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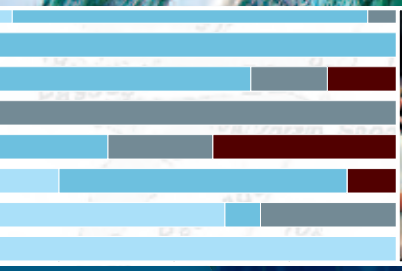
Great Barrier Reef Marine Park Authority

Ecological risk assessment of the

East Coast Otter Trawl Fishery

in the Great Barrier Reef Marine Park

Summary report 1



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Queensland Government

Queensland Seafood Industry Association
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Executive Summary

An ecological risk assessment of the East Coast Otter Trawl Fishery in the Great Barrier Reef Region was undertaken in 2010 and 2011. It assessed the risks posed by this fishery to achieving fishery-related and broader ecological objectives of both the Queensland and Australian governments, including risks to the values and integrity of the Great Barrier Reef World Heritage Area.

This was a comprehensive, robust and transparent assessment of the current fishery that used accepted standards and the latest scientific findings. The risks assessed included direct and indirect effects on the species caught in the Fishery as well as on the structure and functioning of the ecosystem. This ecosystem-based approach included an assessment of the impacts on harvested species, by-catch, species of conservation concern, marine habitats, species assemblages and ecosystem processes. In total, over 900 species, 10 habitat types, 16 assemblages and 14 ecosystem processes were considered in the assessment using a hierarchical process. The assessment also considered known external pressures (i.e. non-trawl fishery-related pressures such as modification of coastal ecosystems, degraded water quality and predicted climate change vulnerabilities), which may increase the susceptibility of an ecological component to the effects of trawling.

The assessment took into account current management arrangements and fishing practices at the time of the assessment. It also recognised that the ecosystem, which has been subject to multiple use for decades, is no longer pristine. The assessment was unusually well informed for an ecological risk assessment and captured a substantial range of published material as well as expert opinion from a diverse range of participants. This material included fishery-independent field studies, experimental manipulation of fishing activities to investigate impact and recovery of seabed species, modelling of the distributions of species, habitats and assemblages, and trophic interactions among the species groups affected by trawl fishing. Research and monitoring on harvested species, by-catch and protected species also informed the assessment. This broad body of knowledge provides a high degree of confidence that the findings about the remaining risk levels are robust.

The main findings of the assessment were:

- **Current risk levels from trawling activities are generally low.** Under current practices and 2009 effort levels the overall ecological risks from trawling in the Great Barrier Reef Region to harvested species and to the broader environmental values and integrity of the area are low, with most species, habitat types, species assemblages and ecosystem processes at low or intermediate-low risk from the Fishery (Figure 1). As trawl fishing effort has remained at similar levels over the period 2007 to 2011, the risk findings are still considered relevant in 2012 and it is unlikely overall ecological risks have changed from those reported here.

- **Some risks from trawling remain.** In particular, high risks were identified for 11 species of skates and rays and two species of sea snakes. The by-product species Balmain bugs (three species of lobsters in the genus *Ibacus*) were at intermediate-high risk. A poorly known upper continental slope habitat (90 to 300 m depth) in the southern Great Barrier Reef Region (that includes deepwater eastern king prawn fishing grounds) and the plant and animal communities occurring there were also assessed as at high risk.

  This particular upper continental slope habitat is not afforded the same levels of protection provided to other habitat types within the Region. In part, this level of protection is an artefact of the way the habitat boundary was defined for this assessment. About half of this area receives consistently high levels of trawl fishing effort. Additional ecological and biological information is required to more confidently assess the risks posed by the Fishery in this area.

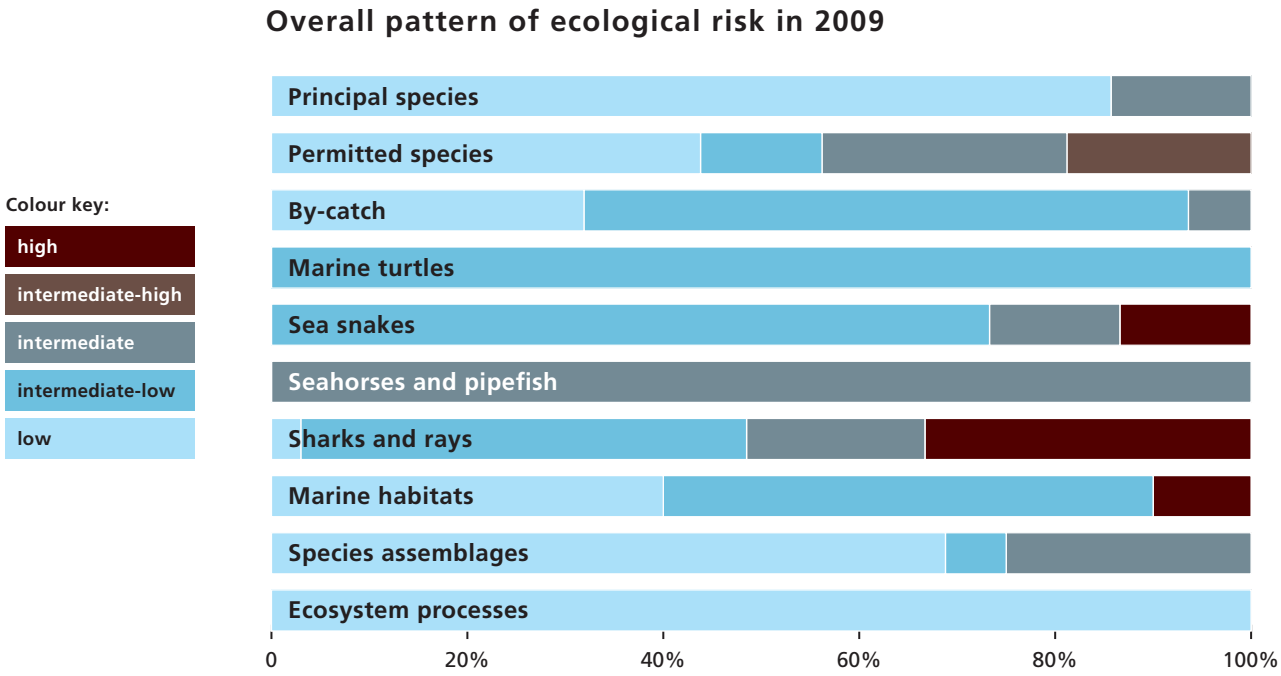


Figure 1. Overall ecological risk from activities of the East Coast Otter Trawl Fishery in the Great Barrier Reef Region.

The colour indicates the risk categories used (see colour key). Each bar is shaded to represent the proportion of species or types assigned to particular risk categories. The categories are explained in Section 3 and the contexts against which risk was assessed are defined in Section 4. The figure is based on trawl fishing effort data for 2009.

- **Risks from trawling have reduced in the Great Barrier Reef Region.** A comparison showed the overall ecological risk profile of the East Coast Otter Trawl Fishery was lower in 2009 compared to 2005 (Figure 2) as a result of a substantial reduction in trawl fishing effort over this period, principally in response to less favourable economic circumstances.
- **Trawl fishing effort is a key driver of ecological risk.** Risk may increase if fishing effort levels increase above those in 2009. Fishery management tools that actively manage effort within sustainable levels for each of the key trawl fishery sectors could provide a mechanism to control risks and impacts on harvested species and the environment.
- **Zoning has been important in reducing risks.** The protection afforded to the Great Barrier Reef Marine Park through zoning (particularly since rezoning in 2004) contributed to the relatively low ecological risks from the otter trawl fishery and is critical for protection of productive habitats, biodiversity conservation and maintaining ecosystem resilience.

  Trawling is allowed within 34 per cent, and currently occurs more than once per year in less than seven per cent, of the Great Barrier Reef Marine Park. Protection through zoning is an important measure which acts to limit spatial expansion of the Fishery and potential risk to the ecosystem.

Risk pattern for 2009 compared to 2005

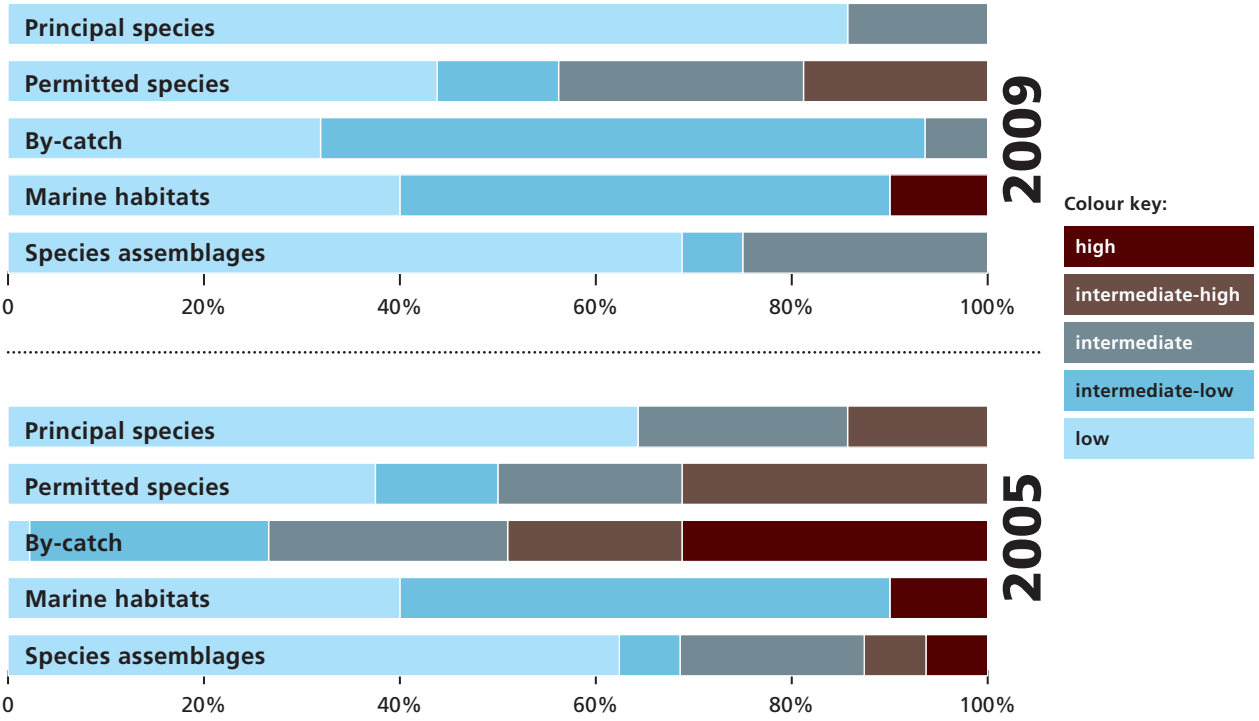


Figure 2. Comparison of overall ecological risk pattern at 2009 (top) and 2005 (bottom) trawl fishing effort levels, where data was available for both years.

The colour indicates the risk categories used (see colour key). Each bar is shaded to represent the proportion of species or habitat types assigned to particular risk categories.

The total annual trawl fishing effort in 2009 was over 40 per cent lower than in 2005, however 2005 levels were still allowable under management arrangements at the time of the assessment.

- **Reducing identified unacceptable risks requires a range of management responses.** Managers and industry will need to continue to work in partnership to prioritise and address the remaining risks. The assessment findings also validated other management actions implemented to address ecological sustainability concerns about trawling, and found that risks and impacts from trawling have been significantly reduced since the introduction of a management plan for the Fishery in 1999.
- **The commercial fishing industry is supportive and being proactive.** Positive steps have been, and are being, taken by trawl fishers to reduce the risks from trawling to the species, seabed communities and habitats of the Great Barrier Reef Region. For example, mandatory use of turtle excluder devices (TEDs) throughout the otter trawl fishery for the last decade has greatly reduced incidental catch of loggerhead turtles and other large animals such as sharks. The trawl industry is encouraged to continue to work with managers and researchers on further improvements and innovation in by-catch reduction devices (BRDs) and related efforts to further reduce the remaining risks for skates, rays and sea snakes in particular. Measures that improve the efficiency with which the catch is taken (such as better by-catch reduction measures) or reduce the Fishery's ecological impact also tend to have economic benefits for industry (e.g. improved product quality leading to higher market price or lower fuel usage).

- **Further reductions in trawl by-catch, high compliance with rules and accurate information from ongoing risk monitoring are important.** Risk monitoring would be assisted by improved reporting via logbooks, monitoring of discard levels and species composition through fishery observer programs and ongoing compliance programs. Measures to ensure adoption of best practice TEDs and BRDs throughout the Fishery and other related efforts to reduce remaining risks for species of conservation concern should be promoted.

  These are important for effective management of the Fishery, for any future re-evaluation of the ecological risks within the Great Barrier Reef Region and for public confidence in the sustainability of the Fishery.

- **Trawl fishing is just one of the sources of risk to the Great Barrier Reef.** Continuing to take positive actions to further improve trawl fishery management and practices is important for maintaining the resilience of the Great Barrier Reef, for which the overall outlook has recently been assessed as poor, in the light of serious threats, especially from climate change.

CONTENTS

SUMMARY REPORT

1. About the assessment

This **Summary Report** provides a condensed overview and the key findings of an ecological risk assessment of the East Coast Otter Trawl Fishery ('the Fishery') in the Great Barrier Reef Region undertaken in 2010 and 2011. A detailed **Technical Report** and accompanying **Data Report** from the assessment are available online at www.gbrmpa.gov.au.

1.1. Need for a contemporary ecological risk assessment

Both globally and in Australia, demersal trawling (on or near the seabed) has been a focus of concern for several reasons. Trawl fishing gear can have a severe and irreversible impact on seabed habitats. The small mesh used in prawn trawl gear also catches a wide variety of non-commercial species that are then discarded, often dead or with a low chance of survival. In the Great Barrier Reef Region other concerns have included the potential effects on the ecosystem from the extraction of groups such as filter feeders or detritivores (e.g. scallops, prawns) and top order predators (such as sharks), illegal fishing (e.g. in areas where trawling is prohibited) and the incidental catch of species of conservation concern (i.e. species protected by law or in need of special management such as marine turtles, sea snakes and sharks) (GBRMPA 2009).

A number of risks from trawling in the Great Barrier Reef Region (e.g. to marine turtles, habitats) have been substantially reduced through a variety of management responses by the Queensland and Australian governments and the fishing industry or external factors such as unfavourable economic conditions (GBRMPA 2009). Nevertheless, ensuring a healthy, resilient marine ecosystem that will support a viable and sustainable fishery into the future is an ongoing process. The ecological risk assessment reported here is the next step in that process.

A review of trawl fishery management arrangements was already under way in Queensland at the time of this assessment. This ecological risk assessment is intended to help management consider remaining risks and, where necessary, implement measures to mitigate any remaining risks posed by the Fishery. An opportunity (and need) to collate and synthesise a considerable amount of new knowledge about the marine environment resulting from a variety of research and monitoring projects is another reason why this assessment was undertaken.

1.2. The approach taken

The ecological risk assessment method chosen for this fishery was an established method and consistent with the current Australian Standard for Risk Management that treats risk as the risk of not meeting objectives. For the Fishery, this required that the questions addressed by the assessment were directed by relevant legislation and policy of the two key management agencies: the Department of Agriculture, Fisheries and Forestry Queensland (DAFF Queensland) and the Great Barrier Reef Marine Park Authority (GBRMPA).

The framework used is considered appropriate for fisheries operating in a World Heritage Area and Marine Park that have multiple-use objectives subject to the primary objective of long-term protection and conservation of the environment, biodiversity and heritage values of the Great Barrier Reef Region. A conventional examination of the risks to components of the ecosystem (e.g. species, habitats) was combined with a novel examination of the risks posed to ecosystem processes that link these components for the final broader view of potential ecosystem impacts from trawling.

The assessment took into account the current management arrangements for the Great Barrier Reef Marine Park and World Heritage Area, including those specific to the Fishery, particularly the extent to which these arrangements mitigate ecological risks. Should these arrangements change in the future, some of the risks may also change. The assessment, however, identifies and treats separately those factors that are affected by the Fishery (such as where fishing occurs and the types of fishing gear used) from intrinsic characteristics of the ecological component being assessed (such as the life history attributes of a species and the habitats in which it lives). Therefore, assessing the effects of changes to management arrangements would be relatively straightforward.

The approach taken encompasses all the components of the ecosystem at potential risk (Figure 3) and all sources of that risk (both direct and indirect) from trawling. The data used and the method followed are fully detailed in the two accompanying reports (Technical Report and Data Report). The application of the method was precautionary in that uncertainty was explicitly considered in the assessment and risk scores were rated higher when there was a critical lack of information.

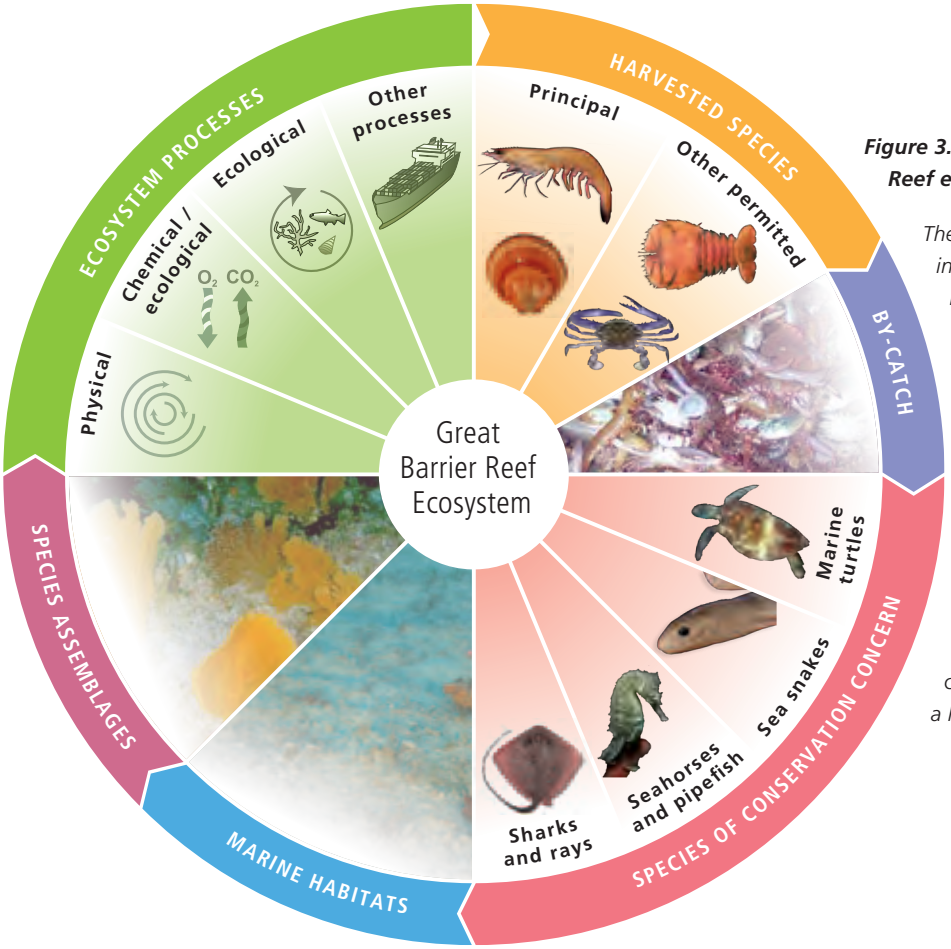


Figure 3. Overview of the Great Barrier Reef ecological components assessed

The risks assessed included direct and indirect effects on the species caught in the fishery as well as on the structure and functioning of the ecosystem. This ecosystem-based approach included an assessment of the impacts on harvested species, by-catch, species of conservation concern, marine habitats, species assemblages and ecosystem processes. In total, over 900 species, 10 habitat types, 16 assemblages and 14 ecosystem processes were considered in the assessment using a hierarchical process.

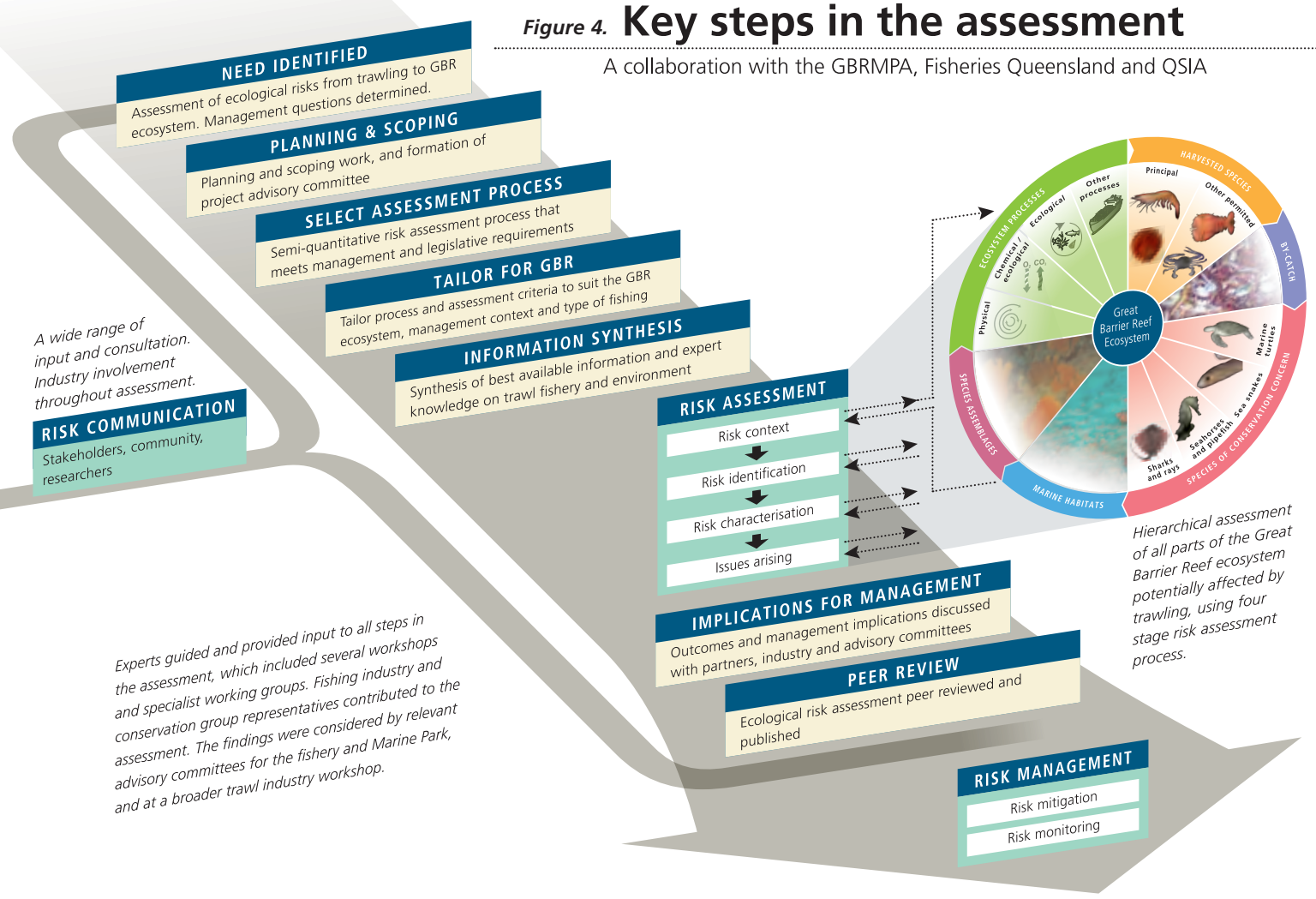
1.3. Undertaking the assessment

The GBRMPA, Fisheries Queensland within DAFF Queensland, and the Queensland Seafood Industry Association worked in partnership on the assessment. Expert advice was also incorporated into the assessment from other organisations, including Agri-Science Queensland in DAFF Queensland, Australian Institute of Marine Science, CSIRO, WWF, and trawl industry members.

The key steps in the assessment process are shown in Figure 4. Engagement of fishing industry and conservation organisation representatives was an important part of the assessment process. Several workshops were held and the assessment was presented to, and discussed with, the relevant advisory committees and at a broader trawl industry workshop convened by DAFF Queensland.

Figure 4. **Key steps in the assessment**

A collaboration with the GBRMPA, Fisheries Queensland and QSIA



2. Ecologically sustainable use of the Great Barrier Reef

The Great Barrier Reef Marine Park is vast but the coral reefs typically associated with this World Heritage-listed property only make up seven per cent of its area. There is a wide variety of other habitats, including muddy and open sandy areas, seagrass meadows, continental slope and deep oceanic habitats. The GBRMPA manages the Marine Park as a multiple-use marine park, in which reasonable uses (particularly tourism, fishing, recreation and shipping) are allowed so far as they are consistent with the main objective of long-term protection and conservation of the environment, biodiversity and heritage values of the Great Barrier Reef Region. A Zoning Plan, which sets out the areas where different activities can occur, is a key measure used to protect the ecosystem and its biodiversity, and manage potentially conflicting uses.

Trawling is restricted to the General Use Zone, which covers 34 per cent of the Marine Park, and only about seven per cent of the total area is trawled more than once per year (Grech and Coles 2011). The area examined in the assessment is the Great Barrier Reef Region. The Region's boundaries match those of the Great Barrier Reef Marine Park, except the Region also includes the areas around major ports.

The *Great Barrier Reef Outlook Report 2009* identified climate change and some remaining impacts from fishing among priority issues to be addressed to ensure the future of the Great Barrier Reef (GBRMPA 2009). This ecological risk assessment, and ongoing risk monitoring, will inform the next Outlook Report (to be completed in 2014), particularly regarding the level of any remaining impacts from fishing, and other assessment processes such as a current strategic assessment of the Great Barrier Reef World Heritage Area under national environmental law.

The whole East Coast Trawl Fishery (which includes both otter and beam trawling) is the largest commercial fishery in Queensland by both product catch weight and economic value. The fleet uses trawl nets designed to operate on or near the seabed targeting prawns, scallops, bugs and squid mainly over muddy, sandy or silty habitats and avoids coral reefs and other hard substrate habitats. Prawns made up 85 per cent of the retained catch by weight in 2010. Various incidentally captured by-product (permitted) species such as some species of fish, crabs, octopus and cuttlefish are also retained and marketed by the fleet.

Otter trawling, the subject of this report, accounts for about 95 per cent of the total retained trawl catch each year from the east coast of Queensland, with the remainder coming from coastal and estuarine beam trawling and fish trawling off southern Queensland.

The trawl fishery is directly managed by Fisheries Queensland in DAFF Queensland. In addition to fisheries legislation, fishing activities in the Great Barrier Reef Region are required to comply with Marine Park zoning and other environmental legislation. The operation of the Fishery has also been assessed against national ecological sustainability guidelines under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC) since 2004.

Along the Queensland east coast, there are several recognisable sectors within the otter trawl fishery (Figure 5): eastern king prawn (deep and shallow water); scallop (saucer and mud); tiger/endeavour and northern king prawns (including red-spot king prawn); and banana prawn. The trawl fleet has a high degree of mobility and boats frequently operate in more than one fishery sector throughout the year.

Fishing for prawns dates back to the mid-1880s in inshore waters of Queensland. Trawl fishing effort (i.e. in days fished) peaked in 1997 at a level more than twice that in 2005 and has since continued to decline (Figure 6).

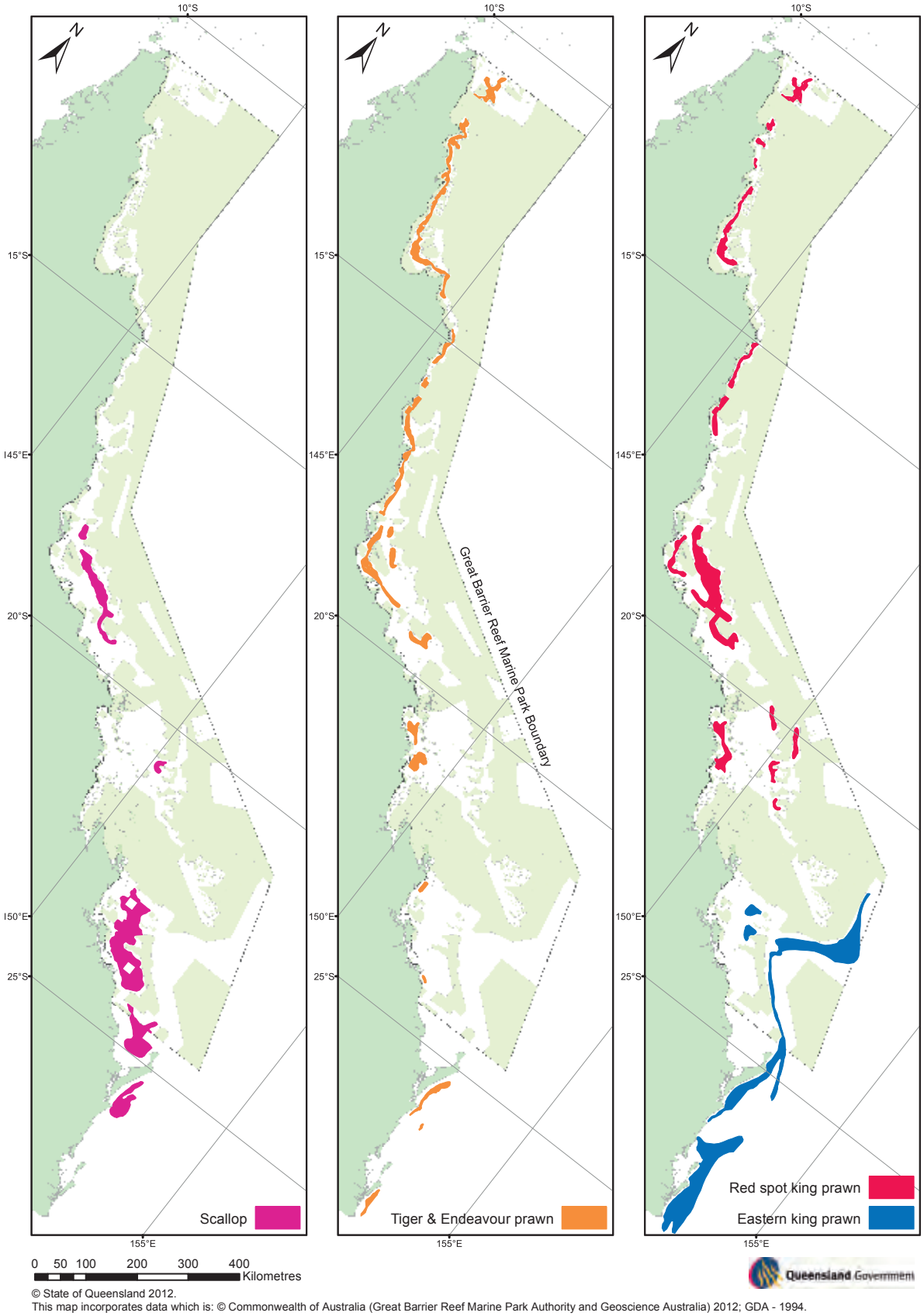
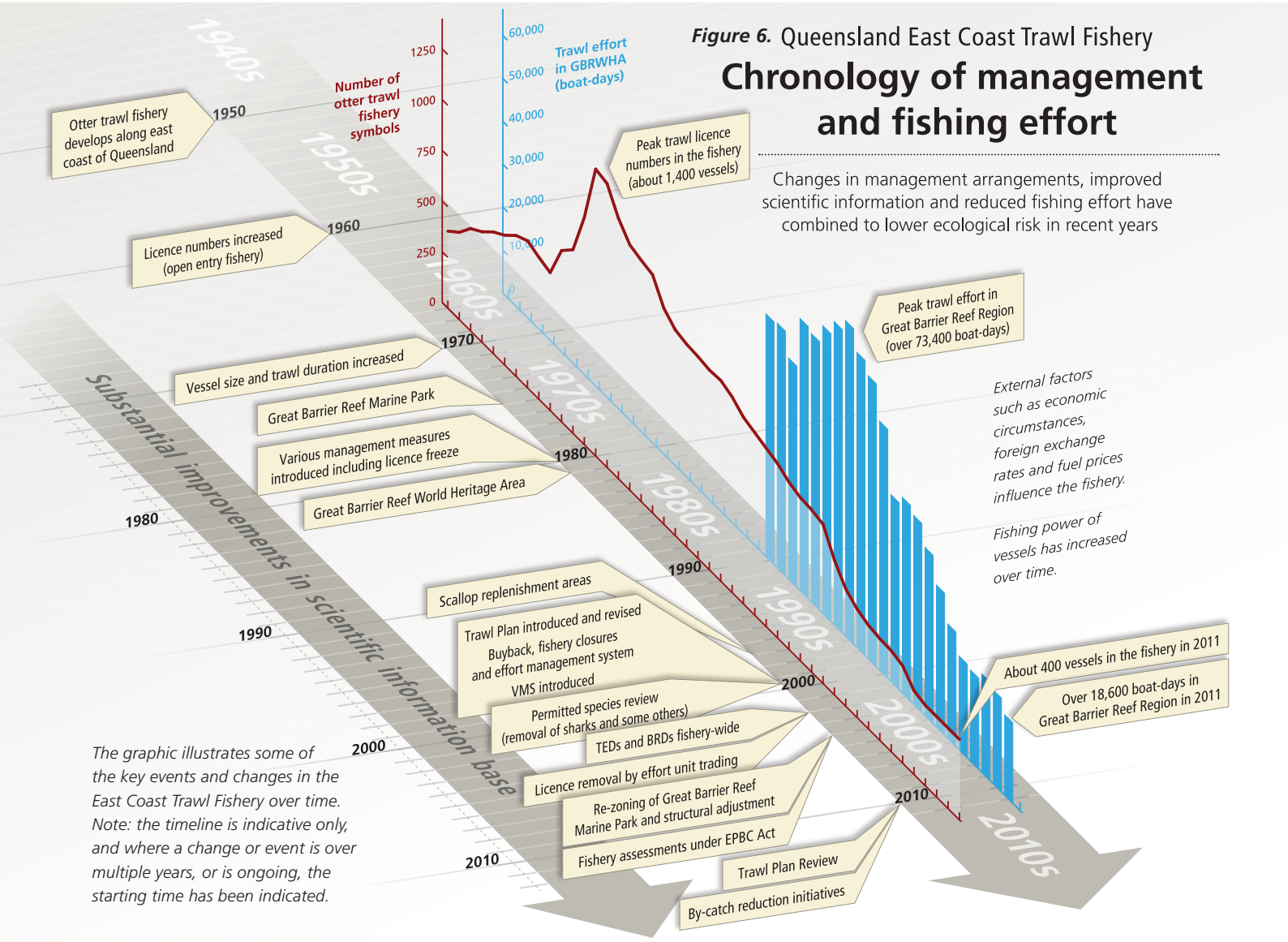


Figure 5. Fishing sectors in the East Coast Otter Trawl Fishery.

Light green areas of water are closed to trawling under Great Barrier Reef Marine Park zoning.

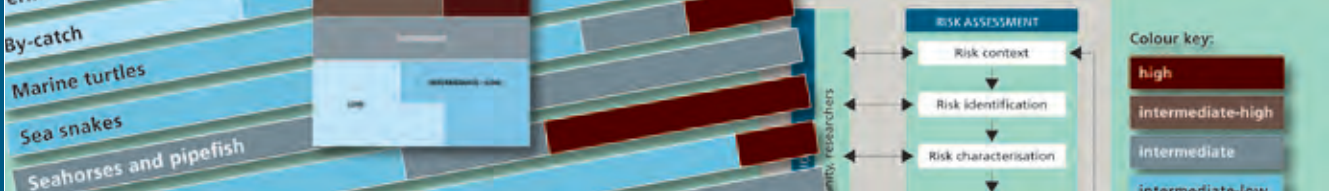
A management plan for the Fishery (the 'Trawl Plan') was first put in place in 1999, and a further review of fishery management arrangements is currently under way (in 2012). Over the last two decades a number of significant scientific projects focusing on the trawl fishery and its effects on seabed fauna and flora have been completed, increasing the knowledge base about the Fishery and its interactions with the Great Barrier Reef and adjacent environment.



The Trawl Plan adopted an effort management system (which includes 'effort units'), and includes restrictions on where and when fishing is allowed (through seasonal and spatial closures). There is, however, an increasing amount of surplus effort in the Fishery and approximately 40 per cent of the total effort units available within the Fishery were not used in 2010. In the period from 2007 to 2011, annual fishing effort remained at relatively low levels due to unfavourable economic conditions (e.g. high fuel prices combined with stagnant or declining prawn prices) and Commonwealth-funded licence buyouts associated with rezoning the Marine Park.

Turtle excluder devices (TEDs) and other types of by-catch reduction devices (BRDs) introduced in the Trawl Plan are mandatory for operators in the Fishery.

The ecological risk assessment is contributing to the reporting of remaining risks to the Great Barrier Reef ecosystem and ensuring trawl fishery management decisions are soundly based and seek to minimise ecological risks.



3. Risk analysis framework

3.1. Overview of methodology

Risk assessment is a key part of an overall process called risk analysis (Figure 7). Risk assessment is intended to provide insights about sources and levels of risk and their potential impacts. Risk management takes action to mitigate against these risks and undesirable outcomes, and monitors whether such action is effective. Risk communication occurs at all stages of a risk analysis between those doing the risk analysis and stakeholders. The latter both receive and provide information to all parts of the risk analysis.

This report (and the Technical and Data reports that it summarises) focused on risk assessment. The reports do not cover risk management or make recommendations about future management responses, as that responsibility rests with agencies in consultation with stakeholders.

Risk assessment consists of four stages – risk context, risk identification, risk characterisation and issues arising.

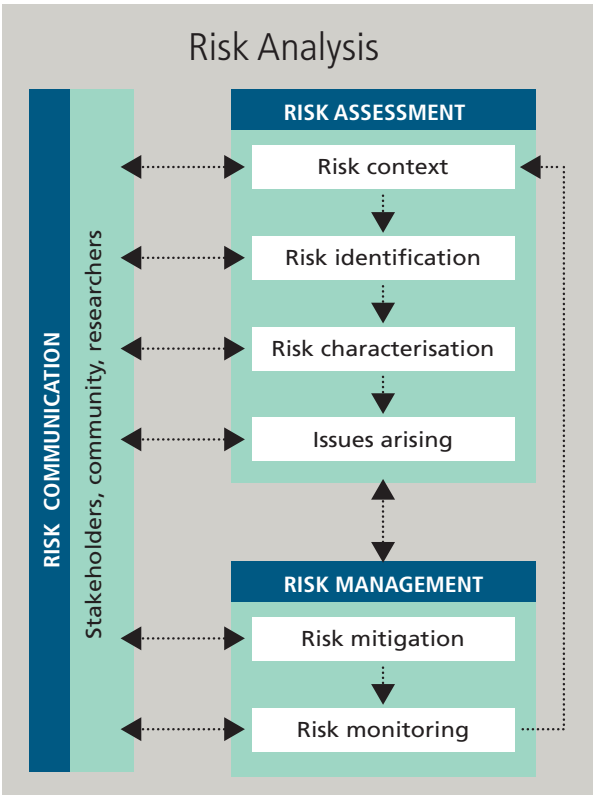


Figure 7. Risk analysis framework, which was developed by Astles and co-workers (2006).

Risk context – This stage defines the undesirable outcome from the activity of the fishery that is to be avoided, and the spatial and temporal extent of that outcome. The undesirable outcome is the consequence managers want to avoid or mitigate against. The Commonwealth *Great Barrier Reef Marine Park Act 1975* and the Queensland *Fisheries Act 1994* were considered in developing each risk context.

The risks assessed were to ecological components within the Great Barrier Reef Region over the next 20 years from interaction with otter trawling activities within and adjacent to this area, under current (2010) management arrangements and circumstances.

Risk identification – This stage categorises the ecological components of the Great Barrier Reef (e.g. habitat types, key species, ecosystem processes) and generates a list of the sources of risk from the fishery (e.g. harvesting, discarding, contact of any part of trawl gear with an ecological component (e.g. species, habitats) but which does not result in the ecological component being caught and landed on deck).

All ecological components and fishing activities that could interact with each other either directly or indirectly were identified.

Risk characterisation – This stage estimates the likelihood that the sources of risk identified in the previous stage will cause the undesirable outcome defined in the risk context. 'Risk characterisation' assigns a level of risk to each ecological component.

Risk characterisation involved a two-stage approach which first examined major sources of risk at a broad ecosystem level and then included a finer level assessment for ecological subcomponents (e.g. individual species or habitat types) that were determined to be potentially impacted by the fishery.

For the finer level assessment, risk characterisation considered traits which directly contributed to ecological sustainability of each component, and assessed each species or type in detail. Risk was assessed by considering two independent aspects (see Figure 8):

1. **Resilience:** the capacity of a subcomponent to resist or recover from disturbance, including fishing, based on intrinsic biological and/or ecological characteristics.
2. **Fishery impact profile:** the pressure exerted by the fishery on the subcomponent.

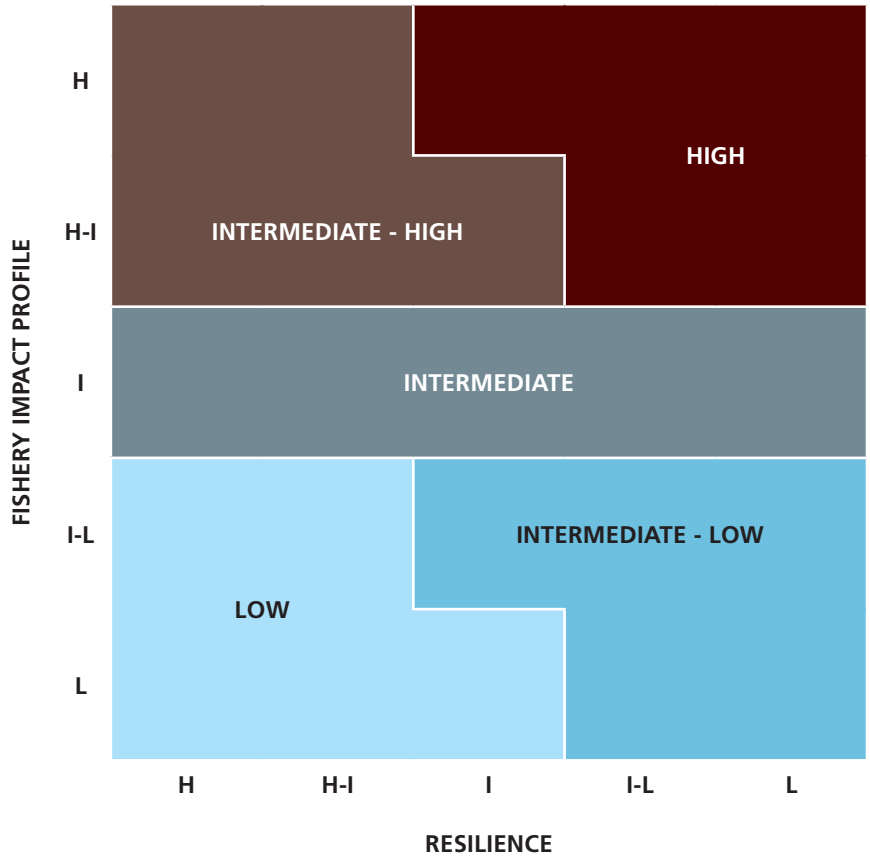


Figure 8. Risk matrix showing the relationship between risk and various levels of resilience and fishery impact profile.

For example, resilience characters used for harvested species included fecundity (ability to reproduce), life history strategy, distribution, and natural mortality. The fishery impact profile for harvested species was made up of factors that collectively indicate the level of pressure exerted by the Fishery on each species being assessed, such as catch levels, discard rates, gear selectivity, and overlap of fishing area with distributions of species. The risk context and additional sensitivities for particular components (e.g. species of conservation concern) were taken into account in scoring the resilience and fishery impact profile.

The ecological risk assessed was from direct or indirect interaction with the activities of the trawl fishery. However, the current assessment also considered known external pressures (i.e. non-trawl fishery-related pressures such as modification of coastal ecosystems or predicted climate change vulnerabilities) under a resilience character called 'cumulative pressures'. This character took account of any known external pressures that may increase the susceptibility of a subcomponent to the effects of trawling, and hence lower its resilience.

Issues arising – This stage considers the issues that managers and/or industry need to prioritise and address in order to reduce any unacceptable risks of an ecological component experiencing any undesirable consequences from the fishery. These issues are then fed into the separate risk management component of risk analysis.

The assessment included all marine ecological components (ranging from species, assemblages and habitats to ecosystem processes) that make up the Great Barrier Reef ecosystem and may be affected by trawling, and all of the activities that make up the operation of the Fishery in that area (from harvesting to presence of trawlers in an area). The risks assessed included direct and indirect effects on the species caught in the fishery, as well as on the structure and functioning of the ecosystem. This ecosystem-based approach included an assessment of the impacts on harvested species, by-catch, species of conservation concern, marine habitats, species assemblages and ecosystem processes. There is a high likelihood, therefore, that all significant risks were identified and assessed.

3.2. Information sources

The assessment was unusually well informed for an ecological risk assessment, and a full bibliography of over 180 scientific references is provided in the accompanying Technical Report. This wide range of published material and datasets used to inform the assessment included:

- Experiments on the impacts on, and recovery rates of, seabed species and habitat areas exposed to trawling in the Great Barrier Reef Region
- Results of a Great Barrier Reef seabed biodiversity project (the 'Seabed Biodiversity Project') that mapped the distribution of a broad range of seabed plants and animals and the habitats in which they live
- Analysis of the distribution of trawl fishing effort from a vessel monitoring system for the Fishery
- Information from fishers logbooks on the species composition, quantities and distribution of catches in the Fishery
- Research and monitoring of harvested species, by-catch and protected species
- Assessments (e.g. stock assessments, exploitation or stock status) for some harvested species in the Fishery
- Detailed data from observers on trawl vessels on the composition and levels of by-catch
- Results of experiments on the effectiveness of BRDs and TEDs, and surveys of current usage patterns across the fleet
- Findings from the development of ecosystem models of the Fishery
- Results of numerous scientific studies on many other aspects of the Great Barrier Reef ecosystem.

In addition, the project benefited from previous risk assessments, particularly work in NSW where the method was developed (DPI 2004, Astles et al. 2006, 2009, Astles 2010), and many other scientific studies on the ecological impacts of fisheries elsewhere in the world. Finally, and particularly where knowledge of some aspects had not been specifically investigated or reported, the project used the combined expertise of a range of participants before, during and after the two expert workshops, including marine scientists, fisheries managers, conservationists, and especially experienced operators in the Fishery whose collective knowledge gained from many years spent on the water was invaluable.

4. Main findings of the Ecological Risk Assessment

Each part of the assessment considered the direct effects from trawling on an ecological component (e.g. harvested species, marine habitats) over the next 20 years. Overviews of the consequences managers are seeking to avoid are provided on the summary page for each part of the assessment.

Indirect effects were considered under the assessments for the other relevant ecological components. For example, physical damage to habitats that support species is covered under marine habitats, and potential flow-on effects of harvesting to relevant processes such as detritivory, particle feeding or competition are covered under ecosystem processes.

The assessment identified the key issues that reduce or contribute to risk status, and detailed discussion of issues arising from the assessment and implications for management is provided in the Technical Report.

4.1. Harvested species

The risk assessed was:

What is the likelihood that the current activities of the Fishery within or adjacent to Great Barrier Reef waters will breach the relevant limit reference point or lead to any harvested species or populations in the Great Barrier Reef Marine Park being classified as overfished (= recruitment overfished) within the next 20 years?

All principal species and most of the other permitted species were assessed as resilient to fishery impacts. The resilience of some other permitted species was lower, and generally supports the use of low possession limits or other controls to discourage targeting and limit the total harvest of these species.

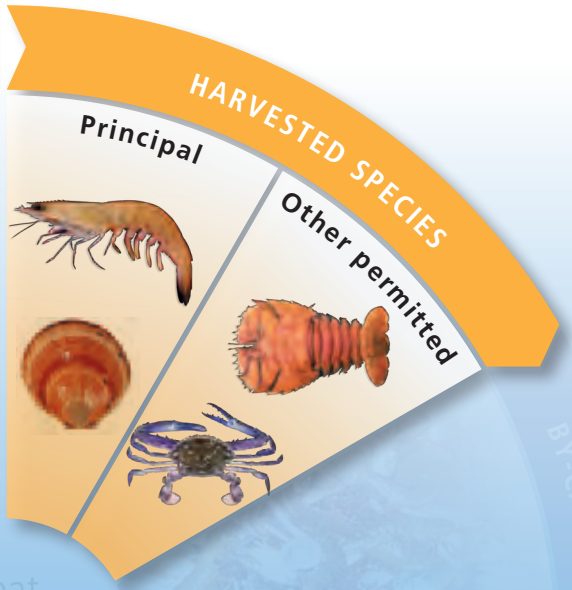
Based on 2009 trawl fishing effort levels, the fishery impact profile was low or intermediate-low for all principal species, except for grooved tiger prawn and Asian moon (mud) scallop, which were intermediate. The fishery impact profile of other permitted species varied from low to intermediate-high.

All but two principal species were at low risk from trawling and these two species (Asian moon scallop and grooved tiger prawn) were at intermediate risk (Table 1). Risk for other permitted species varied from a low to intermediate-high risk from trawling in the Great Barrier Reef (Table 2). Those at an intermediate-high risk level were the three species of Balmain bugs (lobsters in the genus *Ibacus*).

The assessment recognised that the range of current mitigation measures, and prior actions by management and industry, have helped to address historical risks and contributed to the relatively low risk to harvested species. Also, the comparatively low recent levels of fishing effort are a key factor in the current low levels of risk for many species; changes to effort levels may lead to changes in risk.

Several information gaps were identified for harvested species. The risks and information gaps identified in this assessment will inform the priorities for future research, monitoring and assessment.

Summary: Harvested species



Key facts

Ecological component assessed: Principal (target) species and other permitted species. All harvested species were assessed in detail because the fishery interacts significantly with each of these species.

Ecological role: These fishery species fulfil diverse ecological roles across a range of habitats. For example, scallops are particle feeders and prawns are detritivores. Harvested species are exposed to, or involved in, many ecosystem processes (e.g. predation).

Trawl fishery: Several prawn species, scallops, Moreton Bay bugs and squid are target species of the fishery. Various other species (e.g. some fish, three-spotted crabs, octopus and cuttlefish) are also retained for market.

RISK ASSESSMENT FOR THE GREAT BARRIER REEF REGION

Consequences to avoid over the next 20 years: Excessive depletion of any harvested species (indicated by breaching the relevant limit reference point or any harvested species being classified as recruitment overfished). The aim is to ensure they continue to fulfil their ecological roles, support ecosystem processes and are able to provide seafood products into the future.

The direct ways trawling activities could cause excessive depletion of harvested species over a 20-year period, if risks are not managed:

Harvesting	By reducing the biomass and spawning stock of populations of harvested species to below sustainable levels
Discarding	By adding another source of fishery-induced mortality to a population
Contact without capture	By collective damage to individuals of harvested species without capturing them

OVERALL PATTERN OF RISK AT 2009 LEVELS OF TRAWL FISHING EFFORT

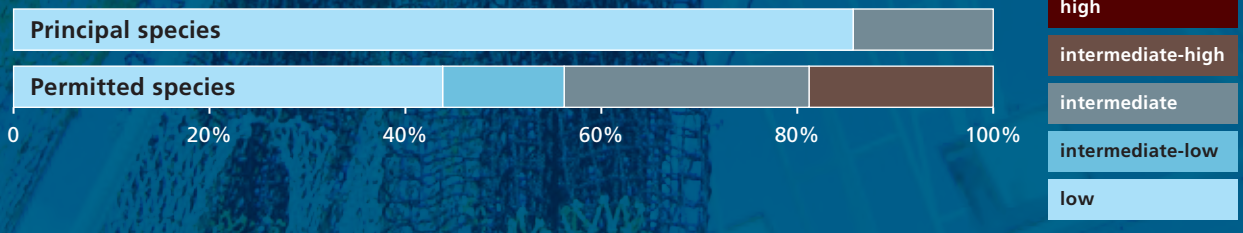


Table 1. Risk assessment of principal species using 2009 trawl fishing effort levels.

Common name	Resilience	Fishery impact profile	Risk
Asian moon (mud) scallop	H	I	INT
Grooved tiger prawn	H	I	INT
Moreton Bay bug/spotted legs (reef bugs)	H-I	I-L	LOW
Moreton Bay bug (mud bugs)	H-I	I-L	LOW
Black tiger prawn	H	I-L	LOW
Blue-legged king prawn	H	I-L	LOW
Brown tiger prawn	H	I-L	LOW
False endeavour prawn	H	I-L	LOW
Red-spot king prawn	H	I-L	LOW
Tropical saucer scallop	H	I-L	LOW
Eastern king prawn	H-I	L	LOW
Squid spp. (pencil & tiger)	H-I	L	LOW
White banana prawn	H-I	L	LOW
Blue endeavour prawn	H	L	LOW

Table 2. Risk assessment of other permitted species using 2009 trawl fishing effort levels.

Common name	Resilience	Fishery impact profile	Risk
Deepwater bug (velvet Balmain bug)	H-I	H-I	INT-HIGH
Shovel-nosed lobster (honey Balmain bug)	H-I	H-I	INT-HIGH
Smooth bug (garlic Balmain bug)	H-I	H-I	INT-HIGH
Slipper lobsters	I-L	I	INT
Red champagne lobster (barking crayfish)	I	I	INT
Mantis shrimp	H-I	I	INT
Threadfin bream (pinkies)	H-I	I	INT
Hammer octopus	I-L	I-L	INT-LOW
Red-spot night octopus	I	I-L	INT-LOW
Cuttlefish	H-I	I-L	LOW
Scribbled night octopus	H-I	I-L	LOW
Southern star-eyed octopus	H-I	I-L	LOW
Plain-spot octopus	H	I-L	LOW
Veined octopus	H	I-L	LOW
Blue swimmer crab	H-I	L	LOW
Three-spotted crab (red-spotted crab)	H	L	LOW

4.2. By-catch species

The risk assessed was:

What is the likelihood that the current activities of the Fishery within or adjacent to Great Barrier Reef waters will exceed the ability of the species to renew themselves, such that populations of by-catch species in the Great Barrier Reef Marine Park are no longer maintained or no longer fulfil their ecosystem role or are excessively depleted within the next 20 years?

The risks from trawling were assessed in detail for the 45 by-catch species or species groups at highest potential risk from the Fishery. These by-catch species included 33 ray-finned fish, eight crustaceans, three bivalves and a sea pen. These were selected from a list of over one thousand species based on the results of other studies or whether they had particular ecological, social, economic or cultural interest.

Resilience of by-catch species ranged from low to high with most (36 species or species groups) having intermediate-low or intermediate values. Fishery impact profiles were mostly low (17 species or species groups) and intermediate-low (25 species or species groups), with the remainder (three species or species groups) at the intermediate level.

Based on the trawl fishing effort in 2009, overall risks for by-catch were also mostly low (13 species or species groups) and intermediate-low (29 species or species groups), with the remainder (three species or species groups) at the intermediate level (Table 3). The three by-catch species assessed as at intermediate risk from trawling were fish: the tufted sole, whipfin ponyfish and longfin silverbiddy. In this assessment, no trawl by-catch species in the Great Barrier Reef Region were at high or intermediate-high risk based on 2009 fishing effort levels.

The risk from trawling for each of the many hundreds of additional species that are caught as trawl by-catch (but were not shortlisted for detailed assessment) are likely to be low to negligible at 2009 effort levels. This is because they were assessed to be at low to negligible risk by a previous quantitative assessment of sustainability based on 2005 trawl fishing effort levels (Pitcher et al. 2007), which were over 40 per cent higher than in 2009. However, there may be unrecognised risks for some rare species for which there were insufficient data to make an assessment.

The use of TEDs and BRDs, areas closed to trawling, and industry stewardship initiatives have all contributed to the low overall risk profile for by-catch. Nevertheless, it was recognised that further reduction in by-catch levels would have benefits for the environment as well as industry. Measures that improve the efficiency with which the catch is taken (such as better by-catch reduction measures) or reduce the Fishery's ecological impact also tend to have economic benefits for industry (e.g. improved product quality leading to higher market price or lower fuel usage) (Roy and Jebreen 2011).

Trawl effort is a key driver of ecological risk for by-catch species, so implementing future fishery management arrangements that can control the amount of fishing effort could help to ensure risks for by-catch species remain low. It is also important that future management arrangements for the Fishery and the Great Barrier Reef Marine Park have appropriate flexibility to encourage and support innovation in by-catch reduction.

Summary: By-catch species

Key facts

Ecological component assessed: Species caught and landed on deck but then discarded (not including any harvested species or species of conservation concern). The detailed assessment focused on the 45 most at-risk by-catch species, which were identified through a shortlisting process based on current understanding of the exposure of species to risk from activities of the fishery.

Ecological role: Part of biodiversity of Great Barrier Reef ecosystem. Fulfil various ecological roles and help sustain ecosystem processes such as herbivory, predation, connectivity and competition.

Trawl fishery: By-catch species in the trawl fishery comprises hundreds of species, many of which are caught very infrequently.

RISK ASSESSMENT FOR THE GREAT BARRIER REEF REGION

Consequences to avoid over the next 20 years: By-catch species being no longer able to renew themselves (indicated by populations no longer being maintained, no longer able to fulfil their ecosystem role, or being excessively depleted). The impact of the fishery on these species should avoid excessively reducing their spawning and recruitment ability and avoid other serious detrimental effects.

The direct ways trawling activities could exceed the ability of by-catch species to renew themselves over a 20-year period, if risks are not managed:

Discarding	By reducing the population size of by-catch species to below sustainable levels
Contact without capture	By collective damage to individuals of by-catch species without capturing them

OVERALL PATTERN OF RISK AT 2009 LEVELS OF TRAWL FISHING EFFORT

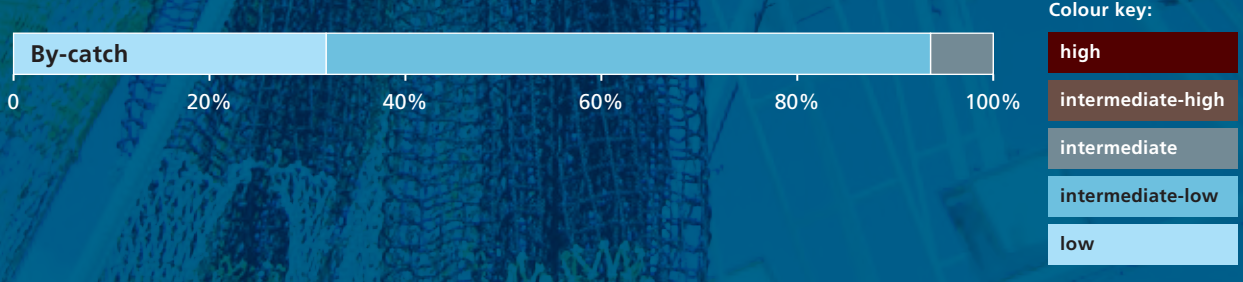


Table 3. Risk assessment for by-catch species using 2009 trawl fishing effort levels.

Common name*	Resilience	Fishery impact profile	Risk
Tufted sole	I-L	I	INT
Whipfin ponyfish	I-L	I	INT
Longfin silverbiddy	I	I	INT
Trumpeter whiting	L	I-L	INT-LOW
Rough flutemouth	I-L	I-L	INT-LOW
Small sea snail	I-L	I-L	INT-LOW
Blotched javelin	I-L	I-L	INT-LOW
Largescale saury (brushtooth lizardfish)	I-L	I-L	INT-LOW
Hairy crab (Family Pilumnidae)	I-L	I-L	INT-LOW
Sea pen	I-L	I-L	INT-LOW
Personifer angelfish	I-L	I-L	INT-LOW
Pineapple fish	I-L	I-L	INT-LOW
Damselfish sp.	I-L	I-L	INT-LOW
Pearly-finned cardinal fish	I	I-L	INT-LOW
Shortfin saury (short-finned lizardfish)	I	I-L	INT-LOW
Hairfin goby	I	I-L	INT-LOW
Longnose stinkfish	I	I-L	INT-LOW
Flathead dragonet	I	I-L	INT-LOW
Ochreband goatfish	I	I-L	INT-LOW
Hardback shrimp (penaeid shrimps)	I	I-L	INT-LOW
Razorfish	I	I-L	INT-LOW
Australian threadfin	I	I-L	INT-LOW
Naked-headed catfish	I-L	L	INT-LOW
Australian halibut	I-L	L	INT-LOW
Prickly leatherjacket	I-L	L	INT-LOW
Spotted-fin tongue-sole	I-L	L	INT-LOW
Splendid ponyfish	I-L	L	INT-LOW
Purse crab (Family Leucosiidae)	I-L	L	INT-LOW
Yellowfin tripodfish	I-L	L	INT-LOW
Blacktip tripodfish (long-nosed tripodfish)	I-L	L	INT-LOW
Hermit crab	I-L	L	INT-LOW
Bivalve sp.	I-L	L	INT-LOW
Sea snail	H-I	I-L	LOW
Orangefin ponyfish	H-I	I-L	LOW
Swimming crab (Family Portunidae)	H-I	I-L	LOW
Pygmy leatherjacket	H-I	I-L	LOW
Largescale grunter (banded grunter)	H-I	I-L	LOW
Fourlined terapon	H	I-L	LOW
Spinycheek grunter	I	L	LOW
Blunt-toothed crab	I	L	LOW
Family Glycymerididae	I	L	LOW
Bivalve sp.	I	L	LOW
Swimming crab (Family Portunidae)	I	L	LOW
Sunrise goatfish (sulphur goatfish)	H-I	L	LOW
Sea snail	H	L	LOW

** Scientific names are provided in the Technical Report, see Table 7 in Section 4.3*

4.3. Species of conservation concern

The risk being assessed was:

What is the likelihood that the current activities of the Fishery within or adjacent to Great Barrier Reef waters will exceed the level of interaction which is acceptable for the species of conservation concern in the Great Barrier Reef Marine Park within the next 20 years?

The first stage in the assessment considered all protected species and sharks and rays encountered in the Great Barrier Reef Region, however only those species that were potentially impacted by the Fishery were included in the detailed assessment. On this basis, four groups were identified for detailed assessment: marine turtles, sea snakes, seahorses and pipefish, and sharks and rays. In contrast, dugongs, whales and dolphins were initially considered but were regarded as have negligible direct interactions with trawling and direct impacts were not assessed further. Discards from trawling make up part of the diet of some seabirds and may influence the breeding success and hence population sizes of these species, but this scavenging was considered as part of the assessment of ecosystem processes.

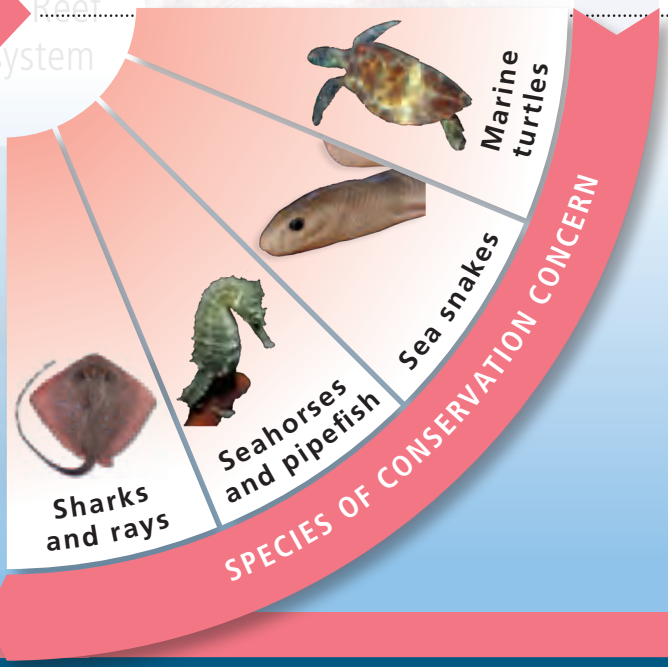
MARINE TURTLES

For all six species of marine turtles that were assessed, their resilience was low, and the fishery impact profile was also either low (one species) or intermediate-low (five species). Hence, the overall risk was assessed as intermediate-low (Table 4). The use of TEDs is considered to have reduced the numbers of turtles landed on deck 100-fold and arrested the decline in nesting loggerhead turtles, which has been important for marine turtle conservation. However, other non-trawl pressures (e.g. incidental capture in international longline fishing gear, ingestion of marine debris, coastal development, depredation of mainland nests by foxes, increased incidence of disease, potential climate change effects on nesting populations and severe weather events) are still of concern for their recovery (Johnson and Marshall 2007, Limpus 2008, GBRMPA 2009, 2011). Therefore, ensuring the level of trawl impacts on marine turtles is minimised as far as practical, and that TEDs continue to be as effective as possible, are considered ongoing priorities for management.

Table 4. Risk assessment of marine turtles.

Common name	Resilience	Fishery impact profile	Risk
Flatback turtle	L	I-L	INT-LOW
Green turtle	L	I-L	INT-LOW
Hawksbill turtle	L	I-L	INT-LOW
Leatherback turtle	L	I-L	INT-LOW
Loggerhead turtle	L	I-L	INT-LOW
Olive ridley turtle	L	L	INT-LOW

Summary: Species of conservation concern



Key facts

Ecological component assessed: Species of conservation concern include species protected by law and all sharks and rays. Four groups were identified for detailed assessment following an initial assessment of the levels of interactions with the fishery: marine turtles, sea snakes, seahorses and pipefish, and sharks and rays.

Ecological role: Part of biodiversity of Great Barrier Reef ecosystem. Fulfil various ecological roles and help sustain ecosystem processes such as herbivory, predation, connectivity and competition.

Trawl fishery: Some species that interact with the fishery are protected by law or require special management, and these additional sensitivities were considered in the risk assessment.

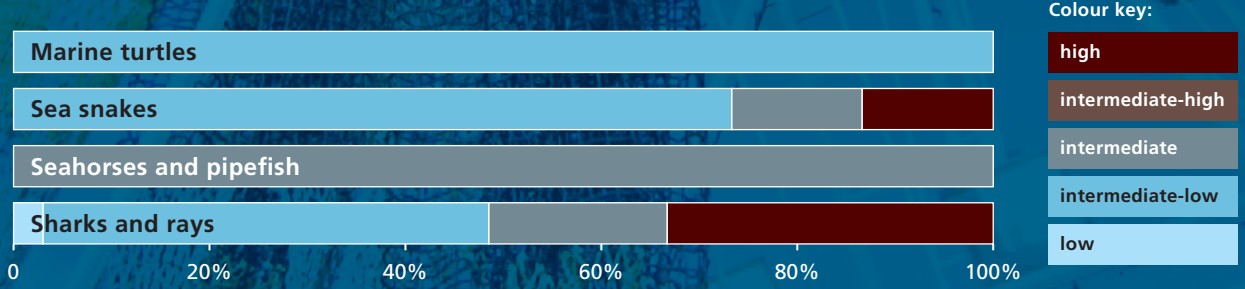
RISK ASSESSMENT FOR THE GREAT BARRIER REEF REGION

Consequences to avoid over the next 20 years: An unacceptable interaction level with species of conservation concern (indicated by exceeding acceptable levels of interaction determined by scientists and/or the community).

The direct ways trawling activities could lead to an unacceptable impact on species of conservation concern over a 20-year period, if risks are not managed:

Harvesting	Unlikely to contribute to such outcomes (except possibly for pipefish which are harvested)
Discarding	By adding a source of mortality which could compromise the ability of depleted populations to recover, cause declines in populations and/or exceed levels of human-induced mortality considered acceptable to the community. Also by providing additional food sources that may increase populations of some species.
Contact without capture	By collective damage to individuals without capturing them
Travel to/from grounds	By disturbing or interfering with some of these species, leading to loss of fitness and longer term population declines
Disturbance due to presence in area	By disturbing or interfering with some of these species, leading to loss of fitness and longer term population declines

OVERALL PATTERN OF RISK



SEA SNAKES

Fifteen species of sea snakes were assessed and, although their resilience was either low (three species) or intermediate-low (12 species), the fishery impact profiles varied from low (six species), through intermediate-low (five species) and intermediate (two species) to high-intermediate (two species). The overall risk therefore also varied from intermediate-low (11 species) through intermediate (two species: spectacled sea snake *Disteira kingii* and the small-headed sea snake *Hydrophis macdowelli*) to high (two species: the elegant sea snake *Hydrophis elegans* and the ornate reef sea snake *H. ornatus*) (Table 5). The Fishery still had a substantial interaction with sea snakes at the time of the assessment, largely because of overlaps between sea snake species distributions and trawl fishing effort in specific areas (Courtney et al. 2010). Reducing these risks to sea snakes from trawling had already been recognised as a high priority by scientists, managers and industry, and a program of further mitigation has occurred since this risk assessment. This assessment has reinforced the need for implementing measures to mitigate these risks, particularly by ensuring use of effective BRDs in specific sectors. In 2011, Fisheries Queensland supplied each otter trawl licence holder with 12 'fisheye' BRDs free of charge to facilitate adoption of this effective BRD.

Table 5. Risk assessment of sea snakes.

Common name	Resilience	Fishery impact profile	Risk
Elegant sea snake	L	H-I	HIGH
Ornate reef sea snake	I-L	H-I	HIGH
Spectacled sea snake	L	I	INT
Small-headed sea snake	I-L	I	INT
Stokes' sea snake	L	I-L	INT-LOW
Horned sea snake	I-L	I-L	INT-LOW
Olive-headed sea snake	I-L	I-L	INT-LOW
Large-headed sea snake	I-L	I-L	INT-LOW
Beaked sea snake	I-L	L	INT-LOW
Dubois' sea snake	I-L	L	INT-LOW
Spine-tailed sea snake	I-L	L	INT-LOW
Olive sea snake	I-L	L	INT-LOW
Spine-bellied sea snake	I-L	L	INT-LOW
Turtle-headed sea snake	I-L	L	INT-LOW
Yellow-bellied sea snake	I-L	L	INT-LOW

SEAHORSES AND PIPEFISH

Two species of seahorses, three species of pipefish and a species of pipehorse were assessed. Both seahorses were assessed as having intermediate-low resilience and an intermediate fishery impact profile, producing an intermediate overall risk rating. The resilience of the pipefish and pipehorse was assessed as either low (two species) or intermediate-low (two species), producing an overall risk rating of intermediate for all four species (Table 6). Individuals of these species are potentially vulnerable to trawling because they have very low survival after capture and BRDs are ineffective at excluding seahorses and pipefish. The information base for these species is quite limited and further research or fishery observer information on their distribution and levels of discarding would improve future risk assessments.

Table 6. Risk assessment of seahorses and pipefish.

Common name	Resilience	Fishery impact profile	Risk
Straightstick pipefish	L	I	INT
Tiger pipefish	L	I	INT
Queensland seahorse	I-L	I	INT
Highcrown seahorse	I-L	I	INT
Bentstick pipefish	I-L	I	INT
Pallid/Hardwick(e)'s pipehorse	I-L	I	INT

SHARKS AND RAYS

The resilience levels for the 33 species of sharks and rays assessed were either low (20 species), intermediate-low (12 species) or high-intermediate (one species). The fishery impact profile of sharks and rays varied from low (eight species), through intermediate-low (eight species), intermediate (six species), high-intermediate (five species) to high (six species). The overall risk rating also varied from low (one species), intermediate-low (15 species), intermediate (six species) to high (11 species) (Table 7). These 11 species at high risk from the Fishery included a shovelnose ray, a coffin ray, three species of stingrays, two species of stingarees, three species of skates and a butterfly ray (from the scientific families Rhinobatidae, Hypnidae, Dasyatidae, Urolophidae, Rajidae and Gymnuridae).

Sharks and rays comprise a relatively minor component of the Fishery by-catch but are not uncommon (Courtney et al. 2007, Kyne 2008). Species at high risk were believed to have habitat associations with sandy and soft sediment habitats also used as trawl grounds. Improvements to the design and deployment of BRDs should be further investigated to improve the effectiveness of the devices at excluding smaller individuals and those that have a flattened body form (i.e. skates and rays). In addition to BRD improvements, there may be other ways to reduce interactions with sharks and rays, or improve survival rates (e.g. avoiding particular times or locations or improving handling protocols). Estimates of survival rates after interactions with the Fishery would also improve confidence in future risk assessments.

Fishers are encouraged to work with the resource managers and researchers to develop new and innovative BRDs and to improve the performance of existing devices to further reduce the remaining risks for skates, rays and sea snakes in particular.

Table 7. Risk assessment of sharks and rays.

Common name	Resilience	Fishery impact profile	Risk
Common stingaree	L	H	HIGH
Bluespotted maskray	I-L	H	HIGH
Speckled maskray	I-L	H	HIGH
Pale tropical skate	I-L	H	HIGH
Argus skate	I-L	H	HIGH
Endeavour skate	I-L	H	HIGH
Coffin ray	L	H-I	HIGH
Blackspotted whipray	L	H-I	HIGH
Patchwork stingaree	L	H-I	HIGH
Australian butterfly ray	L	H-I	HIGH
Eastern shovelnose ray	I-L	H-I	HIGH
Blue-grey carpet shark	L	I	INT
Narrow sawfish	L	I	INT
Green sawfish	L	I	INT
Brown whipray	L	I	INT
Eastern banded catshark	I-L	I	INT
Australian weasel shark	I-L	I	INT
Whitecheek shark	L	I-L	INT-LOW
Whitespotted guitarfish or eyebrow wedgefish	L	I-L	INT-LOW
Estuary stingray	L	I-L	INT-LOW
Tasselled wobbegong	I-L	I-L	INT-LOW
Spotted wobbegong	I-L	I-L	INT-LOW
Sliteye shark	I-L	I-L	INT-LOW
Milk shark	I-L	I-L	INT-LOW
Spinner shark	L	L	INT-LOW
Pink whipray	L	L	INT-LOW
Reticulate whipray	L	L	INT-LOW
Bleeker's variegated whipray	L	L	INT-LOW
Leopard whipray	L	L	INT-LOW
Mangrove whipray	L	L	INT-LOW
Cowtail stingray	L	L	INT-LOW
Banded eagle ray	L	L	INT-LOW
Grey carpetshark	H-I	I-L	LOW

4.4. Marine habitats

The risk assessed was:

What is the likelihood that the current activities of the Fishery within or adjacent to Great Barrier Reef waters will result in serious or irreversible damage to the habitat type such that the habitat type is not able to maintain viable populations, biodiversity, assemblages and/or ecosystem processes in the Great Barrier Reef Marine Park within the next 20 years?

Trawling principally occurs in the continental shelf areas away from coral reefs, and some trawling also occurs on the continental slope. Detailed information on where trawl fishing effort has occurred in the Fishery was examined to determine the areas used by the Fishery. The habitat types of the Great Barrier Reef that at least partially overlap with the Fishery were assessed in detail (Figure 9 and Figure 10).

Ten habitat types were assessed: nine of these habitat types were identified by the Seabed Biodiversity Project (Pitcher et al. 2007) and one was defined by this assessment to cover an area in the southern Great Barrier Reef Marine Park in depths between about 90 and 300 m that is mainly associated with the deepwater eastern king prawn fishery.

Marine habitat types*

Habitat 1: the most barren seabed type, almost entirely bare and bioturbated**, with almost no biogenic habitat (i.e. of living origin).

Habitat 2: very bare seabed, with some bioturbation and little epibenthos or algae.

Habitat 3: patches of sessile epifauna and algae, separated by bare seabed.

Habitat 4: similar to habitat 3, with more algae including *Halimeda* and seagrass.

Habitat 5: mostly bioturbated** and bare seabed with very sparse algae, seagrass and sessile epifauna.

Habitat 6: high seagrass and algal cover, with some epifaunal patches, bioturbated** and bare seabed.

Habitat 7: patchy seagrass and algae, interspersed with bare seabed.

Habitat 8: *Halimeda* banks with other algae, sparse epifauna, and bare patches.

Habitat 9: patchy algae, with some bioturbation, sparse epifauna and bare seabed.

Habitat 10: upper continental slope 90–300 m deep off the southern Great Barrier Reef, with no detailed knowledge.

* *More detailed descriptions are provided in Section 4.5.2 of the Technical Report.*

** *Bioturbation involves biologically reworking sediments during burrow construction and feeding and bioirrigation (mixing of solutes) leading to the mixing of oxygen-bearing waters into sediments.*

Summary: Marine habitats

Key facts

Ecological component assessed: Ten seabed habitat types of the Great Barrier Reef Marine Park with which the fishery potentially interacts. Habitats 1 to 9 are in shelf areas of less than 100 metres, and habitat 10 occurs on the upper continental slope (in depths of 90–300 m).

Ecological role: Populations of all species in the wild, including fishery species, depend on suitable habitats for their survival.

Trawl fishery: Trawling has physical impacts on habitats and can remove or damage seabed plants and animals.

RISK ASSESSMENT FOR THE GREAT BARRIER REEF REGION

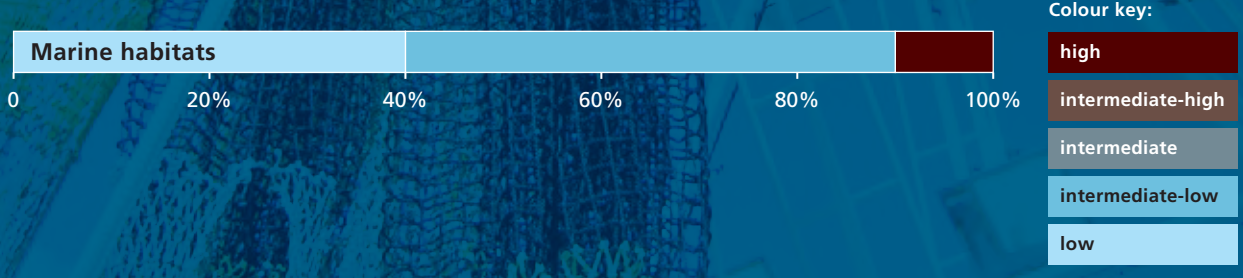
Consequences to avoid over the next 20 years: Serious or irreversible damage to the habitat type (such that the habitat type is not able to maintain viable populations, biodiversity, assemblages and/or ecosystem processes).

Habitat protection is an important part of providing for the long-term protection of the Great Barrier Reef and maintenance of World Heritage values and integrity.

The direct ways trawling activities could lead to serious or irreversible damage to habitats over a 20-year period, if risks are not managed:

Discarding	By removing structural habitat elements such as sponges, which are subsequently discarded, or by translocating plants and animals
Contact without capture	By direct physical damage to marine plants and animals on the seabed. Also by altering the vertical relief of seabed features and/or redistributing sediments.
Loss of fishing gear	By localised smothering effects on small areas of habitat
Boat maintenance, emissions	By potential impacts on marine plants and animals from any local contamination of the water column and the seabed with toxic chemicals

OVERALL PATTERN OF RISK AT 2009 LEVELS OF TRAWL FISHING EFFORT



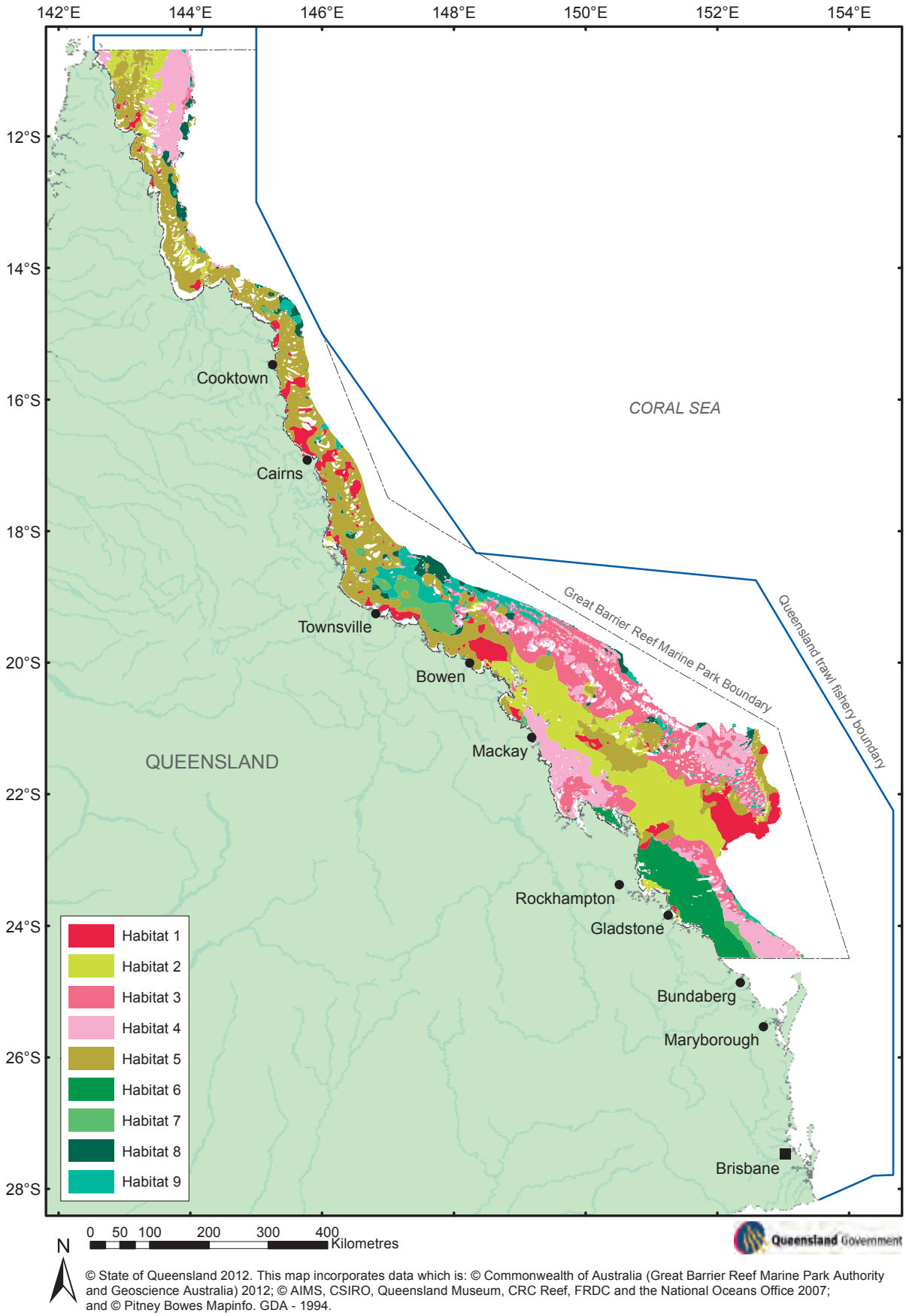


Figure 9. Map of predicted distribution of habitat types 1 to 9 in the Great Barrier Reef Marine Park (Pitcher et al. 2007).

The estimated resilience of the habitats varied and ranged from low to high. The fishery impact profiles also varied and were assessed as low (seven habitats), intermediate-low (two habitats) or high (one habitat). The overall risk rating varied from low (four habitats), intermediate-low (five habitats) to high (one habitat) (Table 8).

The habitat estimated to be at high risk was the newly defined deepwater habitat which had not been mapped in previous research. Its high risk rating was precautionary due to the lack of knowledge about this area. About half of this area receives consistently high levels of trawl fishing effort. This deepwater habitat is known to support species such as champagne lobster, Balmain bugs, skates and rays as well as the target eastern king prawns, and differs from shallower seabed communities. However, little is known about the broader distribution, biology and abundance of many of these deepwater species. Additional ecological and biological information is required to more confidently assess the risks posed by the Fishery in this area.

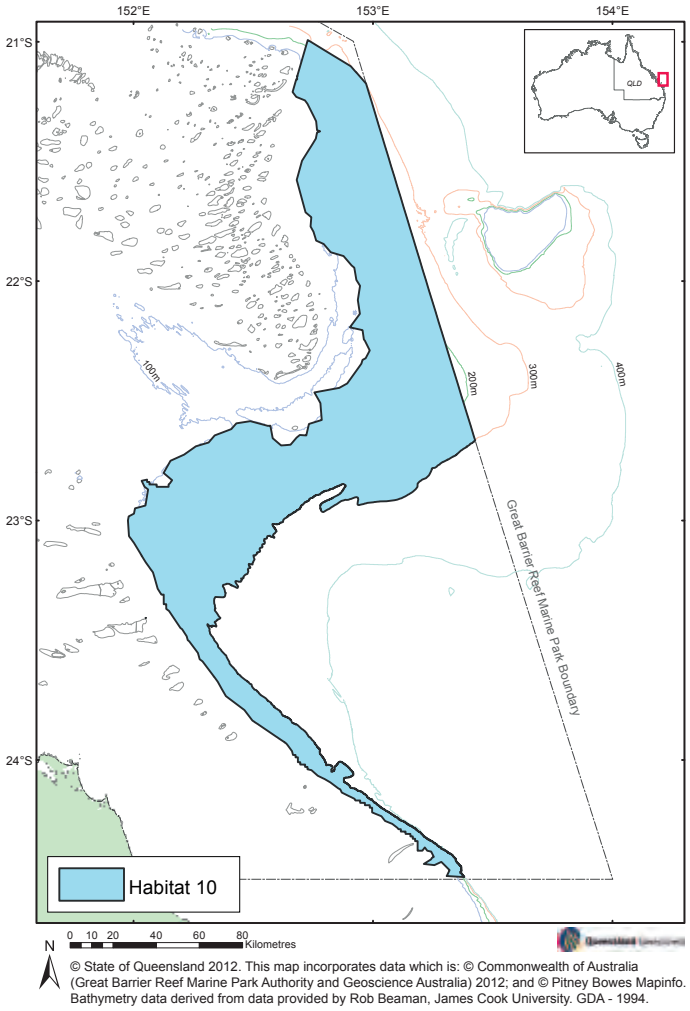


Figure 10. Map showing habitat 10 in the southern Great Barrier Reef Marine Park.

For other habitats, assessments have been informed by robust information on their distributions and knowledge from experiments on the impacts of trawling and recovery rates in the Great Barrier Reef Region. The generally positive findings reflect the full suite of management arrangements for the Fishery in the Great Barrier Reef Region including protected area management and very fine scale data on the distribution of fishing effort.

Table 8. Risk assessment of marine habitats using 2009 trawl fishing effort levels.

Habitat type	Resilience	Fishery impact profile	Risk
Habitat 10	L	H	HIGH
Habitat 6	I	I-L	INT-LOW
Habitat 7	I	I-L	INT-LOW
Habitat 3	L	L	INT-LOW
Habitat 8	L	L	INT-LOW
Habitat 9	I-L	L	INT-LOW
Habitat 4	H-I	L	LOW
Habitat 1	H	L	LOW
Habitat 5	H	L	LOW
Habitat 2	H	L	LOW

4.5. Species assemblages

The risk assessed was:

What is the likelihood that the current activities of the Fishery within or adjacent to Great Barrier Reef waters will result in serious or irreversible damage to species assemblages such that the assemblage type is not able to maintain viable populations, biodiversity and/or ecosystem processes in the Great Barrier Reef Marine Park within the next 20 years?

The assemblage components that were assessed comprised the 16 site-based species assemblages defined by the Seabed Biodiversity Project. A map of the species assemblages is provided in the accompanying Technical Report (Figure 23 in Section 4.6). The resilience of these assemblages was assessed as ranging from intermediate-low (three assemblages), through intermediate (four assemblages), high-intermediate (four assemblages), to high (five assemblages). The fishery impact profiles were assessed as low (12 assemblages) or intermediate (four assemblages). The current overall risk was assessed as low (11 assemblages), intermediate-low (one assemblage) or intermediate (four assemblages) (Table 9). Assemblages and habitats pose more challenges for risk assessments than the other ecological components because their species composition, location and abundances may change over time and their constituent elements have different impact and recovery rates. Analyses of which sectors of the Fishery are contributing to trawl effort for each of the assemblages at intermediate risk would provide a better understanding of fishing impacts and risks in future assessments.

Table 9. Risk assessment of species assemblages using 2009 trawl fishing effort levels.

Assemblage type	Resilience	Fishery impact profile	Risk
Assemblage 12	I-L	I	INT
Assemblage 13	I-L	I	INT
Assemblage 4	H-I	I	INT
Assemblage 1	H	I	INT
Assemblage 7	I-L	L	INT-LOW
Assemblage 11	I	L	LOW
Assemblage 16	I	L	LOW
Assemblage 5	I	L	LOW
Assemblage 9	I	L	LOW
Assemblage 6	H-I	L	LOW
Assemblage 10	H-I	L	LOW
Assemblage 14	H-I	L	LOW
Assemblage 15	H	L	LOW
Assemblage 2	H	L	LOW
Assemblage 3	H	L	LOW
Assemblage 8	H	L	LOW

Summary: Species assemblages

Key facts

Ecological component assessed: 16 species assemblages (often more commonly called 'communities'), which are groups of species that tend to occur together.

Ecological role: The association of species in an assemblage is likely to be ecologically important to the functioning and integrity of the ecosystem, even though the nature of any linkages may not be well understood.

Trawl fishery: Species assemblages represent an intermediate level of complexity between individual species (whether harvested, by-catch or species of conservation concern) and the more general level of ecosystem processes.

RISK ASSESSMENT FOR THE GREAT BARRIER REEF REGION

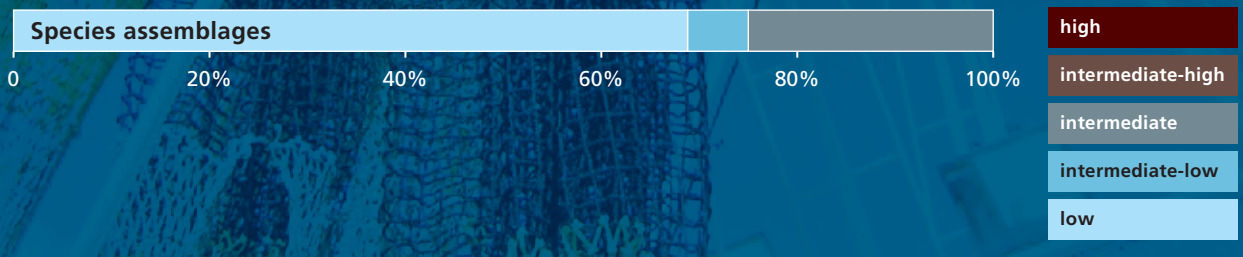
Consequences to avoid over the next 20 years: Serious or irreversible damage to species assemblages (such that the assemblage type is not able to maintain viable populations, biodiversity, and/or ecosystem processes).

An ecosystem-based approach to the management of trawling requires consideration of risks to all aspects of the ecosystem that the fishery might pose a risk to, such as species assemblages.

The direct ways trawling activities could lead to serious or irreversible damage to species assemblages over a 20-year period, if risks are not managed:

Harvesting	By impacts on the relative abundance of species in assemblages via removal of harvested species
Discarding	By impacts on the relative abundance of species in assemblages via death of species landed on the deck of the boat and then discarded
Contact without capture	By physical damage to marine plants and animals on the seabed, or the key structural habitat elements on which they depend
Loss of fishing gear	By localised smothering effects on assemblages in small areas
Boat maintenance, emissions	By potential impacts on marine plants and animals from any local contamination of the water column and the seabed with toxic chemicals

OVERALL PATTERN OF RISK AT 2009 LEVELS OF TRAWL FISHING EFFORT



4.6. Ecosystem processes

The risk assessed was:

What is the likelihood that the current activities of the Fishery within or adjacent to Great Barrier Reef waters will cause serious or irreversible change to ecosystem processes such that the fishery resources and fish habitats, environment, biodiversity or heritage values of the Great Barrier Reef Marine Park are degraded or exposed to an unacceptable risk within the next 20 years?

Ecosystem processes are the physical, chemical, ecological and other processes that underpin the functioning and health of the entire Great Barrier Reef ecosystem. These processes are all interconnected and the overall health of the ecosystem requires that no natural functions are impaired. The ecosystem processes are also the mechanisms which influence the distribution and abundance of organisms, the habitats in which they occur and by which components of an ecosystem are linked or interact.

A suite of 14 ecosystem processes was chosen for evaluation including physical processes (sediment resuspension), biological/ecological processes (nutrient cycling/microbial processes, connectivity, predation, bioturbation, particle feeding, primary production, herbivory, detritivory, scavenging, symbiosis, reef building, competition) and one other process (species introductions). Only processes on which trawling would have a potential impact were included.

The resilience of these processes were assessed as intermediate (three processes), high-intermediate (seven processes) or high (four processes). The fishery impact profile was assessed as low to negligible (10 processes) or intermediate-low (four processes) at the scale of the whole Great Barrier Reef, but may be higher in fished areas for some processes. The overall risk was assessed as low (14 processes) (Table 10).

Table 10. Risk assessment of ecosystem processes.

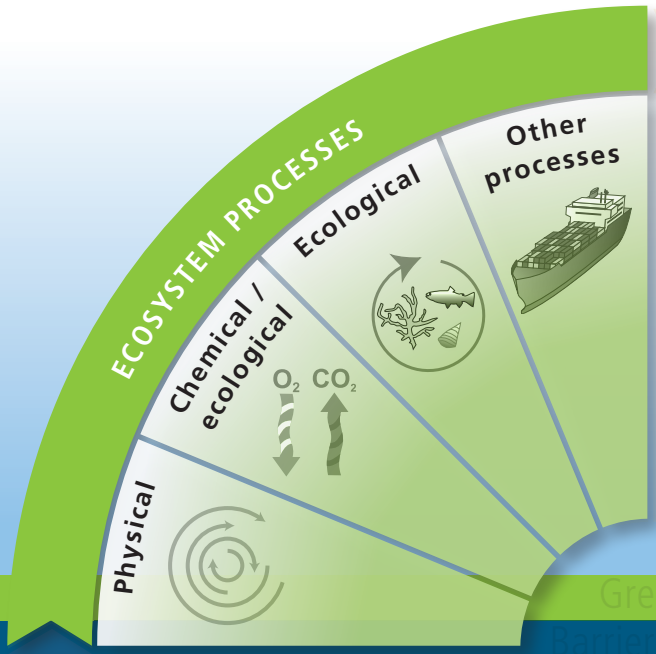
Ecosystem process	Resilience	Fishery impact profile	Risk
Nutrient cycling and microbial processes	H-I	I-L	LOW
Particle feeding	H-I	I-L	LOW
Connectivity	H-I	I-L	LOW
Detritivory	H	I-L	LOW
Primary production	I	L	LOW
Reef building	I	L	LOW
Species introductions	I	L	LOW
Predation	H-I	L	LOW
Bioturbation	H-I	L	LOW
Herbivory	H-I	L	LOW
Scavenging	H-I	L	LOW
Competition	H	L	LOW
Sediment resuspension	H	L*	LOW
Symbiosis	H	L*	LOW

** The fishery impact profiles for sediment resuspension and symbiosis were assessed as low to negligible; therefore these two processes should not be included in any future reassessments.*

The risk assessments for ecosystem processes are inherently more uncertain than those for other components and deriving measures of any of these processes is also a difficult task. The finding that there are no high risks posed by otter trawling to any of the processes considered is encouraging and is consistent with there being relatively few species, habitats or assemblages that were found to be at high risk from the Fishery in the Great Barrier Reef Region.

The approach adopted in this assessment has previously been used in NSW fisheries but, as far as we are aware, the impacts on the full suite of potentially impacted ecosystem processes have not previously been considered as part of a formal ecological risk assessment for any fishery.

Summary: Ecosystem processes



Key facts

Ecological component assessed: 14 ecosystem processes, which are physical, chemical, ecological and other processes that underpin the functioning of the Great Barrier Reef ecosystem.

Ecological role: Ecosystem processes are the mechanisms which influence the distribution and abundance of organisms, the habitats in which they occur and by which components of an ecosystem are linked or interact.

Trawl fishery: Processes on which trawling could have a potential impact were included as part of the assessment of risks from trawling to the ecosystem.

RISK ASSESSMENT FOR THE GREAT BARRIER REEF REGION

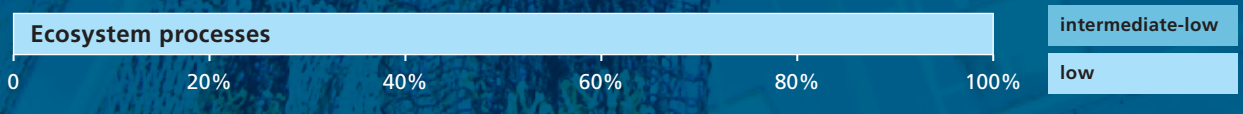
Consequences to avoid over the next 20 years: Serious or irreversible change to ecosystem processes (such that fishery resources and fish habitats, environment, biodiversity or heritage values of the Great Barrier Reef Marine Park are degraded or exposed to an unacceptable risk).

An ecosystem-based approach to the management of trawling requires consideration of risks to all aspects of the ecosystem that the fishery might pose a risk to, such as ecosystem processes.

The ways trawling activities could lead to serious or irreversible change to ecosystem processes over a 20-year period, if risks are not managed:

Harvesting	By impacts on the relative abundance of species via removal of harvested species. Also by other flow-on effects from removal of individuals such as nett loss of nutrients from ecosystem or changes to connectivity or predation processes.
Discarding	By impacts on the relative abundance of species via death of discarded species. Also by other flow-on effects from removal or translocation of individuals such as changes to feeding opportunities or availability of decomposing organic matter locally or changes to connectivity or predation processes.
Contact without capture	By direct physical damage or disturbance to seabed habitats and species. Also via effects such as behavioural disturbance, provisioning or translocation. Also by altering the vertical relief of seabed features, increasing turbidity and/or redistributing sediments.
Travel to/from grounds	Fishing boats may be vectors for the introduction or translocation of species

OVERALL PATTERN OF RISK



Colour key:

- high
- intermediate-high
- intermediate
- intermediate-low
- low

4.7. Comparison of risks at different levels of trawl fishing effort

Comparison of risk patterns based on two different levels of trawl fishing effort revealed an overall decrease in risk for 2009 (relatively low effort) compared to 2005 (higher but still allowable effort level under management arrangements at the time of the assessment). Specifically, four of the five comparisons showed lower risk in 2009, and habitats showed the same low overall risk in both years. The same pattern of reduced risk was found for most individual species and habitat types assessed, and no species or habitat types had an increased risk over this period.

The key driver for this reduction in risk was lower fishing effort levels. In 2009, total trawl fishing effort in the Great Barrier Reef Region was more than 40 per cent lower than in 2005, predominantly in response to less favourable economic circumstances. This finding is important and confirms lower fishing effort levels result in lower ecological risks and impacts from trawling and that under current practices and effort levels overall ecological risks from trawling in the Great Barrier Reef Region are relatively low.

In summary, the key findings from the assessment were:

- Under current practices and trawl fishing effort levels (which are less than half those of the maximum in 1997), overall ecological risks from trawling in the Great Barrier Reef Region are relatively low, with most species, habitat types, species assemblages and ecosystem processes at low or intermediate-low risk from the Fishery.
- Some remaining ecological risks posed by the otter trawl fishery were identified. In particular, high risks were identified for 11 species of skates and rays, two species of sea snakes, a poorly known deepwater seabed habitat (90 to 300 m depth) referred to as 'Habitat 10' in the southern Great Barrier Reef and the plant and animal communities occurring there. The by-product species Balmain bugs were at intermediate-high risk.
- The overall ecological risk profile of the East Coast Otter Trawl Fishery was lower in 2009 compared to 2005 as a result of a substantial reduction in trawl fishing effort over this period and fewer active boats in response to less favourable economic circumstances.
- Many of the identified risks could potentially be further reduced through targeted improvements in areas such as effort management and by-catch reduction.
- The protection afforded to the Great Barrier Reef Marine Park through zoning significantly contributed to the relatively low ecological risks from the Fishery.

The assessment also recognised that many positive steps have been, and are being, taken by trawl fishers to reduce the pressure on the species, seabed communities and habitats of the Great Barrier Reef. For example, the use of turtle excluder devices (TEDs) throughout the Fishery has reduced impacts on loggerhead turtles and other large animals such as sharks.

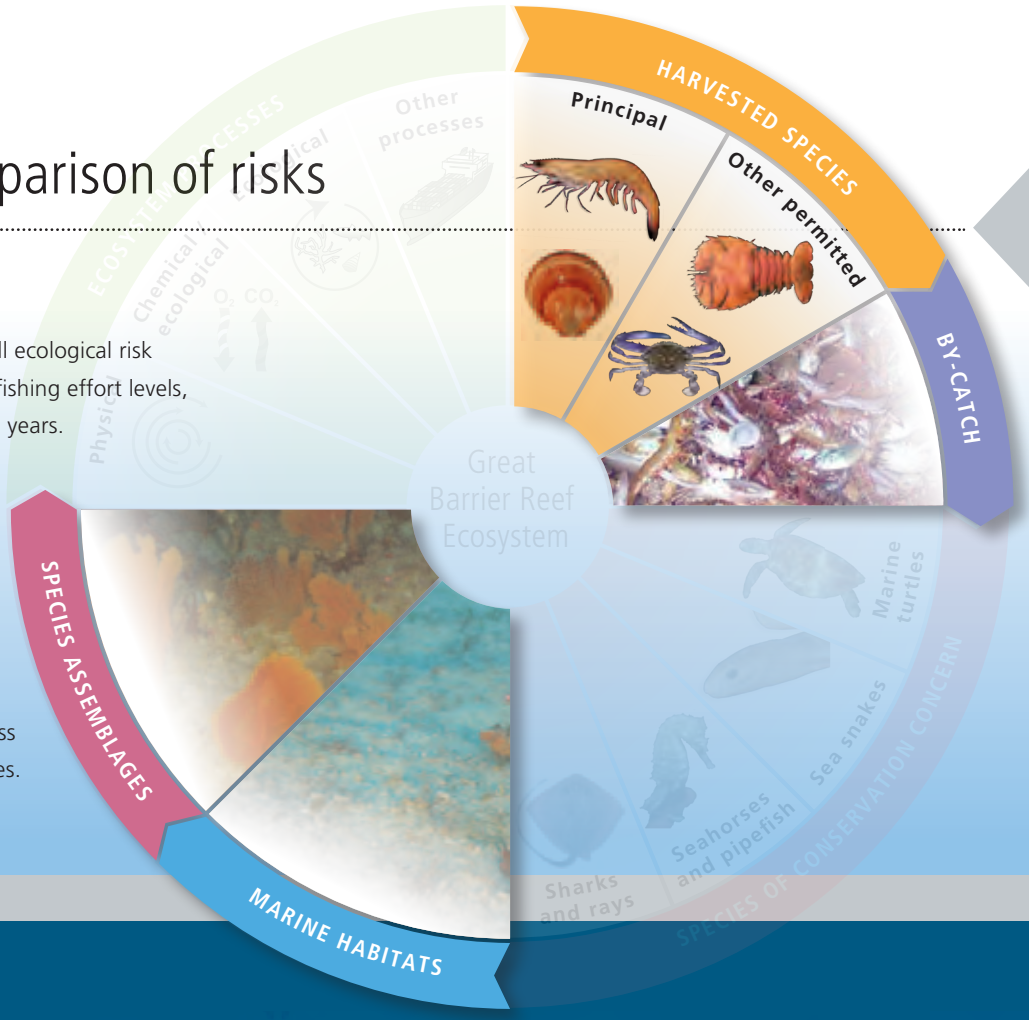
Summary: Comparison of risks

Key facts

What was compared: The overall ecological risk pattern for 2009 and 2005 trawl fishing effort levels, where data was available for both years.

Ecological relevance: Trawl fishing effort is a key driver of ecological risk

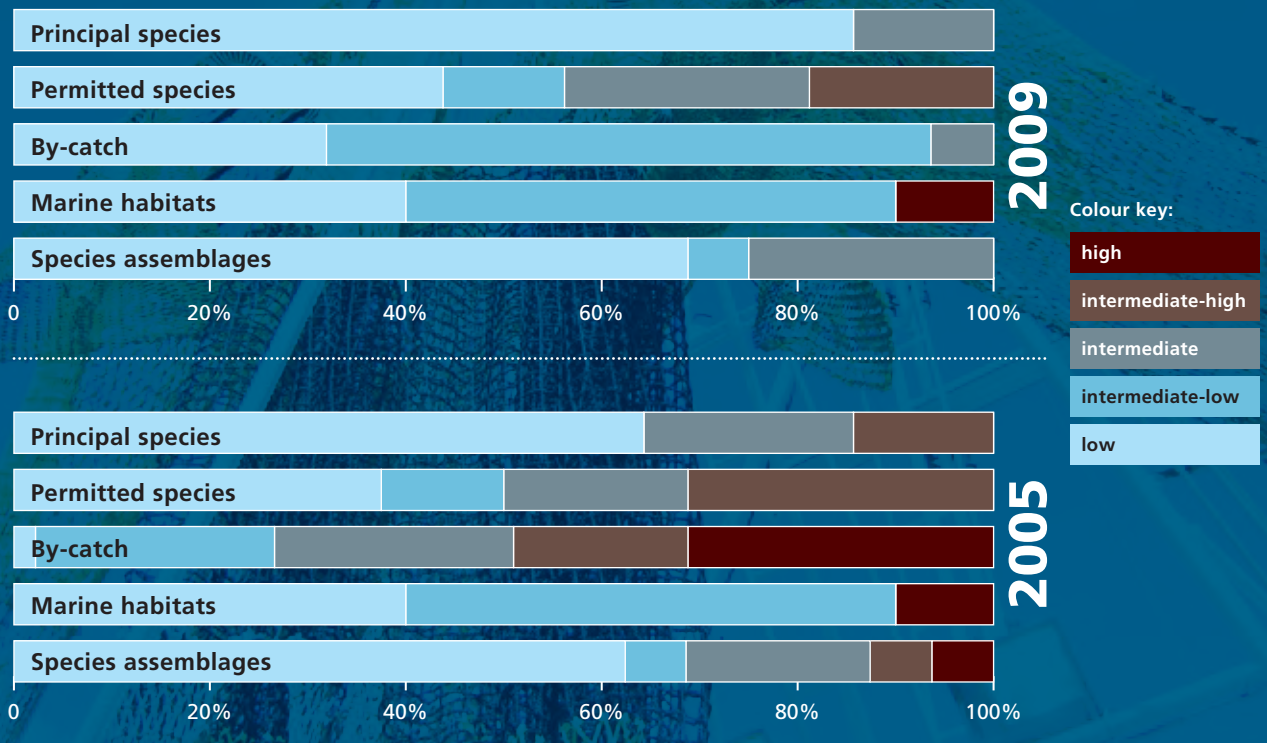
Trawl fishery: The total annual trawl fishing effort in 2009 was over 40 per cent lower than in 2005, principally in response to less favourable economic circumstances.



RISK ASSESSMENT FOR THE GREAT BARRIER REEF REGION

The overall risk pattern based on 2009 levels of trawl fishing effort (top) was much lower than for the higher (but still allowable) 2005 levels of effort (bottom).

RISK PATTERN FOR 2009 COMPARED TO 2005



5. Discussion and Implications

The current ecological risks from trawling in the Great Barrier Reef Region are generally low. Remaining high risks to a few species and a deepwater habitat type were identified. Logbook data show that trawl fishing effort has remained at similar levels over the last five years (2007 to 2011, Figure 11). At the time of writing (2012) therefore, the ecological risks to species and habitats are likely to be similar to the assessment findings reported herein and it is unlikely overall ecological risks from the Fishery have changed in this time period.

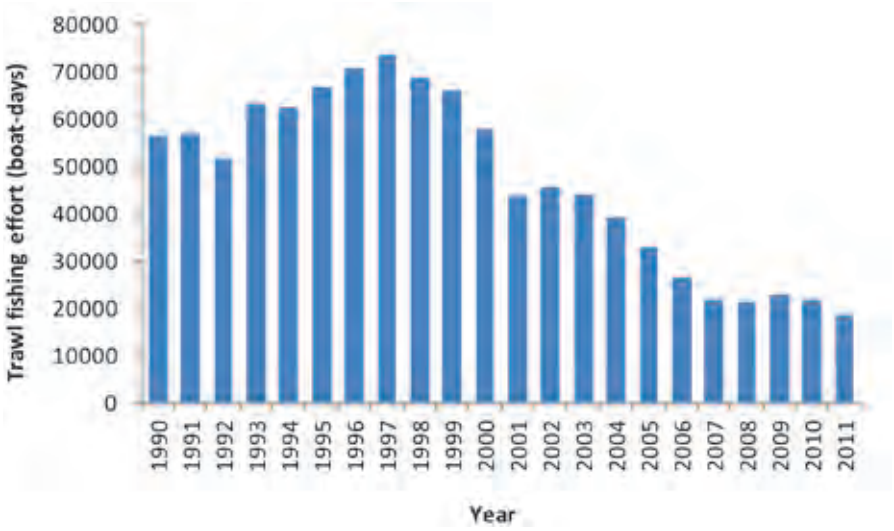


Figure 11. Annual trawl fishing effort levels for the Great Barrier Reef Region from 1990 to 2011 based on fisher logbook records.

The risks and impacts from trawling have been reduced over the last decade or more. Reductions in total annual trawl fishing effort, the use of TEDs and BRDs throughout the Fishery, increased selectivity of trawl gear and changes to the zoning arrangements have been among the most important drivers of reductions in ecological risks across the Fishery. Nevertheless, the Fishery is diverse and while some of the remaining ecological risks were found to be fishery-wide, others are specific to fishery sectors. For example, all sectors interact with one or more of the sharks and rays that were assessed as being at high risk and the red-spot king prawn sector accounted for most of the incidental trawl fishing mortality for sea snakes.

Potential risk mitigation strategies should be considered for the Fishery as a whole and for each of the fishery sectors where relevant. They may include preventing effort from rising to unacceptable levels, ensuring compliance with rules, supporting research to address knowledge gaps, optimising the use of current BRDs, improving BRD design, developing ways to improve post-trawl survival rates or other initiatives to reduce by-catch and interactions with protected species, and supporting measures that discourage targeting and limit the total harvest of other permitted (by-product) species.

The key management 'lever' in the current fishery management plan is effort control, limiting the amount of fishing effort (rather than the catch) on an annual basis. Currently, however, there are surplus effort units in the Fishery: approximately 40 per cent of the effort units available to the Fishery in 2009 were not used; and the amount of effort actually used that year was about half that allowed under the trawl effort cap for the Great Barrier Reef World Heritage Area. Such a significant surplus effort capacity reduces the influence of the effort unit as a management tool. In turn, the potential for fishing effort to rise substantially means that the ecological risks from trawling to the Great Barrier Reef Region may also rise in the future.

The Queensland Government is currently reviewing the management arrangements for the Fishery. Ensuring the results of this risk assessment are incorporated into the current review of management arrangements

These four species of sea snakes were assessed as at high or intermediate risk from trawling in the Great Barrier Reef Region. *Picture credit: Courtney et al. 2010*

is a clear pathway to the development of appropriate solutions for the future management of effort in the Fishery as a key driver of ecological risk.

It is encouraging to see a number of fishers have voluntarily adopted fishing practices that result in lower impacts on the environment, and several initiatives are under way or planned with industry to encourage further uptake of best practice across the Fishery. For example, new prawn trawling otter boards designed and adopted by some fishers reduce physical impacts on the seabed and also reduce towing resistance and fuel usage. Additionally, many fishers have been actively working with DAFF Queensland to trial and improve BRDs, and this work is helping to inform the optimum selection of BRDs for different sectors of the Fishery.

This ecological risk assessment has reinforced the need to further improve by-catch reduction, with a high priority being given to further reducing catch rates of sea snakes and smaller individuals of sharks and rays. Substantial funding from the Queensland Government as part of its commitment to 'Taking bycatch off our beaches' has allowed the commercial fishing industry to reduce its by-catch and its impact on the marine environment. More, however, remains to be done in this area.

Ongoing work, including fishery observer programs, improved reporting via logbooks and efforts to reduce remaining risks for species of conservation concern, is important for effective management of the Fishery, for any future re-evaluation of ecological risks and for public confidence in the sustainability of the Fishery.

Trawl fishing is just one of the sources of risk to the Great Barrier Reef ecosystem. Continuing to take positive actions to further improve the Fishery's management and fishing practices is important for maintaining the resilience of the Great Barrier Reef, for which the overall outlook has recently been assessed as poor, in the light of serious threats, especially from climate change (GBRMPA 2009).

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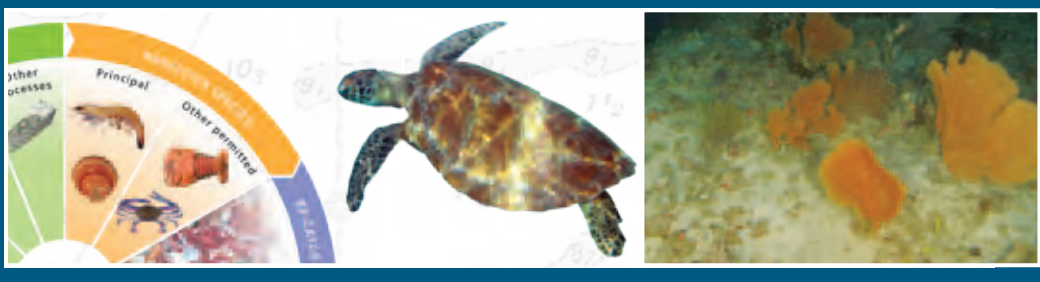

This ecological risk assessment is available at www.gbrmpa.gov.au