Department of Agriculture and Fisheries

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Level 1 Ecological Risk Assessment
Fin Fish (Stout Whiting) Trawl Fishery

Queensland Government

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Executive Summary

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

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

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

In the FFTF, the preliminary ratings indicated that at least 13 of the ecological components were at negligible, low or intermediate risk of experiencing an undesirable event due to fishing activities. The remaining ecological components, bycatch and marine habitats were assigned a preliminary risk rating of intermediate/high and high respectively. After the likelihood of the risk coming to fruition was considered, the preliminary risk ratings for bycatch, sharks, seabirds, sea snakes, marine habitats and ecosystem processes were all downgraded. While not universal, these reductions were primarily due to the fishery having (comparatively) low levels of effort, low participation rates and a limited capacity to expand into the future. Other factors that contributed to the risk rating reductions included the use of bycatch mitigation measures and the presence of a large scale spatial/temporal closure in the fishery.

Based on the results of the Level 1 ERA, none of the ecological components will be progressed to a finer scale (Level 2) assessment. If effort in the fishery increases significantly and/or the management regime changes, outputs of Level 1 ERA should be reviewed to determine if one or more of the ecological components needs to be progressed to a Level 2 ERA. The Level 1 ERA also identified key knowledge gaps in a number of the risk profiles and areas where the scope of the assessment can be further refined. These information needs will be progressed through the *Fisheries Queensland Monitoring and Research Plan* for further consideration and include:

- Improving the level of information on catch compositions for elasmobranchs (*e.g.* batoids and sharks) and other non-target species, with particular emphasis on species compositions and release fates.
- An evaluation of the use of otter trawl and Danish seine nets in the FFTF, the economic benefits/constraints of each method, target species retention rates and their potential to impact on non-target species.

Summary of the outputs from the Level 1 (whole of fishery) Ecological Risk Assessment for the Fin Fish Trawl Fishery (FFTF)

Ecological Component	Level 1 Risk Rating	Progression
Target & Byproduct	Low	Not progressed further.
Bycatch (non-SOCC)	Intermediate	*Monitoring & Research Plan*
Species of Conservation Concern (SOCC)		
Marine turtles	Low	Not progressed further.
Sea snakes	Low	Not progressed further.
Crocodiles	Negligible	Not progressed further.
Dugongs	Negligible	Not progressed further.
Cetaceans	Low	Not progressed further.
Protected teleosts (SOCI only)	Negligible	Not progressed further.
Batoids	Intermediate	*Monitoring & Research Plan*
Sharks	Low/Intermediate	Not progressed further.
Syngnathids	Low	Not progressed further.
Seabirds	Negligible	Not progressed further.
Terrestrial mammal	Negligible	Not progressed further.
Marine Habitats	Low/Intermediate	Not progressed further.
Ecosystem Processes	Low	Not progressed further.

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Definitions & Abbreviations

Active Licence	–	The definition of an active licence is the same as that used by DAF's data reporting system. An active licence is a licence that has reported catch and effort in the FFTF through the logbook reporting system irrespective of the amount of catch and effort.
BRD	–	Bycatch Reduction Device.
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.
DAF	–	Queensland Department of Agriculture and Fisheries.
Ecological Component	–	Broader assessment categories that include *Target & Byproduct* (harvested) species, *Bycatch*, *Species of Conservation Concern*, *Marine Habitats* and *Ecosystem Processes.*
ECOTF	–	East Coast Otter Trawl Fishery.
ECTF	–	East Coast Trawl Fishery.
ERA	–	Ecological Risk Assessment.
EPBC Act	–	*Environment Protection and Biodiversity Conservation Act 1999*.
Fishery Symbol	–	The endorsement that permits access to a fisher and defines what gear can be used *i.e.* N = Net, L = line, T = trawl. The number of fishing symbols represents the maximum number of operators that could (theoretically) access the fishery at a single point in time.
Fishing Licence	–	Effectively a fishing platform. A Fishing Licence can have multiple symbols attached including a net (N) and line (L) fishing symbol.
FFTF	–	Fin Fish (Stout Whiting) Trawl Fishery.
FMP	–	Fisheries Monitoring Program.
FOP	–	Fisheries Observer Program.
ITQ	–	Individual Transferable Quota.
Offshore waters	–	Tidal waters that are at least 2m deep at low water.

Permitted Species	–	Species outlined in the *Fisheries (Commercial Fisheries) Regulation 2019* that are harvested in smaller proportions than principle species. Otherwise referred to as byproduct.
Principle Species	–	Key harvested species outlined by the *Fisheries (Commercial Fisheries) Regulation 2019,* often referred to as target species.
QBFP	–	Queensland Boating and Fisheries Patrol.
RIBTF	–	River and Inshore Beam Trawl Fishery.
SAFS	–	Status of Australian Fish Stocks.
Species of Conservation Concern (SOCC)	–	Broader risk assessment category used in the Level 1 assessments that incorporates marine turtles, sea snakes, crocodiles, dugongs, cetaceans, protected teleosts, batoids, sharks, seabirds, syngnathids and terrestrial mammals. These species may or may not be subject to mandatory reporting requirements.
Species of Conservation Interest (SOCI)	–	A limited number of species subject to mandatory reporting requirements as part of the Queensland logbook reporting system. Any reference to 'SOCI' refers specifically to the SOCI logbook or data compiled from the SOCI logbook.
TACC	–	Total Allowable Commercial Catch.
Target	–	The primary species or species groups that have been selectively fished for and retained for commercial, recreational or Aboriginal peoples and Torres Strait Islander peoples purposes.
TED	–	Turtle Excluder Device.
WTO	–	Wildlife Trade Operation.

1 Overview

The *Fin Fish (Stout Whiting) Trawl Fishery* (FFTF) is one of four trawl fisheries operating on the Queensland east coast and the only one that targets teleosts. The three remaining trawl fisheries, the *River and Inshore Beam Trawl Fishery* (RIBTF), *Moreton Bay Trawl Fishery* (MBTF) and the *East Coast Otter Trawl Fishery* (ECOTF), target prawns, bugs and scallops. When compared to the prawn trawl fisheries, the FFTF operates under a more complex system with quota used to manage key target species and in-possession limits applied to most byproduct species. In addition, the fishery has very few licences and operates in areas generally void of sessile benthic flora or fauna (Robins & Courtney, 1998; Roswell & Davies, 2011). Due to these factors, the FFTF is widely viewed as having a lower overall impact on retained species and the surrounding ecosystem; particularly when compared to the ECOTF (Zeller, 2008; Jacobsen *et al.*, 2018).

While an ecological risk assessment (ERA) has been completed for the FFTF (Zeller, 2003), the operating environment has changed. Consequently, the original ERA is now considered to be outdated. More recent trawl fishing ERAs have been completed for the Great Barrier Reef Marine Park (Pears *et al.*, 2012) and for Southern Queensland (Jacobsen *et al.*, 2018). However, these reports largely focus on otter trawl fishing and do not include fin fish trawl operations. Similarly, assessments connected to the *Wildlife Trade Operation* (WTO) approvals process (Zeller, 2015) provide information on how the fishery has progressed against key reporting requirements *vs.* establishing a risk profile for the fishery. Given this, there are benefits of undertaking a more detailed assessment examining the risks associated with the FFTF and its potential to impact both target and non-target species.

In March 2018, Queensland released the *Ecological Risk Assessment Guidelines* (the Guidelines) (Department of Agriculture and Fisheries, 2018a) as part of the broader *Queensland Sustainable Fisheries Strategy 2017–2027* (Department of Agriculture and Fisheries, 2017). 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, 2) a Level 1, whole of fishery qualitative assessment, 3) a Level 2, species-specific semi-quantitative or low-data quantitative assessment, and 4) a Level 3 quantitative assessment (if applicable).

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

2 Focus & Intent

The risk profiles for Queensland's commercial fisheries vary and are highly dependent on the apparatus used. For example, the risk posed by line fishing activities will be lower when compared to a net or trawl fishery. Similarly, single-species fisheries like Spanish mackerel will present a lower risk when compared to multi-species or multi-apparatus fisheries. Every fishery will have elements that present a higher risk for one or more of the ecological components *i.e.* species groupings, marine habitats and ecosystem 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 objectives of the Level 1 assessment 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 FFTF that may contribute to an undesirable event for one or more of the ecological components.

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

3 Methods

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

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

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

In order to refine the Level 1 ERA for ecosystem processes, a preliminary assessment was undertaken. The preliminary assessment examined the potential for a fishery to impact on 16 categories outlined in the *Great Barrier Reef Outlook Report 2014* (Great Barrier Reef Marine Park Authority, 2014). The specific processes examined in response to fisheries related impacts were *sedimentation*, *nutrient cycling / microbial processes*, *particle feeding*, *primary production*, *herbivory*, *predation*, *bioturbation*, *detritivory*, *scavenging*, *symbiosis*, *recruitment*, *reef building*, *competition*, *connectivity*, *outbreaks of disease* and *species introductions*. Not all processes are applicable to every fishery, but all processes were considered before being eliminated. A full definition of each ecosystem process has been provided in Appendix 1.

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

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

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

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

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

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

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

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

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

4 Whole of Fishery Qualitative Assessments

4.1 Risk Context

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

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

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

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

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

As it is a trawl fishery, there is a risk that issues associated with prawn trawl fishing and the FFTF will be conflated. In reality, the FFTF is a much smaller fishery and presents a much lower risk when compared to the ECOTF. For example, there are currently two active operators in the FFTF compared to 298 in the ECOTF (Department of Agriculture and Fisheries, 2018b). This differential is reflected in the effort data with the FFTF recording 260–300 days fished each year compared to >37,000 days fished in the ECOTF (Department of Agriculture and Fisheries, 2018b). Fin Fish Trawl Fishery operators are also permitted use of a Danish seine net which, when compared to an otter trawl, has a higher degree of selectivity (Roswell & Davies, 2011). This in itself helps to reduce the overall footprint of the fishery including the impact it has on non-target species.

At a whole of fishery level, the risk of an undesirable event has been reduced through management arrangements that restrict access to the fishery. Prior to 2000, stout whiting were classified as a permitted species and could be retained by all ECOTF operators. Their removal from the permitted species list, in effect, restricted the take of the species to T4 operations. The benefit of this change was that the number of operators retaining stout whiting reduced from 88 in 1999 to just five (Department of Agriculture and Fisheries, 2019c). While not universal, a decline in the number of licences accessing a fishery can reduce the risk of a species experiencing an undesirable event. The main reasons for this is that reducing access to a fishery helps to reduce the risk of fishing effort and fishing mortality increasing through time. This risk is further managed in Queensland's fisheries through a limited licensing system which prevents new authorities being issued.

While noting the above, the benefits of licence reductions and limited licensing is tempered by the fact that the species is still caught as bycatch in the ECOTF (Leigh & O'Neill, 2016; Wortmann & O'Neill, 2016). This portion of the catch goes unreported and it can be difficult to ascertain the extent of *in-situ* and post-release mortalities. This is of particular relevance when attempting to understand and quantify the broader 'Risk Context' for this fishery.

4.2 Risk Identification

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

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

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

The inclusion of cumulative impacts in the Level 1 assessment provides further context on factors that may contribute to an undesirable event. In a fisheries-based ERA it can be difficult to account for these impacts in the final risk ratings. The main reason for this is that it can be difficult to define the extent of these impacts or quantify the level of contribution they make to an overall risk; particularly in a whole of fishery assessment (*e.g.* the impact of recreational fishing/boating activities on SOCC subgroups). Given this, final risk ratings will concentrate on commercial fishing activities with cumulative impacts (when and where appropriate) identified as an additional source of risk *e.g.* for species targeted and retained by commercial, charter and recreational fishers. In the event that one or more of the ecological components are progressed to a Level 2 assessment than the cumulative impacts (*e.g.* from other fisheries) will be given additional considerations.

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

The following provides an overview of the key fishing activities / sources of risk in the FFTF and for each of the respective ecological components. When and where appropriate the contributor of risk is also identified in the text.

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

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

4.2.1 Whole of Fishery

Discarding, ***contact without capture***, and ***disturbance due to presence in the area*** are considered to be the greatest contributors of risk in the FFTF. As the fishery has a low number of operators and undergoes regular reviews of the Total Allowable Commercial Catch (TACC) limit, ***harvesting*** was viewed as a secondary risk factor. Given the limited spatial and temporal extent of fishing activities relative to the prescribed fishing area, ***boat maintenance and emissions*** and ***travel to/from fishing grounds*** will present as low risks to ecological subcomponents. Similarly, ***loss of fishing gear*** is unlikely to be a major source of risk in this fishery.

4.2.2 Ecological Subcomponents

Target & Byproduct

Since 1997, the commercial stout whiting catch has been managed through the use of biennial assessments and the setting of a TACC limit. These assessments examine standardised catch rates and take into consideration survival indicators, logbook data and length-age frequency data (Wortmann & O'Neill, 2016). These assessments provide insight into how the fishery is performing against key historical indicators and help to reduce the risk of over-exploitation. This risk is further reduced through a broader management regime that requires operators to use a *Vessel Tracking* system and enforces significant spatial and temporal closures within the T4 fishing area (Department of Agriculture and Fisheries, 2019c).

A significant majority of the retained catch (by weight) consists of stout whiting (98.7%, 2015–17 average) with operators directing the majority of effort towards this species (***harvesting, discarding***). When compared to the ECOTF, the retention of byproduct or permitted species plays less of a role in the FFTF. The catch data for the fishery reflects this with operators retaining small quantities of bugs, cuttlefish, goatfish, and squid (average <1t per year, 2015–17). Even butterfly bream and yellowtail scad which make up the largest component of the byproduct catch are still ***harvested*** in small proportions (<1% of the total catch per species, 2015–17) (Department of Agriculture and Fisheries, 2019c).

As there are no size restrictions for stout whiting, ***discarding*** is unlikely to feature heavily in the risk assessment for target species. Operators are often able to target schools of whiting of a particular size to meet market demand (*i.e.* large stout whiting are sold locally, whereas smaller fish are exported), and ***discarding*** of target product is unlikely to occur (pers. coms. D. Roy). Some byproduct species are subject to size/condition restrictions (*e.g.* bugs), in-possession limits (*e.g.* cuttlefish, octopus *etc.*) or quota (*i.e.* goatfish and yellowtail scad), and are therefore at higher risk of ***discarding*** (Department of Agriculture and Fisheries, 2019c). Operators may also discard retainable byproduct because of its unmarketability; a common practice for species such as yellowtail scad, goatfish and threadfin bream (Roswell & Davies, 2011). As a portion of this catch will be discarded in a dead or moribund state it will contribute to the fishing mortality rates for these species (Melville-Smith *et al.*, 2001). Operators are required to fill out a discard logbook for this fishery, but validation of this data is challenging and its accuracy in the past has been classified as poor (Roswell & Davies, 2011).

Of the remaining fishing activities, ***contact without capture*** and ***disturbance due to presence in the area*** are the most likely contributors of risk. Risks associated with ***contact without capture*** relate to undocumented mortalities and injuries (*i.e.* crushing from the base of the trawl net, injuries incurred while escaping though the net), and ***disturbance due to presence in the area*** relates to local displacement of animals as the trawl gear progresses through the water column. In both instances, there is a low probability of these activities causing an undesirable event for the target and byproduct ecological component.

Bycatch (non-SOCC)

Trawling provides few avoidance strategies to reduce the incidental catch of non-harvested or unwanted species. Since the introduction of TEDs and BRDs, bycatch volumes across trawl fisheries have reduced considerably; particularly for marine megafauna (Robins, 1995; Robins & Mayer, 1998; Brewer *et al.*, 2006; Pears *et al.*, 2012). In Queensland, the use of a TED and BRD is mandatory in the ECOTF and for RIBTF fishers operating in areas outside of creeks and rivers[1]. This differs from the FFTF where the use of a TED is mandatory for all demersal (otter) trawls but the use of a BRD is optional. The main reason for this is that a high proportion of the target catch will be discarded through the BRD along with unwanted teleosts and invertebrates (Brewer *et al.*, 1998). Operators using a Danish seine net are not required to use any bycatch mitigating devices (their implication in this type of gear has proven to be challenging), but the need is less pressing considering the selective nature of the fishing method (Roswell & Davies, 2011).

Fisheries Observer Program (FOP) data for the FFTF revealed that bycatch levels and compositions varied with fishing method. FOP data from 2009–10 revealed that 39–49% of the otter trawl catch and 24–51% of the Danish seine catch consisted of bycatch (***discarding***). This report also compared bycatch compositions and found that species diversity was higher in the otter trawl fishery but larger animals[2] were caught with more regularity in Danish seine nets (Wortmann & O'Neill, 2016). Of the teleosts and invertebrates that are discarded in the fishery, unidentified individuals, blue swimmer crabs, three-spotted crabs and tailor made up the largest components of catch per weight. Recreationally important species such as snapper and pearl perch were also caught in smaller amounts (Roswell & Davies, 2011). Laboratory analysis of unidentifiable bycatch species revealed that this category largely consisted of fin fish species with limited commercial or recreational importance *e.g.* eye gurnard, largescale saury, spotted dragonet, and longspine flathead (Roswell & Davies, 2011).

Although the FOP report provides immense insight into FFTF bycatch compositions, mortality rates were only documented for SOCI and elasmobranchs (sharks and rays) (see *Species of Conservation Concern; Sharks, Batoids, Sea snakes* and *Syngnathids*). Data relating to sharks and rays showed that otter trawl fishing had higher rates of direct or *in-situ* mortalities when compared to Danish seine gear. While difficult to quantify, it is likely that this trend will extend to other non-SOCC bycatch. This inference is supported by research on bycatch fates which found that teleost discards from trawl fishing tend have higher rates of fishing mortality (Wassenberg & Hill, 1989; Broadhurst *et al.*, 2006). Post interaction survival rates for invertebrate species, while varying, tended to be better (Broadhurst *et al.*, 2006). However, this research also showed that direct and post-release mortality rates will vary depending on the fragility of the species, catch composition (*e.g.* presence of debris, large animals *etc.*), catch weight and shot duration (Lindeboom & de Groot, 1998).

The risk posed to non-SOCC bycatch will be dependent on a range of factors but is still considered to be of moderate to high risk for this fishery. This assessment is largely based on the indiscriminate

[1] *In the RIBTF all operations must use a BRD when operating in rivers, creeks and inshore environments. Operators must also use a TED when fishing in areas outside of rivers and creeks.*

[2] *Referred to as 'monsters' in this report, this category included animals that were unusually large and rarely caught (Wortmann & O'Neill, 2016).*

nature of trawl/net fishing and the potential for FFTF operators to interact with a range of non-target species. While this assessment is counter-balanced by comparisons with the ECOTF, the capture of non-target species is considered to be one of the more notable risks within this fishery.

Species of Conservation Concern

Licence holders in the FFTF have reported interactions with a small range of SOCI since the introduction of the compulsory logbook. While the SOCI data is limited to a single species complex (sea snakes; Department of Agriculture and Fisheries, 2019c), FOP data indicates that they also interact with syngnathids (Roswell & Davies, 2011). In addition to SOCI, operators in the FFTF interact with a range of shark and ray species (Roswell & Davies, 2011). As the majority of these species are not classified as SOCI, they are not subject to the mandatory reporting requirements. They have however been included in the expanded SOCC ecological component for the purpose of this ERA.

As the fishery operates in offshore waters, it will interact with more components of the expanded 'Species of Conservation Concern' (SOCC) ecological component, namely sharks and batoids. As most of these species cannot be retained for sale in the FFTF, ***discarding*** is considered to be the largest risk factor for these ecological subcomponents. Secondary factors including ***contact without capture*** and ***disturbance due to presence in the area*** will make a smaller contribution to the overall level of risk. These risks mostly relate to the robustness of the gear, the active nature of the fishing activity and the potential for interactions to go unobserved. This includes animals that are excluded from the net due to the use of a TED and animals that interact with any part of the trawl/net gear but are not landed.

Marine turtles

There are no reports of turtles interacting with the FFTF in the SOCI logbook data or from the FOP. This absence of interactions can be attributed to the fishery operating in habitats not preferred by marine turtles (*i.e.* offshore sandy bottom waters) and the use of TEDs in all otter trawl operations. Turtle excluder devices have proven to be highly effective at excluding marine turtles from the trawl catch (Robins, 1995; Robins & Mayer, 1998; Brewer *et al.*, 2006; Pears *et al.*, 2012) and interaction rates may be higher in this fishery. The extent of these interactions will be difficult to quantify as most animals will enter and escape the net without detection (***contact without capture***). While noting this potential, DAF anticipates that interaction rates will remain low given the comparatively small overlap between the areas fished and preferred habitats of marine turtles.

Dugongs

There are no reports of dugongs interacting with the FFTF in the SOCI logbook data or from the FOP. As the majority of FFTF effort does not occur in environments preferred by this species (*i.e.* bays and shallow areas laden with sea grass) including their feeding grounds (Department of the Environment, 2018), it is highly unlikely that the fishery would cause an undesirable event for the marine mammal. Accordingly, this subcomponent has been assigned a negligible risk rating.

Cetaceans

There are no records of cetaceans interacting with the FFTF in the SOCI logbook data or FOP data. The fishing area overlaps with native distributions of several cetacean species including the Australian humpback dolphin (*Sousa sahulensis*) (Department of Environment and Science, 2018). If interactions were to occur between cetaceans and fin fish trawl vessels, it would most likely be a boat strike (particularly for whales), or contact with the TED (***contact without capture***).

At a whole of fishery level, direct mortalities (*e.g.* entanglement or entrapment in the net) are unlikely; therefore the subgroup was classified as being at low risk of experiencing an undesirable even due to fishing activities in the FFTF.

Batoids

As the majority of batoids are not subject to mandatory reporting, SOCI data for the FFTF provides little insight into how the fishery interacts with this complex. The FOP data is more informative and shows that the fishery regularly interacts with this subgroup, and in some cases, interactions result in higher mortality rates (Roswell & Davies, 2011). The T4 fishing area is understood to house a high diversity of elasmobranch fauna and the fishery encounters a diverse range of batoids including shovelnose rays (*Family Rhinobatidae*), stingrays (*Family Dasyatidae*), stingarees (*Family Urolophidae*) and guitarfish (*Family Rhynchobatidae*) (Roswell & Davies, 2011; Last *et al.*, 2016). The extent of batoid interactions and by extension the risk of undesirable event occurring will be dependent on the fishing method and gear configurations.

Roswell & Davies (2011) provided detailed information on how batoids interact with the two key apparatus; otter trawl and Danish seine nets. While Danish seine nets are more selective and have shorter shot times, the use of a TED is not mandatory for this apparatus (Department of Employment Economic Development and Innovation, 2011; Roswell & Davies, 2011; Department of Agriculture and Fisheries, 2019c). This would have contributed to the findings of a FOP report which showed that batoid interactions (*n* = 2767) were higher for Danish seine nets when compared to otter trawl fishing (*n* = 1097). However, the number of rays being returned to the water dead[3] (***discarding***) was higher in the otter trawl sector (85% compared to 8%). This in part can be attributed to otter trawl fishing having longer shot times and higher injury potential. Eastern shovelnose rays dominated the catch in Danish seine nets, accounting for 85% of the interactions for this fishing method. This species also suffered the greatest (confirmed) discard mortality (in terms of numbers) in the otter trawl sector *(n* = 645), although discards from Danish seine nets of unknown fate were significantly higher (*n* = 1739).

The use of TEDs has had a notable effect on the amount of bycatch that is caught in trawl fisheries along the Queensland coastline. For batoids, research has shown that TEDs are effective at preventing larger rays from entering the cod-end (Stobutzki *et al.*, 2001; Stobutzki *et al.*, 2002; Brewer *et al.*, 2006); although smaller individuals can still slip through a TED (Stobutzki *et al.*, 2001; Brewer *et al.*, 2006; Kyne *et al.*, 2007). As the use of TEDs in the FFTF is limited to otter trawls, their ability to reduce bycatch at a whole of fishery level is reduced. To this extent, expanding the TED provisions to include Danish seine nets would help to reduce the risk posed to batoid species. This however may be unnecessary given that Danish seine fishing presents a lower risk with respect to the fishing method (*e.g.* shorter shot times, slower trawl speeds) and the likelihood of an interaction resulting in a mortality.

Research has shown that smaller batoids are more susceptible to trawl fishing activities as interactions are more likely to result in mortalities (Stobutzki *et al.*, 1996; Stobutzki *et al.*, 2002; Roswell & Davies, 2011). In the FFTF, FOP data reported that 85% and 8% of all batoids died as a direct result of their interaction with an otter trawl and Danish seine net respectively (Roswell &

[3] *Data based on individuals that were confirmed dead at the time of discard. The actual percentage may be higher as a number of batoids discarded had unconfirmed fates (Roswell & Davies, 2011).*

Davies, 2011). When post-release mortalities are taken into consideration, these figures are likely to be higher (Roswell & Davies, 2011). Quantifying the extent of post release mortalities can be difficult as it requires an accurate assessment of post-release fate; something that is difficult to achieve in an active fishing environment. Of interest, Campbell *et al.* (2017) examined post-trawl survival for two batoid species caught as bycatch in the ECOTF. This study showed that after 72 hours, 66–67% of the common stingarees (*Trygonoptera testacea*) and 3–20% of eastern shovelnose rays (*Aptychotrema rostrata*) had died. As these two species interact with the FFTF, these results are informative and highlights the potential for cryptic mortalities to increase the risk posed to some species.

The remaining fishing activities present a moderately low risk to the batoid subgroup. While difficult to document, individuals may experience more direct injuries or mortalities *e.g.* during the net setting process, being struck with the trawl shoe (Lindeboom & de Groot, 1998). Due to the active nature of the fishing activity, ***disturbance due to presence in the area*** is likely to be a factor of influence for the complex, whereby displacement of individuals may affect natural behaviours. At a whole of fishery level though, these risks are considered to be relatively minor when compared to ***contact without capture*****.**

At a species specific level, only sawfish (*Pristis* spp.) and manta rays[4] are afforded full protection under fisheries legislation. The area of the FFTF does not overlap with the known distribution of east coast sawfish populations and the fishery is unlikely to interact with this subgroup. While there are not reported cases of a FFTF operator interacting with a devil ray (*Mobula spp*.), these species have been reported in low numbers from the ECOTF. As the FFTF uses similar gear and overlaps with the ECOTF, fishers may interact infrequently with these species. The extent (if applicable) of these interactions are unlikely to present a significant risk to the long-term sustainability of these species.

Given the above, the capture of batoids and the potential to impact on regional populations is considered to be one of the more notable risks within this fishery. The potential for this to evolve into an undesirable event for one or more of the species though will be low given the small size of the fishery and the (comparatively) low levels of effort. Accordingly, the FFTF is more likely to be a contributor of risk for this subgroup *vs.* the main driver of risk.

Sharks

The risk profiles of batoids and sharks share a number of similarities. The majority of shark species that interact with the FFTF are not classified as SOCI; therefore are not subject to additional reporting requirements. Of the species that are listed as SOCI, none are expected to interact with the FFTF. This is reflected in the catch data with no shark interactions reported from the fishery since the introduction of a SOCI logbook.

Data from the FOP shows that the FFTF interacts with a range of shark species and in some instances has elevated rates of mortality (Roswell & Davies, 2011). As with batoids, the majority of these interactions were reported from otter trawlers (*n* = 256) with the FOP only recording 21 Danish seine – shark interactions. The reasons behind this differential will be complex; although gear modifications and trawl speeds will contribute to the number of sharks being landed. In otter trawl operations, a high percentage of the larger animals will be excluded from the catch via the TED (***contact without capture***). However, smaller species or individuals will have limited opportunities to

[4] *A recent review of the Family Mobulidae (devil rays) reclassified the genus 'manta' as a synonym of the genus 'Mobula' (Last et al., 2016).*

escape the net once they pass through the bars of the TED (***discarding***). Conversely, Danish seine nets do not use a TED which increases the risk of larger sharks being caught in the net. This risk though is partially mitigated by the fact that Danish seine operations trawl at lower speeds allowing more manoeuvrable species or individuals to escape the net prior to or during the net retrieval process (***contact without capture***).

Mortality rates for landed sharks are comparatively high for both otter trawls (87%) and Danish Seine nets (62%) (Roswell & Davies, 2011). Within trawl mortality of elasmobranchs is known to be negatively correlated with length, with smaller individuals less likely to survive the trawl event (Stobutzki *et al.*, 2002; Campbell *et al.*, 2017). This risk is likely to be compounded by post-release mortalities as a portion of the live-release sharks (***discarding***) are expected to die as a result of their interaction with the FFTF (Stobutzki *et al.*, 2002).

At a whole of fishery level, there is considerable potential for FFTF operators to interact with shark species. The fishery also has relatively high rates of mortality with the best available data suggesting that more than half of all sharks (62–88%) are landed in a dead or moribund state. For these reasons, the capture of sharks and the potential impact on regional populations is considered to be one of the more notable risks <u>within</u> this fishery. The potential for this to evolve into an undesirable event for one or more of the species though will be low given the small size of the fishery and the (comparatively) low levels of effort. Accordingly, the FFTF is more likely to be a contributor of risk for this subgroup *vs.* the main driver of risk.

Protected teleosts

There are four species of teleost with SOCI reporting requirements: the humphead Maori wrasse, the potato rockcod, the Queensland groper and barramundi cod. As the FFTF operates in sandy-bottom substrates, there is limited overlap between fishing effort and habitats preferred by these species (*i.e.* rocky or coral reefs) (Australian Museum, 2013; 2016a; b; c). No interactions with protected teleosts have been reported through the SOCI logbooks or the FOP and the fishery does not present a significant long-term sustainability risk to these species.

Sea snakes

Research on the incidental capture of sea snakes in the FFTF quantified the mean sea snake catch rate at 0.14 animals per boat day fished (Courtney *et al.*, 2010). This contrasts with the average interaction rate across all east coast trawl fisheries (2.12 sea snakes per boat-day) and key sectors of the ECOTF *e.g.* redspot king prawns (12.49), banana prawn (8.18), beam trawl (1.18) and tiger/endeavour prawn (0.35) (Courtney *et al.*, 2010). Approximately 17% of the sea snakes caught in the FFTF died during the fishing event (Courtney *et al.*, 2010) and total mortalities are expected to be higher when post-release mortalities are taken into consideration. These figures are countenanced by estimates showing that the fishery interacts with less than 40 sea snakes per year. To put this in context, this estimate was the lowest recorded for a trawl sector operating on the Queensland east coast (Courtney *et al.*, 2010)

Given the level of mortalities and interaction rates, fishing activities in the FFTF pose a relatively low risk to this subgroup. However, further information is required on the potential for this fishery to interact with this subgroup under the current fishing environment. At the time the sea snake bycatch research was undertaken (Courtney *et al.*, 2010), the use of a Danish seine net in the FFTF was a relatively recent development. While the method was accounted for in the study, Courtney *et al*.

(2010) indicated sea snake catch rates would (most likely) be affected by the use of a Danish seine net. With the continued use of both the demersal otter trawl and Danish seine in the FFTF, there may be greater avenues to quantify interaction rates in this fishery and update previous estimates.

Syngnathids

No syngnathid interactions have been reported in SOCI logbooks, although the FOP listed the capture of several pipehorse species (Roswell & Davies, 2011; Department of Agriculture and Fisheries, 2019c). The majority of landed pipehorses were Dunker's pipehorse (*Solegnathus dunckeri*) or pallid pipehorse (*Solegnathus hardwickii*); both of which can be harvested as byproduct in the ECOTF, MBTF and RIBTF. These species are known to inhabit the T4 area and at water depths where stout whiting are targeted (Connolly *et al.*, 2001; Department of Agriculture and Fisheries, 2019c).

Syngnathids in general tend to prefer environments with vertical heterogeneity, such as reefs or sponge beds, and are caught by trawlers fishing in close to these areas (Connolly *et al.*, 2001; Bray, 2017). These factors will help limit the impact of the fishery on this complex. Individuals that are caught in the sweep of the net though have a low probability of surviving the fishing event. Cryptic mortalities are also a factor for this ecological component.

While post-release survival rates are poor for this complex, participation rates and effort levels will help limit the number of interactions. In this context, the FFTF will be a contributor of risk for this complex *verse* the main driver of risk.

Crocodiles

The fishing area for the FFTF is a great distance from natural distributions of saltwater and freshwater crocodiles (Read *et al.*, 2004; Australian Museum, 2018). Interactions with the FFTF are unlikely and the fishery does not present a risk to this subgroup.

Seabirds

Seabirds are not expected to interact with nets used in the FFTF and the risks posed to this subgroup will be minimal. There have been no recorded interactions with seabirds in the SOCI logbooks or FOP data.

Terrestrial mammals

The false water rat, *Xeromys myoides*, is a small mammal that inhabits and feeds in intertidal environments. This native rodent is not truly aquatic and lacks the ability to swim (Department of the Environment and Energy, 2003; 2018), and therefore will not interact with a trawl vessel in operation.

Marine Habitats

Demersal trawling activities such as the type used in the FFTF have a high degree of contact with the seabed and the benthic communities which inhabit them (***disturbance due to presence in the area, contact without capture***) (Sciberras *et al.*, 2018). This fishing method flattens sediment, removes ripples, exposes shell fragments (Lindeboom & de Groot, 1998; Kaiser *et al.*, 2002) and has the ability to penetrate up to 30mm into the benthos depending on the gear type and substrate (de Groot, 1984). These factors increase the risk that biogenic structures and shallow benthic infauna will be removed, dislodged, or damaged (***disturbance due to presence in the area*, *contact without capture***).

Infaunal organisms are highly influential elements in marine habitats, playing important roles in bioturbation, building burrows, creating feeding voids and irrigating sediments (François *et al.*, 2001). This not only creates physical complexity, but alters chemical conditions and transports solutes between water and sediment (Aller & Aller, 1998). Removal of fish which contribute to biogenic processes such as creating burrows or pits in the sand can be important for epifaunal communities to colonise (Coleman & Williams, 2002). Topographic complexity has significant relationships with fish biomass (Luckhurst & Luckhurst, 1978; Roberts & Ormond, 1987).

In Queensland, the impact on regional habitats is reduced by an extensive array of spatial controls which restrict fishing to substrate with a long history of trawl fishing. Stout whiting are targeted on flat, sandy bottom habitats where they naturally occur (Department of Employment Economic Development and Innovation, 2011). These habitats are likely to be resilient to demersal trawling as they have relatively low biomass compared to reefs, sponge beds or seagrass meadows (Collie *et al.*, 2000; National Research Council, 2002; Giakoumi & Kokkoris, 2013). The risk to marine habitats is further reduced with the small number of vessels operating in the fishery and the availability of effort distribution information through *Vessel Tracking*.

The nature of trawl fishing means that areas in and around a trawl event will experience a higher degree of disturbance. The extent of this disturbance will depend on the longevity of the trawl and the frequency with which an area is fished. Areas with a long history of trawl fishing would have already experienced a phase shift in flora and fauna assemblages; therefore would be more resilient to this type of disturbance. The direct (*e.g.* trawling new ground) and indirect (*e.g.* smothering, increase sedimentation) impacts of trawl fishing though may be more significant for marine habitats located on the periphery of the trawl grounds.

From a risk management perspective, the impact on the FFTF on this ecological component will be smaller when compared to larger trawl fisheries. The footprint of FFTF effort and the use of spatial/temporal closures also help to offset the overall level of risk. Despite this, the risk posed to marine habitats will be higher when compared to other ecological components that interact with this fishery.

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 product from the system, the ***discarding*** of non-target species, and the impact of the fishery on offshore habitats.

Stout whiting are mid-level predators in the marine ecosystem, feeding on crustaceans and polychaetes and predated on by sharks, teleosts and dolphins (McKay, 1992). ***Harvesting*** stout whiting may impact a range of ecosystem processes including nutrient cycling / microbial processes, predation, bioturbation, recruitment and competition. Mid-level predators are not overly important in high diversity environments where their impact is buffered from other trophic relationships (Strong, 1992; Polis & Strong, 1996), therefore these ecosystem processes are likely to be at low risk of experiencing an undesirable event from fin fish trawl fishing (Appendix 2).

When catch is returned to the water (***discarding***), there is a strong possibility that the animal has sustained injuries, become stressed, or died (either immediately or after a period of time) as a result of the interaction with the fishing activity (Lindeboom & de Groot, 1998; Broadhurst *et al.*, 2006). The full extent of this impact on discarded individuals is unclear, but may alter or impact ecosystem processes linked to competition and outbreaks in disease, (Stobutzki *et al.*, 1996). The scale and intensity of the FFTF though suggests that there is a low risk of the fishery having a long-term effect on these processes.

The FFTF interacts with a wide range of secondary predators (*e.g.* teleosts, rays, crustaceans) and a few tertiary predators (*e.g.* whaler sharks) (Cortés, 1999; Roswell & Davies, 2011; Jacobsen & Bennett, 2013). Given the potential mortality rates of trawl bycatch, the 'predation' ecosystem process was assessed as being at an intermediate risk of experiencing an undesirable event in this fishery (Stobutzki *et al.*, 1996; Broadhurst *et al.*, 2006; Roswell & Davies, 2011). Another process that is expected to be at risk of impact from ***discarding*** is scavenging, as there is evidence that trawl fishing has significant potential to increase this process in the proximal vicinity (Hill & Wassenberg, 1990; Wassenberg & Hill, 1990; Groenewold & Fonds, 2000; Broadhurst *et al.*, 2006).

On account of the active nature of the fishing activity and the degree of contact with benthos, it is unsurprising that ***disturbance due to presence in the area*** poses the greatest risk to elements of the marine ecosystem. Risks pertain to processes associated with the sea bed, including sedimentation and bioturbation, as direct contact from trawl gear is very likely to impact on these environments (Snelgrove, 1999). Lower range risks pertain to trophic-related components such as nutrient cycling / microbial processes, predation, and detritivory, linking to the mortality of benthic organisms that specialise in these roles (Hutchings, 1990; Poiner *et al.*, 1998; Snelgrove, 1999; Kaiser *et al.*, 2002; Broadhurst *et al.*, 2006) (Appendix 2).

As with the impact on marine habitats (see *4.2.2 Ecological Subcomponents; Marine Habitats*), risks to ecosystem processes will be localised and relatively minor given the size of the fleet operating within the fishery. Nevertheless, interactions with non-retainable species are a challenge for all of Queensland's trawl fisheries and risk minimisation will begin with addressing this area.

4.3 Cumulative Impacts

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

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

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

External Risks are addressed in Queensland through a wide variety of forums and by various departments. Given the wide-ranging nature of these risks, these 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 FFTF is the only commercial fishery in Queensland permitted to target and harvest stout whiting. Only licences with a T4 fishery symbol and ITQ units are permitted to harvest this species, although other fisheries such as the ECOTF are known to catch significant volumes of stout whiting as bycatch (Leigh & O'Neill, 2016; Wortmann & O'Neill, 2016). The New South Wales Ocean Trawl Fishery also harvest stout whiting; albeit in lesser proportions than the FFTF (on average 20% of the total harvest) (Roelofs & Hall, 2018). For the purposes of this ERA, *Fisheries Related Impacts* will pertain only to the impacts on stout whiting[5] under Queensland jurisdiction.

Queensland's ECOTF is expected to be the biggest influence on stout whiting stocks outside of the FFTF (Courtney *et al.*, 2007a; Leigh & O'Neill, 2016). This fishery primarily targets prawn species and the area of operation has a high degree of overlap with the T4 fishery (Business Queensland, 2016; Department of Agriculture and Fisheries, 2018b; 2019c). Bycatch composition analyses for the ECOTF revealed that stout whiting are a primary source of bycatch when trawling for eastern king prawns in shallow water environments (Courtney *et al.*, 2007a). Mortality rates are understood to be high (pers. coms. D. Roy) and the operators must discard this portion of the catch as it is not classified as a permitted species.

Age composition and mortality rate analysis of the east coast stout whiting stock suggests the species has been strongly influenced by fishery-related impacts in more recent years (Gray *et al.*, 2017). In line with this assessment, there is considerable potential for the ECOTF to exert influence on the east coast stout whiting stocks. It is difficult to say though how these impacts compare to the FFTF and/or if they pose a greater risk than the Stout Whiting Fishery. Given the size of the ECOTF, a more effective risk strategy for stout whiting would be to examine the impact of this fishery on the target species.

The recreational whiting catch (*Sillago ciliata, S. analis* and *S. sihama*) is significant, with an estimated 997 000 individual fish being harvested by this sector—*Statewide Recreational Fishing Survey 2013-14* (high confidence) (Webley *et al.*, 2015; Department of Agriculture and Fisheries, 2019b). A large proportion of these will be sand whiting (McGilvray & Hall, 2018) with stout whiting only making a minor contribution to the total catch (Fisheries Research and Development

[5] *The harvesting of all target and byproduct species within the FFTF is considered in Fisheries Related Impacts, but as byproduct species are harvested in negligible amounts, the focus will remain on stout whiting.*

Corporation, 2003; Department of Employment Economic Development and Innovation, 2011; Roelofs & Hall, 2018). While recreationally caught stout whiting are not subject to minimum or maximum legal size limits, the recreational and charter sector are limited to catching fish by line, as netting (aside from cast netting) is prohibited. As stout whiting does not have a prescribed possession limit, it is subject to a general possession limit of 20 fish (Department of Agriculture and Fisheries, 2019a). An emphasis on other whiting species though suggests that the recreational and charter fishing sectors have a limited impact on regional stout whiting stocks.

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

4.3.2 External Impacts

The size of the FFTF including participation rates and effort distributions indicates that the fishery will make only minor contributions to the external risks. Similarly, the fishery primarily targets species with comparatively high resilience and low specificity with respect to the geographical distribution and preferred habits. Due to these factors, external risks are expected to play a more minor role in the FFTF when compared to other fisheries *e.g.* climate change and it's potential to impact of the *Coral Reef Fin Fish Fishery* and the impact of urban development on the *Mud and Blue Swimmer Crab (C1) Fishery*.

Boat Strike

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

Marine Debris & Pollutants

Discarded and lost fishing gear from both commercial and recreational fishing is abundant in the marine environment. Nylon fishing mesh is extremely persistent in the marine environment. Plastic marine debris is a significant problem for the health of marine environments, through the degradation of habitats, ingestion by organisms and entangling marine life. In addition to fishing activities, plastic debris originates from tourism, both land and sea based, land based runoff and shipping (Bergmann *et al.*, 2015). Discarded fishing line, and other plastic debris, will degrade into microplastics, which are easily ingested by many species, including species harvested for human consumption. These microplastics are highly mobile and able to interact with species from all trophic levels (Bergmann *et al.*, 2015).

Discharge of garbage from a marine vessel is illegal in all Australian waters. However, boating causes the discharge of a number of pollutants. The major pollution sources associated with recreational and small to medium fishing vessels is fuel and oil. Antifouling paints, exhaust fumes including greenhouse gases and Polycyclic Aromatic Hydrocarbons (PAHs), and heavy metals are also released into the marine environment through boating activities (Burgin & Hardiman, 2011). Many of these pollutants are bioaccumulative, *i.e.* they build up in the environment due to their persistence. Discarding and loss of fishing related debris also occur in this fishery. This includes both deliberate and incidental release. Aside from lost fishing gear, the most significant sources of fishing related marine debris are bait bags, cigarette butts, and food packaging (Byrnes *et al.*, 2016).

The FFTF 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.

Climate Change

Anthropogenic climate change is expected to have significant and lasting effects on the marine environment. These will likely impact fisheries operations, with some effects already perceptible in recent years. In Queensland, the severity of storms, tropical cyclones and extreme rainfall events are predicted to increase by the end of the century (Steffen *et al.*, 2017). In the past, these events have led to population reductions in affected areas and reduced fish catchability for extended periods after these events (Holbrook & Johnson, 2014). Further to this, increased warming of the atmosphere also leads to increased sea surface temperatures. Temperatures have been steadily increasing around Australia, and globally. This increase in temperature has been responsible for several largescale mass bleaching and die-offs of coral, mangroves and seagrass (Hoegh-Guldberg *et al.*, 2007; Duke *et al.*, 2017; Arias-Ortiz *et al.*, 2018), which are critical spawning (e.g. coral trout (Russell, 2001)) and nursery grounds (e.g. prey (Manson *et al.*, 2005)) for many species.

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

The east coast stout whiting stock is at the upper end of its latitudinal range within the T4 fishing area (McKay, 1992; Department of Agriculture and Fisheries, 2019c). Changes in ocean temperatures have already been suggested to cause southward shifts of temperate teleost species populations along Australia's east coast (Last *et al.*, 2010). Climate change therefore has the potential to influence natural stout whiting populations in south east Queensland waters, which may have negative implications on the FFTF.

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 FFTF, 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, and try to align these changes with the objectives of the *Queensland Sustainable Fisheries Strategy 2017–2027*.

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.

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). They take into consideration the current fishing trends (*e.g.* current catch, effort and licensing), limitations of the current management regime (*e.g.* the potential for additional effort to be transferred into areas already experiencing higher levels of fishing mortality, substantial increases in fishing mortality for key species, changing target species) and the consequences of the interaction. While the majority of SOCC are classified as bycatch they have been assessed as separate entities in recognition of their complex life histories. Risk scores assigned to ecosystem processes are based on the preliminary assessment (Appendix 1) and represent the maximum score assigned to that particular fishing activity.

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

In line with above approach, preliminary assessments for the FFTF indicated that fishing activities presented a negligible or low risk to at least nine of the ecological components or subcomponents (target & byproduct, marine turtles, crocodiles, dugongs, cetaceans, protected teleosts, syngnathids, seabirds and terrestrial mammals). Batoids, sharks and ecosystem processes had preliminary risk ratings of intermediate with bycatch and marine habitats assessed as being at an intermediate/high risk (Appendix 2).

***Table 2**. Summary of preliminary risk scores for fishing within the FFTF, including the impact of the main fishing activities on key ecological components.*

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

** Includes recreational, charter fishing sectors.*

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

- The likelihood of fishing activities in the FFTF being responsible for an undesirable event for one or more of the ecological components was low due to the fishery having a low number of licences, low participation rates and comparatively low levels of effort.

- The fishery is more likely to be a contributing risk factor *vs.* a major source of risk for the majority of ecological components.

- Target and byproduct species received low risk ratings due to a) the presence of an overarching control on catch, b) the fleet size of the fishery, and c) the requirement for operators to use *Vessel Tracking*.
- Bycatch, batoids and sharks were assigned a higher range risk rating due to the fishery having a greater potential to interact with non-target species and an increased potential for interactions to result in mortalities.
- The marine habitat ecosystem component received a higher preliminary risk rating due to the nature of the apparatus and the extent of interactions with the substrate / benthos.
- Other fisheries were assigned a high risk rating because of the impact of the ECOTF on target and byproduct species.

There is some potential for the FFTF risk ratings to be conflated with the ECOTF as they are often grouped and assessed together. It is therefore important to highlight that the risk ratings outlined below are based on an independent examination of the FFTF.

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 for bycatch, sharks, seabirds, sea snakes, marine habitats and ecosystem processes were all downgraded. While not universal, these reductions were primarily due to the fishery having (comparatively) low levels of effort, low participation rates and a limited capacity to expand into the future. Other factors that contributed to the risk rating reductions included the use of bycatch mitigation measures, a small effort footprint and the presence of a large scale spatial/temporal closure in the fishery.

A more detailed account of the secondary assessment and the key considerations has been provided in Appendix 2.

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

Ecological Component	Level 1 Risk Rating	Considerations/Justifications	Level 2 Required?
Target & Byproduct	Low	• Significant measures in place to manage the take of target species including the use of ITQs and TACC limits based on data from the Long Term Monitoring Program. • Size limits, in-possession limits and permit conditions in place for byproduct species. • Significant spatial/temporal closures in place and vessel tracking employed in this fishery. • Licencing restrictions in place, low participation rates and limited capacity for catch and effort to expand into the future. • Cumulative pressures identified as an important risk element—particularly bycatch from the ECOTF. • Limited risk from non-commercial fisheries that target alternate species of whiting.	No
Bycatch (non-SOCC)	Intermediate	• Moderate to high potential for the fishery to interact with non-target species. • Fishing method has higher *in-situ* and post-release mortalities. • Bycatch amounts would be smaller in this fishery due to licence numbers, participation rates and shorter shot times employed in some operations. • Bycatch mitigation measures in place including the introduction of more selective gear (Danish seine), gear restrictions, the use of TEDs in otter trawl fishery and the use of spatial/temporal closures.	No

Ecological Component	Level 1 Risk Rating	Considerations/Justifications	Level 2 Required?
		• Limited avenues for management to collect information on this portion of the catch and/or validate data. • A number of measures to improve catch reporting are being considered as part of the *Queensland Sustainable Fisheries Strategy 2017–2027* including electronic monitoring. The feasibility and applicability of these measures is still being determined.	
Species of Conservation Concern (SOCC)			
Marine turtles	Low	• Limited spatial overlap between key fishing grounds / preferred habitats, lower potential for interactions to occur. • Risk mitigated through the use of TED (otter trawls) or short shot times / slower trawl speeds (Danish seine). • High selectivity and short shot times for Danish seine nets increase survivability of captured individuals. • Limited capacity to validate interaction rates with this subgroup and/or assess the extent (if applicable) of underreporting. • Catch validation / verification measures are being actively considered as part of the *Queensland Sustainable Fisheries Strategy 2017–2027* including the potential use of electronic monitoring. • Interactions with this subgroup (direct capture / expulsion through the TED) will to be lower when compared to otter trawl fishery.	No
Sea snakes	Low	• Research indicates that less than 40 sea snakes interact with the fishery each year (Courtney *et al.*, 2010). While 17% of sea snakes are expected to die during the fishing event, low interaction rates will minimise the risk to this subgroup. • Limited licensing and the use of spatial/temporal closures would help to reduce the total number of interactions. • Limited capacity to validate interaction rates with this subgroup and/or assess the extent (if applicable) of underreporting.	No
Crocodiles	Negligible	• Negligible interactions or spatial overlap.	No

Ecological Component	Level 1 Risk Rating	Considerations/Justifications	Level 2 Required?
Dugongs	Negligible	• Negligible interactions or spatial overlap.	No
Cetaceans	Low	• No reported interactions and mortalities highly unlikely. Risk (if applicable) would be more relevant to dolphins. • More likely to be indirect interactions *e.g.* feeding in and around nets. • Use of TED in otter trawls helps to minimise the risk of a dolphin becoming trapped in the net. • Limited capacity to validate interaction rates with this subgroup and/or assess the extent (if applicable) of underreporting.	No
Protected teleosts	Negligible	• Negligible interactions or spatial overlap.	No
Batoids	Intermediate	• Moderate to high potential for the fishery to interact with a diverse array of species. Interactions likely to occur with both Danish seine and otter trawl nets. • Comparatively high levels of fishing mortality; particularly for otter trawl operations. • Limited information on post-release survival rates and limited capacity to validate data for this subgroup. • Extent of the risk will be limited due to the maximum operating potential and participation rates. Subgroup will also derive benefit from spatial/temporal closures. • While cumulative impacts will also be a factor for this subgroup, the FFTF will be a contributor of risk *verse* the main driver of risk.	No
Sharks	Low / Intermediate	• Subgroup at lower risk than batoids as sharks more likely to a) avoid the net, b) swim out of the net during the net retrieval process or c) be excluded through the TED (otter trawls). • High selectivity and short shot times for Danish seine nets increase survivability of captured individuals. • Extent of the risk will be limited due to the maximum operating potential and current participation rates. Subgroup will also derive benefit from spatial/temporal closures.	No

Ecological Component	Level 1 Risk Rating	Considerations/Justifications	Level 2 Required?
		• While cumulative impacts will also be a factor for this subgroup, the FFTF will be a contributor of risk *verse* the main driver of risk. • Limited information on post-release survival rates and limited capacity to validate data for this subgroup.	
Syngnathids	Low	• Low interaction rates. • Limited spatial overlap between key fishing grounds and preferred habitats. • Limited capacity to validate interaction rates with this subgroup and/or assess the extent (if applicable) of underreporting.	No
Seabirds	Negligible	• Low to negligible interaction and mortality rates. • Interactions (if they were to occur) are unlikely to have significant or long-term implications for regional populations.	No
Terrestrial Mammals	Negligible	• Negligible interactions or spatial overlap.	No
Marine Habitats	Low / Intermediate	High degree of contact with marine habitats over a sustained period. Impacts will be environment specific and will depend on the extent of trawl history. • Fishing areas have a long history of trawl fishing activity and have experienced phase shifts. Species assemblages in these areas would be more resilient to disturbance. • Risks will be more pronounced at the edge of the fishing grounds and/or areas that may not have experienced significant levels of disturbance. • Extent of the risk will be limited due to the maximum operating potential and current participation rates. Subgroup will also derive benefit from spatial/temporal closures. • While cumulative impacts will also be a factor for this subgroup, the FFTF will be a contributor of risk *verse* the main driver of risk.	No

Ecological Component	Level 1 Risk Rating	Considerations/Justifications	Level 2 Required?
Ecosystem Processes	Low	• Interacts with a moderate diversity of species. • High output fishery with notable levels of bycatch and discards. • A fishing method where disturbance due to presence in the area has a high risk rating (bioturbation). • Has the potential to influence few ecosystem processes including predation, scavenging *etc.* • Risk significantly reduced through the use of large-scale spatial/temporal closures. Limited licensing and low participation rates reduce the footprint of the fishery further.	No

4.6 Issues Arising

Capture of non-target species

Given the nature of trawl fishing, it is unlikely that the capture of non-target species will be eliminated from the broader ECTF. There has however been significant advancements in trawl gear technology, and the introduction of BRDs and TEDs has reduced the amount of bycatch significantly (Brewer *et al.*, 2006). To this extent, the ability of gear modifications to deliver an analogous (large scale) reduction in trawl bycatch is considered to be unlikely in the short term. This has been reflected in the rise of research projects examining the most efficient TED–BRD combinations and their ability to exclude key species or species groupings (Courtney *et al.*, 2010; Campbell *et al.*, 2017). In the FFTF, only the use of a TED is mandatory when using otter trawl gear, and the effectiveness of BRDs is limited because of the nature of the target species (*i.e.* whiting will be able to escape through most BRDs).

The benefits of using a TED in the FFTF will be limited as a) only one active operator uses otter trawl gear and b) the majority of bycatch species will pass through the bar spacings and into the cod end. In terms of bycatch reduction, likely the best solution for this fishery is to only permit the use of Danish seine net gear, as it has proven to have far better selectivity for stout whiting (Roswell & Davies, 2011). The ability of this to be achieved in the FFTF though will depend on a range of factors including the business structure used by the current operators.

While the use of BRD is not mandatory, their use in sectors of the ECTF has helped reduce the amount of bycatch being landed included sea snakes and batoids (Courtney *et al.*, 2007b; Courtney *et al.*, 2010). Based on these results, the use of a BRD in the FFTF may help to reduce the impact of the fishery on non-target species. The inherent challenge of used a BRD in a fin fish trawl fishery (*verse* a prawn or scallop trawl fishery) is finding a design that can exclude non-target species without compromising the economic viability of the fishery and/or the catch rates for target species.

Limited understanding of SOCC interactions

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

The number of SOCC interactions will be lower in the FFTF when compared to other trawl fisheries and will present a lower overall risk to this subgroup. In terms of the Level 1 ERA, one of the drivers of risk was a limited understanding of how this fishery interacts with this subgroup. The FOP has ceased operations and challenges remain with data validation for the SOCI and T4 discard logbooks (Courtney *et al.*, 2010; Roswell & Davies, 2011). This risk, in part, is being managed through the required use of *Vessel Tracking* systems in this fishery, which will assist management in gaining a greater understanding of the spatial overlaps with SOCC subgroups.

Obtaining accurate information on SOCC interactions will be of significant importance if and when the fishery progresses to a Level 2 assessment. As Level 2 assessments are precautionary in nature, species with low or inaccurate data sets may be assigned a more conservative risk scores. The provision of more accurate data, either through the SOCI logbooks or up-to-date bycatch analyses, will help to refine these assessments and provide mangers with greater capacity to differentiate between real and potential risks (refer to the Ecological Risk Assessment Guidelines; Department of Agriculture and Fisheries, 2018a).

5 Summary & Recommendations

When the outcomes of the preliminary risk assessment and the secondary evaluation (Appendix 2) are taken into consideration, only two of the ecological components were assigned a risk rating higher than low/intermediate. Based on these results, none of the ecological components will be progressed to a Level 2 ERA.

The FFTF has a well-established management regime for key species, low participation rates (n = 2) and low potential for expansion (n = 5 max.). The management regime also includes measures that minimise the impact of the fishery on both target and non-target species *e.g.* use of a TED for otter trawls, shorter shot times for Danish seine nets and spatial/temporal closures. These factors contributed directly to a number of the ecological components receiving lower risk ratings and reduced the need to conduct a finer scale assessment.

If effort in the fishery increases significantly and/or the management regime changes, the results of the Level 1 ERA should be reviewed to determine if one or more of the ecological components need to be progressed to a Level 2 ERA. If this were to occur, the assessment would benefit from additional information on the composition of non-target species (bycatch and SOCC) and the effectiveness of the two fishing methods. These knowledge gaps will be progressed to the *Fisheries Queensland Monitoring and Research Plan* for further consideration. Key information needs required to refine risk profiles in the FFTF include:

- Improving the level of information on catch compositions for elasmobranchs (*e.g.* batoids and sharks) and other non-target species, with particular emphasis on bycatch compositions and release fates.
- A continued evaluation of the use of otter trawl and Danish seine nets in the FFTF, the economic benefits/constraints of each method, target species retention rates and their potential to impact on non-target species.

In line with the above, the FFTF will not be progressed to a Level 2 ERA and when/where appropriate, risks should be addressed through the current management regime or a harvest strategy.

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Appendix 1—Ecological Processes Preliminary Assessment

A1—Ecological Processes Categories

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

CATIGORY	DESCRIPTION
SEDIMENTATION	The inflow, dispersion, resuspension and consolidation of sediments
NUTRIENT CYCLING / MICROBIAL PROCESSES	The input, export and recycling of nutrients within the ecosystem. Removal of animals through harvesting is a direct loss of nutrients to the ecosystem
PARTICLE FEEDING	Feeding process targeted at particles suspended in the water column, or deposited on submerged surfaces
PRIMARY PRODUCTION	The conversion of the sun's energy into carbon compounds that are then available to other organisms
HERBIVORY	The consumption of plants
PREDATION	The removal of mid and top order predators from the marine environment and the potential for animals to be subject to increase predation
BIOTURBATION	The biological reworking of sediments during burrow construction and feeding and bioirrigation (mixing of solutes) leading to the mixing of oxygen-bearing waters into sediments
DETRITIVORY	Feeding on detritus (decomposing organic matter)
SCAVENGING	Predators eating already dead animals
SYMBIOSIS[6]	The interdependence of different organisms for the benefit of one or both participants
RECRUITMENT	The impact of the fishery on the ability of a species replenishment populations
REEF BUILDING	The process of creating habitats composed of coral and algae and includes the creation of all biogenic (*i.e.* of living origin) habitats
COMPETITION	Interactions between species that favour or inhibit mutual growth and functioning of populations
CONNECTIVITY	Migration, movement and dispersal of propagules between habitats at a range of scales; and functional connectivity which represents ontogenetic cycles of habitat use
OUTBREAKS OF DISEASE	The spread or introduction of disease to organisms or ecosystems
SPECIES INTRODUCTIONS	The introduction of exotic species and their spread once established

[6] According to the practical application of symbiosis outlined in Pears et al. (2012), trawl fishing is unlikely to impact symbiotic relationships based on the premise that both or neither organisms are caught during the fishing event.

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 FFTF.

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

*Includes recreational, charter sectors

Appendix 2—Risk Ratings and Outputs.

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

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

Ecological Component	**Key Issues / Sources of Risk**	**Risk Characterisation (Preliminary rating)**	**Considerations of Likelihood and Mitigation Measures**	**Level 1 Risk Rating**
Target & Byproduct	• Quota and in-possession limits control retention of all target and byproduct species (*excl.* bugs which have size/condition regulations). • Little to no discarding of target product, moderate discarding of byproduct. • Information available on regional effort distributions (*Vessel Tracking*).	Low	*Likelihood* • Low *Mitigation Measures & Considerations* • Significant measures in place including ITQ system in place with TACC set based on LTMP data, and size limits, in-possession	Low

	• Cumulative pressures identified as an important risk element—particularly bycatch from the ECOTF.		limits, condition limits in place for byproduct species. • Spatial/temporal closures, permit conditions, *Vessel Tracking.* • Limited licencing (n = 5 max.), low participation rates (n = 2), limited potential for catch and effort to expand into the future.	
Bycatch (non-SOCC)	• Higher levels of interaction with non-target species. • Fishing method has higher *in-situ* and post-release mortalities. • Species composition data relies heavily on a previous Fisheries Observer Program.	Intermediate / High	*Likelihood* • Moderate because a) little can be done about reducing bycatch in fish trawl fisheries but b) there are few active operators. *Mitigation Measures & Considerations* • Gear restrictions, mesh size, TED for otter trawl nets. • Spatial/temporal closures, permit conditions, *Vessel Tracking*. • Bycatch levels and impact on non-target species will vary between otter trawl and Danish seine. • TEDs can only be installed in otter trawl due to the nature of the Danish	Intermediate

			seine apparatus. BRDs are not mandatory in this fishery. • Risk levels heavily influenced by limited licencing (n = 5 max.), low participation rates (n = 2), limited potential for effort to expand into the future. Generally low levels of effort equals lower levels of bycatch. • The fishery also has a significant spatial/temporal closure.	
Species of Conservation Concern (SOCC)				
Marine turtles	• Low interaction and mortality rates. • Limited spatial overlap between key fishing grounds and preferred habitats. • Risk mitigated through the use of Turtle Excluder Devices (otter trawls) or short shot times / slower trawl speeds (Danish seine).	Low	*Likelihood* • Low *Mitigation Measures & Considerations* • SOCI logbook. • TED in otter trawl net. • High selectivity and short shot times for Danish seine nets increase survivability of captured individuals. • Spatial/temporal closures, permit conditions, *Vessel Tracking*.	Low

			• Limited licencing (n = 5 max), low participation rates (n = 2), limited potential for effort to expand into the future. Generally low levels of effort equals lower levels of bycatch. • Limited capacity to validate interaction rates with this subgroup and/or assess the extent (if applicable) of underreporting.	
Sea snakes	• While the fishery interacts with this subgroup, interaction rates will be lower than that reported in the ECOTF. • Moderately high post-interaction survival rates.	Low/Intermediate	*Likelihood* • Lower than what is presented in the preliminary assessment. *Mitigation Measures & Considerations* • High selectivity and short shot times for Danish seine nets increase survivability of captured individuals. • Risk is largely mitigated by the size of the fishery and the potential for it to expand into the future. • Research indicates that less than 40 sea snakes interact with the fishery each year (Courtney *et al.*, 2010)	Low

			• While 17% of sea snakes are expected to die during the fishing event, low interaction rates will minimise the risk to this subgroup. As such, the fishery will be a contributor of risk vs the main driver of risk. • Limited capacity to validate interaction rates with this subgroup and/or assess the extent (if applicable) of underreporting. • Spatial/temporal closures will also limit the extent of interactions.	
Crocodiles	• Negligible interactions or spatial overlap.	Negligible	N/A	Negligible
Dugongs	• Negligible interactions or spatial overlap.	Negligible	N/A	Negligible
Cetaceans	• No reported interactions and mortalities highly unlikely. • More likely to be indirect interactions *e.g.* feeding in and around nets. • Limited capacity to validate interaction rates with this subgroup and/or assess the extent (if applicable) of underreporting.	Low	*Likelihood* • Low *Mitigation Measures & Considerations* • SOCI logbook. • TED in otter trawl net.	Low

			• High selectivity and short shot times for Danish seine nets increase survivability of captured individuals. • Spatial/temporal closures, permit conditions, *Vessel Tracking*. • Limited licencing (n = 5 max), low participation rates (n = 2), limited potential for effort to expand into the future. Generally low levels of effort equals lower levels of bycatch.	
Protected teleosts	• Negligible interactions or spatial overlap.	Negligible	N/A	Negligible
Batoids	• Increased potential for interactions to occur with a diverse array of species. • Reduced effectiveness of TED (otter trawls). • Greater overlap between key fishing grounds and preferred habitats. • Comparatively high levels of fishing mortality; particularly for otter trawl operations. • Limited information on post-release survival rates.	Intermediate	*Likelihood* • Moderate because a) although there are few operators, b) batoids are less likely to have the ability to avoid trawl nets and or escape from gear. *Mitigation Measures & Considerations* • TED in otter trawl net. • High selectivity and short shot times for Danish seine nets increase survivability of captured individuals.	Intermediate

	• Limited capacity to validate interaction rates with this subgroup and/or assess the extent (if applicable) of underreporting.		• Spatial/temporal closures, permit conditions, *Vessel Tracking.* • Limited licencing (n = 5 max), low participation rates (n = 2), limited potential for effort to expand into the future. Generally low levels of effort equals lower levels of bycatch.	
Sharks	• Increased potential for interactions to occur with a diverse array of species. • Greater overlap between key fishing grounds and preferred habitats. • Comparatively high levels of fishing mortalities for both otter trawls and Danish seine nets. • Limited information on post release survival rates. • Limited capacity to validate interaction rates with this subgroup and/or assess the extent (if applicable) of underreporting.	Intermediate	*<u>Likelihood</u>* • Low than batoids as sharks are more likely be able to avoid trawl nets and or escape from gear. *<u>Mitigation Measures & Considerations</u>* • SOCI logbook. • TED in otter trawl net. • High selectivity and short shot times for Danish seine nets increase survivability of captured individuals. • Spatial/temporal closures, permit conditions, *Vessel Tracking*. • Limited licencing (n = 5 max), low participation rates (n = 2), limited potential for effort to expand into the	Low / Intermediate

			future. Generally low levels of effort equals lower levels of bycatch.	
Syngnathids	• Low interaction and mortality rates. • Limited spatial overlap between key fishing grounds and preferred habitats. • Limited capacity to validate interaction rates with this subgroup and/or assess the extent (if applicable) of underreporting.	Low	*Likelihood* • Low *Mitigation Measures & Considerations* • SOCI logbook. • Spatial/temporal closures, permit conditions, *Vessel Tracking*.	Low
Seabirds	• Low to negligible interaction and mortality rates.	Low	*Likelihood* • Low to negligible. *Mitigation Measures & Considerations* • SOCI logbook. • Spatial/temporal closures, permit conditions, *Vessel Tracking*.	Negligible
Terrestrial mammals	• Negligible interactions or spatial overlap.	Negligible	N/A	Negligible
Marine Habitats	• One of the more active fishing methods and operations will readily interact with the substrate.	Intermediate/High	*Likelihood* • Lower than what is presented in the preliminary assessments.	Low / Intermediate

	• Environment has a long trawl history and has (more than likely) experienced fauna and flora phase shifts. • Trawling has the potential to have direct and indirect impacts on the surrounding environment. This will include direct removal or disturbance, smothering and sediment resuspension. • In terms of the fishing activities and the ecological components that interact with the fishery, marine habitats will be at the higher end of the risk spectrum.		*Mitigation Measures & Considerations* • While trawling results in more disturbance, the extent of this risk is offset by the size of the fishery and the comparatively small footprint • Limited licencing (n = 5 max), low participation rates (n = 2), limited potential for effort to expand into the future. Generally low levels of effort equals less impact on marine habitats. • The fishery also has a significant spatial/temporal closure that will aid in the reduction of risk. • Shot times for Danish seine also smaller when compared to other trawl methods.	
Ecosystem Processes	• Interacts with a moderate diversity of species. • High output fishery with notable levels of bycatch and discards. • A fishing method where disturbance due to presence in the area has a high risk rating (bioturbation).	Precautionary risk rating: Intermediate	*Likelihood* • Low *Mitigation Measures & Considerations* • Spatial/temporal closures, permit conditions, *Vessel Tracking*.	Low

	• Has the potential to influence few ecosystem processes including predation, scavenging *etc.*		• Limited licencing (n = 5 max.), low participation rates (n = 2), limited potential for effort to expand into the future. Generally low levels of effort equals less impact on ecosystem elements. • Although more information is needed, due to the size of the fishery, any impacts on ecosystem processes are expected to be low.	