

Line Fishing

on the Great Barrier Reef

CURRENT STATE OF KNOWLEDGE

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Coral reef fish are caught by hook and line along the length of the Great Barrier Reef from the Torres Strait south to Fraser Island, and from the inshore reefs to the outer barrier reefs. The main targets for the line fishery are coral trout, red throat emperor, Spanish mackerel and red emperor.

The fish of the Great Barrier Reef are important to commercial and recreational fishers, to Indigenous people to maintain their cultural heritage, and to tourists. A great deal of research is being focused on understanding the biology of these species and the impact of fishing on them and the reef, to ensure that the reef line fishery is sustainable. The research is helping managers to balance the needs of users while maintaining the reef fish stocks and the reef ecosystem for future generations.

Fish targets

More than 125 fish species are caught in the reef line fishery, but only a few of them are targeted. These include coral trout species *Plectropomus* spp., red throat emperor *Lethrinus miniatus*, Spanish mackerel *Scomberomorus commerson*, red emperor *Lutjanus sebae* and several cod species.

Many other species are not targeted but are caught incidentally and kept by fishers. These include tropical snappers such as stripey sea perch *Lutjanus carponotatus*, hussar *Lutjanus adetti*, Moses sea perch *Lutjanus russelli*, rosy jobfish *Pristipomoides filamentosus*, gold-band snapper *Pristipomoides multidentis*, large-mouthed nannygai *Lutjanus malabaricus* and small-mouthed nannygai *Lutjanus erythropterus*. These fish are called by-product.

Other fish such as bommie cod *Cephalopholis cyanostigma* are not harvested directly but caught inadvertently by fishers and discarded or, in some cases, used for bait. These unwanted fish are called by-catch. Because of their life history characteristics, fishing may detrimentally affect these species if by-catch fish do not survive when they are discarded or, in future, if they become a target for fishers when markets change.



Red throat emperor *Lethrinus miniatus*.

Photo by Russell Reichelt

Commercial line fishing

Commercial line fishing on the Great Barrier Reef began in the 1940s. Until 1988, information about the fishery was gathered by the Queensland Fish Marketing Board from landings data. Since then, daily reporting of catch and effort became compulsory for all commercial line fishers.

The effort in the commercial reef line fishery has increased from about 23,000 primary boat fishing days in 1990 to more than 41,000 primary boat fishing days in 2001. In 2001, total landings were about 4,400 tonnes of fish.

The Gross Value of Production (GVP) is the price received by the fisher for the product at landing. In 2000, the GVP per boat in the coral reef commercial line fishery was \$42,230.

Coral trout makes up 40-45% of the total commercial harvest, with significant amounts of red throat emperor and Spanish mackerel also caught (15–20% of the total harvest each). Catches have fluctuated over the years with around 2,067 tonnes of coral trout and 862 tonne of red throat emperor landed in 2001.

Regional patterns in fishing harvest have changed between 1989 and 2000. The area between Ingham (18.5°S) and south of Mackay (at 22.5°S) remained stable and was the most productive in terms of total harvest. Harvest from the area to the north of this region doubled while harvest from the area to the south increased three-fold.

Commercial fishers must have a licence to catch and sell fish in Queensland. Since 1991, the number of commercial licences has been capped in an attempt to reduce the potential for overfishing. While no new licences can be issued, there are many licences that are currently not being used or used only some of the time in the reef line fishery. This unused potential effort is known as latent effort. If interest in the fishery increases and many of these unused licences were activated, effort in the fishery could increase further with possible detrimental effects to fish stocks. The burgeoning live fish export industry could provide an incentive for such interest.

Live fish export industry

Until 1993, all commercial catch in Australia was killed and marketed locally and internationally either as frozen fillets, frozen gilled and gutted fish, or chilled whole fish. By 2000, however, nearly half of the entire coral trout catch was exported as live food fish to overseas markets in Hong Kong and south-east Asia.

Restaurant prices in Hong Kong for premium live fish such as coral trout can reach \$A130 per kg at peak times such as the Chinese New Year. This price is reflected in the price paid to commercial line fishers in Australia so that the fishers can be paid up to three times the price for a live fish compared with the same fish sold dead.

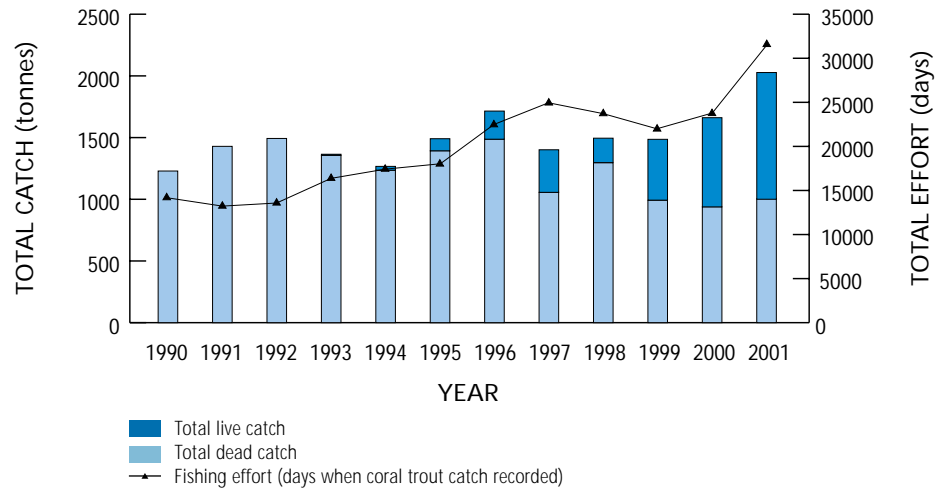
Not all fish species are suitable for the live fish trade. Coral trout are the most popular because of their red colour and robust nature. Barramundi cod, Maori wrasse and many of the groupers are also prized in the live fish markets. In contrast, red-throat emperor do not command a high price in Hong Kong.

Operators catching for the live fish trade are more selective about their catch. They prefer coral trout and avoid fish that are not marketable alive. They also prefer small legal-sized coral trout (38–45 cm) which fetch higher prices per kilogram than larger fish. Higher rates of capture and subsequent release of coral trout that are under the minimum size limit by live fishers may be a concern if post-release mortality is significant. In 2001, the Fisheries Research and Development Corporation (FRDC) formulated a National Strategy for investigating the survival of released line caught fish. This project will establish guidelines to improve the survival of released line fish.

The commercial line fishery in Queensland increased effort targeting live fish from less than 100 days in 1993 to nearly 19,200 days in 2001. This represents a transition of operators from dead to live fishing as well as a reactivation of previously unused licences. While the live fish trade represents considerable potential benefit to commercial fishers and associated local communities and a highly profitable export industry for Australia, there is some concern that this fledgling industry could lead to unsustainable

levels of fishing effort, at least at a regional level, as well as localised depletion of fish stocks. The trade in live fish has not increased individual catch rates or intrinsically changed fishing practices in the Queensland line fishery. Indeed, fishers selling their fish alive report significantly less by-product than when they were killing their catch. Therefore, the transition from frozen to live markets for reef fish may be a positive step economically and ecologically. The higher prices paid for live fish, however, are likely to provide incentive to increase effort in the fishery. Prudent management is needed to control effort and avoid stock depletions and economic hardship in the fishery.

Catch of Coral Trout



A commercial line fishing operation

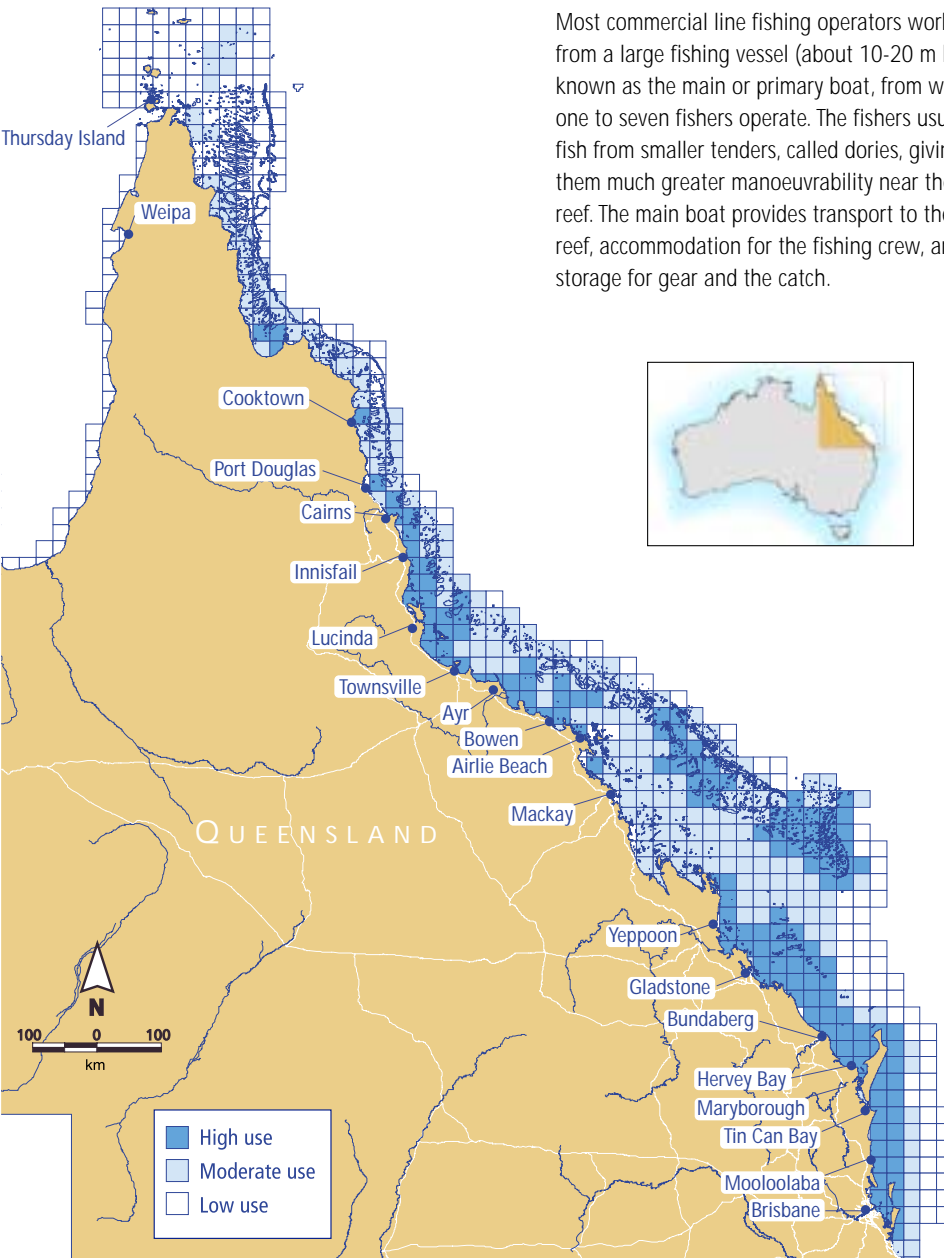
Most commercial line fishing operators work from a large fishing vessel (about 10-20 m long), known as the main or primary boat, from which one to seven fishers operate. The fishers usually fish from smaller tenders, called dories, giving them much greater manoeuvrability near the reef. The main boat provides transport to the reef, accommodation for the fishing crew, and storage for gear and the catch.

Fish not destined for the live market are killed and placed on ice in the dories. Throughout the day, the dories off-load their catch to the main boat where it is filleted or kept whole. The product is then snap frozen or chilled in a brine/ice slurry.

Fish destined for live export must remain in premium condition. When these fish are caught, the hook is removed carefully, and the fish are put in flow-through seawater tanks in the dory and later transferred to larger holding tanks on the main boat until they are off-loaded in port, several days later.

Some fishing boats that work in remote areas may not return to port for months and rely on supply ships to replenish supplies and transport their frozen catch to buyers in port. Under current Queensland legislation, live fish must be transported back to port by the fisher. All fish must be sold to a licenced fish buyer.

Coral trout exported live from Australia are freighted by air in oxygenated or aerated bins. Air freight ensures that the supply of fish to Asia is regular and reliable, and that the fish arrive in premium condition.



Location of all line fishing in Queensland as reported by Queensland commercial fishers.

Information from Fenton DM, Marshall NA. 2001. A Guide to the Fishers of Queensland. Part A. TRC-analysis and social profiles of Queensland's commercial fishing industry. CRC Reef Research Centre Technical Report No. 36.

Charter fishing

Recreational fishers often charter vessels to reach the reef. Charter fishing trips vary from single day trips to extended charters, depending on the distance to the reef and the type of passengers on board. For example, most charter trips near Cairns are day trips because the reef is close to the coast and the passengers are often overseas visitors and have limited time available for fishing. In the southern Great Barrier Reef, fishing charters are more extended because it is further from the ports to the reef and the passengers are often domestic visitors whose sole purpose for visiting the area is fishing. Permits to operate are required from both the Great Barrier Reef Marine Park Authority and the Queensland Fisheries Service, and reporting of catch and effort is compulsory for all operators.

Recreational fishing

A huge number of Queensland residents and inter-state and international visitors go fishing for pleasure. Many of these fishers target reef fish. However, information about the volume and type of catch is limited because there are no licensing or reporting requirements for recreational fishers.

Registration of recreational vessels gives some indication of the potential for off-shore reef line fishing in the recreational sector. Most of the recreational vessels in Queensland are registered in Townsville/ Thuringowa (8,581 boats, 0.06% of the population), Cairns (7,051 boats, 0.06% of the population) and Mackay (6,563 boats, 0.08% of the population). However, the highest per capita ownership is in the Ayr/ Burdekin region where 0.16% of the population have registered recreational vessels (Queensland Department of Transport). Most of these vessels are 3-4m long and because of their size, are restricted to near shore areas. Although many of the vessels may not be used for reef line fishing, recreational fishers make up a significant section of the reef line fishery.

Photo by CRC Reef



Line fishing on the Great Barrier Reef.

Recreational fishers catch mostly coral trout, red throat emperor, sweetlip and tropical snappers. In 1999, the recreational harvest of coral reef species was estimated as 2,070 tonnes from surveys of recreational fishers.

Most reef fish are caught by hook and line, although the recreational sector also includes spear fishers.

Indigenous fishing

Subsistence fishing is an important cultural lifestyle activity for Indigenous peoples. It is connected to traditional responsibilities of land and sea management. Fish are taken for food, exchange and clan obligations.

There is little information about the amount of fishing conducted on the Queensland east coast by Indigenous peoples today and how much and what they catch. The amount of Indigenous fishing is probably small compared with other sectors. The Queensland Department of Primary Industries is currently undertaking several projects to shed some light on Indigenous harvest of reef fish.

For centuries, traditional owners of sea country have managed fishing and collecting through customary law and traditions. Some communities still manage their fisheries this way, though now there is more competition for the resource.

Special fisheries and marine park management arrangements are provided for traditional owners and other Indigenous Australians. For example, traditional fishing is not subject to fish size and bag limits.

Managing line fishing on the Great Barrier Reef

Most coral reef line fishing takes place within the Great Barrier Reef Marine Park which is a multiple-use park and World Heritage Area managed by the Great Barrier Reef Marine Park Authority (GBRMPA). The GBRMPA allows and manages reasonable commercial and recreational uses in the park and, at the same time, protects and conserves the biodiversity of the region. The GBRMPA uses several tools to manage the park including a system of zones which were established under Australian Federal law to protect critical habitats as well as manage human use in the park. In some zones, fishing and other extractive activities are not permitted. In 2002, about 24% of coral reef habitats (where most reef fish are caught) are included in these zones, representing only about 4% of the total area of the park. The GBRMPA has started a process that will increase the area and number of these marine sanctuaries to ensure that the ecological processes and systems of the Great Barrier Reef are maintained. While these closures to fishing are designed to protect biodiversity rather than as a fishery management tool, they do protect spawning biomass.

Line fishing in the Great Barrier Reef, like most other fisheries off the coast of Queensland, is managed by the State of Queensland under an agreement with the Federal Government. Commercial, recreational, charter and Indigenous line fishing are managed by the Queensland Fisheries Service (QFS). The QFS imposes limits on the size of the fish allowed to be kept by all fishers. Limits on the number of fish that can be kept are imposed on recreational and charter fishers. There are also restrictions on the number of commercial fishers who are licenced to fish in Queensland, the type of gear they use, and the size and numbers of vessels they can use. Commercial and charter fishers must complete logbooks each day which are administered by the QFS and provide information about catch and effort.

Queensland fisheries management provisions are primarily enforced by the Queensland Boating and Fisheries Patrol (QBFP). The Queensland Water Police also enforce fisheries regulations under their broad powers. Both these agencies,

together with the Queensland Parks and Wildlife Service (QPWS), Coastwatch, the Australian Federal Police and the Australian Customs Service work with the GBRMPA to enforce the Great Barrier Reef Marine Park Act and Regulations. Enforcement mechanisms include vessel and aircraft surveillance, as well as inspections at ports to ensure compliance with regulations such as size limits for designated species, bag limits and numbers of dories being used.

The Australian Quarantine and Inspection Service (AQIS) monitors exports of live fish from airports in Cairns and Brisbane by carrying out random inspections of live fish bins to ensure that export volumes are accurately reported by the exporter/ wholesaler.

The science behind size limits

A major tool in fisheries management is the setting of minimum size limits to protect fish from being caught until they have spawned at least once. Fishers can only legally keep fish that are longer than the minimum size limit. This ensures that fish are protected from harvest long enough to reproduce, ensuring that there will be enough new recruits to replenish the fishery each year.

Photo by CRC Reef



CRC Reef researchers are investigating the effects of line fishing on the reef.

The life history of tropical reef fishes can complicate the setting of minimum size limits. For example, many tropical reef fishes such as coral trout and red throat emperor usually change sex during their lives. Sex change can be triggered by genetic factors such as age or size, or environmental factors such as the numbers of other males or females present at spawning sites. These responses can mean that sex change occurs to maintain the ratios of reproductive males and females in a population.

Photo by CRC Reef



Dory with main or primary boat.

Fishers usually catch the biggest fish, and therefore the oldest fish, which are more likely to have changed sex. For coral trout, these will generally be males. Therefore, fishing could change the ratio of males to females (or sex structure) in a coral trout population. Removal of too many males could mean that there are insufficient males to fertilise eggs during spawning, especially if sex change is determined genetically and not flexible in response to environmental factors. This may influence the success of reproduction and, therefore, the sustainability of the fishery in the future. To overcome this problem, implementation of maximum size limits may also be considered for some species.

Because tropical fish life histories can be so complex, managers need an intimate knowledge of the biological characteristics of fish species to decide if size limits are necessary and what minimum legal size should be set. CRC Reef researchers from the Fishing and Fisheries Project have been studying the breeding and growth of about a dozen target and non-target fish species to provide managers with this information.

The researchers have been working on three of the most abundant and prized coral trout species in the reef line fishery: common coral trout *Plectropomus leopardus*; bar-cheek trout *P. maculatus*; and blue-spot trout *P. laevis*. Currently, all three species have the same minimum size regulations. However, prior to the research, it was unclear what proportion of mature fish in each species would be protected by current size limits.

Results from the research show that for females of both common and bar-cheek trout, the current size limit of 38 cm (total length) is comparatively conservative and protects fish until they have spawned in at least one year, and possibly two. However, fewer than 5% of blue-spot females are likely to have spawned before reaching 38 cm.

For the males, there is even more variation. The size at which common coral trout and bar-cheek trout change sex to male varies; meaning that many already have changed sex to male and spawned (as a male) before reaching 38 cm. Most of the fishable stock of bar-cheek trout are male. For blue-spot trout, few if any fish have changed sex to male before reaching legal size.

The research shows that for common and bar-cheek coral trout current legal size limits adequately protect both males and mature females. However, for blue-spot trout, a minimum size limit of 38 cm may not be adequate protection for either males or females, especially in heavily fished populations. A size limit of 60 cm for blue-spot trout, as proposed in the Draft Management Plan for the Queensland Coral Reef Fin Fish Fishery, would protect the females of this species, allowing them to spawn at least once before reaching legal size. However, few fish would have changed sex to male before reaching this size.

Research has also led to a shift in thinking about other reef fish. Many reef fish were thought to live fast and die young and so be reasonably resilient to fishing pressure. But CRC Reef researchers have found that some reef fish live much longer than was once thought. For example, the bommie cod *Cephalopholis cyanostigma* lives for up to 45 years and only reaches about 30 cm long. Although bommie cod are not usually kept by fishers in Australia, they may become targets for fishing in the future if other species become less abundant or market trends change. Importantly, many of the other groupers that are popular in the Hong Kong markets are being found to have similar life histories to bommie cod and may be more susceptible to overfishing than previously thought.

The future

A management plan for Queensland line fishery is being developed by the Queensland Fisheries Service. It is aimed at ensuring that fish stocks are well protected and remain healthy enough to support valuable commercial, charter, recreational and Indigenous line fisheries into the future.

The first draft management plan for the fishery was released for public comment in 1999. A revised draft management plan was released in October 2002. Measures in the draft plan include adjustments to existing regulations such as reductions in commercial effort, reduced recreational bag limits, new size limits and total protection of some species.

An experiment to measure the effects of line fishing on fish and the reef

Closing areas of the reef to harvesting activities such as fishing is a major strategy to protect reef fish stocks. However, there is little evidence from the Great Barrier Reef that this strategy adequately protects fish stocks over the whole region.

The Effects of Line Fishing (ELF) experiment will give researchers a window into the future. It is being run by scientists from CRC Reef Research Centre and will last for 10 years, span 1,000 kilometres of the Great Barrier Reef and involve scientists, students and staff from six institutions in Australia and overseas. The researchers are experimentally increasing fishing pressure on some reefs as if they were turning the clock forward – as if there were a lot more boats, catching a lot more fish.

The results will show how fish stocks and the reef ecosystem respond to this pressure - which fish are most vulnerable to fishing and why, and whether closing reefs to fishing really protects the fish. The experiment will help separate the effects of fishing, management and natural fluctuations on fish stocks and their prey.

The experiment has already indicated that closing reefs to fishing does protect reef fish, at least in some regions. For example, there tend to be more and bigger coral trout in areas closed to fishing in the southern areas of the Great Barrier Reef but this pattern is less pronounced in northern areas of the Reef.

Using information from the experiment, the CRC Reef researchers are also developing innovative computer models that can evaluate strategies for managing fish stocks in complex environments like the Great Barrier Reef. The models can 'test-drive' different management strategies before they are implemented and determine which ones will best protect fish stocks, catch rates and the fishery.

With increasing demand for seafood both domestically and internationally, the information being supplied by the ELF experiment will help managers ensure that reef fish can be harvested sustainably into the future.

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*Other information from: Lunow CP, Bullock CL, Helmke SA. 2002. Fisheries long-term monitoring program - reef fish summary: 1999–2001. Dept Primary Industries, Queensland. 4p.
Williams LE. 2002. Queensland's fisheries resources. Current condition and recent trends 1988–2000. Dept Primary Industries, Queensland.*



Ensuring the future of the world's coral reefs

CRC Reef Research Centre Ltd is a knowledge-based partnership of coral reef researchers, managers, and industry. Its mission is to provide research solutions to protect, conserve and restore the world's coral reefs.

CRC Reef is a joint venture between:

- Association of Marine Park Tourism Operators
- Australian Institute of Marine Science
- Great Barrier Reef Marine Park Authority
- Great Barrier Reef Research Foundation
- James Cook University
- Queensland Department of Primary Industries
- Queensland Seafood Industry Association
- Sunfish Queensland Inc.

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