Department of Agriculture and Fisheries

Sustainable Fisheries Strategy 2017–2027

# Level 1 Ecological Risk Assessment

# Queensland Sea Cucumber Fishery (East Coast)

**August 2021**

Queensland Government

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# Executive Summary

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

The aim of Level 1 ERAs is to produce a broad risk profile for a single fishery at a time 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.* 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/substantial levels of fishing mortality for secondary or key species, or changing target species), and life-history constraints of the species being assessed. It should be noted that, as the risk profiles for Queensland's commercial fisheries vary depending on their multi- or single-species nature and predominant apparatus, risk ratings produced through ERAs cannot be compared between fisheries as the scale, extent and impact of the risks are unlikely to be equal.

In the Queensland Sea Cucumber Fishery (QSCF) the Level 1 ERA assessed fishing-related risks in 18 ecological components including the three quota management units (black teatfish, *Holothuria whitmaei*; white teatfish, *H. fuscogilva*; 'other species' basket quota), the burrowing blackfish (*Actinopyga spinea*) management unit (a subcomponent of the 'other species' basket quota), 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,* and *boat maintenance and emissions*) were assigned an indicative score (low, intermediate, high) representing the risk posed by the fishery to each ecological component. Each ecological component was then assigned a preliminary risk rating based on the highest risk score within their profile. Preliminary risk ratings are precautionary and provide 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 ratings. This evaluation examined the key drivers of risk, 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 to minimise the number of false positives.

The Level 1 ERA indicated that 16 (89%) of the ecological components were at negligible, low or low/intermediate risk of experiencing an undesirable event due to fishing activities in the QSCF. These low ratings reflect the fact that the QSCF is a hand collection fishery and has minimal/negligible impacts on non-target species. The two remaining subgroups, burrowing blackfish and the 'Other Species' basket quota, were assigned risk ratings of intermediate and intermediate/high respectively. As the Level 1 ERA examines risk levels within a fishery, these could be considered priority areas for further assessment and management review.

At a whole-of-fishery level, the ERA gave significant weighting to risk mitigation measures already in place in the QSCF. These measures include the use of catch limits for key species or groupings, and

the establishment of a voluntary and industry-led Memorandum of Understanding (MoU) and Rotational Harvest Arrangement. Harvest data also shows that all four quota management units are operating at or below the prescribed Total Allowable Commercial Catch (TACC) limits. Conversely, the Level 1 ERA identified the absence of stock assessments, the voluntary nature of some risk mitigation strategies, and an inability to compare harvest rates against key sustainability reference points as the key drivers of risk. These risks were, again, confined to the *target & byproduct species* ecological component.

Within the main risk group (*target & byproduct species*), black teatfish, white teatfish and burrowing blackfish received lower risk ratings as they possess more restrictive management regimes, species-specific TACC limits, and/or sustainability evaluations (Roelofs, 2020; Roelofs *et al.*, 2020). The risk rating for burrowing blackfish was marginally higher as there is greater capacity for catch to increase up to prescribed catch limits over the short to medium term. The 'Other Species' unit was also assigned a higher rating as effort could theoretically be redirected towards a small number of species if, for example, market demand for a single species increased. This could lead to a situation where one or more of the species are being overfished without the fishery exceeding the 308 tonnes 'Other Species' TACC limit. This risk is compounded by the limited information that is available on the stock structure/sustainability of species included in the 'Other Species' unit, which are also not subject to species-specific management controls.

The Level 1 ERA indicates that the QSCF poses a low or negligible risk to most ecological components. Risks identified in the Level 1 ERA are largely confined to the *target & byproduct species* ecological component and are being managed (to varying degrees) within the current fishing environment. These risks will be addressed further with the introduction of a QSCF-specific harvest strategy based on output controls and trigger limits (Department of Agriculture and Fisheries, 2020a). The completion of stock assessments for priority species (*i.e.* black and white teatfish) will also assist in the assessment of quota limit suitability and the need (if applicable) for management intervention.

Based on the outputs of the Level 1 ERA and the pending introduction of a fishery-specific harvest strategy, progression of the QSCF to a Level 2 assessment is not considered a priority. However, the Level 1 ERA identified key knowledge gaps in a number of areas where the scope of the assessment can be further refined. Recognising that a number of these areas are being addressed through the harvest strategy development process, the following gaps may need to be progressed *e.g.* to the *Fisheries Queensland Monitoring and Research Plan* for further consideration:

- Improve the level of information on the biology, stock structure, and status of key species; prioritising white teatfish, black teatfish and burrowing blackfish for sustainability assessments.
- Consider the need for sustainability assessments for other target species not currently managed under quota (*i.e.* prickly redfish, curryfish). Based on the results of these assessments, examine the suitability or applicability of managing their take under species-specific TACC limits.
- Improve the level of understanding on catch composition in 'Unspecified' catch categories within the 'Other Species' management unit.
- Obtain greater information on the cumulative fishing pressures (*e.g.* commercial, recreational and indigenous fishing) exerted on these species, gaining a better understanding of total fishing mortality.

***Summary of the outputs from the Level 1 (whole-of-fishery) Ecological Risk Assessment for the Queensland Sea Cucumber Fishery (QSCF) as at August 2021.***

| Ecological Component | Level 1 Risk Rating | Progression |
|---|---|---|
| **Target & Byproduct** | | |
| *Black teatfish* | Low / Intermediate | Not progressed further – Addressed through Harvest Strategy |
| *White teatfish* | Low / Intermediate | Not progressed further – Addressed through Harvest Strategy |
| *Burrowing blackfish* | Intermediate | Not progressed further – Addressed through Harvest Strategy |
| *Other species* | Intermediate / High | Not progressed further – Addressed through Harvest Strategy |
| **Bycatch (non-SOCC)** | Negligible | Not progressed further |
| **Species of Conservation Concern (SOCC)** | | |
| *Marine turtles* | Low | Not progressed further |
| *Sea snakes* | Negligible | Not progressed further |
| *Crocodiles* | Negligible | Not progressed further |
| *Dugongs* | Low | Not progressed further |
| *Cetaceans* | Low | Not progressed further |
| *Teleosts (protected / SOCI only)* | Negligible | Not progressed further |
| *Batoids* | Low | Not progressed further |
| *Sharks* | Negligible | Not progressed further |
| *Syngnathids* | Negligible | Not progressed further |
| *Seabirds* | Negligible | Not progressed further |
| *Terrestrial mammal* | Negligible | Not progressed further |
| **Marine Habitats** | Low | Not progressed further – Addressed through Harvest Strategy |
| **Ecosystem Processes** | Low / Intermediate | Not progressed further |

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# Definitions & Abbreviations

| | | |
|---|---|---|
| AIVR | – | Automated Interactive Voice Response (AIVR) system |
| Bycatch | – | The portion of the catch that is discarded/returned to sea. For the purpose of this ERA, the definition of bycatch does not include unwanted target & byproduct species. |
| Byproduct | – | The portion of catch retained for commercial sale that was not intentionally targeted. |
| BFZ | – | Burrowing Blackfish Zones |
| CDR | – | Catch Disposal Records |
| DAF | – | Queensland Department of Agriculture and Fisheries |
| Ecological Component | – | Broader assessment categories that include *target & byproduct* (harvested) species, *bycatch (non-SOCC)*, *species of conservation concern*, *marine habitats* and *ecosystem processes.* |
| Ecological Subcomponent | – | Species, species groupings, marine habitats and categories included within each Ecological Component. |
| EPBC Act | – | *Environment Protection and Biodiversity Conservation Act 1999* |
| ERA | – | Ecological Risk Assessment |
| False negative | – | The situation where a species at high risk is assigned a lower risk rating. When compared, false negative results are considered to be of more concern as the impacts/consequences can be more significant. |
| False positive | – | The situation where a species at low risk is incorrectly assigned a higher risk rating due to the method being used, data limitation etc. In the context of an ERA, false positives are preferred over false negatives. |
| Fishing Licence | – | A Fishing Licence can have multiple symbols attached including a net (N) and line (L) fishing symbol. However, operators in the Queensland Sea Cucumber Fishery are only required to hold a B1 (hand collection) licence. |
| GBR / GBRMP / GBRMPA | – | Great Barrier Reef / Great Barrier Reef Marine Park / Great Barrier Reef Marine Protected Area |
| Guideline | – | Ecological Risk Assessment Guideline |
| ITQ | – | Individual Transferable Quota |
| MoU | – | Memorandum of Understanding |

| | | |
|---|---|---|
| MSE | – | Management Strategy Evaluation |
| PMS | – | Performance Management System |
| QBFP | – | Queensland Boating & Fisheries Patrol |
| QSCF | – | Queensland Sea Cucumber Fishery |
| RHA | – | Rotational Harvest Arrangement |
| SAFS | – | Status of Australian Fish Stocks |
| Species of Conservation Concern (SOCC) | – | Broader risk assessment category used in the Level 1 assessments that incorporates marine turtles, sea snakes, crocodiles, dugongs, cetaceans, protected teleosts, batoids, sharks, seabirds, syngnathids and terrestrial mammals. These species may or may not be subject to mandatory reporting requirements. |
| Species of Conservation Interest (SOCI) | – | A limited number of species subject to mandatory reporting requirements as part of the Queensland logbook reporting system. Any reference to 'SOCI' refers specifically to the SOCI logbook or data compiled from the SOCI logbook. |
| TACC | – | Total Allowable Commercial Catch |
| Target | – | The primary species or species groups that have been selectively fished for and retained for commercial, recreational or Aboriginal peoples and Torres Strait Islander peoples purposes. |
| WTO | – | Wildlife Trade Operation |

# 1 Overview

The Queensland Sea Cucumber Fishery (QSCF) is a hand collection fishery that targets white teatfish (*Holothuria fuscogilva*), black teatfish (*H. whitmaei*), burrowing blackfish (*Actinopyga spinea*), and a range of other sea cucumber species. The fishery operates in Queensland and Commonwealth waters from Cape York to Tin Can Bay, including parts of the Great Barrier Reef Marine Protected Area (GBRMPA). In Queensland, the take of sea cucumber is dominated by the commercial sector, with negligible catch reported from the recreational and charter fishing sectors.

The QSCF is managed through input and output controls that include gear restrictions, limited entry provisions, catch limits (TACCs), Individual Transferable Quotas (ITQs), in-possession limits, size limits and no-take species (Department of Agriculture and Fisheries, 2021a). While input controls and no-take species are applied across sectors, output controls relating to quota are only applicable to the commercial fishery. The QSCF uses ITQs to manage commercial catch with the TACC split unevenly between three quota management units: white teatfish (53 tonnes), black teatfish (30 tonnes), and an overarching basket quota for all other sea cucumber species (308 tonnes). While burrowing blackfish are managed as part of the 'Other Species' management unit, this species is subject to a 225 tonne TACC which is accounted for in the broader 308 tonne limit (Department of Agriculture and Fisheries, 2020b).

A partial ecological assessment of the QSCF was carried out in 2004 and focused on the efficacy of the fishery in relation to principles and objectives of Ecologically Sustainable Development. This assessment incorporated all species and examined the direct impacts of the fishery on the most targeted species (Roelofs, 2004). A number of species have also been provided with indicative sustainability evaluations through the National Status of Australian Fish Stocks (SAFS) and Queensland stock status processes including white teatfish and burrowing blackfish (Department of Agriculture and Fisheries, 2018b; Fisheries Research and Development Corporation, 2018; Roelofs, 2020; Roelofs *et al.*, 2020; Department of Agriculture and Fisheries, 2021a).

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

The following provides a broad, qualitative assessment of the risk posed by the QSCF on a number of key ecological components. The Level 1 ERA is specifically focused on the QSCF and highlights high-risk elements within this fishery. The Level 1 assessment follows on from the completion of a Scoping Study that provides information on the current fishing environment, licencing trends and broad catch and effort analyses (Department of Agriculture and Fisheries, 2021a).

# 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 hand collection fishing activities will be lower when compared to a net or trawl fishery. Similarly, single-species fisheries (*e.g.* Spanish mackerel) will

present a lower risk when compared to multi-species or multi-apparatus fisheries (*e.g.* East Coast Inshore Fishery). However, every fishery will have elements that present as a higher risk for one or more of the ecological components *i.e.* species groupings, marine habitats, and ecosystem process that interact with the fishery. These elements will still be present in smaller fisheries, including those where there is greater capacity to target individual species.

In recognition of the above, the primary objectives of the Level 1 assessments were to identify the key sources of risk within a particular fishery, and the ecosystem components that are most likely to be affected by this risk. Used in this context, Level 1 ERAs produce assessments that are 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 risks are unlikely to be equal. They will, however, provide insight into the areas or fishing activities within the QSCF 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, Level 2 ERA (Department of Agriculture and Fisheries, 2018a). These Level 2 assessments focus on the species, species groupings, marine habitats or ecosystem processes (if applicable) contained within each of the respective ecological subcomponents.

# 3 Methods

The Level 1 assessment is used to assess risk at the whole-of-fishery level, with the primary objective being to establish a broad risk profile for each fishery. Level 1 assessments examines the risk posed to a wide range of ecological components and includes detailed assessments for *target & byproduct* (harvested) species, *bycatch (non-SOCC)*, *species of conservation concern (SOCC)*, *marine habitats*, and *ecosystem processes*.

The management regime for *target & byproduct species* is based on three quota management units: white teatfish (53 tonnes), black teatfish (30 tonnes) and an overarching basket quota for all other sea cucumber species (308 tonnes). These three quota management units formed the basis of the *target & byproduct species* ecological component. However, the 'Other Species' basket quota encompasses a TACC limit for a third species, the burrowing blackfish (225 tonnes). As burrowing blackfish are managed under a TACC limit, this species was included in the Level 1 ERA and assessed as a separate entity. For clarity, the risk profile for the 'Other Species' management unit considered the risk posed to all sea cucumber species excluding white teatfish, black teatfish and burrowing blackfish.

For the purposes of this ERA, the term 'Species of Conservation Concern' (SOCC) was used instead of 'Species of Conservation Interest' (SOCI) as the scope of the assessment will be broader. In Queensland, 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. In the case of the *SOCC* ecological component, this assessment group was further divided into *marine turtles, sea snakes, crocodiles, dugongs, cetaceans, batoids, sharks, syngnathids, seabirds, protected teleosts* and *terrestrial mammals*. While a number of these subgroups will have negligible or limited interactions with the QSCF, their inclusion in the assessment provides the fishery with a more complete risk profile.

Of the ecological components assessed, *ecosystem processes* represents the biggest challenge for a 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 a fishery has on these processes. This problem is compounded by the fact that it is often difficult to identify measurable indicators of marine ecosystem processes (Pears *et al.*, 2012; Evans *et al.*, 2016). For example, what parameters need to be measured to determine if an ecosystem process is in decline, stable, or improving, and how much of this change can be attributed to the presence or absence of fishing activities.

In order to refine the Level 1 ERA for *ecosystem processes*, a preliminary assessment was undertaken. This preliminary assessment examined the potential for a fishery to impact 16 categories outlined in the Great Barrier Reef Outlook Report 2019 (Great Barrier Reef Marine Park Authority, 2019). 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 ERA, this stage will assign each fishing activity with an indicative risk rating representing the risk posed to each ecological component. These scores will then be used to assign each ecological component with a preliminary risk rating based on the highest risk score within the profile. Preliminary risk scores provide the first opportunity to identify low-risk elements within 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 to be overestimated in whole-of-fishery ERAs. This step assesses the likelihood of the risk occurring under the current management arrangements and takes into consideration the key factors of influence and 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 the *Ecological Risk Assessment Guideline* (Department of Agriculture and Fisheries, 2018a) and helps to limit the extent of false positives (*e.g.* the misclassification of low-risk elements as high risk).

While viewed as a higher-level assessment, the Level 1 ERA provides important information on drivers of risk in a fishery, the ecological components at risk, and areas within the fisheries management system that contribute to the level of risk. 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 to refine the scope of subsequent ERAs. If required, a Level 2 assessment 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 Guidelines.

# 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 Queensland Sea Cucumber 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 the term "potential" in the 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 QSCF.

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. The use of a 20-year timeframe aligns with other Level 1 ERAs constructed under the Guidelines and is considered precautionary.

At a whole-of-fishery level, the risk of the QSCF contributing to or causing an undesirable event has decreased over the last few decades. This has been achieved through a range of management adjustments designed to reduce both real and potential effort. Many of these management adjustments came about through initiatives led by industry members and the Sea Cucumber Fishery Working Group (FWG) including the implementation of measures to reduce localised fishing pressures and to monitor the take of key species (black and white teatfish). Other notable examples of industry-led risk management include the establishment of a voluntary Memorandum of Understanding (MoU) for the harvesting of sea cucumbers, the use of species-specific triggers/harvest levels, and the introduction of Rotational Harvest Arrangements (RHA) and Burrowing Blackfish Zones (BFZ). These initiatives have had a significant impact on reducing catch and effort on key species.

*Note—owing to the success and value of industry-led and voluntary management arrangements, the management regime for the QSCF is being reviewed as part of the Queensland Sustainable Fisheries Strategy 2017–2027. This ongoing review has progressed a number of reforms that will improve and streamline management arrangements for this fishery, with many arrangements now being captured and formalised through the implementation the QSCF-specific harvest strategy. While noting these reforms, the Level 1 ERA only considered management arrangements that were in effect at the time of the assessment (i.e. the MoU and Performance Measurement System [PMS]).*

## 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/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 for the risk profiles and will be used to assign preliminary risk ratings to each ecological component (see section 4.4 Risk Characterisation).

In Queensland, *cumulative fishing pressures* have also been identified as a 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. In the QSCF, cumulative fishing pressures are considered to be less of a risk as sea cucumbers are harvested in comparatively low numbers across recreational, charter and subsistence fisheries.

In addition to the cumulative fishing pressures, this section will include a secondary examination of the cumulative risks that exist outside of the control of fisheries management. These factors often have a wide range of contributors, are generally more complex and are, 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 the relationship between fisheries-specific risks and external risk factors. These include broader risk factors that the QSCF will contribute to (*e.g.* boat strike) and factors that have the potential to negatively impact on the fishery (*e.g.* climate change, the potential for urban development to affect recruitment rates).

The inclusion of cumulative impacts in the Level 1 ERA provides further context on factors that may contribute to an undesirable event. However, it can be difficult to account for these impacts in the final risk ratings of a fisheries-based ERA. This is because it can be difficult to quantify the extent of this risk and/or their contribution to the overall risk rating. Given this, ratings assigned to cumulative risks will not be used in the determination of preliminary risk scores (see section 4.4 Risk Characterisation). The main reason for this is that the preliminary risk scores relate specifically to commercial fishing activities. In the event that one or more of the ecological components are progressed to a Level 2 assessment, cumulative impacts will be given additional considerations.

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

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

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

### 4.2.1 Whole-of-fishery

The QSCF is managed under a complex system of input and output controls based on legislation (including licence conditions), a PMS and a MoU (Department of Agriculture and Fisheries, 2021a). Some of the most effective measures used in the fishery are enacted through the MoU and include limiting the number of divers that can be used in a single operation, and temporal/spatial closures outlined in the RHA and BFZ. These measures provide the fishery with a strong foundation to manage the risk of overexploitation at a whole-of-fishery and regional level. While effective, it is important to note that management arrangements contained in the MoU are not underpinned by legislation, and compliance with the MoU cannot be enforced through traditional avenues (*e.g.* Queensland Boating & Fisheries Patrol [QBFP]).

From a risk management perspective, an inability to enforce key restrictions is important as fishing behaviours can deviate from observed historical trends *e.g.* if market demand for one or more species increases significantly. Given that the fishery is co-managed and has a high level of industry engagement, there is low risk of this occurring over the short to medium term. It is, however, a limitation in the current management system and is considered a longer-term source of risk for species not managed under species-specific catch limits.

Of significance, this risk is being actively addressed through reforms implemented as part of the *Queensland Sustainable Fisheries Strategy 2017–2027* (Department of Agriculture and Fisheries, 2017). One of the main objectives of the QSCF reforms package is to streamline and improve the efficiency of the current management arrangements. In a number of instances, these reforms will be enforced through the establishment of a dedicated QSCF harvest strategy, formalising previous industry-led and voluntary arrangements (*e.g.* MoU, PMS). Some of the more significant reforms being considered for the fishery include:

- Making minimum legal size limits part of an industry standard operating procedure (currently in the MoU);
- Listing TACC limits as declared quotas in legislation instead of licence conditions; and
- Creating a harvest strategy which captures the RHA aspect of the MoU, sectoral catch shares, and catch triggers for Tier 2 species that are currently outlined in the PMS.

At a whole-of-fishery level, *harvesting* was identified as the greatest contributor of risk, with the remaining fishing activities having a low or negligible impact. Harvest in the QSCF is highly selective and is restricted to hand collection with the use of a breathing apparatus (*e.g.* hookah/SCUBA). This means that the fishery is unlikely to present notable risks in terms of *discarding*, *contact without capture*, and *loss of fishing gear*. Due to the nature of hand collection fisheries, most of the impacts associated with the above activities will be of low risk, highly regionalised, and temporary in nature. These risks (including *harvesting*) will be higher in northern and central Queensland (*e.g.* around Bowen) where effort and fishing pressures are more concentrated. These risks are offset by the use of a RHA and additional protections afforded to these species through the GBRMP Zoning Plan.

### 4.2.2 Ecological Subcomponents

***Target & Byproduct***

Over the 2000–2019 period, at least 20 sea cucumber species or complexes were retained in the QSCF (Department of Agriculture and Fisheries, 2021a). Data collected from the fishery indicates that

the majority of the catch consists of blackfish (*A. palauensis*), burrowing blackfish (*A. spinea*) and white teatfish (*H. fuscogilva*). These three species accounted for 70–90% of the total catch reported from the fishery during the 2003/04 – 2013/14 period. While burrowing blackfish and white teatfish remain key targets, recent commercial catches are more diversified. For example, the fishery had trended away from burrowing blackfish towards prickly redfish (*T. ananas*), black teatfish (*H. whitmaei*), curryfish (*S. hermanni* / *S. vastus*) and brown sandfish (*B. vitiensis*) (Department of Agriculture and Fisheries, 2021a). This trend can be partly attributed to the implementation of improved management controls (*e.g.* the introduction of the RHA and BFZs) and the use of a more refined logbook reporting system**.**

Extractive fishing of sea cucumbers can affect the size and structure of regional populations and there is evidence that the complex is susceptible to overfishing (Skewes *et al.*, 2000; Purcell *et al.*, 2013; Patterson *et al.*, 2020). Historical data has shown that recovery times for depleted sea cucumber stocks can be considerable and overfishing can lead to the local extirpation of key species (Friedman *et al.*, 2011; Eriksson & Byrne, 2013). There are significant knowledge gaps surrounding the impact of removing biomass on a whole-of-fishery scale, particularly with respect to the ecological functionality of tropical ecosystems (Friedman et al., 2011). It is known, however, that because of the density-dependent reproductive ecology of sea cucumbers, unsustainable fishing practices can rapidly push stocks past critical thresholds, jeopardising the ability of these stocks to recover to sustainable levels (Uthicke *et al.*, 2004; Bell *et al.*, 2008; Friedman *et al.*, 2011).

As a hand collection fishery, the majority of risks relate to fishing pressures exerted on key species (*harvesting*). Overfishing risks in the QSCF are managed using a mixture of input and output controls. These controls/restrictions include the use of a complex array of spatial and temporal closures contained within the RHA, BFZs and the GBRMP Zoning Plan (Department of Agriculture and Fisheries, 2021a). These measures are complemented by a PMS that includes catch trigger limits supported by decision rules and prescribed actions if and when they are exceeded (Department of Primary Industries and Fisheries, 2008)**.** For three species, black teatfish, white teatfish and burrowing blackfish, the risk of overexploitation is further reduced through the use of species-specific TACC limits. These initiatives maintain recruitment rates at a regional level and help to ensure the long-term sustainability of the fishery.

The situation surrounding the remaining species is more complex as quota-setting mechanisms for the 'Other Species' management unit are less developed and have reduced flexibility in terms of their ability to respond to a changing fishing environment. Catch for most of these species is comparatively low and more reflective of opportunistic *harvesting*. Harvest rates for a small number of species though have increased through time. This is perhaps best exemplified by the prickly redfish, curryfish and (to a lesser extent) brown sandfish (Department of Agriculture and Fisheries, 2021a).

As the take of most secondary species is managed under the 'Other Species' quota unit, there is increased potential for catch and effort to increase/shift through time towards a small number of species or a particular species due to increased market demand (*harvesting*). While unlikely in the current fishing environment, existing regulations for the 'Other Species' basket could (theoretically) allow the take of a single species up to 308 tonnes.[1] If this were to occur, one or more species could

*[1] Except for burrowing blackfish which, while managed under the 'Other Species' basket, has a fishery-wide TACC limit of 225 tonnes. The burrowing blackfish TACC limit is unevenly split between Lizard Island (120 tonnes), Bunker Reef (60 tonnes) and Gould Reef (45 tonnes). These management arrangements are implemented as part of the BFZs.*

be fished beyond key sustainability reference points despite the fishery operating within the confines of the 'Other Species' basket quota. This highlights the added importance of improving the level of information on regional stock structures, collecting accurate information on catch compositions, and continuing to monitor catch trends through time.

At the time of this assessment, no sea cucumber species had been the subject of a quantitative stock assessment for the Queensland east coast. Without this information, it is difficult to compare harvest rates against key sustainability reference points and/or the ability of the fishery to meet long-term objectives outlined in the *Queensland Sustainable Fisheries Strategy 2017–2027* (Department of Agriculture and Fisheries, 2017). A Management Evaluation Strategy (MSE) was completed for the fishery in 2014 and revealed the risk of overexploitation and localised depletions was reduced for most species (Skewes *et al.*, 2014). However, the MSE also noted that the fishery still posed risks to some highly targeted species, and identified a number of important information gaps that are critical to the continued sustainable use of the resource on the GBR (Skewes *et al.*, 2014). Some of these information gaps and risks were addressed in a subsequent Spatial Resource Evaluation for burrowing blackfish and black teatfish. The outputs of this evaluation were used to develop catch triggers for the BFZs and to establish a conservative TACC limit for black teatfish (Department of Agriculture and Fisheries, 2020b).

Going forward, black and white teatfish have been prioritised for assessment and, once completed, these assessments will provide more detailed accounts of their biomass and sustainability reference points. The need to undertake stock assessments for the remainder of the species will be largely dependent on harvest rates. The low overall harvest rates of the 'Other Species' unit reduces the risk of overexploitation for most of these species, and they will remain lower priorities for detailed sustainability assessments. This need will be more pressing for burrowing blackfish, prickly redfish and curryfish which are targeted and retained in higher quantities (Department of Agriculture and Fisheries, 2021a).

As with most quota-based fisheries, there is a degree of risk associated with illegal fishing, non-reporting of product (black marketing), inaccurate reports of catch weights, and/or non-compliance *e.g.* minimum legal size and in-possession limits (Department of Agriculture and Fisheries, 2021a). Illegal and unreported fishing activities are frequently identified as some of the biggest risks to sustainable fisheries management (Mapstone *et al.*, 1997; Williamson *et al.*, 2015; Vince *et al.*, 2020). For sea cucumbers, this may include illegal, unreported and unregulated (IUU) fishing in more remote areas or in adjacent jurisdictions (Skewes & Persson, 2017). In Queensland managed waters, these risks are managed through the QBFP, who continue to enforce the current regulations including adherence to spatial/temporal closures, minimum legal size limits, and Vessel Tracking.

On-water compliance is supported by a range of monitoring and reporting initiatives that include the use of commercial logbooks, an Automated Integrated Voice Response (AIVR) system (prior reporting), and Unloaded Fish Notices (Business Queensland, 2019). Catch can also be verified using the *Beche-de-mer Buyers Reporting Logbook* (BB02) (Department of Agriculture and Fisheries, 2021a). This logbook provides a more detailed, species-specific account of the weighed and processed product, and provides an added method of catch data validation (Department of Agriculture and Fisheries, 2020b). This combination of measures provides a system of crosschecks that can be used to validate catch against key reference points including ITQ holdings. While the catch validation measures do not address issues relating to non-compliance at sea (*i.e.* illegal catch, fishing during a

temporal closure or in no-take zones, or the misreporting of species), they reduce the risk of non-compliance with the quota system.

When compared to *harvesting*, the remaining fishing activities pose a low or negligible risk to the *target & byproduct species* ecological component. Of the fishing activities assessed, *disturbance due to presence in the area* was the only activity identified as a secondary risk factor. Likely impacts of this activity include increased sediment resuspension, increased turbidity, and disruption of benthic communities. In the QSCF these impacts will be highly localised, temporary in nature and are unlikely to have a significant or long-term impact on regional communities. This is due, in part, to a small fleet size, the type of apparatus used by commercial operators, and risk mitigation strategies already employed in the fishery *e.g.* maximum diver numbers, the use of a RHA and BFZs (Department of Agriculture and Fisheries, 2021a). For these reasons, *harvesting* of sea cucumbers presents as a more significant long-term risk.

In Level 1 ERAs involving line, net and trawl fisheries, *discarding* (including high grading) was assigned comparatively high-risk scores (Department of Agriculture and Fisheries, 2020d). *Discarding* is viewed as less of an issue in hand collection fisheries such as the QSCF, where gear types and targeting is highly selective and intentional. In the *target & byproduct species* ecological component, *discarding* will primarily relate to individuals that do not meet the prescribed minimum legal size limits. Information on post-capture mortality of wild-caught sea cucumbers is limited, with most literature centred around survival of individuals as a result of restocking programs (Purcell, 2004). While this has been identified as a knowledge gap, the risk posed to these species is likely to be low as discarded animals will more than likely survive the fishing event.

***Bycatch (non-SOCC) and Species of Conservation Concern (SOCC)***

Interactions with *bycatch (non-SOCC)* and *SOCC* ecological components will be limited by the fishing apparatus used in the QSCF. Bycatch in this fishery will be confined to *target & byproduct species* as operators will not need to extricate non-target species from the catch.

Interactions with the *SOCC* ecological component will most likely involve *disturbance due to presence in the area, contact without capture* and *travel to/from fishing grounds*. In most of these instances, the interaction will be indirect, involve the animal moving out of the fished area, or interactions with the vessel (*e.g.* boat strike).

***Marine Habitats***

Coral reefs and soft-bottom environments contribute significantly to the cultural and economic values of the GBR region, are a significant sink for global carbon, and are one of the greatest contributors to biodiversity (Kinsey & Hopley, 1991; Great Barrier Reef Marine Park Authority, 2019). As a hand collection fishery, the direct impacts of fishing for sea cucumbers will be highly localised, temporary and unlikely to result in significant or long-term damage to the marine environment.

Across the fishery (*i.e.* commercial, recreational, charter), general boating activities such as anchoring have the potential to damage regional habitats. Anchors can damage coral reefs and the substratum, particularly during the setting and retrieval process (*e.g.* if the anchor is dragged or wrapped around structures). Dropping and dragging anchors is also a source of resuspended sediments (see *Ecosystem Processes* below). There is a significant relationship between areas of high boating activity and coral damage due to anchoring (Dinsdale & Harriott, 2004). However, DAF notes that the small

size of QSCF's fishing fleet means that the fishery will make a comparatively minor contribution to these impacts.

As a commercial fishery, additional impacts on marine habitats may be contributed via the loss of ancillary equipment (*loss of fishing gear*) and localised pollutants (*boat maintenance and emissions*) (Table 1). However, these impacts will be much smaller in the QSCF due to the small size of the fleet and the apparatus used.

***Ecosystem Processes***

Ecosystem-based fisheries management, which takes into account the likely effects of fishing on the broader ecosystem and on ecological processes, is essential to sustaining healthy marine ecosystems and the fisheries they support (Link, 2002; Food and Agriculture Organization (FAO), 2003; Pikitch *et al.*, 2004). Over time, more emphasis has been placed on how fisheries contribute to the overexploitation of certain species, the flow-on effects that may reduce the capacity for ecosystem regeneration, and their resilience to broad-scale stressors. An understanding of the linkages formed by these components, and their influence on *ecosystem processes*, promotes the development of more specified and refined policy and fisheries management (Purcell *et al.*, 2016).

Sea cucumbers play a key role in benthic communities and make a prominent contribution to the physico-chemical processes of soft-bottom and reef ecosystems (*e.g.* bioturbation, carbonate processing) (Department of Agriculture and Fisheries, 2020b). Research indicates that burrowing sea cucumber species are one of the main contributors to bioturbation in tropical reefs and soft-bottom ecosystems (Reise, 2002). Bioturbation has many benefits in these ecosystems, including the enhancement of primary production, infaunal biodiversity, and infaunal biomass (Solan *et al.*, 2004).. As with the ingestion of sediments, it has been found that deposit-feeding sea cucumber species expel sediment, reducing the accumulation of excess organic matter. This process, in effect, 'cleans' sediments and facilitates bacterial decomposition (Paltzat et al., 2008; MacTavish et al., 2012; Yuan et al., 2015)

Holothuroids are also responsible for nutrient recycling through the conversion of organic matter (*i.e.* nitrogen) into inorganic forms (*i.e.* ammonia and phosphate) to be taken up by primary producers (Purcell *et al.*, 2016). This form of nutrient recycling and expulsion assists in raising sea water alkalinity and dissolved inorganic carbon, facilitating calcification and productivity of biota such as corals and calciferous algae, and increases the buffering capacity of reefs against local ocean acidification (Schneider *et al.*, 2011; Schneider *et al.*, 2013). In high density areas, characteristic of unfished reefs and soft-bottom environments, sea cucumbers are of great importance to the integrity of reefs in buffering local carbonate chemistry and boosting primary productivity (Purcell *et al.*, 2009; Eriksson & Byrne, 2013). Moreover, sea cucumbers act as hosts to over 200 ecto- and endo-commensals and parasites (*e.g.* platyhelminthes, polychaetes, echinoderms, gastropods, arthropods), increasing ecosystem biodiversity and species richness (Eeckhaut *et al.*, 2004). Their contribution to benthic and benthopelagic food webs via predation is also significant, acting as a conduit for the transfer of energy from organic detritus to consumers at higher trophic levels in marine food webs (*e.g.* crustaceans, gastropods, sea stars) (Francour, 1997; Purcell *et al.*, 2016).

The overexploitation of sea cucumbers is expected to have a negative impact on predators for which they are a major food source. This has the potential to lead to a loss of biodiversity, reduced abundance of these predators and the associated cascading effects of altering/removing one or more

keystone species from the marine food web. The impacts of alterations to food webs is far-reaching, likely having negative impacts on other fisheries target species that rely on sea cucumbers as part of their prey (*e.g.* emperors, wrasses, cods, perches) (Francour, 1997; Dance *et al.*, 2003). Not only this, but overexploitation is likely to result in reduced nutrient cycling, species richness, and the transfer of energy to higher trophic levels, all of which would impact heavily on ecosystem health and productivity. Other ecological benefits of holothuroids to fisheries and fisheries management include taking advantage of their sediment cleaning role in modified coastal habitats (*e.g.* coastal aquaculture) (Slater & Carton, 2009).

Currently, there are various measures in place to reduce fishing pressures and promote population regeneration (*i.e.* RHA, BFZs, spatial closures and catch limits), particularly in relation to target species (*e.g.* burrowing blackfish, black teatfish, white teatfish). However, risks to secondary/less targeted species such as curryfish and prickly redfish remain high due to the less specified controls on catch and effort. Under this arrangement, the already substantial catch of these species can increase with market demand, potentially leading to localised depletions (*harvesting*). As information on the stock structure of these species is limited, it is difficult to ascertain how their exploitation may impact (if at all) regional ecosystems and their processes.

## 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 are made up of multiple sectors (commercial, recreational, charter, subsistence). These sectors, for the most part, are managed alongside the commercial fishery and are subject to management regimes managed by 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.

In Queensland, *External Risks* are addressed through a wide variety of forums and by various departments. Given the wide-ranging nature of these risks, they 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 pose a risk to the fishery, or are a factor that the fishery contributes to. When and where appropriate, the Queensland Government will contribute to these discussions, including (among others) through participation in 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***

Sea cucumbers are not retained or sold in other commercial fisheries in Queensland and their take in the recreational, charter and indigenous fishing sectors is comparatively small. For these reasons, their harvest in adjacent jurisdictions will arguably be of more significance in terms of cumulative risks and fishing pressures. This will be of particular relevance to species like black teatfish and sandfish (*H. scabra*) where research has shown that there is degree of connectivity between stocks situated in the Torres Strait, Queensland east coast and Coral Sea (Uthicke & Benzie, 2000; Uthicke & Benzie, 2003; Department of Agriculture and Fisheries, 2020b). This suggests that the regional harvesting of some species may influence recruitment/harvest rates in other areas. The extent of this connectivity and the potential for fisheries in adjacent jurisdictions requires further investigation. Improving the level of information on stock connectivity would also assist with the long-term management of key species and minimising the potential risk of overexploitation.

The majority of information for the recreational sector comes from infrequent voluntary fisher surveys. However, the 2009/10, 2013/14, and 2019/20 surveys did not include any estimates of the recreational catch of sea cucumber (Taylor *et al.*, 2012; Webley *et al.*, 2015; Department of Agriculture and Fisheries, 2021b; Teixeira *et al.*, 2021). While noting this absence of results, it is anticipated that the recreational sector makes a small contribution to the overall rate of fishing mortality. If or when sea cucumbers are targeted by recreational fishers, the risk profile for this sector will be similar to the QSCF, with *harvesting* identified as the fishing activity providing the key source of risk.

Risks relating to the harvest of QSCF species by Aboriginal and Torres Strait Islander peoples are more difficult to assess as there is less information on catch and effort rates. Gear restrictions for aspects of the fishery take into account the importance of traditional fishing rights, and as a result may be less stringent. 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 and Torres Strait Islander peoples will most likely present a lower risk for most of the ecological components assessed.

Outside of their direct harvest, there will be limited fishing pressures exerted on regional sea cucumber stocks. Of the fisheries that operate on the Queensland east coast, the majority of non-commercial interactions will occur in the East Coast Trawl Fishery. As sea cucumbers are caught as bycatch in the Otter Trawl Fishery (Courtney *et al.*, 2007), *discarding* and *disturbance due to presence in the area* will be the key activities in this fishery. To date, there have been limited studies on the survivability of sea cucumbers that have been caught in a trawl event or it's potential to impact regional stocks.

### 4.3.2 External Impacts

***Boat Strike***

The effects of vessel use are similar regardless of whether they are used for fishing or another marine-based activity. For most air-breathing species the general boat-strike probability is low, but will be higher in key habitats and in areas where there are higher amounts of vessel traffic. For turtles,

interactions are more likely to occur in complex/intricate habitats and whilst travelling through shallow coastal foraging areas to and from the fishing grounds (*travel to/from fishing grounds*) (United Nations Environment Program, 2014). Dugongs, too, are vulnerable in shallow coastal foraging areas.

As boat strikes can occur without notice, there is a higher probability of the interaction going unreported (*contact without capture*). This makes it difficult to assess the contribution an individual fishery makes to this risk and/or how it compares to other sectors or marine-based activities. The size and structure of the QSCF fleet suggests that it poses a smaller risk when compared to other sectors (*e.g.* recreational use of marine resources) and commercial fisheries. With that said, boat strike remains a significant issue and it will be a key source of mortality for a number of the *SOCC* subgroups. For example, the Marine Wildlife Stranding and Mortality Database attributed between 60 and 126 turtle mortalities per year to boat strike or associated fractures (2000–2011 data) (Meager & Limpus, 2012). This compares to state-wide estimates <20 mortalities per year for high-incident fisheries like gillnet fishing and 1–53 mortalities attributed to entanglements with ghost nets (2000–2011 data) (Meager & Limpus, 2012).[2]

***Urban Development & Changes in Land Use***

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

Sugarcane farming, grazing, and urban development in GBR catchment areas are the largest contributors to land-based runoff. Excess nutrients, fine sediments and pesticides have substantially increased in the GBR since pre-development levels, and significantly reduce the overall water quality of the whole GBR region (Brodie *et al.*, 2017). Reduced water quality leads to loss of corals and seagrass cover, population declines in mega fauna, increased crown of thorns outbreaks, and overall degradation to the GBR (Brodie *et al.*, 2017). For the QSCF, urban development is an ongoing and long-term risk that has the potential to impact on the fishery and the long-term viability of regional populations. The extent of this risk will be difficult to quantify for regional sea cucumber stocks and populations.

***Climate Change***

Anthropogenic climate change is expected to have significant and lasting effects on the marine environment. These will likely impact fisheries operations, with some effects already perceptible in recent years. In Queensland, the severity and frequency of storms, tropical cyclones, and extreme rainfall events are predicted to increase by the end of the century (Steffen *et al.*, 2017). In the past, these events have led to population reductions in affected areas and reduced fish catchability for extended periods after these events (Holbrook & Johnson, 2014). Further to this, increased warming

[2] *Includes data collected from both the Queensland east coast and the Gulf of Carpentaria.*

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 large-scale mass bleaching events 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 in stock distributions. There is also evidence of increased ocean acidity (Hoegh-Guldberg *et al.*, 2007; Godbold & Calosi; Hoegh-Guldberg *et al.*, 2017). Increased carbon dioxide in the atmosphere decreases the pH of seawater, leading to ocean acidification and dissolution of calcium based reef-building corals, molluscs and crustaceans (Hoegh-Guldberg *et al.*, 2007). Within this context, sustainably managed fisheries will be in a better position to respond to the effects of climate change.

While sea cucumbers, to an extent, provide a buffer to acidification through the expulsion of inorganic nitrogen (ammonia) and phosphate (Purcell *et al.*, 2016), these ecological effects are localised, limited by sea cucumber population density, and do not speak to the effects of climate change on the individual. Laboratory experiments have indicated that some sea cucumber species may be vulnerable to climate change-induced effects, and this may present a risk to the fishery. Combined environmental stresses (*i.e.* thermal plus hypoxic) have been found to alter gene expression in one species of sea cucumber (*Apostichopus japonicus*), affecting various biological processes such as immunity, energy metabolism, and the cell cycle (Huo *et al.*, 2020). While studies are limited on the capacity of sea cucumbers to adapt to climate change, preliminary research may suggest a limited ability to adjust to increased seawater temperature and ocean acidification in the short term, as is the case with most other marine species.

## 4.4 Risk Characterisation

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 base Sustainability Assessment for Fishing Effects (bSAFE), the results of the Level 1 assessment will identify the activities within the fishery that are contributing to this risk.

The scores assigned to each ecological component (excluding *ecosystem processes*) and *SOCC* subcomponent are based on the issues raised during the Risk Identification process. They take into consideration current fishing trends (catch, effort and licensing), limitations of the current management regime (*e.g.* the potential for additional effort to be transferred into areas already experiencing changes to / increases in / higher levels of fishing mortality for key species) and the consequences of the interaction. Scores assigned as part of the Risk Characterisation stage considered management arrangements that are in effect at the time of the assessment including any perceived limitations. It did not, however, take into consideration the content of the draft QSCF harvest strategy as it has yet to be implemented in this fishery (see Section 4.2.1).

While the majority of the *SOCC* are not part of the targeted harvest, 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 Impacts were not considered as the preliminary risk scores are only applicable to the commercial fishery. The Cumulative Impacts scores 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 QSCF indicated that fishing activities presented a negligible, low or low/intermediate risk to all but four of the ecological components or subcomponents. Of the components assessed, only the *target & byproduct* component was assigned preliminary ratings higher than intermediate (Table 2; Appendix 2). A full account of the preliminary 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 majority of the ecological components were scored negligible or low-risk ratings due to the highly selective nature of hand collection fisheries, particularly with respect to the apparatus used and the ability of the operator to avoid non-target species.
- The majority of the risks associated with the QSCF relate to the *harvesting* of *target & byproduct species* across the four quota management units (including burrowing blackfish).
- Key areas of risk for the *target & byproduct species* ecological component include the absence of stock assessments / sustainability reference points, an absence of species-specific controls for secondary species, and the potential for catch and effort to increase for one or more species under the current management regime.
- The ‘Other Species’ management unit was viewed as a higher risk within this fishery due to:
    - An absence of fine-scale management initiatives and species-specific catch limits;
    - An absence of biomass estimates for most species and limited assessments/evaluations of stock sustainability, including through SAFS;
    - Greater potential for catch and effort to increase through time for one or more of the species; and
    - The potential for higher amounts of effort to be concentrated on an individual species or a smaller number of a species *e.g.* due to increased market demand.
- While management of the risk of exploitation in this fishery is highly effective, a number of the key restrictions are based on a MoU and do not form part of the legislative framework. This contributed to the ‘Other Species’ management unit receiving a higher preliminary risk score.

- The QSCF poses a low to negligible risk to most other ecological components including the *SOCC* and *marine habitats*.
- When *non-target SOCC* were assigned a risk rating above negligible, it was associated with indirect impacts *i.e. travel to/from fishing grounds, disturbance due to presence in the area,* and *boat maintenance and emissions.*

***Table 2.*** *Summary of risk scores for the Queensland Sea Cucumber Fishery, including the impact of the main fishing activities on key ecological components. Ecological components were assigned a score of low (L), intermediate (I), or high (H). Intermediary risk scores (L/I, I/H) were also assigned to ecological components where the risks posed were considered to be on the boundary.*

| **Ecological Component** | **Hand collection – Main activities of the Fishery** | | | | | | | **Preliminary Risk Rating** | **Cumulative impacts Other fisheries*** |
|---|---|---|---|---|---|---|---|---|---|
| | *Harvesting* | *Discarding* | *Contact without capture* | *Loss of fishing gear* | *Travel to/from fishing grounds* | *Disturbance due to presence in area* | *Boat maintenance and emissions* | | |
| **Target & Byproduct** | | | | | | | | | |
| *White teatfish* | I/H | - | - | - | - | L | - | I/H | L |
| *Black teatfish* | I/H | - | - | - | - | L | - | I/H | L |
| *Burrowing blackfish* | I/H | - | - | - | - | L | - | I/H | L |
| *Other species* | H | - | - | - | - | L | - | H | L |
| **Bycatch (non-SOCC)** | - | - | - | - | - | - | - | - | - |
| **Species of Conservation Concern (SOCC)** | | | | | | | | | |
| *Marine turtles* | - | - | - | - | L | L | L | L | L |
| *Sea snakes* | - | - | - | - | - | L | - | L | - |
| *Crocodiles* | - | - | - | - | - | - | - | - | - |
| *Dugongs* | - | - | - | - | L | L | L | L | L |
| *Cetaceans* | - | - | - | - | L | L | L | L | - |
| *Batoids* | - | - | - | - | - | L | L | L | - |
| *Protected teleosts* | - | - | - | - | - | L | L | L | - |
| *Sharks* | - | - | - | - | - | L | L | L | L |
| *Syngnathids* | - | - | - | - | - | L | L | L | - |
| *Seabirds* | - | - | - | - | - | L | L | L | - |
| *Terrestrial mammals* | - | - | - | - | - | - | - | - | - |
| **Marine Habitats** | L | - | - | - | L | L | L | L | L |
| **Ecosystem Processes** | I | - | - | - | L | L | L | I | L |

** Includes recreational, charter fishing sectors*

## 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 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 determining if they represent a real or potential 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 was 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 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, risk ratings for all four *target & byproduct species* subcomponents were reduced (Table 3; Appendix 2). The downgrading of these scores recognises that these species are being fished below the quota limits and the (low) probability of the fishery deviating from this trend into the future. Similarly, additional consideration was given to the risk mitigation strategies already used in this fishery which include the use of a PMS with prescribed actions for exceeding catch trigger limits, the use of species-specific catch limits, and a detailed RHA (Department of Agriculture and Fisheries, 2021a). These measures, despite not all of them being underpinned by legislation, provide significant protections for key species and minimise the risk of overexploitation.

Risk score reductions for the ‘Other Species’ management unit were less pronounced when compared to black teatfish, white teatfish and burrowing blackfish (Table 3). This reflects the multi-species nature of the quota management unit, an absence of biomass estimates (excluding burrowing blackfish), and uncertainty surrounding regional stock sustainability. Given that the QSCF operates under a management system that includes limited licencing, rotational harvesting, and size and catch limits, this rating may not reflect the low level of concern surrounding the sustainability of some species covered by this management unit (Skewes *et al.*, 2014; Department of Agriculture and Fisheries, 2020b). Accordingly, the risk rating assigned to this ecological subcomponent may reflect the potential

risk. The veracity of this inference though could not be fully tested in the Level 1 ERA due to the aforementioned data deficiencies.

The remaining amendments involved low-risk elements that are unlikely to interact with the QSCF. For example, risk ratings for the *sharks*, *syngnathids* and *seabirds* were all downgraded due to the fishery having low or negligible interaction rates, and a low likelihood of entanglements and/or adverse interactions. Preliminary ratings for the remaining ecological components were retained and reflect their low and indirect potential to interact with the fishery, including the vessels used *i.e.* risks associated with *disturbance due to presence in the area* and *travel to/from fishing grounds*.

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

## 4.6 Issues Arising

***Sustainability assessments and evaluations***

The management regime for the QSCF includes a complex array of initiatives that reduce the impact of the fishery on regional populations and stocks. These measures include the use of TACC limits, a RHA, and an industry-wide MoU. While noting the value of these measures, further information is required on the health of key stocks, biomass reference points, and species-specific harvest limits. These deficiencies make it difficult to assess how harvest rates compare to key biomass reference points and the suitability of catch limits currently used in this fishery.

Previous work has improved the level of understanding on how the QSCF interacts with regional populations with resource estimates and a MSE providing considerable information on the operating environment (Skewes *et al.*, 2014; Department of Agriculture and Fisheries, 2020b). The sustainability of white teatfish and burrowing blackfish has also been supported through the National SAFS process (Roelofs, 2020; Roelofs *et al.*, 2020). For white teatfish, these results will be built upon through quantitative stock assessments (Department of Agriculture and Fisheries, 2020b; a).

While noting the above advancements, there remains a pressing need to increase the level of understanding on stock health for key species. At present, stock assessments have only been scheduled for the two teatfish species. These however will need to be complemented by analogous assessments or sustainability evaluations involving other species. As harvest rates will vary across the QSCF, it is unlikely that all species retained for sale will require stock assessments or sustainability evaluations. Catch data for the fishery though suggests that a number of secondary species would benefit from this information including burrowing blackfish, prickly redfish and curryfish.

While not currently in effect, the draft QSCF harvest strategy classifies black teatfish, white teatfish, and burrowing blackfish as Tier 1 species. Under the draft harvest strategy, the management regime for Tier 1 species will include performance indicators that are based on biomass reference points produced by stock assessments. Tier 1 management also involves the use of reactive trigger points aimed at reducing fishing pressure when and where necessary *i.e.* when catch approaches, reaches or exceeds a TACC limit. All remaining sea cucumber species will be classed as Tier 2 and will be managed using reactive catch triggers that can prompt the establishment/implementation of TACC limits (Department of Agriculture and Fisheries, 2020a; c). When implemented, the harvest strategy will (likely) result in downgrading risk scores for most of the *target & byproduct species* subgroups.

***Table 3.*** *Level 1 ERA ratings for the ecological components and subcomponents interacting with the Queensland Sea Cucumber Fishery, taking into consideration the likelihood of the risk coming to fruition in the short to medium term.*

| Ecological Component | Level 1 Risk Rating | Likelihood Considerations | Progression to Level 2 ERA |
|---|---|---|---|
| **Target & Byproduct** | *Black teatfish*<br>Low / Intermediate | • The fishery operates under a more complex management regime that includes a number of risk mitigation measures *e.g.* two rotational management systems (RHA & BFZs) and restrictions on the number of divers permitted per vessel. These arrangements provide a strong foundation to manage the short and medium-term risk of key species being overexploited.<br>• While the QSCF operates under a more complex management system, a number of the key risk initiatives are based on a MoU. As the MoU is not underpinned by legislation, the effectiveness of these measures relies on industry participation / self-compliance.<br>• TACC limits are used to manage the catch of three key species (black teatfish, white teatfish and burrowing blackfish), and across a multi-species group of sea cucumbers. Catch data indicates that current harvest rates remain below these limits.<br>• While white teatfish, black teatfish and burrowing blackfish are managed under a TACC limit, catch and trigger points are not based on the outputs of a quantitative stock assessment. Further, only white teatfish and burrowing blackfish have been the subject of sustainability evaluations (Roelofs, 2020; Roelofs *et al.*, | Not required – Best addressed through the harvest strategy development process. |
| | *White teatfish*<br>Low / Intermediate | | Not required – Best addressed through the harvest strategy development process. |

| Ecological Component | Level 1 Risk Rating | Likelihood Considerations | Progression to Level 2 ERA |
|---|---|---|---|
| | *Burrowing blackfish*<br>Intermediate | 2020). These evaluations indicate that the risks posed to these species are being managed within the current fishing environment.<br>• While black teatfish does not have a stock assessment or sustainability evaluation, a DAF endorsed survey was completed for the species. This supported the re-introduction of a conservative TACC limit for this species (30 tonnes or the equivalent of 10% of the unfished biomass).<br>• General assessments including a MSE and Spatial Resource Evaluations (burrowing blackfish, black teatfish) indicate that risks posed to key target species are also being managed within the current fishing environment.<br>• At a whole-of-fishery level, the key drivers of risk for the *target & byproduct* ecological component are a) an absence of sustainability assessments, and b) the potential for catch and effort to increase for one or more species under the current management regime. This is of particular relevance to the 'Other Species' management unit and contributed to the species receiving a higher risk rating.<br>• The 'Other Species' management unit is considered to be at a at higher risk due to a) the multi-species nature of the management unit and b) the ability for catch and effort to increase for individual species under the basket quota (308 tonnes).<br>• Under the current management arrangements, one or more species in the 'Other Species' management unit could (theoretically) be fished beyond sustainability reference points without the fishery exceeding the 308 tonne TACC limit. This could occur if market demand were to increase significantly for an individual species.<br>• Of significance, development of a fishery-specific harvest strategy has commenced. This harvest strategy will consolidate management arrangements currently applied through legislation, licence conditions, the MoU and the PMS. The implementation of the harvest strategy, once completed, will likely result in risk | Not required – Best addressed through the harvest strategy development process. |
| | Other species - Intermediate / High | | Not required – Best addressed through the harvest strategy development process. |

| Ecological Component | Level 1 Risk Rating | Likelihood Considerations | Progression to Level 2 ERA |
|---|---|---|---|
| | | score reductions for a number of the quota management units and/or facilitate finer-scale assessment of the risks posed to species in the 'Other Species' category.<br>• As a hand collection fishery, there are few additional sources of fishing mortality due to the negligible risks associated with bycatch and cryptic mortalities. Cumulative fishing risks (commercial, recreational, charter and subsistence) will also be lower for these species.<br>• Data validation through the use of the *Vessel Monitoring System*, prior reporting through AIVR, and cross-referencing catch records with Unloaded Fish Notices and Buyer's Returns Logbooks also reduce the risk of non-compliance in this fishery. | |
| **Bycatch (non-SOCC)** | Negligible | • Due to the highly selective nature of the hand collection fishery, risks related to bycatch retention/discarding are expected to be negligible in the QSCF. | Not required |
| **Species of Conservation Concern (SOCC)** | | | |
| *Marine turtles* | Low | • The fishery will have low to negligible interactions with this subgroup and, outside of *boat strike*, will not result in the direct mortality of the animal.<br>• Risk ratings for this subgroup were heavily influenced by the potential impacts of *disturbance due to presence in the area, contact without capture events, travel to/from fishing grounds,* and *boat maintenance and emissions.* This risk transcends the QSCF and will be applicable to most other commercial fisheries, the recreational fishing sector and other marine-based industries.<br>• Some mitigation measures are in place to reduce the risk of interactions including spatial closures in GBR.<br>• Further management of risk is not considered necessary in the QSCF. | Not required |

| Ecological Component | Level 1 Risk Rating | Likelihood Considerations | Progression to Level 2 ERA |
|---|---|---|---|
| *Sea snakes* | Negligible | • No reported interactions and highly unlikely to occur.<br>• Risk mitigation measures not considered necessary for this fishery. | Not required |
| *Crocodiles* | Negligible | • No reported interactions and highly unlikely to occur.<br>• Risk mitigation measures not considered necessary for this fishery. | Not required |
| *Dugongs* | Low | • QSCF poses a low to negligible impact to dugongs as direct interactions (outside of boat strike) with this species are highly unlikely.<br>• In the rare instance that the fishery does interact with dugongs it would be while *traveling to/from the fishing grounds* and *involve contact without capture* events. This risk is partially offset by limits placed on the number of licences and vessels permitted for use in the fishery.<br>• Mitigation measures are in place to reduce the risk posed by general fishing activities, including those enacted as part of the GBRMP Zoning Plan.<br>• Further management of risk is not considered to be necessary. | Not required |
| *Cetaceans* | Low | • Risk profile for cetaceans will be similar to dugongs in that the QSCF poses a low to negligible risk to this subgroup.<br>• If an interaction were to occur it would most likely be with the vessel and be considered a *contact without capture* event.<br>• Further management of risk is not considered to be necessary. | Not required |

| Ecological Component | Level 1 Risk Rating | Likelihood Considerations | Progression to Level 2 ERA |
|---|---|---|---|
| *Teleosts (protected / SOCI only)* | Negligible | • Apparatus not suited to the targeting of teleosts, and interactions between operators and protected species are unlikely.<br>• Risk rating reflects the potential for these species to be disturbed if fishing in the immediate area, and will not result in any long-term implications.<br>• Further management of risk is not considered to be necessary. | Not required |
| *Batoids* | Low | • Risk rating reflects the potential for these species to be disturbed if fishing in the immediate area, and will not result in any long-term implications for this subgroup.<br>• While elasmobranchs (sharks and rays) will ingest holothurians (Jacobsen & Bennett, 2011), this prey is small and has limited overlap with the cohorts being targeted by operators in the QSCF.<br>• Further management of risk is not considered to be necessary. | Not required |
| *Sharks* | Negligible | • Risk rating reflects the potential for these species to be disturbed if fishing in the immediate area, and will not result in any long-term implications for this subgroup.<br>• Interactions with this subgroup (if applicable) are more likely to be instigated by the animal or be incidental interactions with the equipment.<br>• Further management of risk posed to this subgroup is not warranted. | Not required |
| *Syngnathids* | Negligible | • Low probability of interacting with this fishery and the QSCF does not pose a risk to the long-term conservation of these species. | Not required |
| *Seabirds* | Negligible | • Risk rating downgraded from low to negligible due to the low probability of an interaction occurring in this fishery. | Not required |

| Ecological Component | Level 1 Risk Rating | Likelihood Considerations | Progression to Level 2 ERA |
|---|---|---|---|
| *Terrestrial Mammals* | Negligible | • No reported interactions, mitigation measures not considered necessary. | Not required |
| **Marine Habitats** | Low | • Direct disturbances from fishing activities in the QSCF will include sediment resuspension, increased turbidity, and disturbance to the surrounding benthos.<br>• While the impacts may be greater in high-use areas, they are likely to be localised, temporary in nature and are unlikely to result in any long-term or significant damage. The QSCF is highly selective and targets relatively sedentary species that can be removed for harvest with relatively little disturbance.<br>• The direct risks of fishing in the QSCF are also being managed through the use of a rotational management system (*e.g.* RHA and BFZ). The fishery would benefit from having these measures formalised as part of a QSCF-specific harvest strategy.<br>• Additional risks to this ecological component relate to the regional impacts associated with general boating activities *e.g. disturbance due to presence in the area*. These risks are expected to be more significant in high effort/usage areas and areas frequented by both commercial and recreational fishers (including those not targeting sea cucumbers).<br>• While best practice methods of anchoring and mooring have been developed and promoted, these risks are difficult to monitor across sectors, and difficult to avoid the associated direct impacts. These risks extend beyond the commercial fishery and will be equally applicable to the recreational fishing sector. | Not required – Best addressed through the harvest strategy development process & formalising spatial/temporal closures. |

| Ecological Component | Level 1 Risk Rating | Likelihood Considerations | Progression to Level 2 ERA |
|---|---|---|---|
| **Ecosystem Processes** | Low / Intermediate | • Sea cucumbers play a key role in benthic communities and contribute greatly to the physico-chemical processes of soft-bottom and reef ecosystems *e.g.* bioturbation, carbonate processing (Department of Agriculture and Fisheries, 2020b).<br>• Research indicates that burrowing sea cucumbers are one of the main bioturbators in tropical reefs and soft-bottom ecosystems (Reise, 2002); the benefits of bioturbation being the enhancement of primary production, infaunal biodiversity, and infaunal biomass (Solan *et al.*, 2004).<br>• There is a degree of uncertainty with respect to the 'Other Species' management unit and how the fishery impacts ecosystem processes for these species.<br>• Of significance, a number of strategies are already employed in the QSCF to minimise the impact on regional ecosystems. This includes catch limits for key species, rotational harvesting and a complex system of spatial/temporal closures. These measures would all assist in the maintenance of regional recruitment and connectivity processes.<br>• This risk is considered to be lower due to current catch and effort levels, but may change into the future with less restrictive management and the ability for catch and effort to increase. | Not required – Best addressed through the harvest strategy development process and risk management of target & byproduct species. |

***Increased catch and effort ('Other Species' management unit)***

Under the current management arrangements, total catch for at least three species is capped using a TACC limit. TACC limits for black teatfish (30 tonnes) and white teatfish (53 tonnes) are set at the species level and both are managed as separate entities. While burrowing blackfish has a TACC limit (225 tonnes), this species and the corresponding catch limit forms part of the 'Other Species' quota management unit.

Outside of burrowing blackfish, management of the 'Other Species' management unit is more limited and less effective in terms of restricting harvest levels for individual species. Current quota usage for the 'Other Species' management unit, sits at around 80% of the TACC limit and includes up to 17 different sea cucumber species (Department of Agriculture and Fisheries, 2021a). As all species fall under the same quota limit, there is capacity for fishing effort to switch between individual species and/or for effort to be concentrated on a limited number of species. This inability to control fine-scale catch and effort trends within the 'Other Species' management unit presents as one of the more significant risks in this fishery. This was reflected in the scores assigned to each of the respective quota management units (Table 3).

The risk of overexploitation is being actively addressed as part of the harvest strategy development process. Under the strategy, management of key sea cucumber species will be transitioned to a 2-tier system. For Tier 1 species (black teatfish, white teatfish and burrowing blackfish), performance indicators and sustainable harvests will be estimated from stock assessments. For the remaining Tier 2 species, catch triggers will be used to monitor and assess longer-term increases in fishing mortality. Under this system, annual catch levels will be assessed against pre-defined reference levels to determine the extent of the risk posed to individual species. If the annual catch for a Tier 2 species exceeds its trigger level, then a TACC will be set to maintain annual catches at/below the trigger level until a further assessment can be undertaken (Department of Agriculture and Fisheries, 2020a).

Once implemented, the harvest strategy will establish a number of safeguards to ensure the long-term sustainability of species targeted in the QSCF. However, these measures have yet to be fully implemented in the fishery, with the finalisation of the draft harvest strategy yet to come.

***Validation and catch compositions ('Other Species' management unit)***

While most of the catch in the 'Other Species' management unit is reported to the species level, a small proportion is still reported under generic categories *e.g.* '*Beche de mer–Unspecified*' and '*A holothurian – Stichopodidae family'*. This component of the catch is reported infrequently and in lower quantities. As it stands, there is limited capacity to validate catch in this management unit and/or quantify bycatch compositions and discard rates, if any.

'*Improved Monitoring & Research'* was included in the *Queensland Sustainable Fisheries Strategy 2017–2027* as one of four foundation reforms (Department of Agriculture and Fisheries, 2017). The improvement of commercial fishing data is now being addressed through a dedicated *Fisheries Data Validation Plan* and through the *Monitoring and Research Plan* (Department of Agriculture and Fisheries, 2018d; c). These reforms along with (*e.g.*) the expanded use of Vessel Tracking and the catch disposal records (CDR), will improve the accuracy of data collected across commercial fisheries in Queensland. As these measures will take time to develop and implement, the benefits will be better identified and understood once they filter through to the ERA process.

***Information on additional (cumulative) fishing pressures***

When compared to the commercial fishing sector, there is limited information on harvest rates in the recreational sector and by Aboriginal and Torres Strait Islander peoples. While harvest rates are expected to be small in these sectors, future ERAs would benefit from additional data on the cumulative fishing pressures exerted on regional sea cucumber species. This information would be of particular benefit when assessing total rates of fishing mortality, the suitability of current catch limits and the need (if applicable) to include non-commercial catch in fishing limits.

***Commercial Logbooks vs. Buyers Reporting Logbook***

The collection of catch data in the QSCF is subject to a series of cross-checks and data validation using various reporting methods (*i.e.* AIVR, Unloaded Fish Notices, *Buyers Reporting Logbook*, BD04 commercial logbook). While catch data is collected through the logbooks, Unloaded Fish Notices are used to monitor quota utilisation (Department of Agriculture and Fisheries, 2021a) and the *Buyers Reporting Logbook* provides an accurate representation of the species-specific weights.

Historically, data collected through the commercial logbooks and the *Buyers Reporting Logbook* lacked symmetry (Table 4). This can be attributed to the historical reporting of numbers of individuals in previous iterations of the commercial logbook, and the subsequent need for the use of weight-conversion factors. In an active fishing environment, this often yielded overestimates in trip weights which may have produced larger discrepancies over the duration of the fishing season. Updates to commercial logbooks in 2014 transitioned the fishery to reporting weights, and these updates have greatly reduced the extent of this differential.

Within this fishery, Unloaded Fish Notices and the *Buyers Reporting Logbook* will remain the key mechanisms in monitoring within-season quota usage and documenting species-specific rates of harvest. However, improving the level of information collected through the logbooks and the real or near-real time monitoring of catch could yield benefits for the fishery. Examples of which include an improved capacity to link catch rates / species compositions with regional effort usage patterns and another avenue to verify catch/effort trends.

***Table 4.*** *Summary of harvest reported in both the Commercial Logbook (BD04) and Buyers Reporting Logbook (tonnes).N/A*

| Financial year | Commercial Logbook catch (tonnes) | Buyers Reporting Logbook catch (tonnes) |
|---|---|---|
| **2000-2001** | 330.31 | 243.86 |
| **2001-2002** | 389.15 | 262.38 |
| **2002-2003** | 390.70 | 282.58 |
| **2003-2004** | 606.96 | 266.61 |
| **2004-2005** | 1,035.06 | 367.12 |
| **2005-2006** | 1,253.95 | 286.21 |
| **2006-2007** | 1,482.73 | 284.02 |
| **2007-2008** | 1,428.62 | 317.41 |
| **2008-2009** | 1,411.31 | 355.64 |
| **2009-2010** | 1,324.90 | 354.60 |
| **2010-2011** | 1,458.20 | 386.87 |
| **2011-2012** | 1,001.37 | 328.71 |

| Financial year | Commercial Logbook catch (tonnes) | Buyers Reporting Logbook catch (tonnes) |
|---|---|---|
| **2012-2013** | 1,156.49 | 334.12 |
| **2013-2014** | 877.92 | 318.36 |
| **2014-2015** | 353.37 | 360.96 |
| **2015-2016** | 354.13 | 356.43 |
| **2016-2017** | 343.45 | 338.08 |
| **2017-2018** | 297.47 | 314.06 |
| **2018-2019** | 302.78 | 302.12 |
| **2019-2020** | 257.74 | 394.74 |

***Non-compliance***

QBFP and the quota-monitoring unit detect instances of non-compliance. These have identified a number of issues which affect the enforceability and effectiveness of the current management arrangements. Not all trips can be inspected, and as a result, there is a level of self-compliance about the correct weighing and reporting of catch. While this is not considered to be an issue of significance in the QSCF, the inability to monitor catch in real or near-real time remains an area of risk for most commercial fisheries operating in Queensland.

# 5 Summary & Recommendations

When the outcomes of the preliminary risk assessment and the secondary evaluation of likelihood (Table 3; Appendix 2) are taken into consideration, only the *target & byproduct species* ecological component was assigned a risk rating above low/intermediate. As these risks relate specifically to the take of these species, they will be better addressed through the whole-of-fishery harvest strategy. Accordingly, they will not be progressed to a Level 2 ERA.

The Level 1 ERA did identify a number of information gaps which contributed to a level of uncertainty and produced more conservative/precautionary risk evaluations. These issues are currently being addressed as part of the development of a fishery-specific harvest strategy, and will likely result in the refinement of a number of risk profiles. Going forward, the following recommendations may assist with this process and improve the level of understanding surrounding the risk posed to key species or species complexes. In some instances, a recommendation may be best addressed or progressed through the *Fisheries Queensland Monitoring and Research Plan*:

- Improve the level of information on the biology, stock structure, and status of key species; prioritising white teatfish, black teatfish and burrowing blackfish for sustainability assessments;
- Consider the need to conduct sustainability assessments for target species not managed under species-specific quotas (*i.e.* prickly redfish, curryfish). Based on the results of these assessments, examine the suitability or applicability of managing their take under species-specific TACC limits;
- Improve the level of understanding on catch composition in ‘Unspecified’ catch categories within the ‘Other Species’ management unit; and
- Obtain greater information on the cumulative fishing pressures (commercial, recreational and indigenous fishing) exerted on these species and gaining a better understanding of total fishing mortality.

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# 7 Appendices

*Appendix 1—Ecological Processes Preliminary Assessment*

*Appendix 2—Risk Ratings and Outputs*

# Appendix 1—Ecological Processes Preliminary Assessment

***Appendix 1A**—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 2019* (Great Barrier Reef Marine Park Authority, 2019) and Pears *et al.* (2012).

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

***Appendix 1B**—Ecosystem Processes Preliminary Assessment*

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

For the Level 1 ERA, each fishing activity was assigned a final risk score that corresponded with the maximum risk rating assigned in the preliminary assessment. If for example 'Predation' received a '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 QSCF.

| **Ecosystem Processes Category** | **Hand collection – Main activities of the fishery** | | | | | | | **Cumulative impacts** |
|---|---|---|---|---|---|---|---|---|
| | *Harvesting* | *Discarding* | *Contact without capture* | *Loss of fishing gear* | *Travel to/from fishing grounds* | *Disturbance due to presence in area* | *Boat maintenance and emissions* | **Other fisheries*** |
| *Sedimentation* | L | - | - | - | L | L | - | N/A |
| *Nutrient cycling / Microbial activity* | I | - | - | - | - | - | L | N/A |
| *Particle feeding* | - | - | - | - | - | - | - | N/A |
| *Primary production* | L/I | - | - | - | - | - | L | N/A |
| *Herbivory* | - | - | - | - | - | - | - | N/A |
| *Predation* | L/I | - | - | - | - | - | - | N/A |
| *Bioturbation* | I | - | - | - | - | - | - | N/A |
| *Detritivory* | L/I | - | - | - | - | - | - | N/A |
| *Scavenging* | - | - | - | - | - | - | - | N/A |
| *Symbiosis* | L | - | - | - | - | - | - | N/A |
| *Recruitment* | L/I | - | - | - | - | - | - | N/A |
| *Reef building* | L | - | - | - | - | L | - | N/A |
| *Competition* | L | - | - | - | - | - | - | N/A |
| *Connectivity* | L/I | - | - | - | L | L | L | N/A |
| *Outbreaks of disease* | - | - | - | - | L | L | L | N/A |
| *Species introductions* | - | - | - | - | L | L | L | N/A |
| **ECOSYSTEM PROCESSES (overall)** | I | - | - | - | L | L | L | N/A |

** Includes recreational, charter sectors, as well as other commercial fisheries harvesting the same species within Queensland waters*

# Appendix 2—Risk Ratings and Outputs

The primary objectives of the Level 1 ERAs 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. Preliminary risk ratings developed as part of the Risk Characterisation stage take into consideration the current fishing environment (*e.g.* catch, effort, and licensing trends) and risk factors associated with the current management regime (*e.g.* the potential for the transfer of additional effort to areas of high fishing mortality, increases in fishing mortality for key species, changing target species). Depending on the fishery, broader risk factors may also contribute to conservative risk ratings being assigned to ecological components. These preliminary ratings are precautionary/conservative in nature, provide a more holistic account of the risks posed by the fishery, and provide the Level 1 ERA with greater capacity to address the long-term consequences of a risk. Inherent trade-offs with this approach include the preliminary overestimation of the level of risk posed to an ecological component, or the representation of the potential risk, otherwise known as false positives.

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 QSCF. 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 Species** | • Key drivers of risk for this ecological component include an absence of sustainability assessments, and the potential for catch and effort to increase for one or more species under the current management regime, primarily within the 'Other Species' unit.<br>• While catch limits are in place for key species, these limits are not based on the outputs of a qualitative stock assessment. | *Black teatfish* – Intermediate / High | <u>*Likelihood*</u><br>• Preliminary risk ratings were likely influenced by the conservative nature of the methodology.<br>• Risks to this ecological component are linked to limited sustainability data available, and management limitations. | *Black teatfish* – Low / Intermediate |

| Ecological Component | Key Issues / Sources of Risk | Risk Characterisation (Preliminary rating) | Considerations of Likelihood and Mitigation Measures | Level 1 Risk Rating |
|---|---|---|---|---|
| | • A number of the risk management initiatives are based on a MoU and are not underpinned by legislation. Accordingly, operators are not under any direct obligation to adhere to these provisions.<br>• There is limited capacity for management to constrain catch in the 'Other Species' category outside of the MoU.<br>• There is a long-term risk that high amounts of effort could be targeted at a small number of species within the 'Other Species' management unit *e.g.* due to increased market demand.<br>• One or more species in the 'Other Species' management unit could, theoretically, be fished beyond sustainability reference points without the fishery exceeding the 308 tonne TACC limit. This could occur if market demand were to increase significantly for an individual species. | *White teatfish* – Intermediate / High<br>*Burrowing blackfish* – Intermediate / High<br>*Other species* – High | • These deficiencies and limitations are most prevalent in the 'Other Species' management unit.<br>• Management arrangements for the three remaining quota units are more advanced and include species-specific catch limits.<br>• It is recognised that risk ratings for the 'Other Species' management unit may still be an overestimate. However, the multi-species nature of the category combined with data deficiencies supported the adoption of a more conservative approach.<br><u>*Mitigation measures & considerations*</u><br>• While stock assessments have not been completed for key species, white teatfish, and burrowing blackfish are both deemed 'sustainable' by indicative sustainability evaluations (Roelofs, 2020; Roelofs *et al.*, 2020).<br>• Standing biomass estimates have also been collated for burrowing blackfish and black teatfish. The burrowing blackfish | *White teatfish* – Low / Intermediate<br>*Burrowing blackfish* – Intermediate<br>*Other species* - Intermediate / High |

| Ecological Component | Key Issues / Sources of Risk | Risk Characterisation (Preliminary rating) | Considerations of Likelihood and Mitigation Measures | Level 1 Risk Rating |
|---|---|---|---|---|
| | | | survey helped to establish the BFZs. The black teatfish survey was used to set a conservative (10% of standing biomass) TACC limit (Department of Agriculture and Fisheries, 2020b).<br>• A MSE was undertaken for the fishery in 2014 (Skewes *et al.*, 2014). This study found that the management system including measures enacted through the MoU, reduced the risk of overexploitation for most species, and the risk of localised depletion.<br>• Stock assessments have been prioritised for black teatfish and white teatfish as part of the harvest strategy development process. Further consideration will need to be given regarding the development of sustainability evaluations for other targeted species *e.g.* burrowing blackfish, prickly redfish, and curryfish.<br>• While not enforceable, the departure of industry from the MoU is considered unlikely in the short to medium term. This risk will reduce further with the | |

| Ecological Component | Key Issues / Sources of Risk | Risk Characterisation (Preliminary rating) | Considerations of Likelihood and Mitigation Measures | Level 1 Risk Rating |
|---|---|---|---|---|
| | | | introduction of a QSCF-specific harvest strategy.<br>• Development of a QSCF-specific harvest strategy has commenced. The harvest strategy will consolidate management arrangements currently applied through legislation, licence conditions, the MoU and the PMS. Once completed, the strategy will likely result in risk-score reductions for a number of the quota management units and/or facilitate fine-scale assessment of the risks posed to species in the 'Other Species' unit.<br>• As a hand collection fishery, there are few additional sources of fishing mortality due to negligible risks associated with bycatch and cryptic mortalities. Cumulative fishing pressures will also be less for this fishery. | |

| Ecological Component | Key Issues / Sources of Risk | Risk Characterisation (Preliminary rating) | Considerations of Likelihood and Mitigation Measures | Level 1 Risk Rating |
|---|---|---|---|---|
| **Bycatch (non-SOCC)** | • Interaction rates with non-target/bycatch species will be negligible due to the use of highly selective fishing apparatus, and opportunistic harvesting of all sea cucumber species.<br>• Limited discarding occurs in this fishery for the above reasons. | Negligible | *Likelihood*<br>• Negligible<br>*Mitigation measures & considerations*<br>• Further management of risk not viewed as necessary. | Negligible |
| **Species of Conservation Concern (SOCC)** | | | | |
| *Marine turtles* | • High spatial overlap between key fishing grounds and preferred habitats (GBR) but limited/no direct interactions with this SOCC subgroup.<br>• Indirect impacts (boat strike*, travel to/from fishing grounds,* and *disturbance due to presence in the area)* considered to be higher risk than direct impacts.<br>• Risks will vary with species size and relate more to post-interaction injuries and (potential) mortalities. Both of which are difficult to assess as the majority will involve *contact without capture* events. | Low | *Likelihood*<br>• Low to negligible<br>*Mitigation measures & considerations*<br>• Key risks will be applicable to most commercial fisheries, the recreational fishing sector and other marine-based activities.<br>• Management of this risk will be difficult through the management reform process as it is broader than the QSCF.<br>• Media encouraging best practice such as ensuring rubbish is disposed of correctly. | Low |

| Ecological Component | Key Issues / Sources of Risk | Risk Characterisation (Preliminary rating) | Considerations of Likelihood and Mitigation Measures | Level 1 Risk Rating |
|---|---|---|---|---|
| | | | • SOCI reporting will continue in this fishery and this subgroup will derive benefit from the GBR zoning plan.<br>• Further management of risk not viewed as necessary. | |
| *Dugongs* | • Risk profile will be similar that observed for marine turtles.<br>• Indirect impacts (boat strike, *travel to/from fishing grounds,* and *disturbance due to presence in the area*) considered to be higher risk than direct impacts.<br>• These (indirect) risks will be higher in inshore waters and areas where dugongs are likely to be found in higher densities.<br>• Interactions, while still negligible, are anticipated to be higher in the recreational fishing sector due to a larger number of participants. | Low | *Likelihood*<br>• Low to negligible<br>*Mitigation measures & considerations*<br>• Risk and mitigation measures similar to marine turtles.<br>• Further management of risk not viewed as necessary. | Low |
| *Cetaceans* | • Risk profile will be similar that observed for marine turtles and dugongs. | Low | *Likelihood*<br>• Low to negligible | Low |

| Ecological Component | Key Issues / Sources of Risk | Risk Characterisation (Preliminary rating) | Considerations of Likelihood and Mitigation Measures | Level 1 Risk Rating |
|---|---|---|---|---|
| | | | *Mitigation measures & considerations*<br>• Risk largely relates to non-fishing-related activities *e.g.* boat strike, *disturbance due to presence in the area, travel to/from fishing grounds.*<br>• Further management of risk not viewed as necessary. | |
| *Teleosts (protected / SOCI only)* | • Apparatus not suited to the targeting of teleosts. Interactions between operators and protected species are unlikely.<br>• Risk rating reflects the potential for these species to be disturbed if fishing in the immediate area, and will not result in any long-term implications. | Low | *Likelihood*<br>• Negligible<br>*Mitigation measures & considerations*<br>• Further management of risk not viewed as necessary. | Negligible |

| Ecological Component | Key Issues / Sources of Risk | Risk Characterisation (Preliminary rating) | Considerations of Likelihood and Mitigation Measures | Level 1 Risk Rating |
|---|---|---|---|---|
| *Batoids* | • Indirect interactions likely to occur with this subgroup within the immediately fished area.<br>• Interactions will not have a significant or long-term impact on the affected animals. | Low | *Likelihood*<br>• Low to negligible<br>*Mitigation measures & considerations*<br>• Risk rating reflects the potential for these species to be disturbed if fishing in the immediate area, and will not result in any long-term implications for this subgroup.<br>• While elasmobranchs (sharks and rays) will ingest holothurians (Jacobsen & Bennett, 2011), this prey is small and has no overlap with the cohorts being targeted by operators in the QSCF.<br>• Further management of risk not viewed as necessary. | Low |
| *Sharks* | • Indirect interactions likely to occur with this subgroup within the immediately fished area.<br>• Interactions will not have a significant or long-term impact on the affected animals. | Low | *Likelihood*<br>• Negligible<br>*Mitigation measures & considerations*<br>• Risk rating reflects the potential for these species to be disturbed if fishing in the | Negligible |

| Ecological Component | Key Issues / Sources of Risk | Risk Characterisation (Preliminary rating) | Considerations of Likelihood and Mitigation Measures | Level 1 Risk Rating |
|---|---|---|---|---|
| | | | immediate area, and will not result in any long-term implications for this subgroup.<br>• Rating for this subgroup is lower than batoids as there is less risk of direct interaction/disturbance.<br>• While elasmobranchs (sharks and rays) will ingest holothurians (Jacobsen & Bennett, 2011), this prey is small and has no overlap with the cohorts being targeted by operators in the QSCF.<br>• Further management of risk not viewed as necessary. | |
| *Sea snakes* | • No reported interactions and (if applicable) fishery is unlikely to impact significantly on regional populations.<br>• High spatial overlap between key fishing grounds and preferred habitats (GBR).<br>• Indirect impacts (*travel to/from fishing grounds,* and *disturbance due to presence in the area*) considered to be higher risk than direct impacts. | Low | *Likelihood*<br>• Low<br>*Mitigation measures & considerations*<br>• Continued SOCI reporting<br>• Best practice management and handling in place.<br>• Further management of risk not viewed as necessary. | Negligible |

| Ecological Component | Key Issues / Sources of Risk | Risk Characterisation (Preliminary rating) | Considerations of Likelihood and Mitigation Measures | Level 1 Risk Rating |
|---|---|---|---|---|
| *Crocodiles* | • Limited spatial overlap between key fishing grounds and preferred habitats (possibly in FNQ).<br>• Interactions with this subgroup are highly unlikely and infrequent. | Negligible | N/A | Negligible |
| *Syngnathids* | • Subgroup highly unlikely to interact with the hand collection apparatus. | Low | *Likelihood*<br>• Negligible<br>*Mitigation measures & considerations*<br>• Risk rating reflects the potential for these species to be disturbed if fishing in the immediate area, and will not result in any long-term implications for this subgroup.<br>• Fishery unlikely to have significant interactions with key habitat/substrate where this subgroup is most likely to be found. | Negligible |
| *Seabirds* | • No reported interactions and (if applicable) fishery is unlikely to impact significantly on regional populations. | Low | *Likelihood*<br>• Negligible<br>*Mitigation measures & considerations*<br>• Continued SOCI reporting | Negligible |

| Ecological Component | Key Issues / Sources of Risk | Risk Characterisation (Preliminary rating) | Considerations of Likelihood and Mitigation Measures | Level 1 Risk Rating |
|---|---|---|---|---|
| | • Direct interactions and (if applicable) mortalities unlikely to have a long-term impact on regional populations.<br>• Risks likely to be more relevant to diving species. Interactions with these species still unlikely in the QSCF. | | • Best practice management and handling in place.<br>• Further management of risk not viewed as necessary. | |
| *Terrestrial mammals* | • Negligible interactions or spatial overlap. | Negligible | N/A | Negligible |
| **Marine Habitats** | • Contact with marine habitat is highly localised and regional impacts may include increased turbidity/sediment resuspension, disturbance to the immediate area and dislocation of benthic communities.<br>• Cumulative impacts will be a risk for areas that attract higher levels of effort (*e.g.* key reefs), including general boating activities such as anchoring.<br>• Longer term impacts will be driven largely by the areas of high use and the cumulative (commercial and recreational) impacts. | Low | *Likelihood*<br>• Low risk overall, noting that there may be an increased general risk in high-effort areas, or areas where there is greater overlap between the commercial and recreational fishing sectors.<br>*Mitigation measures & considerations*<br>• Direct impacts of QSCF will be regionalised, temporary, and unlikely to result in significant or long-term damage to the surrounding ecosystem.<br>• The direct risks of fishing in the QSCF are also being managed through the use of a | Low |

| Ecological Component | Key Issues / Sources of Risk | Risk Characterisation (Preliminary rating) | Considerations of Likelihood and Mitigation Measures | Level 1 Risk Rating |
|---|---|---|---|---|
| | | | rotational harvest system (*e.g.* RHA and BFZ).<br>• Best practice methods of anchoring and mooring in the marine park are encouraged by GBRMPA. However, this issue will be compounded by cumulative impacts *i.e.* recreational fishing.<br>• Media encouraging best practice such as ensuring rubbish are disposed of correctly.<br>• Some fishers are part of the GBRMP Reef Guardian program that encourages best practice operation in the marine park.<br>• Further management of risk not viewed as a priority. However, this ecological component would benefit from the formalisation of rotational harvesting strategies currently enforced through the MoU. | |
| **Ecosystem Processes** | • Overexploitation is likely to result in reduced nutrient cycling, reef-building capacity, resilience to climate change, water quality, species richness, and | Intermediate | *Likelihood*<br>• Low / Intermediate<br>*Mitigation measures & considerations* | Low / Intermediate |

| Ecological Component | Key Issues / Sources of Risk | Risk Characterisation (Preliminary rating) | Considerations of Likelihood and Mitigation Measures | Level 1 Risk Rating |
|---|---|---|---|---|
| | reduced transfer of energy to higher trophic levels.<br>• Information on the extent of exploitation that will cause far-reaching negative impacts is unknown *e.g.* biomass reference points.<br>• Main sources of risk include *harvesting, disturbance due to presence in the area,* and potentially *travel to/from fishing grounds.* | | • Quotas limit the take of certain species (black and white teatfish, burrowing blackfish), but not all species (*e.g.* prickly redfish, curryfish).<br>• Effective management of the targeted stocks will help to minimise the risk posed to regional ecosystem processes.<br>• Mitigation measures in place including spatial closures, rotational harvesting, in-possession limits (recreational), limited licencing and a range of other initiatives instigated as part of the MoU.<br>• Risks may be higher in the recreational fishing sector due to a higher number of participants and more concentrated effort.<br>• Further management of risk not viewed as a priority. However, this ecological component would benefit from the formalisation of rotational harvesting strategies currently enforced through the MoU. | |