls means that there is limited capacity within the GOCIFFF management regime to address increasing effort levels. This risk will be applicable to both the whole of fishery and species level. At the whole of fishery level, the risk of effort increasing significantly in the short to medium term is considered to be low. A 20% reduction in the number of large mesh net symbols has helped mitigate against a substantial effort increase. This risk continues to be managed through a range of policy and legislative restrictions, e.g. a limited licensing policy with legislation that restricts the number N12 and N13 fishing symbols, and prevention of fishers from simultaneously fishing under multiple fishing symbols.²

At a species specific level, there are few measures in place to manage catch and effort for individual species or species groupings. With the exception of hammerhead sharks,³ Total Allowable Commercial Catch (TACC) limits are not used to manage the harvest of target and byproduct species. Similarly, the GOCIFFF does not use access symbols to control catch and effort for key species such as those used on the Queensland east coast to limit the take of sharks.⁴ To this extent, there is limited capacity within the current management system to address changing fishing patterns or restrict the amount of effort that is directed towards an individual species or species complex (**harvesting**). If effort were to increase substantially, it may translate to a higher risk for a number of target and/or byproduct species. The extent of this risk will be dependent on a range of factors including:

- pre-existing fishing pressure (on individual species prescribed for harvest) and/or the operational costs of targeting a particular species or subgroup of species;
- life history of the species (species with similar spatial or temporal movements may be harvested together or more readily);
- effectiveness of input controls such as the annual barramundi closure in the N3 fishery; and
- the reasons behind the shift in fishing behaviours.

Operators in the GOCIFFF interact with a wide range of harvest species with catch data revealing that over 100 species or species complexes were retained for sale in 2017 (**harvesting**). However, the

² Section 57 Fisheries (Commercial Fisheries) Regulation 2019.

³ Schedule 2 Part 2 Fisheries Declaration 2019

⁴ Operators in the ECIFFF are required to hold a shark (S) fishery symbol if they want to retain sharks in larger quantities / in quantities above the in-possession limits for non-S symbol holders.

GOCIFFF catch is dominated by a subset of key species that includes grey mackerel, barramundi, king threadfin, blacktip sharks and blue threadfin (Department of Agriculture and Fisheries, 2019a). These five species / species complexes make up around 90% of the annual GOCIFFF catch and the risk associated with increasing effort would be more immediate for these species. This risk would be of particular relevance to king threadfin and barramundi whose stocks have been classified as ‘depleting’ in the Gulf of Carpentaria (Saunders *et al.*, 2018; Whybird *et al.*, 2018). Declining stock levels combined with a limited ability to constrain increases in fishing effort and mortality present as a real risk for these species.

The multi-species nature of the GOCIFFF combined with the operational constraints of the logbook system mean that a proportion of the targeted catch will be reported in broad catch categories. This makes it more difficult to define species-specific fishing mortalities and therefore assess the risk of a species being overexploited. This risk continues to be addressed in this fishery and improvements in catch monitoring techniques has seen a reduction in the amount of catch being reported with generic identifiers (*e.g.* ‘fish unspecified’ and ‘shark unspecified’). For sharks, the quality of the catch data will continue to improve with the introduction of a dedicated shark and ray logbook. This logbook has been in operation on the Queensland east coast since 2009 and is now a compulsory reporting requirement for all GOCIFFF operators.⁵ However, broader catch categories or species groupings, by necessity, will continue to be used in this fishery. This risk will remain even for shark species given a) the difficulties of obtaining individual species identifications and b) a diminished capacity to validate catch in real time.

Diversity in the GOCIFFF catch is attributed to net fishing (in general) having less capacity to target key species. While the specificity of net fishing can be improved by altering the set times and locations (*e.g.* the targeting of barramundi after rainfall, high water flows), there is still a high probability that operators will interact with a number of unwanted species including regulated fish species or fish that fall outside of the prescribed size limits.⁶ As a portion of this catch will be **discarded** in a dead or moribund state (Halliday *et al.*, 2001; Tobin, 2014; Uhlmann & Broadhurst, 2015), this has the potential to undermine the effectiveness of management arrangements used in the GOCIFFF including minimum and maximum legal sizes limits. For most of these species, there will be limited information on the amount of target species being discarded as this data is not collected for teleosts.

While net attendance provisions are applied to the GOCIFFF, they are considered to be less effective than on the Queensland east coast. As target and byproduct species are retained for sale, having extended net attendance provisions will have less influence of harvested species (in terms of post-release injuries/mortalities) than it would on released species (*e.g.* bycatch, SOCC). The most likely implications of having a 5 or 6nm (~9 or 11km) net attendance provision is that it reduces the capacity of fishers to detect catch signals early and, if needed, adjust *e.g.* if they are catching higher percentages of fish outside the prescribed size limits or large amounts of low-quality byproduct species (**discarding**).

Illegal fishing activities present an additional risk for most fisheries and the GOCIFFF is no exception. In terms of illegal fishing operations, there is little evidence to suggest that the Gulf of Carpentaria differs markedly from the Queensland east coast. However, the remoteness of the Gulf of Carpentaria combined with a lack of infrastructure means that the region is more sensitive to operational constraints.

⁵ As of 1 January 2018.

⁶ This portion of the catch is typically referred to as bycatch as it cannot be retained for sale. For the purposes of this ERA, undersized or unwanted target and byproduct are assessed as part of the ‘harvested species’ grouping. The primary reason for this is that this ERA deals with factors that may impact on the long-term sustainability of the species.

In the GOCIFFF, risks associated with illegal fishing will include unreported catch / black-marketing (**harvesting**), the retention of regulated species, the use of unattended nets (**loss of fishing gear**), fishing in regulated waters and use of non-compliant apparatus. These risks are managed through the Queensland Boating and Fisheries Patrol (QBFP) who continue to enforce the current regulations. These risks are not considered to be exclusive to a particular sector and the overwhelming majority of people adhere to the regulations. However, illegal fishing activities have the potential to impact all ecological components including harvested species and are therefore relevant to this ERA. The ability of QBFP to manage some of these risks *i.e.* fishing in regulated waters will improve overtime with the continued implementation of the data validation plan data (Department of Agriculture and Fisheries, 2018b) and the introduction of *Vessel Tracking* (Department of Agriculture and Fisheries, 2018f).

The remaining fishing activities will make smaller contributions to risk levels for the harvest species ecological component. Target species that interact with a net without capture (**contact without capture**) will either be small enough to pass through the mesh, large enough to prevent entanglement or strong enough to break free from the net. The consequence of these interactions are likely to include increased injuries, greater susceptibility to predation and increased post-interaction mortalities. As fishing periods (*i.e.* days at sea) in the GOCIFFF tend to be longer, **disturbance due to presence in the area** may be more influential. For example, an area may be subject to an increased number of net setting and retrieval processes. The impact of this risk on harvested species though is not expected to be significant.

Further information on key target and byproduct species including the impact of the fishery on sharks and rays is provided in the *Species of Conservation Concern* overview. Additional information on the impact of the recreational fishing sector is contained within the 'cumulative impacts' section of this report.

Bycatch (non-SOCC)

One of the challenges of undertaking a broad-scale ERA for bycatch in the GOCIFFF is trying to identify the scope and depth of the assessment. This issue largely relates to the multi-species nature of the fishery and the fact that some species are retained as byproduct in very small quantities (Department of Agriculture and Fisheries, 2019a). Further, the distinction between bycatch and byproduct will most likely vary between operators and fishing events.

While information on the amount and composition of GOCIFFF bycatch is limited, this portion of the catch will largely consist of low-value teleost species (Halliday *et al.*, 2001), species not able to be retained under each symbol and regulated species harvested in other fisheries (*e.g.* mud and blue swimmer crabs). The risk to these species will be similar to that observed for unwanted harvest species and will include an elevated risk of *in-situ* mortalities, injuries, post-release mortalities, increased susceptibility to predation (**discarding**) and possible illegal retention.

As a higher number of licences operate in the N3 fishery, this sector of the GOCIFFF will arguably present as a higher risk for non-targeted bycatch. It is noted though that gear limitations in the N12 fishery are less restrictive with licence holders permitted use of nets up to 1800m long; compared to 600m in nearshore waters of the N3 fishery. The use of larger nets in the N12 fishery will increase the fished area and therefore the potential for fishers to interact with non-target species. Bycatch compositions may also vary between symbols as they operate in different regions and target different species. While the GOCIFFF includes an N13 fishery symbol, no catch and effort was reported against this symbol since its inception in 2012 (Department of Agriculture and Fisheries, 2019a).

The impact of the remaining fishing activities will be similar to that observed for harvested species (Target and Byproduct).

Species of Conservation Concern

The GOCIFFF has the potential to interact with a wide range of subgroups from the *Species of Conservation Concern* (SOCC) ecological component. The overwhelming majority of interactions will be with the shark subgroup which can be retained for sale and are actively targeted by fishers operating under the N12 or N13 fishery symbol. Of the interactions recorded in the SOCI logbook, more than 75% of the reported interactions were with sawfish (*Family Pristidae*), crocodiles (15%) or marine turtles (8%) (Department of Agriculture and Fisheries, 2019a).

As a high proportion of the SOCC subgroups cannot be retained for sale, **discarding** is considered to be the key driver of risk for most of the SOCC subgroups. There will however be notable risks associated with the **harvesting** of sharks and batoids, **loss of fishing gear** and **contact without capture**. The extent of these risks will be dependent on the subgroup in question.

Marine turtles

Marine turtles have a high susceptibility to net entanglements and this subgroup can experience both *in-situ* and post-release mortalities. In the GOCIFFF, the risk of a turtle interaction ending in a mortality will be dependent on the extent of the entanglement and the location of the fisher. In nearshore waters where net attendance limits are set at 6nm (~11km), there is an increased risk that a marine turtle interaction will go undetected. This has the potential to increase the length of the interaction and the likelihood of a drowning event occurring due to further entanglement and fatigue. The risk posed to this subgroup by netting activities will be higher in nearshore and offshore waters where there is greater overlap with the preferred habitats of marine turtles. This risk will be lower in creek and riverine systems where water conditions differ, reducing the likelihood of a marine turtle interaction.

Outside of the SOCI logbooks, there is limited information on marine turtle interactions in GOCIFFF. On the Queensland east coast, the *Marine Wildlife Stranding and Mortality Database* was used to provide further context and insight into the extent of turtle-net interactions (Meager & Limpus, 2012). This type of comparison would be of limited value to the GOCIFFF as the *Marine Wildlife Stranding and Mortality Database* relies heavily on public notifications and the population of the southern Gulf of Carpentaria and Western Cape York Peninsula is much smaller. The extent of reporting programs in the Gulf of Carpentaria is further restricted by operational and economic constraints; something that is reflected in both quantity and resolution of the data. The ability of this data to be attributed to a particular sector or fishery is also hampered by the prominence and impacts of ghost nets (Meager & Limpus, 2012; Ghost Nets Australia, 2018).⁷ Despite these limitations, the *Marine Wildlife Stranding and Mortality Database* highlights the potential consequences of this type of interaction and suggests fishing activities in the GOCIFFF will be a risk factor for this subgroup.

Overall, there is significant potential for sectors of the GOCIFFF to interact with marine turtles. The fishery has a notable overlap with the habitats preferred by marine turtles and there is an elevated risk of an interaction resulting in mortality. This risk is largely driven by the structure of the current net attendance provisions; particularly in nearshore waters. There is limited information on the effectiveness of net attendance in the Gulf of Carpentaria and/or the ability of the operator to access the net under the current arrangements.

⁷ *Marine turtles reportedly make up around 80% of the marine life found entangled in ghost nets (Ghost Nets Australia, 2018).*

Sea snakes

A small number of sea snake interactions ($n = 4$) have been reported from the GOCIFFF through the SOCI logbook (Department of Agriculture and Fisheries, 2019a). If a sea snake were to interact with the net, the risk of entanglement or injury would be low (**contact without capture**). Similarly, sea snakes are unlikely to be landed by GOCIFFF operators in significant quantities. Given these considerations, the risk of an undesirable event occurring in this subgroup is expected to be low.

Crocodiles

The GOCIFFF operates in areas where crocodiles are prevalent (Fukuda *et al.*, 2008) and in habitats where these species are most active. There have been 78 crocodile interactions reported from the fishery with more than half occurring in 2016 ($n = 15$) and 2017 ($n = 27$) (Department of Agriculture and Fisheries, 2019a). The SOCI data indicates that post-interaction survival rates for this subgroup is poor with over half of the crocodiles caught in 2016 ($n = 13$ or 86%) and 2017 ($n = 18$ or 67%) dying as a result of this interaction (**discarding**).

Crocodile mortality rates in the GOCIFFF will be exacerbated by the tendency of a crocodile to roll as both a defensive and predatory strategy. Crocodiles that become trapped in a net, either by swimming into it or attempting to eat enmeshed fish, are more likely to roll in an attempt to escape. In some instances these behaviours will help the animal break free of the net (**contact without capture**) with limited injuries. These same behaviours though increase the risk of the animal becoming further entangled within the net. If this were to occur, the net will continue to wrap around the crocodile further restricting its capacity to access the surface.

Crocodile numbers have recovered strongly in northern Australia and they occur in higher densities in Northern Territory and the Gulf of Carpentaria (Fukuda *et al.*, 2008). To this extent, the risk of fishing-related mortalities causing an undesirable event will be lower than in other SOCC subgroups. The risk to this subgroup though will be elevated due to the fishery having higher interactions rates and an increased potential for mortalities. Without additional information on what animals are interacting with the fishery (e.g. sex ratios, size classes, frequency of interactions including) and the consequences (e.g. extent of any injuries or mortalities including for **contact without capture**), it is difficult to ascertain the extent of this risk or its potential to impact regional crocodile populations.

Dugongs

The risk profile for dugongs is similar to that observed for marine turtles. Data collected through the SOCI logbooks included two dugong interactions; both of which occurred in 2016. A further 10 mortalities not linked to traditional fishing have been recorded in the *Marine Wildlife Stranding and Mortality Database* (based on 2000–2015 data). Of these, net entanglements (unknown origin) were responsible for two dugong deaths and a third death was linked directly to boat strike (Biddle *et al.*, 2011; Meager, 2016). The causal effects of the remaining mortalities could not be verified.

Dugongs occur in higher densities in the Torres Strait and key areas of south east Queensland e.g. Moreton Bay and Hervey Bay (Department of the Environment, 2018). There are however a number of dugong hotspots in the Gulf of Carpentaria including around Mornington Island, Wellesley and South Wellesley Islands, Pellow Islands, and the north-western coast of the Cape York Peninsula (Department of Environment and Heritage Protection, 2018b). In a number of instances, regional closures have been employed to protect dugongs in these areas and/or habitats where dugongs are likely to congregate in higher densities e.g. seagrass beds (Zeller & Snape, 2006). Outside of these

areas, it can be difficult to assess the level of overlap (small, medium, large) between GOCIFFF effort and dugong distributions as *Vessel Tracking* data for the fishery is not available yet (implementation was less than 12 months ago). Fine-scale effort information such as that obtained from *Vessel Tracking* will improve understanding of this issue

While the total number of dugong interactions is lower than both turtles and sawfish (Department of Agriculture and Fisheries, 2019a), the reproductive rate for dugongs is exceptionally low. Research has shown that female dugongs do not breed until between seven and 17 years and calve only once in every three to six years (Marsh *et al.*, 2011). This combined with a higher risk of interactions ending in mortality increases the risk that a regional dugong population will experience an undesirable event due to fishing activities in the GOCIFFF. As this subgroup has already experienced significant population declines, this risk will be present even at low levels of fishing mortality.

Cetaceans

The SOCI logbooks and the Fisheries Observer Program both include data on cetacean interactions in the GOCIFFF. The SOCI logbooks document the capture of two bottlenose dolphins (2007, 2008), two Australian snubfins (2016) and one unidentified species (2016). Fisheries observers recorded the capture of eight bottlenose dolphins (*Tursiops* spp.), one Indo-Pacific humpback dolphin (*Sousa chinensis*)⁸, and one Australian snubfin dolphin (*Orcaella heinsohni*) in the offshore net fishery (formerly N9) over a seven year (2000–2006 inclusive) period (Stapley & Rose, 2009). This data indicates that there is some potential for the GOCIFFF to interact with and impact on regional dolphin populations. The extent of this risk will be highly dependent on the region being fished and the species interacting with the fishery.

A previous ERA of Queensland-managed fisheries in the Gulf of Carpentaria indicated that the capture of bottlenose dolphins (*Tursiops truncatus*) in the offshore net fishery presented a moderate risk to the breeding stocks. This assessment was based on an estimated catch rate of 10–25 bottlenose dolphins per year in the offshore fishery (Zeller & Snape, 2006). The risk posed to other species including the Irrawaddy dolphin (*Orcaella brevirostris*)⁹ and the Indo-Pacific humpback dolphin (*Sousa chinensis*) were classified as negligible (Zeller & Snape, 2006). As this ERA was undertaken in 2006, it predates an extensive 2011 management reform process. Accordingly, the operating environment for the GOCIFFF has experienced considerable change and the outputs of this assessment may now be outdated.

At a whole of fishery level, there are a number of underlying factors that increase the risk of the GOCIFFF contributing to an undesirable event for one or more dolphin species. Information on the extent of dolphin interactions across the entire fishery has not increased substantially since the last ERA. The capacity of management agencies to monitor and quantify dolphin interaction rates has also decreased due to the cessation of the Fisheries Observer Program. This is significant as there is little recourse (at present) for management to validate the catch data of non-target species in the GOCIFFF or assess the potential for species to be misidentified or underreported.

More broadly, the GOCIFFF management regime relies almost exclusively on spatial closures and broad-scale effort management to minimise dolphin interactions. As dolphins are more mobile, spatial

⁸ The Australian humpback dolphin (*Sousa sahalensis*) was assumed until recently to be a conspecific of the Indo-Pacific humpback dolphins (*Sousa chinensis*) (Jefferson & Rosenbaum, 2014).

⁹ The Australian snubfin dolphin (*Orcaella heinsohni*) was assumed until recently to be a conspecific of the Irrawaddy dolphin (Zeller & Snape, 2006; Department of Environment and Heritage Protection, 2018a).

closures are expected to be less effective when compared to the dugong subgroup. Given the passive nature of net fishing, the fishery offers few avoidance strategies to prevent the animal interacting with the net when they enter a fished area. If a dolphin were to become entangled in the net, less-stringent attendance provisions in some sectors of the fishery increase the risk of the interaction ending in a mortality. All of these factors increase the potential of the GOCIFFF contributing to an undesirable event for one or more species in this subgroup.

For some of the more prominent species including bottlenose dolphins, regional populations are expected to be more resilient to fishing pressures. For other species such as the Australian snubfin dolphin (*Orcaella heinsohni*) which is typified by small population sizes, a preference for shallow nearshore and estuarine habitats, active foraging related movement patterns and low population growth rates (Department of Environment and Heritage Protection, 2018a), the risk of an undesirable event occurring will be high even with low levels of fishing mortality. These inter-specific differences will be examined further in the Level 2 assessment but will be difficult to differentiate without finer-scale data on effort distributions in the GOCIFFF. The expansion of the *Vessel Tracking* system under the *Queensland Sustainable Fisheries Strategy 2017–2027* will assist in this process.

Smaller whale species including the false killer whale (*Pseudorca crassidens*) and the melon-headed whale (*Peponocephala electra*) may inhabit the Gulf of Carpentaria (Department of Environment and Energy, 2019), and therefore have the potential to interact with GOCIFFF operations. Interactions with whales are infrequent and are unlikely to present a long-term sustainability concern for the species involved. This has been reflected in previous ERAs where net fishing in the Gulf of Carpentaria was identified as a low risk for whales in general due to the a) the species preferring deeper waters of the continental slope and b) the fishery operating outside of the (known) migratory pathways for baleen whales (Zeller & Snape, 2006).

Protected teleosts

There are four species of teleost with SOCI reporting requirements: the humphead Maori wrasse (*Cheilinus undulatus*), the potato rockcod (*Epinephelus tukula*), the Queensland groper (*Epinephelus lanceolatus*) and barramundi cod (*Chromileptes altivelis*). The distribution of all four species largely centre on the Queensland east coast with only limited accounts of the Queensland Grouper and Barramundi Cod occurring in waters of the Gulf of Carpentaria (Australian Museum, 2013; 2016a; b; c). As a net only fishery the GOCIFFF has limited opportunities to interact with these coral reef associated species and the subgroup is on the lower end of the risk spectrum.

Batoids

Batoids, unlike other subgroups included in the SOCC ecological component, can be retained for sale in the GOCIFFF. Catch data for the fishery shows that stingrays contribute a small amount to the total catch, with less than 5t retained as byproduct since 2004 (**harvesting**). However, total catch for this subgroup is likely to be higher as fishers are not required to report batoid discards (**discarding**). Catch records including bycatch analyses (Halliday *et al.*, 2001) show that the majority of batoid interactions in the GOCIFFF are with sawfishes (*Family Pristidae*), stingrays (*Family Dasyatidae*), shovelnose rays (*Family Rhinobatidae*), guitarfish (*Family Rhynchodidae*) and eagle rays (*Family Myliobatidae*) (Department of Agriculture and Fisheries, 2019a). Of these, only sawfish and two manta ray species are afforded full protection in Queensland waters including within the Gulf of Carpentaria. An in possession limit of five rays (maximum) is also applied to all shovelnose rays and guitarfish or any combination of these fish.

Fishing effort in the GOCIFFF overlaps with the distribution of a number of inshore (<2m) and offshore (>2m) batoid species. Batoid interactions are expected to be higher in the N3 fishery and this sector will encounter a wider diversity of species (Last & Stevens, 2009; Last *et al.*, 2016). The risk posed to these species will vary depending on the spatial extent of their distribution, the spatio-temporal overlap with fishing effort, their life-history constraints and their ability to survive a fishing event. For instance, smaller benthic batoids are expected to be more resilient to net entanglements when compared to larger, pelagic species that rely on ram ventilation (Ellis *et al.*, 2016).

Sawfish distributions have contracted through time and populations on the Queensland east coast (for some species) may now be extirpated; particularly in central and southern Queensland (D'Anastasi *et al.*, 2013; Kyne *et al.*, 2013; Simpfendorfer, 2013). These contractions have seen northern Australia (including the Gulf of Carpentaria) identified as one of the few remaining sawfish population strongholds in the Indo-Pacific region (Kyne *et al.*, 2013). Of the commercial fisheries operating in Queensland, the GOCIFFF has the highest number of sawfish reports ($n = 395$ since 2003) and the greatest potential to interact with sawfish species (Department of Agriculture and Fisheries, 2019a).

As sawfish are frequently associated with inshore environments (Last *et al.*, 2016), the majority of the GOCIFFF interactions will be with the N3 fishery. However, species like the largetooth sawfish (*Pristis pristis*) and the green sawfish (*Pristis zijsron*) are also found in offshore waters and therefore may be susceptible to N12 net fishing activities (Peverell, 2005; 2010; Last *et al.*, 2016; Department of Agriculture and Fisheries, 2019a). While around 7% of the animals reportedly died as a result of this interaction, there is limited capacity (at present) to verify or validate the veracity of the SOCI data. Based on the above information, there is considerable potential for fishing activities in the GOCIFFF to contribute to an undesirable event for one or more of the sawfish species.

Other than sawfish, the two manta ray species are the only other batoids afforded full protection under fisheries legislation. While a recent review of the *Family Mobulidae* (devil rays) reclassified the genus 'manta' as a synonym of the genus 'Mobula' (Last *et al.*, 2016), the original intent of the legislation was to provide additional protections to the manta subgroup. As a consequence, only the giant manta ray (*Mobula birostris*) and the reef manta ray (*M. alfredi*) are classified as no-take in the Gulf of Carpentaria (**discarding**). The distribution of both species overlaps with the GOCIFFF and there is some potential for the species to interact with the nets either through direct entanglement or **contact without capture**. The overall risk to manta rays though is considered to be low when compared to regional pressures exerted on these species in adjacent jurisdictions *e.g.* unregulated catch in Indonesia.

Of note, the estuary stingray (*Hemirhynchus fluviorum*) is not classified as a SOCI but is listed as 'Near Threatened' under the *Nature Conservation Act 2006*. This listing is linked with declining habitats; although their capture as bycatch in New South Wales and Queensland has been identified as key source of risk (Kyne *et al.*, 2016). The estuary stingray is commonly associated with shallow-inshore waters and frequently occurs in mangrove fringed rivers and estuaries. While the species has been observed with more frequency on the Queensland east coast, it has a distribution that extends west through to (at least) Darwin (Kyne *et al.*, 2016). The estuary stingray has not been reported interacting with the GOCIFFF, but there is strong potential for it to interact with the N3 fishery.

The GOCIFFF management regime for the remaining batoids is less stringent. The take of rays in the Gulf of Carpentaria is not managed under quota and all operators can target rays in higher quantities (**harvesting**) or fish in areas where there are higher densities (**discarding**). The notable exceptions to this are shovelnose rays and guitarfish which are managed under a combined in-possession limit. While a 1.5m maximum size limit applies to this subgroup, these restrictions were developed for sharks and

will be less effective for batoids which attain smaller total lengths. At this point in time, the biggest constraint on catch and effort for this subgroup is a lack of market demand.

Sharks

Assessing the risk posed to the shark SOCC subgroup is more complicated as it includes both protected species and species that can be retained for sale. When compared to the ECIFFF, the system used to manage shark catch in the GOCIFFF is less advanced. For example, there are no restrictions on retaining larger quantities of shark product¹⁰, the majority of species are not managed under quota, and there are no caps on total catch or effort. The notable exception to this is the hammerhead shark complex which has been managed under a combined 50t TACC limit since 1 January 2018 (Department of Agriculture and Fisheries, 2018g).

In the Gulf of Carpentaria, the targeting and retention of sharks is managed through the use of regulatory species lists. Under provisions governing the use of the GOCIFFF symbols, fishers are permitted to retain sharks under the N3, N12 or N13 (**harvesting**). However, sharks may only be targeted by fishers with an N12 or N13 symbol. As only four of the 89 large-mesh net symbols are endorsed for the N12 or N13 fishery, this provision significantly reduces the number of operations that can actively target sharks. However, it does not prevent N3 fishers from retaining larger quantities of shark (**harvesting**) providing they have been caught whilst targeting the primary species e.g. barramundi, barred javelin, threadfins, queenfish, scaly jewfish (Department of Agriculture and Fisheries, 2019a). From a management perspective, this can be difficult to enforce as it requires a sound understanding of fisher intentions and a finer scale evaluation of effort usage and shark distributions. Without further catch validation measures, it can also be difficult to differentiate between sharks that have been targeted and those that have been retained as byproduct. Due to these factors, fishing mortality rates outside of the N12 and N13 fishery could increase over time.

In the past, catch reporting mechanisms for sharks only concentrated on the retained portion of the catch. This deficiency is being actively address in Queensland with operators now required to report all shark catch (retained and discarded) through the compulsory logbook reporting system since 1 January 2018. However, there are limitations with the logbook reporting system and information on shark catch compositions (retained and discarded) is still lacking for the GOCIFFF. The significance of this issue is reflected in the fact that the development and implementation of shark monitoring strategies has been included as a priority in the *Fisheries Queensland Monitoring and Research Plan* (Department of Agriculture and Fisheries, 2018d). Further, a dedicated shark monitoring project has been established within DAF to assist in this process and identify mechanisms to improve the level of information on catch rates and compositions.

Under the current management arrangements, there is considerable potential for effort to shift between shark species or complexes (**harvesting**). This means that some species could experience a significant increase in fishing mortality without a discernible change to the total shark catch. This is viewed as a considerable risk for sharks as the current reporting system relies heavily on the use of logbooks to collect catch composition data. The resolution of logbook data will vary as it includes both species-specific and complex-specific categories. For example, a high proportion of the shark catch from the

¹⁰ *The ECIFFF utilises an 'S' fishery symbol that permits an operator to retain shark product in larger quantities i.e. above the in possession limit of 10 sharks or rays for net operators without an S fishery symbol and the 4 sharks or rays for line operators without an S fishery symbol. In the GOCIFFF, the targeting of sharks is limited to the N12 and N13 fishery symbol, however operators fishing under the N3 symbol can retain large quantities of shark if they are caught whilst targeting primary species like barramundi, queenfish or threadfins.*

Gulf of Carpentaria is reported as blacktip whaler which may include varying proportions of common blacktip sharks (*Carcharhinus limbatus*), spot-tail shark (*C. sorrah*), the Australian blacktip shark (*C. tilstoni*) and even the graceful shark (*C. amblyrhynchoides*) (Last & Stevens, 2009). The grouping of species in broader catch categories will restrict management's capacity to monitor individual catch rates and quantify mortality rates for key species (**harvesting**).

Sharks are often collectively described as long-lived species with delayed maturity and long gestation periods. While broadly true, research has shown that this picture is more complicated and that some species will be more resilient to fishing pressures (Harry *et al.*, 2011). In the above example, research has shown that there are notable differences in the biology of *C. tilstoni*, *C. limbatus* and *C. sorrah* (Harry *et al.*, 2012; Harry *et al.*, 2013). These differences are likely to have a bearing on the ability of each species to resist or rebound from decline due to fishing activities. The difficulty with the GOCIFFF is that there is limited information on the broader dynamics of the fishery including size classes, sex compositions and maturity status. This combined with limitations in the catch composition data makes it difficult to identify how key species may respond to changing fishing pressures and areas (e.g. regions, species) where fishing activities may present a higher sustainability risk.

Worldwide, the finning of sharks or removing the fins and discarding the body is considered to be a significant risk to shark populations. This risk is well managed within Australian jurisdictions and the practice of finning is prohibited across State and Commonwealth jurisdictions. In the GOCIFFF, operators are permitted to process sharks at sea providing they maintain the relevant ratio of fin sets to trunks (or fillet equivalent). This differs from some jurisdictions which operate under a 'fins-attached' policy which places further restrictions on the processing of sharks at sea. From an operational perspective, the fins ratio policy is more functional, but has been identified as a concern in third party sustainability assessments; namely the GOCIFFF Wildlife Trade Operation (WTO) approvals (Department of the Environment and Energy, 2019).

On a species-specific level, interactions between GOCIFFF operators and most shark species classified as SOCI are expected to be low. This in part is due to the low number of species afforded full protection in Queensland waters: river sharks (*Glyphis* spp.), grey nurse sharks (*Carcharias taurus*; *Odontaspis ferox*) and the white shark (*Carcharodon carcharias*). Of the species with additional protections, interactions with the speartooth shark (*Glyphis glyphis*) will present as the greatest risk. The distribution of the speartooth shark is restricted to estuaries and rivers in northern Australia and Papua New Guinea. Due to this restricted range and threats from fisheries and habitat degradation, the species is currently listed as Endangered on the IUCN Red List (Last & Stevens, 2009; Lyon *et al.*, 2017). While interactions with this species will be explored further in the Level 2 assessment, research indicates that there is considerable potential for net fisheries to interact with this species; particularly in the Port Musgrave catchment / Wenlock river region (Lyon *et al.*, 2017). Despite this potential, no speartooth shark interactions have been recorded in Gulf of Carpentaria fisheries since the introduction of the SOCI logbook (Department of Agriculture and Fisheries, 2019a). One likely explanation for the absence of catch reports is misidentifications with some of the more commonly caught species e.g. bull sharks (*C. leucas*) (Pillans *et al.*, 2008; Field *et al.*, 2013)

Of the remaining species, interactions with *C. taurus* and *Odontaspis ferox* are unlikely based on their known geographical distributions (*pers. comm.* D. Bowden; Last & Stevens, 2009). Similarly, the impact on *C. carcharias* will be negligible; despite the distribution of the species overlapping with the GOCIFFF.

Syngnathids

There have been no reported interactions with syngnathids in the GOCIFFF and the risk of the fishery causing an undesirable event for this group is considered to be low to negligible. In the unlikely event that a seahorse, pipefish or seadragon interacted with the net apparatus, their body structure would allow them to pass through the mesh or extract themselves with relative ease (**contact without capture**).

Seabirds

Seabird interactions with net fisheries in the Gulf of Carpentaria are poorly understood including the extent and type (e.g. entanglement, feeding from nets or on bycatch). In the GOCIFFF, the risk posed to sea birds was considered to be low with the majority of interactions expected to occur if and when the animal is feeding. The risk of a trapped bird becoming further entangled and drowning is potentially higher in the N3 fishery as there is a higher potential of an interaction going undetected due to the structure of the net-attendance provisions. Even so, seabirds are expected to be at the lower end of the risk spectrum when compared to other subgroups within the SOCC ecological component.

Terrestrial mammals

The false water rat *Xeromys myoides* is a small native mammal that has a semi-aquatic lifestyle. This animal feeds on small crabs, shellfish, and worms found in coastal mangrove forests, and hunts on mud flats on an outgoing tide. Interactions between GOCIFFF operators and this species are highly unlikely and the fishery presents a negligible risk to this subgroup due to the nature of the apparatus.

Marine Habitats

The GOCIFFF operates in a diverse range of inshore and offshore environments. While there is potential for this fishery to have an impact on regional marine habitats, it will be far smaller when compared to more active fishing methods such as trawl fishing. The extent of the impacts will depend on a range of factors (e.g. soak times, the concentration of fishing effort, and repetition) but will be higher in inshore and estuarine environments where nets are more likely to interact with the sea floor. Likely impacts may include progressive declines in regional vegetation and/or increased sediment suspension around the affected area. These areas though also experience a higher degree of natural disturbance (e.g. storms, tidal flows etc.) and would be more resilient to this type of disturbance.

Net fishing, as a whole, is a relatively passive exercise that relies on fish swimming into and becoming entangled within a net. In some instances nets will be set in place or in locations where it will connect with the sea floor. Likely impacts of these events include temporary and localised disruption to the substrate, increased turbidity and sediment resuspension. Most of these actions will occur during the net setting and retrieval process and will have negligible long-term implications. These impacts may accumulate through time in areas that are regularly subjected to net fishing operations. Depending on the species being targeted, some operators will set nets above harder substrate. These nets tend to be set with sufficient buoyancy to minimise the risk of it becoming entangled or snared on hard surfaces.

Of the fishing activities identified, **loss of fishing gear** has the greatest potential to impact the marine environment. Apart from being a hazard to a range of animals, lost or ghost nets have the potential to cause significant damage to regional environments including (for example) acting as a sediment trap and smothering benthic assemblages, becoming entangled in the substrate/vegetation and localised damage and degradation as they move with tidal fluctuations. Net attendance provisions may reduce the risk of mesh nets becoming lost; although there is still potential for equipment to be lost in this fishery;

particularly in the N3 fishery where net attendance provisions are less stringent. Examples of where this may occur include during extended soak times, in deteriorating weather conditions, due to the actions of a third party (e.g. gear being run over by a larger vessel), loss of markers due to entanglement with marine megafauna and illegal fishing activities.

While noting the above, Australian fisheries make up only a small proportion of the ghost nets collected in the Gulf of Carpentaria. Further, the majority of the ghost nets originate from trawl fisheries that are managed by adjacent jurisdictions like Indonesia (Ghost Nets Australia, 2018). These factors are important as it provides additional context to this assessment.

Ecosystem Processes

Of the ecosystem processes taken into consideration as part of this Level 1 assessment (Appendix 1), the most significant risks will be associated with the removal of predators and the potential to impact recruitment rates.

A large proportion of the species targeted by GOCIFFF operators are often classified as tertiary consumers in marine food webs. These include the majority of the shark species (Cortés, 1999), a number of the key teleost species (Ceccarelli & Ayling, 2010) and occasional ray species (Jacobsen & Bennett, 2013). Given this, one of the more likely risks associated with this fishery will be the removal of top order predators and secondary consumers from the food chain (Appendix 1). At a whole of fishery level, this risk will be due to their retention for commercial sale (**harvesting**) and the **discarding** of animals in a dead or moribund state due to their low value or where regulations prohibit their retention.

The management regime for the GOCIFFF includes a range of measures to protect larger individuals with higher reproductive potential e.g. minimum legal size limits, mesh size restrictions. These arrangements are more developed for target species where minimum legal size limits are based on length at sexual maturity. These measures increase the likelihood that an individual will reproduce at least once before they are harvested and helps maintain long-term recruitment rates. In the case of barramundi (*Lates calcarifer*), a maximum legal size limit acknowledges the positive relationship between length and fecundity whereby larger specimens (>120cm Total Length) cannot be retained in tidal waters¹¹. These fish (theoretically) make a larger contribution to recruitment and play an important role in maintaining the health of regional populations. Size limits may however be less effective in a net fishery where there is increased potential for interaction with cohorts outside prescribed size limits.

Of note, catch size selectivity has improved in the GOCIFFF with the evolution of the mesh size provisions. For example, from 1995–1999 N3 set mesh nets used in rivers, creeks, foreshores and offshore waters all had a prescribed mesh size of 150–245mm. From 1999–2011, mesh size for all N3 set mesh nets increased to 162.5–245mm and in 2012 mesh size was differentiated further to 160–215 mm in rivers, creeks and nearshore waters (i.e. tidal waters <2m deep at low water) and 160–165mm in offshore waters (i.e. tidal waters >2m deep at low water). Without more rigorous assessment of the effectiveness of these management changes, impacts on some species are likely to remain unknown.

Of the remaining ecosystem processes, the GOCIFFF will have limited influence over the remaining categories with scavenging and connectivity the only other components to receive a rating higher than 'low' (Appendix 1). Scavenging relates more to the **discarding** of unwanted product and its potential to alter the behaviour of some species (Pears *et al.*, 2012). Risks associated with 'connectivity' primarily

¹¹ Schedule 2 Part 2, Fisheries Declaration 2019

relate to regionally specific phase shifts in species assemblages due to the continued targeting of key species including larger predators.

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 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

The risk posed by the recreational and charter fishing sectors will be smaller and more targeted when compared to the commercial fishery. From a risk management perspective, the cumulative impacts of these fishing activities will be highly dependent on the species and its broader appeal within the recreational fishing sector. These cumulative fishing pressures are likely to be greater for species that featured prominently in the *Statewide Recreational Fishing Survey* including (among others) yellowfin bream, whiting, tailor, flathead, trevally and barramundi (Webley *et al.*, 2015).

It can be difficult to obtain accurate information on participation rates, regional catch trends and species assemblages for the recreational fishing sector; particularly in the Gulf of Carpentaria. These limitations may make it difficult to estimate the total level of fishing mortality (commercial plus recreational and charter) and therefore assign a level of risk. Data obtained through the recreational fishing survey

revealed that a considerable portion of the recreational catch is released (**discarded**) (Webley *et al.*, 2015). However, this survey also showed that the recreational harvest for some species can exceed that of the commercial fishery *e.g.* the Dusky Flathead (McGilvray *et al.*, 2018). While the appeal of the dusky flathead as a target species may be less in the Gulf of Carpentaria, these results demonstrate that cumulative fishing pressures will be a significant contributor of risk for some species. These issues will be of particular relevance in the Level 2 assessments where the focus shifts from the whole of fishery level to individual species.

More broadly, the recreational and charter fishing sectors will contribute to the overall risk ratings through **harvesting**, **discarding** and **loss of fishing gear**. Most of these impacts will relate to **harvesting** of targeted species and **discarding** of unwanted or prohibited fish. Given the popularity of recreational fishing (including charter), the sector has the potential to interact (directly and indirectly) with the SOCC ecological component. Examples may include a) interactions with marine turtles where research has shown there to be a higher propensity for entanglement in lost fishing gear, b) bird entanglements due to the inadequate disposal of unwanted fishing line (**loss of fishing gear**) and c) interactions with the shark and batoid subgroup including depredation (**contact without capture**).

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

It is acknowledged that Aboriginal peoples and Torres Strait Islander peoples will interact with a high number of the species in the SOCC subgroup. There are however significant differences between SOCC interactions in this sector and those that occur in the commercial, recreational and charter fishing sectors.

4.3.2 External Risks

Climate Change & Environmental Degradation

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 resulting 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 GOCIFFF, 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.

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 GOCIFFF, 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 inter-nesting 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 like Moreton Bay. 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 organisms and entangling marine life. In addition to fishing activities, plastic debris originates from tourism, both land and sea based, land based runoff and shipping (Bergmann *et al.*, 2015). Discarded fishing line, and other plastic debris, will degrade into microplastics, which are easily ingested by many species, including species harvested for human

consumption. 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, 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 beyond 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 megafauna and the overall degradation of the marine environment (Brodie *et al.*, 2017). These impacts may not be as prevalent in the GOCIFFF largely due to the lower level of agricultural development outside of the main ports and population centres such as Karumba and Weipa.

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

Ghost Nets

The issue of ghost nets have been discussed at length in this Level 1 ERA. Of the cumulative impacts that exist in the Gulf of Carpentaria, ghost nets arguably present one of the more significant risks. An issue that expands across ecological components, ghost nets have the potential to significantly impact target and non-target species, as well as regional habitats. This issue though is much larger than the GOCIFFF 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% come 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 4.3). To this extent, they take into consideration the current fishing trends (e.g. current catch, effort and licensing), limitations of the current management regime (e.g. the potential for additional effort to be transferred into areas already experiencing higher levels of fishing mortality, substantial increases in fishing mortality for key species, changing target species) and the consequences of the interaction. While the majority of SOCC are classified as bycatch they have been assessed as separate entities in recognition of their complex life histories. Risk scores assigned to ecosystem processes are based on the preliminary assessment (Appendix 1) and represent the maximum score assigned to that particular fishing activity.

Table 2. Summary of preliminary risk scores for the GOCIFFF including the impact of the main fishing activities on key ecological components.

Ecological Component	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	H	I/H	L	I	L	L	L	H	-
Bycatch (non-SOCC)	-	I/H	L		L	L	L	I/H	I/L
SOCC									
- Marine turtles	-	H	I/H	I	L/I	L/I	L	H	I
- Sea snakes	-	L	L	L	L	L	L	L	L
- Crocodiles	-	I	I	I	L	L	L	I	L
- Dugongs	-	I/H	I/H	I	L/I	L/I	L	I/H	I
- Whales	-	L	I	L/I	L	L	L	I	L
- Dolphins	-	H	I/H	I	L/I	L/I	L	H	L
- Protected teleosts	-	L	L	L	-	L	L	L	L
- Batoids	L	H	I	I	L	L	L	H	L
- Sharks	H	H	I/H	I	L	L	L	H	L
- Syngnathids	-	-	-	-	-	L	L	L	-
- Seabirds	-	L	-	-	-			L	I
- Terrestrial mammal	-	-	-	-	-	-	-	-	-
Marine Habitats	-	-	-	I	L	L	L	I	I
Ecosystem Processes**	H	I	-	I/H	-	L	-	H	I

* Represents the risk that gear will be lost. However, the impacts of lost gear i.e. ghost nets will be much higher.

** Refer to Appendix 2

Outputs of the *Risk Categorisation* stage, excluding *cumulative impacts*, were used to assign each ecological component with a preliminary risk rating based on the highest risk score in the profile (Table 2). If for example an ecological component received a 'high risk' for one or more of the fishing activities, it would be reflected in the preliminary risk ratings (Table 2; Appendix 2). These preliminary risk ratings are conservative in nature and provide the first opportunity to remove low risk elements from the assessment process. Scores assigned to the cumulative risks were not considered as the preliminary risk scores are only applicable to the commercial fishery. The cumulative impacts scores though provide insight into the potential for ancillary risks to impact each of the respective ecological components.

In line with the above approach, preliminary assessments for the GOCIFFF indicated that fishing activities presented a negligible, low or intermediate risk to at least eight of the ecological components or subcomponents (sea snakes, whales, protected teleosts, syngnathids, seabirds, terrestrial mammals, crocodiles and marine habitats). The potential for the GOCIFFF to contribute to an undesirable event for the remaining ecological components was considered to be higher: target & byproduct (high), bycatch (intermediate/high), marine turtles (high), dugongs (intermediate/high), dolphins (high), batoids (high), sharks (high) and ecosystem processes (precautionary high, data deficient (Appendix 2)).

While not universal, an absence of an effective control on effort for key species, data limitations, an inability to validate catch/discard rates (e.g. SOCI data) and the adequacy of net-attendance provisions were factors of influence in a number of the higher risk ratings (Appendix 2). A full account of the preliminary risk ratings, the key considerations and risk factors are provided in Appendix 2. However, the following provides a general overview of the key findings of the risk characterisation stage:

- target and byproduct species received a higher risk rating due the absence of an overarching control on catch or effort and sustainability concerns surrounding the stocks of at least one key species (barramundi);
- the structure of the current net in-attendance provisions influenced the risk ratings of a number of the ecological components including key SOCC subgroups e.g. marine turtles, cetaceans and dugongs;
- the absence of finer-scale information on effort overlap with key species distributions resulted in more conservative scores being assigned for some subgroups;
- net fishing specificity combined with an elevated risk of *in-situ* and post release mortalities was a factor of influence for a number of the ecological subgroups including the discarding of target and byproduct species, bycatch and SOCC;
- the fishery presented an intermediate to high risk to a number of the SOCC subgroups due to both direct (discarding) and indirect (contact without capture, loss of fishing gear) impacts;
- the highest risk ratings assigned to batoids was largely driven by interactions with sawfish;
- the removal of predators and impacts on recruitment were identified as the key drivers of risk for the ecosystem processes ecological component;
- the broader impacts of ghost nets were significant factors of influence with respect to cumulative fishing pressures but had a limited influence on the risk profiles of each ecological component.

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 preliminary risk ratings of four ecological components were reduced (Appendix 2). The risk rating for crocodiles was reduced from intermediate to low/intermediate based on the number of interactions and the health of populations across northern Australia. The risk ratings for whales and marine habitats were reduced from intermediate to low due in recognition that a) ghost nets influenced the final risk score for both ecological components and b) research showing that the majority of ghost nets come from fisheries outside of Australia. Lastly, the risk rating for syngnathids was reduced from low to negligible to reflect the likelihood of an interaction occurring and the low potential for entanglement.

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 Inshore Fin Fish Fishery (GOCIFFF) taking into consideration the likelihood of the risk coming to fruition in the short to medium term. .

Ecological Component	Level 1 Risk Rating	Considerations of Likelihood and Mitigation Measures	Level 2 Required?
Target & Byproduct	High	<ul style="list-style-type: none"> Moderate to high risk to this ecological component depending on whether the species is a target (high) or a byproduct species (moderate) and ancillary factors like 	Yes

Ecological Component	Level 1 Risk Rating	Considerations of Likelihood and Mitigation Measures	Level 2 Required?
		<p>market demand e.g. black jewfish catch has tripled within 12 months due to increased market demand.</p> <ul style="list-style-type: none"> • Mesh size controls, use of spatial closers, best management and handling practices already implemented in the fishery. However key risk factors relate to the absence of effective control on catch and effort at a whole of fishery, regional and species level. • Sustainability concerns exist for key species including barramundi and king threadfin who have negative stock status assessments in the Gulf of Carpentaria. • Large net attendance provisions (5nm in rivers & creeks; 6nm in nearshore waters) reduces the ability of the fisher to detect negative catch signals e.g. catching higher percentages of fish outside the prescribed size limits or large amounts of low-quality byproduct species. • A number of management and monitoring changes are being considered for the fishery including changes to the stock assessment process, increased use of ITQs and TACs, catch triggers and incidental catch allowances to reduce wastage. A high proportion of these measures have yet to be implemented and are still being worked up through the harvest strategy process. DAF is also examining ways to increase the number of stock assessments to support tier 1 and 2 species. • Improved catch reporting processes, including the introduction of electronic logbooks to improve catch composition data and electronic observation are also being investigated as part of the <i>Sustainable Fisheries Strategy 2017–2027</i>. • Cumulative risks including the impact of recreational and charter fishing will be a broader risk factor for some species in this subgroup. 	
Bycatch (non-SOCC)	Intermediate / High	<ul style="list-style-type: none"> • High likelihood as it would occur daily across the majority, if not all, the apparatus used in the GOCIFFF. • Extent of these interactions and therefore risk will vary between regions and gear types. The amount of bycatch will also vary as by region and operation as GOCIFFF fishers can retain a wide range of species. 	Yes

Ecological Component	Level 1 Risk Rating	Considerations of Likelihood and Mitigation Measures	Level 2 Required?
		<ul style="list-style-type: none"> Information on bycatch rates and compositions unlikely to improve without further measures to validate catch. However, the amount of bycatch discarded may be lower as GOCIFFF operators retain a high number of species. Mitigation measures including mesh size controls, net attendance provisions, spatial closures and best management and handling practices already implemented in the fishery. The effectiveness of these measures will vary between GOCIFFF sub-fisheries. High potential for <i>in-situ</i> and cryptic mortality (e.g. post-release mortalities); an issue that will be exacerbated by the current net attendance provisions. Electronic observation being considered in a range of fisheries as part of the <i>Queensland Sustainable Fisheries Strategy 2017–2027</i>. 	
Species of Conservation Concern (SOCC)			
Marine turtles	High	<ul style="list-style-type: none"> Moderate to high risk, depending on the location and apparatus used. Overall risk will vary between sectors but there is still considerable potential for subgroup to interact with GOCIFFF operations in nearshore and offshore waters. Limited bycatch mitigation measures in place including mesh size restrictions, net attendance provisions, spatial closures and best management & handling measures. Subgroup will also derive benefit from spatial closures implemented by the Commonwealth Government in 2018. As air-breathing species, there is a higher potential for an interaction to result in a mortality and the subgroup has notable life-history constraints. Marine turtles are also particularly susceptible to cumulative impacts/risks including those related to boat strike. Net attendance provisions will be less effective when compared to the ECIFFF; particularly in nearshore waters where it extends out to 6nm. This distance increases the risk of an interaction going undetected and/or extending over a longer time period. The extended net attendance provisions also increase the risk that the entanglement will be fatal. 	Yes

Ecological Component	Level 1 Risk Rating	Considerations of Likelihood and Mitigation Measures	Level 2 Required?
		<ul style="list-style-type: none"> • There are inherent limitations on the amount of available data, the ability to validate SOCI data and obtain an accurate account on the total number of interactions / fishing mortalities. This risk may transfer to a compliance issues with non-reporting of SOCI interactions considered to be a risk for this subgroup. • While electronic observation is being considered for some fisheries, the feasibility and applicability of this method is still being determined. • Cumulative risks including customary hunting, boat strike etc. will be a factor for this subgroup. 	
<i>Sea snakes</i>	Low	<ul style="list-style-type: none"> • Low interaction rates and if best management and handling practices followed a high percentage of these animals will be released alive. 	No
<i>Crocodiles</i>	Low / Intermediate	<ul style="list-style-type: none"> • Low to intermediate, depending on location of the fishing operation. Risk may be more relevant to operations fishing in creek, river, estuarine and nearshore environments. • Mesh size controls, net attendance provisions, spatial closures and best management and handling practices already implemented in the fishery. • Net attendance provisions will be less effective when compared to the ECIFFF; particularly in creeks, rivers and nearshore waters. This distance increases the risk of an interaction going undetected and/or extending over a longer time period. The extended net attendance provisions also increase the risk that the entanglement will be fatal. • Crocodile populations in northern Australia are healthy and fishing activities in the GOCIFFF are unlikely to have a significant long-term impact on the overall population. Less certainty around the level of risk posed to regional populations. • Finer scale information on effort distributions would assist in quantifying this risk. Electronic observation being considered, however the feasibility and applicability of this method is still being determined. 	No

Ecological Component	Level 1 Risk Rating	Considerations of Likelihood and Mitigation Measures	Level 2 Required?
<i>Dugongs</i>	Intermediate / High	<ul style="list-style-type: none"> Potential for interactions to occur will depend on location and netting activity. Risk will also vary considerably between sectors (<i>i.e.</i> inshore vs. offshore). Net attendance provisions will be less effective when compared to the ECIFFF; particularly in nearshore waters where it extends out to 6nm. This distance increases the risk of an interaction going undetected and/or extending over a longer time period. The extended net attendance provisions also increase the risk that the entanglement will be fatal. Spatial closures will provide subgroup with effective protection from fishing mortality due to the species having smaller home ranges. Subgroup has considerable life-history constraints and even low interactions may have long-term implications. There are inherent limitations on the amount of available data, the ability to validate SOCI data and obtain an accurate account on the total number of interactions / fishing mortalities. This risk may transfer to a compliance issues with non-reporting of SOCI interactions considered to be a risk for this subgroup. While electronic observation being considered, the feasibility and applicability of this method is still being determined. This subgroup is particularly susceptible to cumulative risks including customary hunting and boat strike. 	Yes
Cetaceans	Whales – Low	<ul style="list-style-type: none"> Risk posed to this subgroup will be highly dependent on the morphology of the species and the potential for interaction to result in a mortality. Whale interactions less likely to result in direct mortalities with dragging of equipment more likely than entanglement. Greatest risk to this subgroup relates to longer term injuries (<i>e.g.</i> tail ropes) and the potential risk posed to smaller species by ghost nets. Risks posed to dolphins will be elevated due to the subgroup being to smaller and having a higher susceptibility to entanglement. 	No

Ecological Component	Level 1 Risk Rating	Considerations of Likelihood and Mitigation Measures	Level 2 Required?
	Dolphin – High	<ul style="list-style-type: none"> • The dolphin subgroup contains species with significant life-history and geographical constraints. As with dugongs, this means that low levels of fishing mortality may have long-term implications for regional populations or key species (e.g. snubfin dolphins). • There are inherent limitations on the amount of available data, the ability of management to validate SOCI data and obtain an accurate account on the total number of interactions / fishing mortalities. This risk may transfer to a compliance issues with non-reporting of SOCI interactions considered to be a risk for this subgroup. • While electronic observation is being considered, the feasibility and applicability of this method is still being determined. 	Yes
Protected teleosts	Low	<ul style="list-style-type: none"> • No reported interactions from the fishery and effort distributions largely exist outside habitats preferred by these species. 	No
Batoids	High	<ul style="list-style-type: none"> • High likelihood of interactions and most species can be retained for sale in the GOCIFFF. • The GOCIFFF presents as one of the more significant fisheries-based risks to sawfish (<i>Pristis</i> spp.) and this subgroup exerted considerable influence on the final risk ratings. • Sawfish have considerable life-history constraints and have experienced notable contractions in their distribution. This means that low levels of fishing mortality may have long-term implications for regional populations and for the species as a whole. • While batoids (in general) are not retained in substantial quantities, most of this subgroup can be sold commercially. The main suppressor of catch and effort for this subgroup is low marketability. There is considerable potential for fishing effort to increase in this subgroup if market demand for one or more species were to increase. • Limited information on species compositions / post-release mortality rates and limited capacity to validate catch data for this subgroup. This risk though will arguably be more relevant to inshore and nearshore species. 	Yes

Ecological Component	Level 1 Risk Rating	Considerations of Likelihood and Mitigation Measures	Level 2 Required?
		<ul style="list-style-type: none"> Expansion of the <i>Vessel Tracking</i> system will help identify the extent of the overlap between fishing effort and habitats preferred by batoids. <i>Vessel Tracking</i> will also provide insight into the type of species that may interact with the fishery. 	
Sharks	High	<ul style="list-style-type: none"> Risk profile for sharks is complicated as it includes species that can be targeted and retained for sale, no-take species and species afforded additional protections under the EPBC Act and GBRMP legislation. The fishery interacts with a wide range of species and risk levels will be highly dependent on the species, their biological constraints and their marketability. Artificially mitigated to some extent by reductions in the shark meat and fin markets. However this situation can be readily reversed depending on market demand. Management arrangements for this subgroup less advanced than on the Queensland east coast <i>i.e.</i> TACC limit only applies to the hammerhead shark complex. While catch data for this subgroup has improved through time, some of the data continues to be reported in generic catch categories. This problem is compounded by an inability to validate catch compositions and discard rates. Measures introduced in January 2018 to improve management of sharks including the introduction of a shark specific logbook for sharks in the GOCIFFF, monitoring of shark discards and a strengthening of management arrangements for hammerhead sharks. A range of measures are currently being considered as part of the <i>Sustainable Fisheries Strategy</i> but have yet to be implemented fully and/or examined in the context of the GOCIFFF. These include: <ul style="list-style-type: none"> A proposed three tiered system of ITQs, TACs, catch triggers to manage risk where species can move up the tiers based on fishery data. Incidental catch allowances to reduce wastage given the number species and net selectivity issues. Increasing the number of stock assessments to support tier 1 and 2 species. 	Yes

Ecological Component	Level 1 Risk Rating	Considerations of Likelihood and Mitigation Measures	Level 2 Required?
		<ul style="list-style-type: none"> - Improving catch reporting processes, including the introduction of electronic logbooks to improve catch composition data and electronic observation. • While electronic observation is being considered, the feasibility and applicability of this method is still being determined. 	
Syngnathids	Negligible	<ul style="list-style-type: none"> • N/A as interaction rates (if applicable) are unlikely to have long-term implications for regional populations. 	No
Seabirds	Low	<ul style="list-style-type: none"> • Interactions with this subgroup expected to be low and infrequent. • In the unlikely event of an interaction, extended net attendance provisions increase the risk of entanglements ending in mortality. The extent of these interactions though are not expected to have long-term implications for regional seabird populations. 	No
Terrestrial mammal	Negligible	<ul style="list-style-type: none"> • N/A as interaction rates (if applicable) are unlikely to have long-term implications for regional populations. 	No
Marine Habitats	Low / Intermediate	<ul style="list-style-type: none"> • The fishery will typically have a low level of impact on regional environment but may depend on the netting activity, netting frequency and location. • Fishery operates under controls that determine how nets are used and where they can be set. • Area most impacted (e.g. inshore waters) would experience varying degrees of natural disturbance (e.g. natural tidal fluctuations, high flow events, significant wet-seasons). • <i>Vessel Tracking</i> systems have been expanded across Queensland's commercial fisheries. This will improve the level of understanding of regional net usage and its potential to impact marine habitats. • Net attendance provisions less effective at preventing gear loss due to permitted distances. However, research indicates that Australian fisheries make a minor contribution with respect to the number of ghost nets that occur in the Gulf of Carpentaria. 	No

Ecological Component	Level 1 Risk Rating	Considerations of Likelihood and Mitigation Measures	Level 2 Required?
Ecosystem Processes	Precautionary high; data deficient	<ul style="list-style-type: none"> Risk levels uncertain due to data deficiencies. Fishery interacts with a wide range of trophic levels and fishing activities will transverse a number of the ecological components. Ecosystem processes most likely to be influenced by fishing activities in the GOCIFFF include predation, recruitment and scavenging. Some measures in place to protect larger fish that contribute more to recruitment rates. Measures being considered as part of the <i>Sustainable Fisheries Strategy 2017–2027</i> will help alleviate this risk further including proposals that increase the use of ITQs and TACs would help to manage this risk. There is limited capacity at present to quantify this risk and/or what contribution the GOCIFFF makes to the overall level of risk. 	Not progressed due to data limitations.

4.6 Issues Arising

Net attendance provisions

Current net attendance provisions in the GOCIFFF were identified as one of the major sources of risk. At 5nm and 6nm (~9km or ~11km), there is limited potential for a fisher to negate an interaction with non-target species in creeks, rivers and nearshore waters. It is recognised that fishers may operate within these limits or be stationed much closer to the apparatus when fishing. However, there is limited information on how fishers interact with their gear during a fishing event and it was difficult to take this into account as part of the risk assessment process. Some of the more significant consequences of having wider net attendance provisions include a larger number of *in-situ* mortalities and poorer post-interaction survival rates. These provisions may also limit a fisher's capacity to minimise the extent of the impacts. If for example a pod of dolphins entered into a fished area, a licence holder stationed 5 or 6nm away from a net would not be aware of this risk and could not implement strategies to minimise the risk of multiple entanglements.

The use of extended net attendance provisions in the GOCIFFF are a consequence of the fishery operating in a complex marine environment and the need to account for external factors including operational constraints and safety considerations. While noting these constraints, these provisions increase the risk of non-target species being captured and accentuates risks associated with **contact without capture** and **loss of fishing gear**. This contrasts with the ECIFFF where more stringent net attendance provisions resulted in **contact without capture** and **loss of fishing gear** being assigned lower risk ratings.

From an ERA perspective, the above risks were applicable to most of the ecological components including a high number of the SOCC subgroups.

Absence of effective control on total effort & catch

An inability to control catch and effort at a whole of fishery, regional and species level influenced the risk profiles of a number of the ecological components. While the overall fishery may not experience a significant increase in effort, there is considerable potential for effort to increase at a regional and species level. This risk, at present, will be most applicable to the five species / species complexes that make up around 90% of the GOCIFFF catch (grey mackerel, barramundi, king threadfin, blacktip sharks and blue threadfin). Evidence suggests that at least two of the species (barramundi, king threadfin) are being fished beyond key sustainability reference points (Saunders *et al.*, 2018; Whybird *et al.*, 2018). Depending on the fishing environment and market demands, this risk may extend to other species, including those that are currently retained in smaller quantities.

The development of harvest strategies for key species is one of the key objectives of the *Sustainable Fisheries Strategy 2017–2027* and will be largely driven through Fisheries Working Groups (FWG). These groups include a wide range of stakeholders from the scientific community, management agencies, conservation groups and the commercial and recreational fishing sectors. One of the key priorities of the GOCIFFF working group will be to discuss the current management arrangements and the suitability/applicability of alternate management arrangements *e.g.* the use of ITQs or a TACC limit for key species, key monitoring and research priorities etc.

Shifting Catch and Effort

Issues associated with the displacement or transfer of effort will be present in most fisheries that are (largely) managed through input controls. In the GOCIFFF, this will be a risk of particular relevance to high value species or species that experience high levels of effort from multiple fishing sectors. The ability of management agencies and the FWG to effectively manage this risk will depend on the species in question and in some instances the affected region. Quantifying this risk across the entire GOCIFFF will be more problematic given the number of species that are retained for sale in this fishery and the poor resolution of some of the catch data. From the perspective of a Level 2 (PSA or SAFE) ERA, this may result in some species being assigned more conservative (precautionary) risk scores (Department of Agriculture and Fisheries, 2018a).

A number of initiatives being undertaken as part of the *Queensland Sustainable Fisheries Strategy 2017–2027* will greatly assist in the monitoring and mitigation of this risk. The most notable of these is the expansion of *Vessel Tracking* to include all commercial fishing boats by the end of 2020 (Department of Agriculture and Fisheries, 2018f). This move alone will help to improve the accuracy of Level 2 assessments and help to quantify the level of risk associated with the movement of effort within a fishery. It will however take time to both implement this policy and obtain the level of data needed to inform the ERA process. In the interim, future ERAs will benefit from a) a more immediate evaluation of shifting catch compositions and effort patterns through time and b) the reasons behind any shifts including increased marketability, licence transfers and increased regulations.

Species Composition Data

In multi-gear, multi-species fisheries like the GOCIFFF, the acquisition of better catch data will continue to be of high priority. While the use of more generic categories has reduced, the fishery continues to report (by necessity) a proportion of the catch as species complexes or generic categories. This will

make it difficult to assess the level of exploitation each species is exposed to and therefore the potential for one or more of the species within the complex to experience an undesirable event.

Refinements to the logbook reporting system have improved the level of data on GOCIFFF catch composition through time. This is most notable in the amount of catch being reported in generic categories like “*Fish–unspecified*”, “*Shark–unspecified*”, “*Shark–whaler unspecified*” (Department of Agriculture and Fisheries, 2019a). In the past this catch has been partly validated through a Fisheries Observer Program. This program ceased in 2013 due to operational constraints and the focus of data validation is now based on data analysis, limited range checks at the data entry point, and outlier reports generated once the data has been entered. Cross checking of logbook data through catch disposal records and prior and unload reporting also occurs where links have been identified (Department of Agriculture and Fisheries, 2018b).

From an ERA perspective, the quality of the species composition data will have a bearing on the accuracy of the Level 2 ERAs. This will be of particular importance to the shark and batoid ecological components where the life-history traits tend to be more conservative. While the Level 2 ERAs allow for use of proxies, both the PSA and SAFE deal with data deficiencies in a precautionary manner. For species with limited data, this increases the probability that they will be assigned more conservative scores and present in the Level 2 ERA as higher risk elements.

‘Improved Monitoring & Research’ was included in the *Queensland Sustainable Fisheries Strategy 2017–2027* as one of four foundational reforms. The improvement of commercial fishing data is now being addressed through a dedicated *Fisheries Data Validation Plan* and through the *Monitoring and Research Plan* (Department of Agriculture and Fisheries, 2018b; c). These reforms along with the expansion of the *Vessel Tracking* program will improve the accuracy of Queensland’s catch and effort data. These measures though will take time to develop and implement; therefore they will take time to filter through to the ERA process.

Discard and Non-retention Rates

The overwhelming majority of data compiled through the logbook reporting system relates to the retained portion of the catch. As discards are not accounted for in the logbook data for most species, the reporting systems may mask the true extent of fishing mortality in the GOCIFFF. This heightens the risk that one or more of the ecological components or their subcomponents will experience an undesirable event due to fishing activities. The extent of this risk will be highly dependent on the species, how it interacts with the fishery (e.g. capture by net in shallow water or deep water) and its resilience with respect to surviving a fishing event.

A lack of data on discards and post-release mortalities is a risk factor in a number of Queensland’s commercial fisheries. However, the multi-species and multi-faceted nature of the GOCIFFF combined with the above limitations in species composition data will factor heavily in the Level 2 assessments. Going forward, obtaining additional data on discard and mortality rates will be of central importance to understanding and mitigating this risk. Improved data on all three parameters (species compositions, discards, and total mortality) will also help to quantify the level of risk in each sub-sector (*i.e.* N3, N12 and N13) and help to direct resources towards areas and species with a higher risk potential.

Efforts are already being undertaken in the GOCIFFF to improve information on discard rates for some species. As of 1 January 2018 all commercial net fishers in the GOCIFFF are required to report all shark catch (retained and discarded) through the logbook system. Discard data for this complex will initially be collected at a higher level and will require additional validation measures. While the scope of this

data will be limited, it is the first step towards estimating discard rates for an important complex in the fishery. Information on discard rates for other species including key teleosts will remain limited until they are addressed through the *Fisheries Data Validation Plan* or the *Monitoring and Research Plan* (Department of Agriculture and Fisheries, 2018c; b).

SOCI Interactions

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

Obtaining accurate information on SOCI interactions will be of significant importance to the Level 2 assessments for this fishery. Level 2 assessments are precautionary in nature, meaning species with low or inaccurate data sets may be assigned a more conservative risk scores. The provisions of more accurate SOCI data enables risk assessments to be refined and provides managers and the FWG with greater capacity to differentiate between real and potential risks—refer to the *Ecological Risk Assessment Guidelines* (Department of Agriculture and Fisheries, 2018a). In a fishery like the GOCIFFF where SOCI interactions cover a range of subgroups, this will be important as it ensures that resources are directed towards species that require risk mitigation measures.

At a whole of fishery level, the commercial fishing sector already has the mechanisms in place to improve the level of information on SOCI interactions. In terms of the conditions imposed on the export approval and third-party assessments, there is arguably greater impetus for this sector to improve the quality of the SOCI logbook data. Further information is also required on the potential for other fishery sectors to interact with these species.

Shark & Batoid Catch Data

The life history constraints of elasmobranch species and the role they play in regional ecosystems has seen this subgroup receive a considerable level of attention. This attention will continue into the future as more species are subject to broad-scale sustainability assessments including those conducted through the *Convention on International Trade in Endangered Species of Wild Fauna and Flora* (CITES), the *Convention on the Conservation of Migratory Species of Wild Animals* (CMS) and the *EPBC Act 1999*. From a fisheries perspective, these types of assessments can have important implications for how shark resources are managed in Queensland.

One of the key criticisms levelled at the GOCIFFF is that there is insufficient information on the composition and structure of the shark catch. As the resilience capabilities of this complex will vary between species, the fisheries reliance on catch and effort data may mask interspecific differences in the amount of effort / fishing mortality each species is exposed to. This increases the risk that one or more species will experience an undesirable event due to fishing activities in the GOCIFFF. In the Level 2 assessments, the absence of biological data on the retained catch combined with poor species differentiation may result in some species receiving more conservative risk ratings.

Of notable importance, the level of information on shark catch compositions and sustainability reference points has improved through time. In 2015, a detailed stock assessment was completed for 12 species or species complexes harvested for sale in the Gulf of Carpentaria and the Queensland east coast. This report concluded that existing levels of the shark harvest in Queensland were below the predicted maximum sustainable levels. However, the report also acknowledged a number of data limitations, particularly with respect to species identifications and the quantity and reliability of the available shark catch data (Leigh, 2015). With the introduction of a dedicated shark and ray logbook, the level of information on catch compositions and discard rates in the Gulf of Carpentaria will continue to improve. As this measure was only implemented on 1 January 2018, this information will be of more benefit in the Level 2 assessments. The extent of these benefits though may be dependent on management's capacity to validate the accuracy of this information and its relevance to the current fishing environment.

Recreational Fishing Data

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

The majority of information on recreationally caught species is obtained through voluntary localised collection of data (e.g. the boat ramp survey program, the Fisheries Monitoring Program) and the more expansive voluntary recreational fisher surveys (Webley *et al.*, 2015). Although limited, the data indicates that in many fisheries the catch from the recreational sector is as high, or higher, than the commercial sector. Given these factors, the extent of fishing mortality resulting from the recreational fishing requires further investigation.

5 Summary & Recommendations

When the outcomes of the preliminary risk assessment and the secondary evaluation (Appendix 2) are taken into consideration, seven ecological components will be progressed to a Level 2 assessment: target & byproduct species, bycatch, marine turtles, dugongs, dolphins, batoids and sharks. While ecosystem processes were assigned a precautionary high risk rating, it was not progressed to a Level 2 ERA due to data limitations. The Level 2 assessment will produce risk profiles for key species or species groupings and address issues relating to risk variability.

Under Queensland's ERA framework (Department of Agriculture and Fisheries, 2018a), SOCC subgroups will be prioritised for Level 2 assessments followed by the target & byproduct and bycatch ecological components. The scope of the initial Level 2 ERAs may be expanded to include a small number of non-SOCI species. The extent of this expansion will depend on a range of factors including discussions held as part of the GOCIFFF fisheries working group and ancillary projects being undertaken as part of the *Queensland Sustainable Fisheries Strategy 2017–2027* (Department of Agriculture and Fisheries, 2017)

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

Agriculture and Fisheries, 2018d), the *Fisheries Data Validation Plan* (Department of Agriculture and Fisheries, 2018b) and through the development of harvest strategies for key species and fisheries (Department of Agriculture and Fisheries, 2018e). Specifically:

- Providing greater differentiation between target, byproduct and bycatch species including an examination of regional variability in catch compositions and emerging market trends e.g. secondary target species that may experience increased fishing mortality over the short to medium term or where international demand is increasing.
- Increasing the level of information on discard rates and fates for low value target/byproduct species and non-target species including those identified as threatened, endangered and protected.
- Validating species compositions, interaction rates and catch dynamics (e.g. size structures, sex ratios) for the SOCC ecological component.
- Improving the level of information on the efficiency of the current net attendance provisions and how they are utilised by net fishers in the Gulf of Carpentaria.
- Further assessment of regional catch and effort levels in the recreational fishing sector for key species where cumulative fishing impacts present as a higher risk.

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Appendix 1—Ecological Processes Preliminary Assessment

A1—Ecological Processes Categories

Categories taken into consideration as part of the Level 1 preliminary 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 PROCESSES	The input, export and recycling of nutrients within the ecosystem. Removal of animals through harvesting is a direct loss of nutrients to the ecosystem
PARTICLE FEEDING	Feeding process targeted at particles suspended in the water column, or deposited on submerged surfaces
PRIMARY PRODUCTION	The conversion of the sun's energy into carbon compounds that are then available to other organisms
HERBIVORY	The consumption of plants
PREDATION	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>i.e.</i> 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', than the final risk score for harvesting will be a H. To this extent, the final risk scores assigned to each fishing activity present the highest potential risk and therefore may not be applicable to all of the ecosystem processes categories. Used in this context, the Level 1 assessment for ecosystem processes should be considered as both precautionary and preliminary in nature. The following presents a summary of the preliminary risk scores assigned to the main fishing activities in the GOCIFFF.

Ecosystem Processes Categories	Net 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	-	L	-	L
Nutrient cycling / Microbial processes	L	L/I	-	-	-	-	-	-
Particle feeding	-	-	-	-	-	-	-	-
Primary production	-	-	-	L	-	-	-	-
Herbivory	L	-	-	L	-	-	-	-
Predation	H	L/I	-	L	-	-	-	I
Bioturbation	-	-	-	-	-	L	-	-
Detritivory	-	-	-	-	-	-	-	-
Scavenging	L/I	I	-	L	-	-	-	L
Symbiosis	-	-	-	-	-	-	-	-
Recruitment	I	-	-	L	-	-	-	L/I
Reef Building	-	-	-	-	-	-	-	-
Competition	L	-	-	L	-	-	-	L
Connectivity	L/I	-	-	-	-	-	-	L
Outbreaks of disease	-	L	-	-	-	-	-	L
Species introductions	-	-	-	-	-	-	-	-
ECOSYSTEM PROCESSES (overall)	H	I	-	L	-	L	-	I

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 affected 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 ratings are precautionary or more conservative in nature and provide a more holistic account of a) risks posed by the fishery and b) provide the Level 1 ERA with greater capacity to address the (potential) long-term consequences of a risk. The trade-off with this approach is that the preliminary risk may overestimate the level of risk posed to an ecological component or be a reflection of the ‘potential risk’. Otherwise known as a ‘false positive’, these values effectively overestimate the risk posed to an ecological component or subcomponent.

The potential for large-scale qualitative ERAs to produce ‘false positives’ places added importance on examining the likelihood of the risk coming to fruition in the short to medium term. The following provides an overview of the preliminary risk ratings and an assessment of the likelihood of it occurring in the GOCIFFF. 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"> Complex, multi-species, multi-sector fishery that operates in both inshore and offshore waters. Absence of effective controls on catch and effort at a whole of fishery, regional and species level. Poor species resolution in some of the catch composition data including the use of generic catch categories. 	High	<p><u>Likelihood</u></p> <ul style="list-style-type: none"> Moderate to high, depending on whether the species is a target (high) or a byproduct species (moderate). <p><u>Mitigation Measures & Considerations</u></p> <ul style="list-style-type: none"> A number of State-wide initiatives being considered as part of the <i>Queensland Sustainable Fisheries Strategy 2017–2027</i> that may impact on the GOCIFFF. 	High

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"> • High potential for effort to transfer between species or for catch and effort to increase for key species. • Research indicates that at least two of the key species are being fished above sustainability reference points. • Large net attendance provisions (5nm in rivers & creeks; 6nm in nearshore waters) reduces the ability of the fisher to detect negative catch signals e.g. catching higher percentages of fish outside the prescribed size limits or large amounts of low-quality byproduct species. • Cumulative risks including the impact of recreational and charter fishing will be a broader risk factor for some species in this subgroup. 		<ul style="list-style-type: none"> • Proposing a three tiered system of ITQs, TACs and catch triggers to manage risk. Species can move up the tiers based on fishery data. • Proposed incidental catch allowances to reduce wastage given the number species and net selectivity issues. • Increased number of stock assessments to support tier 1 and 2 species. • Improved catch reporting processes, including the introduction of electronic logbooks to improve catch composition data and electronic observation. • Mesh size controls and best management and handling practice in place. • Some spatial closures in place and temporal/seasonal closures used for barramundi. • Spatial closures used in the Gulf of Carpentaria have recently been expanded by the Australian Government. 	
Bycatch (non-SOCC)	<ul style="list-style-type: none"> • Fishery has higher potential to interact with non-target species. 	Intermediate / High	<u>Likelihood</u>	Intermediate / High

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 bycatch compositions and diversity. Total amount of bycatch likely to be reduced due to high retention rates. Bycatch compositions and risk levels will vary between the N3 (creeks, rivers, inshore) and the N12/N13 (offshore) fishery. High potential for <i>in-situ</i> and cryptic mortality (e.g. post-release mortalities); an issue that will be exacerbated by the current net attendance provisions. Limited avenues to collect information or validate bycatch levels within the GOCIFFF. Extent of bycatch monitoring and sampling programs limited due to cost and operational constraints. 		<ul style="list-style-type: none"> High because it would occur daily across the majority, if not all, the apparatus used in the GOCIFFF. Extent of these interactions and therefore risk will vary between regions and gear types. The amount of bycatch discarded may be lower as GOCIFFF retains a high number of species. Information on bycatch rates and compositions unlikely to improve without improved catch validation. <p><u>Mitigation Measures & Considerations</u></p> <ul style="list-style-type: none"> Mesh size controls, net attendance provisions, spatial closures and best management and handling practices already implemented in the fishery. Net attendance provisions will be less effective in this fishery when compared to the ECIFFF. Electronic observation being considered in a range of fisheries as part of the <i>Queensland Sustainable Fisheries Strategy 2017–2027</i>. 	

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"> Spatial closures used in the Gulf of Carpentaria has recently been expanded by the Australian Government. 	
Species of Conservation Concern (SOCC)				
Marine turtles	<ul style="list-style-type: none"> Higher potential for this subgroup to interact with the fishery and for the interaction to result in <i>in-situ</i> and cryptic mortalities (e.g. post-release mortalities). Net attendance contributed to the overall risk ratings as it a) increased the risk of an interaction going undetected, b) has the potential to increase the length of an interaction and c) reduces the ability of the fisher to remedy the situation quickly if an animal becomes entangled in the net. The risk posed to this subgroup will vary across the GOCIFFF and will be higher in nearshore and offshore environments. Subgroup has more conservative life-history traits. 	High	<p><u>Likelihood</u></p> <ul style="list-style-type: none"> Moderate, depending on location and apparatus used. <p><u>Mitigation Measures & Considerations</u></p> <ul style="list-style-type: none"> Mesh size controls, net attendance provisions, spatial closures and best management and handling practices already implemented in the fishery. Net attendance provisions will be less effective in this fishery when compared to the ECIFFF. Extended net attendance provisions increase the risk of entanglements ending in mortality / unobserved interactions. 	High

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 capacity to validate interaction rates with this subgroup, the impact of under-reporting and/or assess the effectiveness of net attendance provisions. Cumulative risks including the impact of recreational and charter fishing will be a variable risk factor for some species in this subgroup. 		<ul style="list-style-type: none"> Electronic observation being considered in a range of fisheries as part of the <i>Queensland Sustainable Fisheries Strategy 2017–2027</i>. Spatial closures used in the Gulf of Carpentaria have recently been expanded by the Australian Government. Cumulative risks including customary hunting will be a factor for this subgroup. 	
Sea snakes	<ul style="list-style-type: none"> A low number of interactions reported from the fishery. Escapement capabilities (e.g. contact without capture) expected to be good and post-release mortalities for this subgroup will be negligible. 	Low	<p><u>Likelihood</u></p> <ul style="list-style-type: none"> Low. <p><u>Mitigation Measures & Considerations</u></p> <ul style="list-style-type: none"> Best management and handling practice in place. SOCI logbooks. Electronic observation being considered. 	Low
Crocodiles	<ul style="list-style-type: none"> Fishery has higher potential to interact with this subgroup due to the area of operation and the preferred habitats/feeding behaviours of this subgroup. Crocodiles have the second highest number of reported SOCI interactions. Interactions with 	Intermediate	<p><u>Likelihood</u></p> <ul style="list-style-type: none"> Low to moderate, depending on location. <p><u>Mitigation Measures & Considerations</u></p> <ul style="list-style-type: none"> Mesh size controls, net attendance provisions, spatial closures and best management and 	Low / Intermediate

Ecological Component	Key Issues / Sources of Risk	Risk Characterisation (Preliminary rating)	Considerations of Likelihood and Mitigation Measures	Level 1 Risk Rating
	<p>this subgroup increased substantially in 2016 and 2017.</p> <ul style="list-style-type: none"> • Current net attendance provisions were a factor of influence in the overall risk ratings for this subgroup. • Limited capacity to validate interaction rates with this subgroup, the impact of under-reporting and/or assess the effectiveness of net attendance provisions. • Behavioural patterns (<i>i.e.</i> rolling) will increase the risk of animals dying as a result of the interaction. • Total mortality due to legal fishing activities (alone) is not expected to result in an undesirable event for this subgroup. • The GOCIFFF is considered to be a contributor of risk to regional populations. 		<p>handling practices already implemented in the fishery.</p> <ul style="list-style-type: none"> • Net attendance provisions will be less effective in this fishery when compared to the ECIFFF. • Extended net attendance provisions increase the risk of entanglements ending in mortality. • Crocodile populations in northern Australia are healthy and fishing activities in the GOCIFFF unlikely to have a significant long-term impact on the population (overall). • Regional impacts of fishing activities may be more relevant. • Electronic observation being considered in a range of fisheries as part of the <i>Queensland Sustainable Fisheries Strategy 2017–2027</i>. 	
Dugongs	<ul style="list-style-type: none"> • Low number of interactions reported from the fishery and moderate potential for the fishery to interact with this subgroup in inshore waters. 	Intermediate / High	<p><u>Likelihood</u></p> <ul style="list-style-type: none"> • Low to moderate, depending on specific netting activity and location. <p><u>Mitigation Measures & Considerations</u></p>	Intermediate / High

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 the extent or propensity of this subgroup to interact with net fisheries in the Gulf of Carpentaria. • Subgroup at increased risk of an interaction resulting in a mortality. • Information on total interaction and mortality rates (within net plus post-release mortality rates) also limited. • Limited capacity to validate interaction rates with this subgroup, the impact of under-reporting and/or assess the effectiveness of net attendance provisions. • Net attendance contributed to the overall risk ratings as it a) increased the risk of an interaction going undetected, b) has the potential to increase the length of an interaction and c) reduces the ability of the fisher to remedy the situation quickly if an animal becomes entangled in the net. • Subgroup has significant life-history constraints and fragmented populations. As a consequence, even low levels of fishing mortality may have long-term consequences. 		<ul style="list-style-type: none"> • Mesh size controls, net attendance provisions, spatial closures and best management and handling practices already implemented in the fishery. • Spatial closures will provide subgroup with effective protection from fishing mortality due to the species having smaller home ranges. • Net attendance provisions will be less effective in this fishery when compared to the ECIFFF. • Extended net attendance provisions increase the risk of entanglements ending in mortality. • Electronic observation being considered in a range of fisheries as part of the <i>Queensland Sustainable Fisheries Strategy 2017–2027</i>. • Spatial closures used in the Gulf of Carpentaria has recently been expanded by the Australian Government. • Cumulative risks including customary hunting will be a factor for this subgroup. 	

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 cumulative risks were a factor for this subgroup, they will be more significant on the Queensland east coast. 			
Cetaceans	<ul style="list-style-type: none"> Complex includes a diverse range of species with varying geographical and life-history constraints. High degree of spatial overlap between key fishing grounds and preferred habitats. Risk dependent on size of animal and susceptibility to entanglement and is more relevant to dolphins. Limited capacity to validate interaction rates with this subgroup, the impact of under-reporting and/or assess the effectiveness of net attendance provisions. Net attendance contributed to the overall risk ratings as it a) increased the risk of an interaction going undetected, b) has the potential to increase the length of an interaction and c) reduces the ability of the fisher to remedy the situation quickly if an animal becomes entangled in the net. 	<p style="text-align: center;">Whales – Intermediate</p> <hr/> <p style="text-align: center;">Dolphins – High</p>	<p><u>Likelihood</u></p> <ul style="list-style-type: none"> Low to moderate, depending on the species, specific netting activity and location. <p><u>Mitigation Measures & Considerations</u></p> <ul style="list-style-type: none"> Mesh size controls, net attendance provisions, spatial closures and best management and handling practices already implemented in the fishery. Extended net attendance provisions increase the risk of entanglements ending in mortality. Whale interactions less likely to result in direct mortalities with dragging of equipment more likely than entanglement. Greatest risk to this subgroup relates to longer term injuries (e.g. tail ropes); although net attendance provisions would reduce this risk and reduce the interval of any interaction. 	<p style="text-align: center;">Whales – Low</p> <hr/> <p style="text-align: center;">Dolphins – High</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"> For some species, low levels of fishing mortality may have regional or national implications. 		<ul style="list-style-type: none"> Electronic observation being considered in a range of fisheries as part of the <i>Queensland Sustainable Fisheries Strategy 2017–2027</i>. 	
Protected teleosts	<ul style="list-style-type: none"> No reported interactions from the fishery and effort distributions largely exist outside habitats preferred by these species. 	Low	<p><u>Likelihood</u></p> <ul style="list-style-type: none"> Low. <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. 	Low
Batoids	<ul style="list-style-type: none"> High potential for the fishery to interact with batoids in creeks and riverine systems, inshore waters and offshore waters. Interactions likely to be with a diverse range of species but will be more prominent in inshore fisheries e.g. the N3 fishery. The GOCIFFF presents as one of the more significant fisheries-based risks to sawfish (<i>Pristis</i> spp.) and this subgroup exerted considerable influence on the final risk ratings. Some protections for key species and subgroups; namely sawfish and manta rays. 	High	<p><u>Likelihood</u></p> <ul style="list-style-type: none"> High but variable. Risk likely to be elevated for key batoid subgroups e.g. sawfish. <p><u>Mitigation Measures & Considerations</u></p> <ul style="list-style-type: none"> While not retained in substantial quantities, most of this subgroup can be sold commercially; providing there is a market. Mitigation measures include mesh size controls, net attendance provisions and best management and handling practice in place. 	High

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"> Sawfish in particular are susceptible to entanglements and fishing related injuries. These impacts are likely to be exacerbated by the current net attendance provisions. While the majority of batoids can be retained, a higher proportion are discarded/returned as unwanted bycatch. Limited information on species compositions / post-release mortality rates and limited capacity to validate catch data for this subgroup. The life history and distribution of some species (e.g. sawfish) may place them at higher risk. Few reporting requirements in the current monitoring system which is primarily targeted at sharks and teleosts. 		<ul style="list-style-type: none"> Electronic observation being considered in a range of fisheries as part of the <i>Queensland Sustainable Fisheries Strategy 2017–2027</i>. Limited information on catch compositions, discard rates and discard fates. Discards not required to reported for most species (excluding SOCI). Expansion of the <i>Vessel Tracking</i> system will help identify the extent of the overlap between fishing effort and habitats preferred by batoids. <i>Vessel Tracking</i> will also provide insight into the type of species that may interact with the fishery. Spatial closures in place but unlikely to be batoid specific. 	
Sharks	<ul style="list-style-type: none"> Key target species with high interaction rates. High degree of spatial overlap between key fishing grounds and preferred habitats. Substantial capacity for catch and effort to increase for one or more species targeted by GOCIFFF operators. 	High	<p><u>Likelihood</u></p> <ul style="list-style-type: none"> Low to high depending on the species (some are actively targeted), location and apparatus. <p><u>Mitigation Measures & Considerations</u></p> <ul style="list-style-type: none"> Artificially mitigated to some extent by big reductions in the shark meat and fin markets. 	High

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	<ul style="list-style-type: none"> • Management arrangements for this subgroup less advanced than on the east coast <i>i.e.</i> TACC limit only applies to the hammerhead shark complex. • While managed as a single entity, the biology of key species can vary considerably including between closely related species. • The life history and distribution of some species within this complex may place them at higher risk. • Limited ability to monitor and validate total catch (retained plus discards) in this fishery. • Catch composition data lacks resolution for some species / high proportion of catch reported in broader categories <i>e.g.</i> blacktip shark, whaler unspecified. • The shark maximum legal size limit is not applicable to this fishery including in the bait fishery. • While sharks can only be targeted by operators in the N12 and N13 fishery, N3 operators can still retain large quantities of incidental shark catch. 		<p>However this situation can be readily reversed depending on market demand.</p> <ul style="list-style-type: none"> • Measures introduced in January 2018 to improve management of sharks including the introduction of a shark-specific logbook for sharks in the GOCIFFF, monitoring of shark discards and a strengthening of management arrangements for hammerhead sharks. • A number of State-wide initiatives being considered as part of the <i>Queensland Sustainable Fisheries Strategy 2017–2027</i> that may impact on the GOCIFFF. • Proposing a three tiered system of ITQs, TACs, catch triggers to manage risk. Species can move up the tiers based on fishery data. • Proposed incidental catch allowances to reduce wastage given the number species and net selectivity issues. • Increased number of stock assessments to support tier 1 and 2 species. • Improved catch reporting processes, including the introduction of electronic logbooks to 	

Ecological Component	Key Issues / Sources of Risk	Risk Characterisation (Preliminary rating)	Considerations of Likelihood and Mitigation Measures	Level 1 Risk Rating
			<p>improve catch composition data and electronic observation.</p> <ul style="list-style-type: none"> • Mesh size controls and net attendance provisions. • Electronic observation being considered. • SOCI reporting. • Spatial closures. 	
Syngnathids	<ul style="list-style-type: none"> • Negligible interactions and limited spatial overlap with the fishery. 	Low	<p><u>Likelihood</u></p> <ul style="list-style-type: none"> • Low. <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
Seabirds	<ul style="list-style-type: none"> • No reports in the SOCI logbooks and the total number of seabird interactions in this fishery expected to be low to negligible. • In the unlikely event that a sea bird were to interact with a net, the risk would be more significant in diving species. This however was not considered to be significant enough to increase the overall risk rating. 	Low	<p><u>Likelihood</u></p> <ul style="list-style-type: none"> • Low to negligible. <p><u>Mitigation Measures & Considerations</u></p> <ul style="list-style-type: none"> • In the unlikely event of an interaction, extended net attendance provisions increase the risk of entanglements ending in mortality. 	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"> Electronic observation being considered in a range of fisheries as part of the <i>Queensland Sustainable Fisheries Strategy 2017–2027</i>. 	
Terrestrial mammal	<ul style="list-style-type: none"> Negligible interactions or spatial overlap 	Negligible	<p><u>Likelihood</u></p> <ul style="list-style-type: none"> Low <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. SOCI reporting. 	Negligible
Marine Habitats	<ul style="list-style-type: none"> Limited information on fine-scale effort distributions in the GOCIFFF. Impacts of ‘active’ net fishing expected to be localised and most obvious during the net setting and retrieval process. The extent of the impacts will depend on a range of factors including soak times, the concentration of fishing effort and repetition Overall risk will be higher in inshore and estuarine environments where nets are more likely to interact with the sea floor for extended periods. 	Intermediate	<p><u>Likelihood</u></p> <ul style="list-style-type: none"> Typically low, but depends on specific netting activity and location. <p><u>Mitigation Measures & Considerations</u></p> <ul style="list-style-type: none"> Fishery operates under controls that determine how nets are used e.g. where they can be set. Area most impacted (e.g. inshore waters) would experience varying degrees of natural disturbance (e.g. natural tidal fluctuations, high flow events, significant wet-seasons). Use of <i>Vessel Tracking</i> systems being expanded across Queensland’s commercial 	Low

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	<ul style="list-style-type: none"> • However, inshore and estuarine waters also experience a high degree of natural disturbance (e.g. storms, tidal flows etc.). • The potential for nets to become entangled in the substrate will be higher in the GOCIFFF due to the structure of the current net attendance provisions. 		<p>fisheries. This will improve the level of understanding of regional net usage and its potential to impact marine habitats.</p> <ul style="list-style-type: none"> • Net attendance provisions less effective at preventing gear loss due to permitted distances. • Evidence suggests Australian fisheries make a minor contribution with respect to the number of ghost nets that occur in the Gulf of Carpentaria. 	
Ecosystem Processes	<ul style="list-style-type: none"> • Has the potential to influence a range of ecosystem processes. • Key risks relate to the removal of predators from the system, the potential to influence/impede recruitment and scavenging. • Difficult to assess because of: <ul style="list-style-type: none"> a) multi-species, multi-sector nature of the fishery; and b) an absence of data on the influence of external factors not related to commercial fishing. 	Precautionary high; data deficient	<p><u>Likelihood</u></p> <ul style="list-style-type: none"> • Uncertain. <p><u>Mitigation Measures & Considerations</u></p> <ul style="list-style-type: none"> • Proposing a three tiered system of ITQs, TACs, catch triggers to manage risk. Species can move up the tiers based on fishery data. • Proposed incidental catch allowances to reduce wastage given the number species and net selectivity issues. • Increased number of stock assessments to support tier 1 and 2 species. • Improved catch reporting processes, including the introduction of electronic logbooks to 	Precautionary high; data deficient

Ecological Component	Key Issues / Sources of Risk	Risk Characterisation (Preliminary rating)	Considerations of Likelihood and Mitigation Measures	Level 1 Risk Rating
			<p>improve catch composition data and electronic observation.</p> <ul style="list-style-type: none"> • Mesh size controls and spatial closures. 	